AN ADJUSTED MATERIAL FLOW COST ACCOUNTING FRAMEWORK FOR PROCESS WASTE-REDUCTION DECISIONS IN THE SOUTH AFRICAN BREWERY INDUSTRY

By

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DECLARATION

I declare that "**An Adjusted Material Flow Cost Accounting Framework for Process Waste-Reduction Decisions in the South African Brewery Industry"** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete reference.

2014-07-25

Signature Date

Michael Bamidele Fakoya

DEDICATION

This study is dedicated to the glory of God Almighty, the Giver of life, who made it possible for me to complete the study. I appreciate the Lord for life, grace, mercy, and faith.

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ABSTRACT

While contemporary environmental problems arise partly from increased industrial activities resulting in waste creation, the continued extraction and depletion of earth's natural resources by organisations to meet consumers' demand have led to unsustainable business practices (Jennings & Zandbergen 1995). Moreover, reversing the negative environmental impact caused by unsustainable business practices is the responsibility of the organisations whose activities cause harm to the environment (Ahuja & Khamba 2008). More importantly, managers require adequate and accurate financial and non-financial information on their unsustainable business practices to successfully manage both internal and external environmental effects of their actions (Schaltegger & Burritt 2000). But the lack of contemporary management accounting tools to capture waste information in the brewery process reduces the chance to improve waste-reduction decisions while opportunities for cost savings are also lost. Admittedly, Gale (2006:1231) argues that conventional management accounting Systems (MASs) do not have the ability to adequately monitor the increasing material costs and overheads in production processes with sufficient transparency. Nevertheless, this inability to provide adequate process waste information may likely limit organisations' effort to implement and achieve desired waste-reduction strategies. As a result, it is imperative to integrate both physical and monetary waste information for sound decision-making.

The main objective of this study is to adopt and adjust the existing MFCA framework to support and improve on managers' process waste-reduction decisions in the South African brewery industry. In order to achieve this main objective, the study:

- examines the extent to which conventional MASs provides process waste information to support waste-reduction decisions in a micro-brewery (Hope Brewery) and a large brewery (SAB Ltd);
- assesses the impact of insufficient process waste information as provided by the conventional MASs on brewery waste-reduction decisions in a micro-brewery (Hope Brewery) and a large brewery (SAB Ltd); and
- adjusts the existing MFCA framework to include waste categories subsumed or neglected in the provision of waste information to improve brewery waste-reduction decisions.

The study adopted an exploratory multiple case study approach by means of in-depth interviews and a pilot study in two breweries- a micro-brewery and a large brewery to achieve the study objectives.

Findings revealed that, while the use of technology is essential to reduce brewery process waste, there is lack of appropriate waste-capturing management accounting tool in both organisations. Besides it is essential for organisations to adopt appropriate management accounting tool to capture waste-related information for improved waste-reduction decisions and selection of appropriate waste management strategy. The study therefore suggests the adoption of an adjusted MFCA framework for a more robust approach to improve waste-reduction decisions since ‘what cannot be measured cannot be managed’.

Keywords*: Conventional Management Accounting Systems, Material Flow Cost Accounting, waste-reduction decisions, brewery, waste information, good product, and negative product.*

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CHAPTER ONE

GENERAL INTRODUCTION

1.1. INTRODUCTION

The lack of adequate measures for waste costs and the related benefits of pollution and waste prevention programs present a barrier to the full implementation of an appropriate waste reduction strategy (Tanner, Twait, Rives, & Bollman 1996). Wagner (2003a) argues that, most often, organisations, especially in the brewery industry, believe that environmental costs translates to the amount spent on end-of-pipe environmental protection and the amount spent on environmental technology, or the costs of integrated environmental protection measures. An effective approach to become a wasteless organisation, as Van Berkel (2005) suggests, should be based on problem solving and helping the organisation understand the cost implications on the organisation when waste is generated. According to the International Federation of Accountants Committee's Guidance Document on Environmental Management Accounting, a successful approach to assess an organisation's costs correctly is to collect both physical and monetary data on material usage, personnel hours and other costs drivers (IFAC 2005:20). This might ensure a focused transition to a more sustainable waste management system that is dependent on finding practical ways for organisations to minimise and possibly eliminate their waste generation (MacDonald 2005), thereby reducing both environmental impact and cost at the same time.

In South Africa, attempts by breweries to reduce process waste have been technologically driven, such as improving water efficiency without an appropriate waste cost capturing tool to support technological innovations (SAB Ltd 2012; WWF 2012). As such, efforts to reduce brewery process waste, both in quantity and costs may have been thwarted because of insufficient and inadequate material flow cost information (Jasch 2008). While there are a substantial number of studies on the environmental impact of breweries, especially in Europe and Asia (METI 2007; Jasch 2009; Kokubu, Campos, Furukawa & Tachikawa 2009; Schaltegger, Viere & Zvezdov 2012), the majority of these studies focused mainly on large-sized and medium-sized organisations (METI 2007; Jasch 2009; Kokubu *et al.* 2009; Onishi, Kokubu. & Nakajima 2009; Hyršlová, Vágner & Palásek 2011).

This study examines previous work on the adoption of Environmental Management Accounting (EMA) tools such as material flow cost accounting (MFCA) in capturing brewery environmental costs to enable brewery managers in South Africa to improve waste-reduction decisions. Researchers have shown that the adoption of the MFCA framework is more relevant in providing both financial and non-financial waste information that is necessary for improved waste-reduction decisions (Wagner 2003a; METI 2007; Jasch 2009).

This study assesses the use of the conventional Management Accounting Systems (MASs), recommends the adoption of the MFCA framework especially at a micro level but also in a large brewery in South Africa and specifically adjusts the existing MFCA framework for the brewery industry in South Africa. Using a case study research method and conducting a pilot study in a micro-brewery, the researcher demonstrates how the existing MFCA framework can be adapted for the capturing and generation of sufficient and adequate waste cost information to support and improve waste-reduction decisions. A case study using the in-depth interview approach for data collection was used in the large brewery.

This study makes several advances on prior literature. First, an adjustment is made to current MFCA framework by integrating identified waste-related costs that have been exempted from the general MFCA framework thereby contributing to existing literature on this subject. Second, the study adopts and tests the MFCA framework through a pilot study in a micro-brewery in South Africa. Indeed there is no existing literature of any study that has adopted the MFCA framework to an owner-managed small business especially in South Africa. Also, the study conducts case studies in both a micro-brewery and a large brewery in South Africa to demonstrate the usefulness of the MFCA framework to improve waste-reduction decisions. Lastly, a significant contribution of the study to knowledge and practice is the demonstration of the potential to adopt the MFCA framework under different organisational circumstances that generally do not support systematically structured management systems.

1.1.1 Goal of this chapter

This chapter introduces the background to the problem being researched in this thesis and provides the problem statement undertaken in this research. An outline of the research methodology used in this study is given which includes the survey of relevant literature and case studies that used a qualitative in-depth interview approach to collect data.

1.1.2 Layout of this chapter

Following this introduction, the background of the research problem is discussed in Section 1.2. The brewery industry is reflected on in Section 1.3, followed by a statement of the researched problem in Section 1.4. The research objectives are presented in Section 1.5 followed by the research questions addressed in this study in Section 1.6. The scope and delineation of the study are discussed in Section 1.7. The importance and possible beneficiaries of the outcome of this research are specified in Section 1.8. In Section 1.9, the research methods used in the study are presented, while the ethical requirements for the study are the topic of Section 1.10. In Section 1.11, the definition of terms employed in this work is presented. A layout of the thesis is presented in Section 1.12, and a conclusion to Chapter One is presented in Section 1.13. This layout is represented in Figure 1.1.

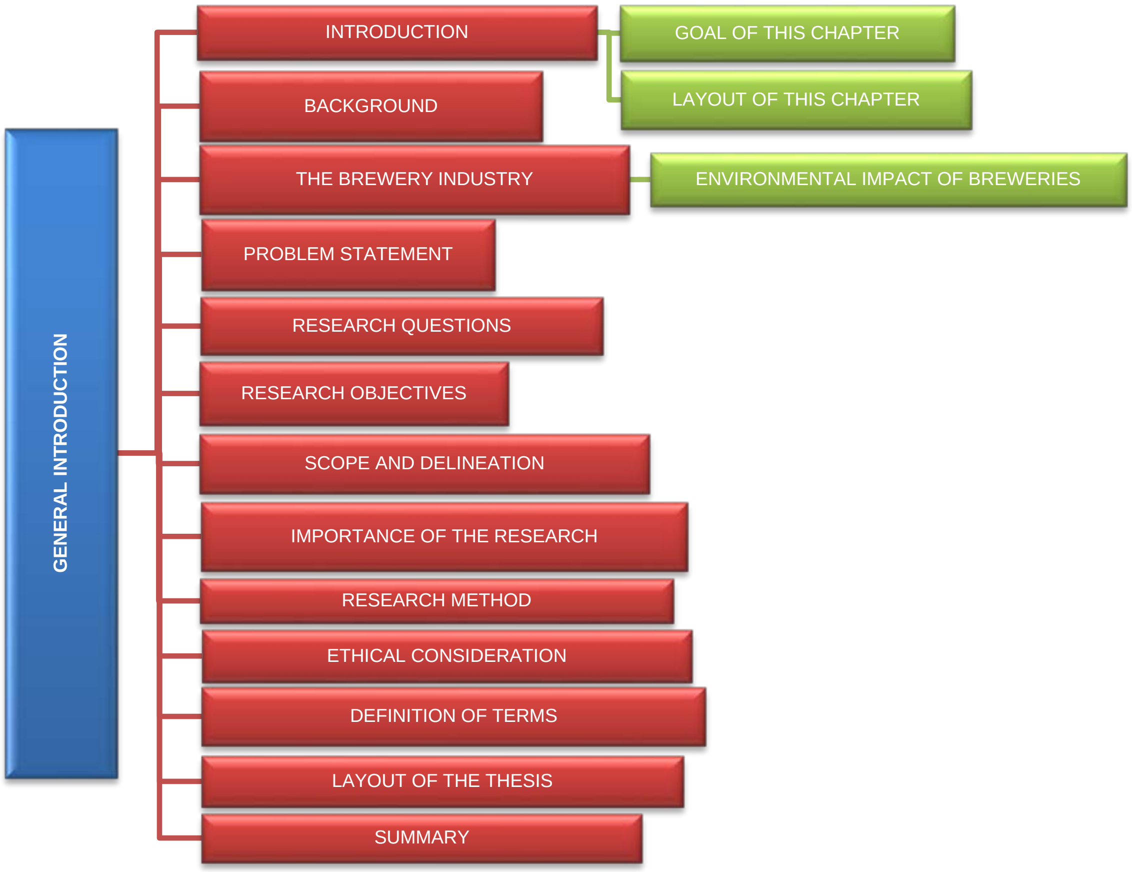


Figure 1.1: A visual representation of the layout of Chapter 1

1.2. BACKGROUND

The global society is experiencing serious environmental problems and it is widely believed that industrial waste contributes to contemporary environmental problems (Rosen 2012:113). As such, this study argues that waste-reduction decisions and waste-information tools may have become imperative to assist in alleviating environmental problems. It is plausible that the lack of a proper waste information capturing tool have limited the opportunity for process waste-reduction and contributed to the volume of waste that results from manufacturing processes. A large volume of waste occurs due to inefficiencies in production from the input stage, through the production process to the output stage (Jasch 2009). However, financial managers have a responsibility to ensure that appropriate process waste information is made available to responsible managers for sound waste-reduction decisions (Darlington, Staikos & Rahimifard 2009:1275). The process waste-reduction option is the beginning-of-pipe rather than the end-of-pipe approach (Tuttle & Heap

2007:101). They continue to say that the beginning-of-pipe approach attempts to limit the creation of process waste at the input stage and throughout the whole production process in order to avoid excessive waste-treatment costs, disposal costs, and negative impact of waste sites to the environment. In contrast, the end-of-pipe approach is the treatment of output waste to reduce its hazardous content for safe disposal to waste sites (Zotter 2004:686). Hence, there may be a need for the implementation and adjustment of the current MFCA waste information system to assist brewery managers in waste-reduction decisions.

An objective of process waste-reduction from an environmental point of view is to eliminate inefficiency in resource usage throughout the whole production process (Gray & Bebbington 2001:143; Schiliephake, Stevens & Clay 2009:1258). Process waste-reduction decisions in most organisations have focused on waste treatment and disposal and on compliance with environmental legislations (Gray & Bebbington 2001:140; Ahuja & Khamba 2008:710; Janhoma, Wattanachiraa & Pavasant 2009:1185; Massoud, Fayad, Kamleh & El-Fadel 2010: 1885; SAB Limited 2012). The challenge to improve process waste-reduction decisions means that many opportunities for reducing process waste costs and improving environmental performance might have been lost. Resistance to environmental regulations is strong amongst organisations due to the costs involved in adhering to these regulations (Darnall, Henriques & Sadorsky 2010:1072). Organisations currently adhering to environmental regulations attest that if a proper process waste-reduction decisions tool is effectively applied, it will result in cost reductions and increased profitability (Canon 2011). It may be possible that, by adopting the MFCA waste information system, breweries will be able to reduce environmental costs and increase profitability.

1.3. THE BREWERY INDUSTRY

Beer is an alcoholic beverage made from fermented cereal grains, usually but not only barley, and typically has an alcohol content of 12g of ethanol (Nielsen & Gronbaek 2008:1109). According to Nelson (2005:6), beer was first made in Egypt, Africa, where it became a common drink for a long time. However, Nelson (2005:3) argues that a brewed malt beverage made with hops originated in Europe. Nelson maintains that both the technique of brewing beer and that of adding hops to beer are purely European innovations. He explains that ancient Egypt had massive breweries with up to forty per cent of their grain stores given over to beer production. Moreover, beer formed part of the Egyptian currency, paid as wages each day to skilled workers on the building of the Egyptian pyramids. This made beer a vital commodity in ancient Egypt as it was used as a means of payment (Nelson 2005).

According to Hornsey (2003:64), artistic evidence indicates that brewing in ancient Egypt was regarded as a domestic chore done mostly by women. Nelson (2005:9) is of the opinion that the history of beer, like any other alcoholic beverage, is shrouded in mystery. He contends that beer's history goes back a long time before humans began to write down their experiences. Nelson (2005:10) maintains that the history of beer is unfortunately irrecoverable since the first evidence of record of production came after the development of agriculture. As such, there might not have been proper references to the actual beginning of beer production.

In South Africa, the history of beer dates back to the early 20th century. Beer production in South Africa has had two main influences on its economic development (SAB Ltd 2012). European settlers who colonised the country brought with them expertise and the know-how in brewing (SAB Ltd 2012). These include the Dutch immigrants in the 1650s, and British immigrants during the 19th and 20th centuries had both contributed in different ways to the knowledge of beer production (SAB Ltd 2012). Since that time, beer production has become an integral part of South Africa's economic growth and development (DEA 2010a; SAB Ltd 2012); however, its production generates a lot of solid wastes and wastewater resulting in negative environmental performance (SAWIC 2010).

The South African Breweries Limited (SAB Ltd) was first registered on the London Stock Exchange in 1895 and the Johannesburg Stock Exchange (JSE) in 1897 (SAB Ltd 2012). This marked the beginning of commercial brewing in South Africa. The beer industry is one of the biggest sources of food processing wastes worldwide, generating more than 300 000 tons of spent grain annually in South Africa alone (ScienceScope 2008:24). Brewery solid waste includes spent grains, trub or slurry, spent yeast, diatomaceous earth slurry from filtration and packing materials

(Parawira, Kudita, Nyandoroh & Zvauya 2005). Waste is considered an environmental problem (Vukina 2003); reducing or eliminating it may become an opportunity to increase profits (Russo & Fouts 1997) if all waste-related costs are appropriately captured and documented through a Management Accounting waste information system.

1.3.1. Environmental impact of breweries

Brewery waste is generated throughout the whole production process, from input to output (Fillaudeau, Blanpain-Avet & Daufin 2006). Since brewing is an integral part of economic growth and development in South Africa, it contributes about 3.1% of its annual Gross Domestic Product (GDP), however, it also generates a lot of solid waste and wastewater contributing to the industry's negative environmental performance (SAWIC 2010; SAB LTD 2012). In South Africa, brewing generates more than 300 000 tons of spent grain annually (DEA 2010a). Environmental issues associated with brewing include energy consumption, water consumption, wastewater discharges, solid waste, and carbon emissions. Energy consumption in brewery processes is relatively intensive in terms of both electrical and thermal energy (Rivera González, Carrillo & Martínez. 2009). Specific energy consumption in a brewery is influenced by the process design and utility system, which can vary from 100-200 mega joules per hectolitre (MJ/hl), depending on size and sophistication (IFC 2007).

The brewing process also involves high consumption of good-quality water, which is a scarce resource in South Africa (WWF 2012). Much water is used in the brewing process for heating and cooling; packaging cleaning; production equipment; cleaning of delivery vehicles; sanitation; and general house-keeping (European Commission, 2006). Water consumption in beer production takes between 4-7 litres (*l*) to make 1 litre of beer (Midžić-Kurtagić, Silajdžić & Kupusović 2010). The brewing process also generates a lot of liquid waste due to weak wort and residual beer (Fillaudeau *et al.* 2006; IFC 2007). The main source of residual beer is found in process tanks, diatomaceous earth filters, pipes, beer rejected in packaging area, returned beer, and breakages in packaging area (The Brewers of Europe 2002). Solid waste in beer production results in a variety of residues such as spent grains, which can be sold at a value to local farmers. Odour and dust are also considered the most significant air emissions from breweries. The wort boiling process is the main source of odour emissions from a brewery, while the use and storage of grains, sugar, and kieselguhr are sources of dust emissions (IFC 2007). Brewery process waste is considered a good source of nutrients in livestock farming while at the same time; it is a potentially harmful environmental pollutant (Fillaudeau *et al.* 2006). Therefore, there might be a need for an appropriate tool to measure the quantity of brewery waste to enable managers make improved decisions.

1.4. PROBLEM STATEMENT

The continued extraction and depletion of earth's natural resources by organisations have led to unsustainable business practices (Jennings & Zandbergen 1995). Reversing the negative environmental impact caused by unsustainable business practices is the responsibility of the organisations whose activities causes harm to the environment (Ahuja & Khamba 2008). Civil societies and governments are pressurising organisations to redress their unsustainable business practices by reducing the negative impacts caused by their actions so as to preserve the natural environment (Aguilera, Rupp, Williams & Ganapathi 2007). Managers require adequate and accurate financial and non-financial information on their unsustainable business practices to successfully manage both internal and external environmental effects of their actions (Schaltegger & Burritt 2000). Gale (2006:1231) argues that the conventional MAS do not have the ability to adequately monitor the increasing material costs and overheads in production processes with sufficient transparency. This inability to provide adequate process waste information will make it difficult for organisations to keep accurate waste records. As a result, it is important to integrate both the physical quantity and cost information of process waste for sound decision-making. It is, therefore, essential that managers use an appropriate EMA tool to generate adequate environmentally-related data on material flow, energy, and systems costs that will enable managers improve on their waste-reduction decisions and adopt appropriate environmental management strategy (Wagner 2003a). Peat (2007) notes that many accounting practitioners have been more comfortable dealing with readily quantifiable information and have therefore handled environmentally related information with reluctance. Dascalu, Caraiani, Lungu, Colceag and Guse (2010) reiterate that accounting practitioners have an environmental responsibility to provide managers with both financial and non-financial environmental information necessary to improve environmental decisions.

Many organisations have yet to fully embrace environmental accounting, which requires that conventional accounting systems undergo and incorporate environmental changes to their costing system (Gray, Bebbington & Walters 1993; da Silva Monteiro & Aibar-Guzmán 2010; Barquet, Cunha, Oliveira & Rozenfeld 2011). The slow pace of incorporating environmentally-related impacts in corporate annual reports through the conventional MAS has limited managers' opportunity to make informed waste-reduction decisions because of the lack of appropriate and adequate waste information (Fritsche, Jonas, Kayser & Koranyi 2010). The conventional MASs has a responsibility to provide managers with waste information to improve waste-reduction decisions thereby reducing the level of environmental devastation (Cardinaels & Veen-Dirks 2010). This is necessary since activities within the organisation affect both the internal and external business environment (Wong, Boon-Itt & Wong 2011). In South Africa, the King III Code on Sustainability Reporting is a requirement for listing on the Johannesburg Stock Exchange (JSE) which stipulates that organisations report their environmental, social, and economic activities annually to stakeholders in Integrated Reports (IOD 2009).

The growing concerns about the negative impact which organisations' activities have imposed on the natural environment require that the conventional MAS identifies and assess organisations' environmental impact in a more accurate manner (IOD 2009). The problem arises in arriving at sound waste-reduction decisions most often when environmental costs are inappropriately hidden in overhead accounts (Jasch 2003:78). This may indicate that inaccurate environmental or waste cost information could have been used by decision-makers to make waste-reduction decisions in the past. Jasch and Schnitzer (2002:6) contend that the waste generated by organisations impacts on both costs and the environment in several ways such as lost income through a combination of lost materials and disposal costs. However, certain barriers exist to limit organisations' quest to achieve and implement a successful waste-reduction strategy. These barriers are oftentimes related to administrative preferences for different information needs (Allen 1996:55).

Invariably, different managers prefer certain other sources of information to others to the effect that all available information sources are not fully exploited (Allen 1996).

Some managers regard accounting information as limited to generating financial statements and the preparation of budgets, but not useful to environmental issues (Jasch 2003: 668). Decision-makers often wait to assess waste information at the end of a batch before initiating corrective measures (Jasch 2009). This might have led to substantial losses occurring which could have been prevented if a more waste specific waste data capturing tool had been applied to provide waste information (Jasch 2003). The use of the conventional MAS is insufficient to provide adequate waste information since it ignores vital process waste related costs hidden in overhead accounts (Nakajima 2003).

Consequently, MFCA, a contemporary EMA tool was developed to provide both financial and non-financial waste information necessary to improve process waste-reduction decisions (Kokubu *et al.* 2009). While MFCA-related research and case studies have been conducted in European countries like Japan, Germany, and Austria (Jasch 2003; Nakajima 2003); this study seeks to replicate this trend in the South African brewery industry. Extending the applicability of MFCA to support process waste-reduction decisions in South Africa remains almost unexplored according to the researcher. The focus of this study is to extend the adoption and to adjust the MFCA framework for use in the brewery industry of South Africa which generates a lot of waste especially wastewater considering that brewing consumes a lot of clean water in beer production which is also a very scarce resource in South Africa (WWF 2012).

This study therefore seeks to adjust the existing MFCA framework for use in the brewery industry in South Africa through case studies in a micro-brewery (Hope Brewery) and a large brewery (SAB Ltd). In addition, the study seeks to contribute to practice, knowledge and literature by focusing on the South African brewery industry on the importance of adopting the MFCA framework and also to adjust the existing MFCA framework to include and separate important waste components either neglected or subsumed to improve waste-reduction decisions in the South African brewery industry.

1.5. RESEARCH QUESTIONS

The following research questions were designed to aid in resolving the research problem stated above.

- To what extent do the conventional MASs provide process waste information to support waste-reduction decisions in the South African brewery industry?
- Why is the process waste information provided by the conventional MASs insufficient to improve brewery waste-reduction decisions?
- How can the MFCA framework be improved and adjusted to provide sufficient process waste information to improve brewery waste-reduction decisions?

The answers to these research questions will provide the current reality of capturing waste cost information among organisations within the brewery industry. It will indicate whether the current conventional MASs provide adequate waste information necessary to support sound waste-reduction decisions. This will lead to the adjustment of the current MFCA framework to support waste-reduction decisions in the South African brewery industry to provide adequate and accurate process waste information.

1.6. RESEARCH OBJECTIVES

The main objective of this study is to adopt and adjust the existing waste specific accounting framework (MFCA) to support process waste-reduction decisions in the South African brewery industry. In order to achieve this objective, the study sought to:

- examine the extent to which the conventional MASs provide process waste information to support waste-reduction decisions in a micro-brewery (Hope Brewery) and a large brewery (SAB Ltd).
- assess the impact of insufficient process waste information as provided by the conventional MASs on brewery waste-reduction decisions in a micro-brewery (Hope Brewery) and a large brewery (SAB Ltd).
- adjust the existing MFCA framework to include waste categories subsumed or neglected in the provision of waste information to improve waste-reduction decisions.

By achieving these objectives, this study would contribute to the existing process waste-reduction literature by encouraging and promoting the use of the adjusted Management Accounting Waste Information System (AMFCA) to support waste-reduction decisions in the South African brewery industry.

1.7. SCOPE AND DELINEATION

The capturing of relevant and adequate waste cost information to improve brewery process waste-reduction decisions in the South African brewery industry are the central concept of this study. The brewery industry in South Africa was chosen since the brewing process involves high consumption of good-quality water which is a scarce resource in South Africa (Momba, Malakate & Theron 2006:289; WWF 2012). Also, the brewery processes generates a lot of liquid waste such as the weak wort and residual beer (Fillaudeau *et al.* 2006; IFC 2007). Water is used for the production, heating and cooling, cleaning packaging vessels, production machinery, cleaning of delivery vehicles, and sanitation (European Commission (EC) 2006; Fillaudeau *et al.* 2006). Water consumption in beer production takes between 4-7 litres (*l*) to produce 1 litre of beer (EC 2006). Solid waste and by-products in beer production result in a variety of residues such as spent grains, while odour and dust are considered the most significant air emissions from breweries. The vast majority of waste from breweries is organic (Fillaudeau *et al.* 2006). As such, breweries in South Africa need to make concerted efforts to reduce the environmental impact of beer not only in the way it is packaged, but in the entire brewing process (Parawira *et al.* 2005), including a reduction in emissions from transporting the end product to waste treatment sites.

However, in order to properly interpret the findings and results of this study, certain assumptions and delineations have been made. These are discussed below:

- The research was primarily exploratory and descriptive. The study sample was limited to two breweries, namely, a micro-brewery and a large brewery. A combination of the two breweries is equal to 98 per cent of the total market share of beer consumption in South Africa. For this reason, care should be exercised in generalising the findings to other breweries because of their individual uniqueness;

- Access associated with the collection of qualitative data limited the number and choice of breweries for the case study and interview. Six breweries were approached before access was granted by these two to participate (see Appendix E);
- Although, assumptions made in this study's theoretical perspective might have led to the possibility of inferring a causal relationship, an empirical test was made through a case study in the micro-brewery, since MFCA may be considered a new concept in the South African brewery industry; and
- Other factors that could affect the interpretations of the findings of this study, on what the potential benefits of using MFCA as a tool to improve brewery process waste-reduction decisions, may be the inherent subjectivity likely to emerge from the interview data.

The scope of this study has been limited to these two breweries since it reflects a logical balance among the participants in the brewery industry in terms of relevance and size.

1.8. IMPORTANCE OF THE RESEARCH

This study contributes to both knowledge and practice. It contributes to knowledge by adding to existing literature the adoption of a waste-specific accounting tool like MFCA to capture accurate and relevant waste-related cost information within the South African brewery industry. It contributes to practice by adjusting the existing MFCA Waste Information framework to include major waste-related costs that is either subsumed or neglected in the current framework to improve process waste-reduction decisions in the South African brewery. The study provides an understanding of whether the existing conventional MAS in the South African brewery industry specifically separates, identifies and measures brewery process waste; identifies weaknesses in the existing conventional MAS used by breweries in South Africa for process waste-reduction decisions; extends the use of the MFCA framework to the South African brewery industry; and suggests the potential benefits of the MFCA framework to provide process waste-related information for improved brewery process waste-reduction decisions.

1.9. RESEARCH METHOD

The first step in conducting this study was the review of relevant literature to explore similar work of other researchers relevant to this study in order to understand their approach, arguments and conclusions. Other information was sourced from participating organisations' websites and from relevant literature in order to establish the knowledge gap that this study intended to fill. The study develops an adjusted MFCA Waste Information System to support and improve process waste-reduction decisions in the South African brewery industry by examining the extent and insufficiency of the existing conventional MAS and MFCA to provide waste-cost information. To achieve these objectives, the use of an exploratory study, which followed a qualitative case study approach, was adopted. A case study approach based on a constructive paradigm allows a close collaboration between the researcher and the participant, while enabling participants to tell their stories (Crabtree & Miller 1999:294). The approach enables a researcher to understand the participants' actions better; since participants are able to describe their views of reality when they tell their stories (Lather 1992:88). To enable the researcher to explore differences within and between cases and to replicate findings across cases, a case study and an in-depth interview design were chosen (Yin 2003; Baxter & Jack 2008:550).

A pilot study was done where an analysis of the current MAS of Hope Brewery and the MFCA framework was thereafter employed for a period of six months to be able to establish the shortcomings and benefits of the framework in the brewery industry. This was followed by case studies in two breweries of which Hope Brewery was one, within South Africa using face-to-face interviews. To this end, ethical clearance was obtained from the departmental ethics committee of the Department of Management Accounting, to conduct these interviews. The letter of research ethical clearance is presented in Appendix E. In-depth interviews were conducted in the micro-brewery with the brewery manager who also doubled as the brew master. In the large brewery, interviews were conducted with key individuals with managerial functions of both brew master and financial planner, so as to understand the existing MAS to capture brewery process waste information to improve waste-reduction decisions. To adjust the existing MFCA Waste Information System to support process waste-reduction decisions in the South African brewery industry, an analysis of the findings of the existing conventional MAS from the interviews was integrated into MFCA for improved brewery process waste-reduction decisions.

In view of the scarcity of research on MFCA for improving brewery process waste-reduction decisions in South Africa, that is, according to the literature review done by the researcher, this study sought to extend the scope of process waste costs to include all resources such as materials, energy and systems costs consumed during production and all waste-related information to improve current MFCA waste calculations.

1.10. ETHICAL REQUIREMENTS

A case study and an in-depth interview approach were used in this study. The researcher came into contact with people selected as participants in the course of the interviews. Participants were made aware of the fact that the interviews were completely voluntary and that they could withdraw at any stage. This necessitated the granting of ethical clearance by the Department of Management Accounting Ethics Committee. Ethical clearance was given to the researcher for this purpose as provided in Appendix E. The participants included managers from both the micro-brewery and South African Breweries Limited (SAB Ltd).

1.11. DEFINITION OF TERMS

Brewing: the process of mashing, soaking, germination, boiling and fermentation of ingredients like barley, hops, water, sugar, wheat, starch and yeast, to create a low alcohol beverage such as beer (Xu 2007:11).

Decision-making tool: a technique that is employed to provide relevant information that assists managers to make better decisions (Drury 2008:18).

End-of-pipe: end-of-pipe solution is an environmental control technology for waste and emissions that is applied to the end of the production process. It operates independently from the production process in order to modify the residual products of the production process so that they are less damaging to the environment than untreated residual products (Zotter 2004:686).

Good product: the portion of production output costs that is ready for sale (METI 2007).

Material Flow Cost Accounting (MFCA): an EMA framework that tracks, traces, identifies, and measures the flow and stock of materials, which include raw materials, parts and components in the production process, in terms of both physical and monetary units, in order to separate waste costs into good product and negative product. These costs are categorised as material costs, system costs, transportation costs and waste treatment costs (METI 2007).

Negative product: the portion of production output costs that represent material loss or waste (METI 2007).

Process waste: non-product output that is generated in each production process from the input to the output stage. It is the result of inefficiencies in equipment designs, human error in production, poor quality control, use of aging equipment and poor factory layout (Jasch 2003; Wagner 2003a).

Process waste-reduction: an attempt to limit inefficiencies in production from the input stage and throughout the process to the output or completion stage. This is a beginning-of-pipe approach rather than end-of-pipe approach (Tuttle & Heap 2007).

Transparent flow of materials: making material loss visible through its quantity and cost throughout the production process (METI 2007).

1.12. LAYOUT OF THE THESIS CHAPTERS

This study comprises eight chapters. The structural organisation of the chapters is presented below.

Chapter two outlines a general understanding of MASs for waste management. The theoretical perspective underlying this study is discussed.

Chapter three discusses Material Flow Cost Accounting in detail, which is the focus of this study. It relates the usefulness of MFCA to brewery waste information needs and outlines the benefits of integrating MFCA with Enterprise Resource Planning systems (ERPs). The chapter also discusses the applicability of MFCA to breweries.

Chapter four outlines the research method used for this study. The study adopts an exploratory case study. The chapter gives detailed explanation on the steps taken to conduct the study and states the research limitations.

Chapter five presents the findings from the six months pilot study and the in-depth interview held with the manager of Hope Brewery. The chapter analyses the findings as it answers the research objectives.

Chapter six gives the findings from interviews held with the participants of SAB Ltd. Detailed relevant responses from the participants are presented. An analysis of how it addresses the research objectives was explained.

Chapter seven presents an adjusted MFCA Waste Information System to support process waste-reduction decisions in the South African brewery industry. In this chapter, a detailed explanation of the steps involved in the framework is provided. The framework is an attempt to improve the existing waste-reduction decision process through the effective capturing of waste-related costs.

Chapter eight provides the summary and conclusion of the study. Research contributions and recommendations are discussed. The chapter suggests areas for further studies.

1.13. SUMMARY

The availability of relevant, adequate and accurate waste cost information to assist with sound waste-reduction decisions cannot be over-emphasised. It is a general norm that what gets measured gets managed. It is on this premise that this study is conducted. The study determines the extent to which conventional MASs have been supportive in providing the necessary waste-cost information for waste-reduction decisions; discovers the insufficiency of the conventional MASs; and attempts to adjust the existing MFCA framework to improve waste-cost information generation for sound waste-reduction decisions. This chapter introduced the background to the study. The problem statement, research objectives, research questions as well as the scope and delineation of the study were discussed. The importance of the study, and research method used were explained. Definitions of important terms were given and a layout of the chapters was presented. Chapter Two provides a theoretical perspective for the study and a review of relevant literature.

CHAPTER TWO

MANAGEMENT ACCOUNTING INFORMATION SYSTEMS FOR WASTE MANAGEMENT

2.1. INTRODUCTION

Chapter One introduced the research background, problem and methodology. There are four main parts to Chapter Two. The first part, which contains Sections 2.2 and 2.3, provides the theoretical perspective for the study and reviews relevant literature on the link between Management Accounting and waste management. The second part containing Section 2.4 discusses various waste management concepts, in essence concentrating on the management of waste reduction which is the major theme of this study. This is to provide a contextual base for the rest of the study and to trace the incursion of contemporary Management Accounting into environmental issues. The third part of this chapter, encompassing Sections 2.5 and 2.6, looks at the major environmental impact of the brewery industry as well as relevant standards by the International Standards Organisation (ISO) that regulates the issue of waste in the industry. This is followed by a review of the challenges of accounting for waste. This chapter provides the theoretical base for objectives one and two of this study. The fourth part includes Sections 2.7 and 2.8 which review the interventions and recent developments in the Management Accounting discipline to incorporate and report environmental-related information like waste separately for improved decision making.

Process waste-reduction decisions are contingent upon the availability of accurate and sufficient waste information both in quantity and costs (Qian, Burritt & Monroe 2011). In essence, process waste-reduction is a key component in any cost-reduction strategy implemented by organisations (Rao & Holt 2005). As such, a sustainable waste-reduction strategy entails the determination of its associated costs. The identification of all waste-related information should assist decision-makers by highlighting specific areas of production inefficiencies for reduction in production costs and environmental impact (Jasch 2006). Equally important in process waste-reduction decisions may be the use of a sufficiently appropriate Management Accounting waste information system for collecting and separating waste information into a visible and analysable form to improve waste-reduction decisions.

2.1.1 Goal of this chapter

The aim of this chapter is to discuss general waste management approaches in relation to the underlying challenges of Management Accounting. Process waste-reduction is not only a problem to production and environmental scientists, but also a challenge to the Management Accounting function which is responsible for providing the necessary costs and qualitative information to assist managers to make sound decisions. Hence, a research into process waste-reduction from a Management Accounting angle may broaden the understanding of managers on waste-reduction for improved decision-making.

2.1.2 Layout of the chapter

This chapter sets out to gain a general understanding of Management Accounting information systems for waste management. Figure 2.1 provides a visual representation of the chapter. In Section 2.2, the theoretical perspective of this study is explained and a brief outline of the relationship between accounting, management information systems and waste management is portrayed in Section 2.3. A review of major waste management concepts is provided in Section 2.4 and the waste management hierarchy is discussed in Sub-section 2.4.1. Section 2.5 presents the major environmental impact of the brewery industry while Section 2.6 addresses the challenges of the conventional MAS in relation to waste information. In Section 2.7, the development of Management Accounting for the environment is provided. Sub-section 2.7.1 provides insight into the development of environmental accounting while in Sub-section 2.7.2 the Environmental Management Accounting (EMA) concept is discussed. Environmental cost approaches are presented in Section 2.8, and Sub-sections 2.8.1, 2.8.2 and 2.8.3 address concepts such as activity-based costing, full cost accounting, and life-cycle costing approaches respectively. This leads to discussions on Material Flow Cost Accounting (MFCA) on which this study is based in Sub-section 2.8.4. Section 2.9 summarises the chapter. The above layout is represented in Figure 2.1.

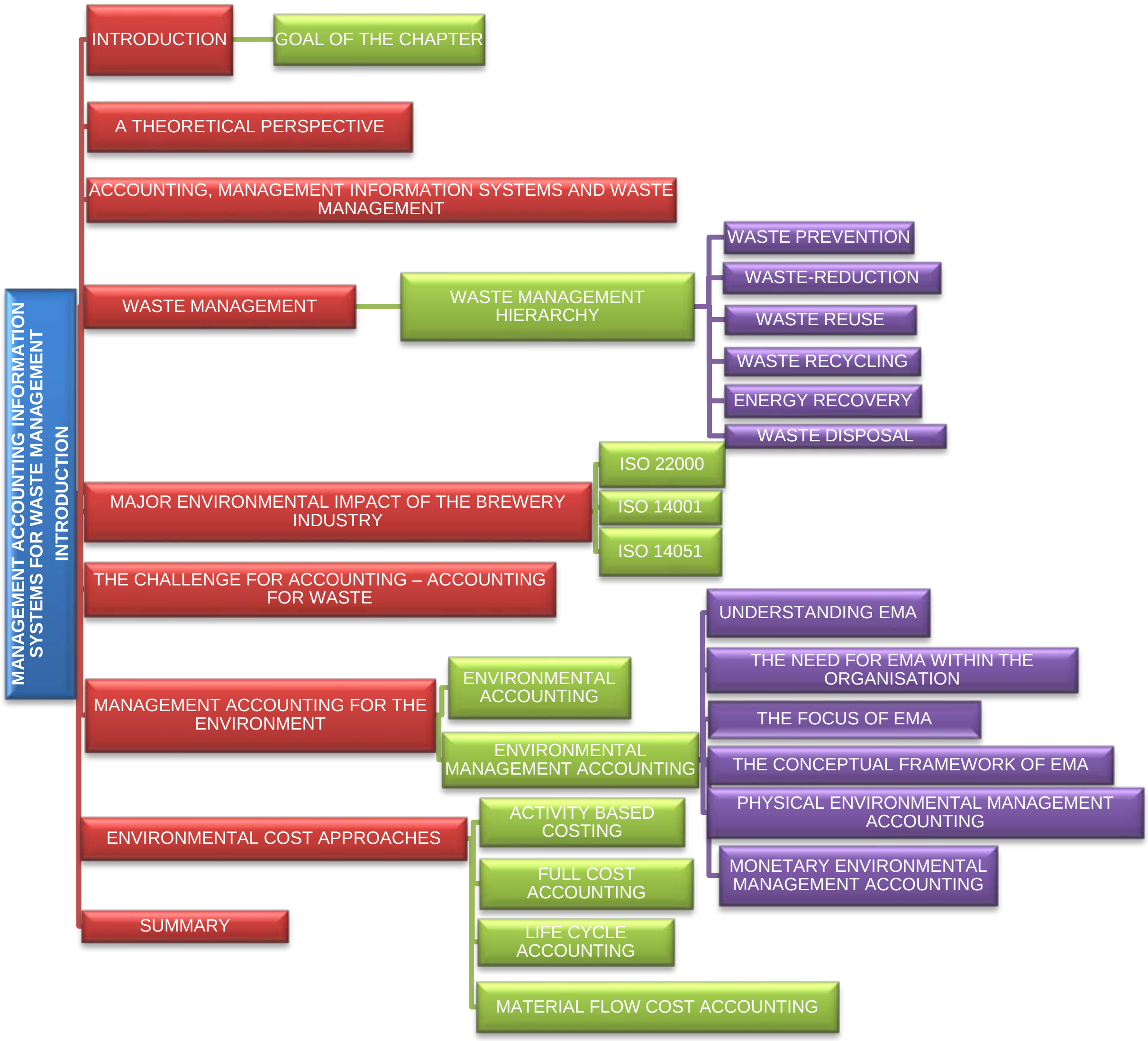


Figure 2.1 A visual representation of the layout of Chapter 2

2.2. A THEORETICAL PERSPECTIVE

The contingency theory suggests that an accounting information system should be designed in a flexible manner so as to consider the environment and organisational structure confronting the organisation (Riahi-Belkaoui 2002:140). Waterhouse and Tiessen (1978) further indicate that Management Accounting information systems should adapt to specific organisational needs. As such, Management Accounting information systems should be designed within an adaptive framework (Ferreira &

Otley 2009). Contingency theory takes into account the environment, organisational attributes, and managerial decision-making styles (Riahi-Belkaoui 2002). However, Emmanuel, Otley and Merchant (1990:57); and Drury (2008:407) concur that the contingency theory approach to Management Accounting is based on the premise that there is no universally appropriate accounting system applicable to all organisations in all circumstances. Therefore, contingency theory attempts to identify specific aspects of the conventional MASs that are associated with certain defined circumstances and to demonstrate an appropriate matching such as the organisation's environmental impact and resource utilisation.

To identify specific aspects and design effective MAS, it is necessary to consider the circumstances in which it will be used (Drury 2008:407). He explains that the applicability of the MAS is contingent on the situational factors faced by organisations, one of which is waste-reduction. Drury (2008) further states that contingent factors include external environmental pressures faced by organisations, the type of competitive strategy they adopt, the organisational structure and the nature of the production process. Hence, by adjusting the existing MFCA framework, there exists the likelihood to address such contingent environmental pressures, as process waste-reduction for the continual improvement and increased environmental performance within the brewery industry may be achieved.

Sisaye (2001:22) indicates that the contingency theory drew largely from the ecological approach of organisations. According to Pfeffer and Salancik (2003:24) the ecological approach analyses how the environment and technology shape strategy and influence organisations decisions. Strategy is a process by which an organisation utilises its resources to maximise its environmental opportunities and minimise potential threats raised by the environment. Bouma and van der Veen (2002:281) further argue that contingency theory expands the scope of strategic and management control by emphasising the balance between external environmental factors and internal resources of the organisation. Contingency theory was selected by the researcher since it refers and relates to the adoption and effectiveness of an MAS within the organisation and it can be used to analyse and provide insights into the relationship between business strategy and Management Accounting.

Bennett, Bouma and Wolters (2002:283) indicate that to measure the effectiveness of environmental accounting (EA) systems, it requires that one measures an organisation's environmental performance. Although the main reason for allocating environmental costs, such as waste costs, to processes is most probably economic, such allocation would assist organisations to identify profitable options for waste-reduction (Bennett *et al.* 2002). The furthermore indicate that environmental cost allocation relates to business strategy rather than to the environmental strategy. This study explores the effectiveness of MASs to measure environmental costs, especially waste costs to support an organisation's waste-reduction decisions for a competitive environmental management strategy. It seems logical for organisations with relatively high waste costs to implement MASs that enable the control of its waste costs (Bennett *et al.* 2002). As such, Yu and Kittler (2012) stress that the contingency theory indicates that a matching of strategy and management control systems is related to ensuring organisational environmental effectiveness. Therefore it plausible for managers to adopt MAS that assists them to manage environmental contingencies such as waste as it arises.

2.3. MANAGEMENT ACCOUNTING, MANAGEMENT INFORMATION SYSTEMS AND WASTE MANAGEMENT

The quality of data contained in accounting information systems has a significant impact on both internal business decision-making and external regulatory compliance (Yakhou & Dorweiler 2004:66). Drury (2008) states that to provide relevant and timely information for decision-making is an objective of MASs. MASs are designed to accumulate, measure, and communicate financial information about an organisation. He continues to state that a conventional MAS provides information for making informed decisions about how best to use available resources. Information provided by the accounting systems includes two broad categories - Financial Accounting and Management Accounting (Drury 2008:15). According to Chapman and Kihn (2009) the focus of Financial Accounting is to provide information for external reporting such as the balance sheet, income statement, and statement of cash flows to investors, creditors, suppliers, customers, employees, competitors, the government, and the press. However, Management Accounting information is focused on internal reporting such as budgets, cost analyses, and performance reports mainly to the management of the organisation (Chapman & Kihn 2009:152). In essence, the provision of adequate waste-related information through a MAS is likely to assist managers to improve their environmentally-related decisions.

In the past, the conventional MAS excluded environmental and social costs in financial information since these costs are regarded as externalities (Mook & Quarter 2009:1380). According to Mook and Quarter (2009), the growing concern over organisations' environmental impacts generated criticisms of the conventional MAS being used. They affirm that such criticism brought about a twist in the conventional MAS to adapt and reflect environmental impacts caused directly or indirectly by an organisation in its records. Schaltegger and Burritt (2000:77) indicate that the conventional MASs do not provide information on how much the environment is harmed, no matter how high the social costs and no matter whether the damage is irreversible or whether carrying capacity is exceeded. For this reason, an improvement of the conventional MAS would probably provide much needed environment-related information for improved environmental performance.

The need for improved environmental performance by organisations has attracted continued attention by both the external and internal stakeholders alike, especially the industrial sector that is considered to be heavy on creating negative environmental impacts such as the manufacturing industries (in this case the brewery industry) and in emerging economies like South Africa (DEA 2010a). The negative impact on the environment by organisations, as a result of the unsustainable use of natural resources and production inefficiencies, has been attributed to negative environmental impacts caused by Green-House-Gas emissions (GHG) and the high concentration of process waste discharged to the society on a daily basis (Meerganz von Medeazza 2005:68). Therefore, Raj, Prasad and Bansal (2006:918) concur that the high volume of process waste discharged into the environment requires efficient management by organisations. This may go beyond compliance with waste management regulations and raises major implications and challenges to the Management Accounting function. Consequently, there may be a need for the adoption of an improved MAS specifically designed to capture waste-related information in the South African brewery industry to assist managers with the improvement of these environmental challenges. The next sections discuss some waste management systems.

2.4. WASTE MANAGEMENT

The conventional waste management approach considers waste generation, collection, and disposal systems as independent operations (Seadon 2010:1640). However, waste management involves managing all waste-related materials whether they are solid, liquid, gaseous, or radioactive (Okafor 2011:278). More importantly, waste management practices differ from one country to another, between rural and urban areas, and between residential and industrial areas (Ali, Eqani, Malik, Neels & Covaci 2013). In addition, organisations' waste management preferences differ by nature of their activities (Bansal 2005). Nevertheless, manufacturing industries are pressured to use natural resources efficiently and to avoid wastage in production (Murovec, Erker & Prodan 2012:266). Likewise, while environmental laws and regulations guide the operations of manufacturing concerns, compliance is largely linked to future benefits in terms of cost savings and increased profitability (DEA 2010b; Unruh 2010:3).

Nonetheless, waste management practices range from avoidance and reduction to outright disposal at dumping sites, hence, the waste management hierarchy is the specific precedence given to waste management activities by an organisation (Raj *et al.* 2006:918). In short, managers may be likely to prefer a waste management practice that affords an opportunity for cost savings and increased profitability. The next section provides a discussion on the waste management hierarchy.

2.4.1. Waste management hierarchy

Preference for waste management practice in an organisation is likely dependent on the type of waste it creates and on its overall waste management strategy. The waste management hierarchy is a waste policy that prefers avoidance, reduction, reuse, or recycling of waste to waste disposal (Batayneh, Marie & Asi 2007:1870). Kirkeby, Birgisdottir, Hansen, Christensen, Bhander and Hauschild (2006:17) furthermore argue that a waste-management hierarchy promotes waste avoidance, reduction, reuse and recycling, incineration with energy recovery above disposal or land filling (see Figure 2.2). Accordingly, this study proposes the adoption of process waste-reduction through an appropriate Management Accounting framework like MFCA to capture waste-related costs for the purpose of improving waste-reduction decisions and strategy.

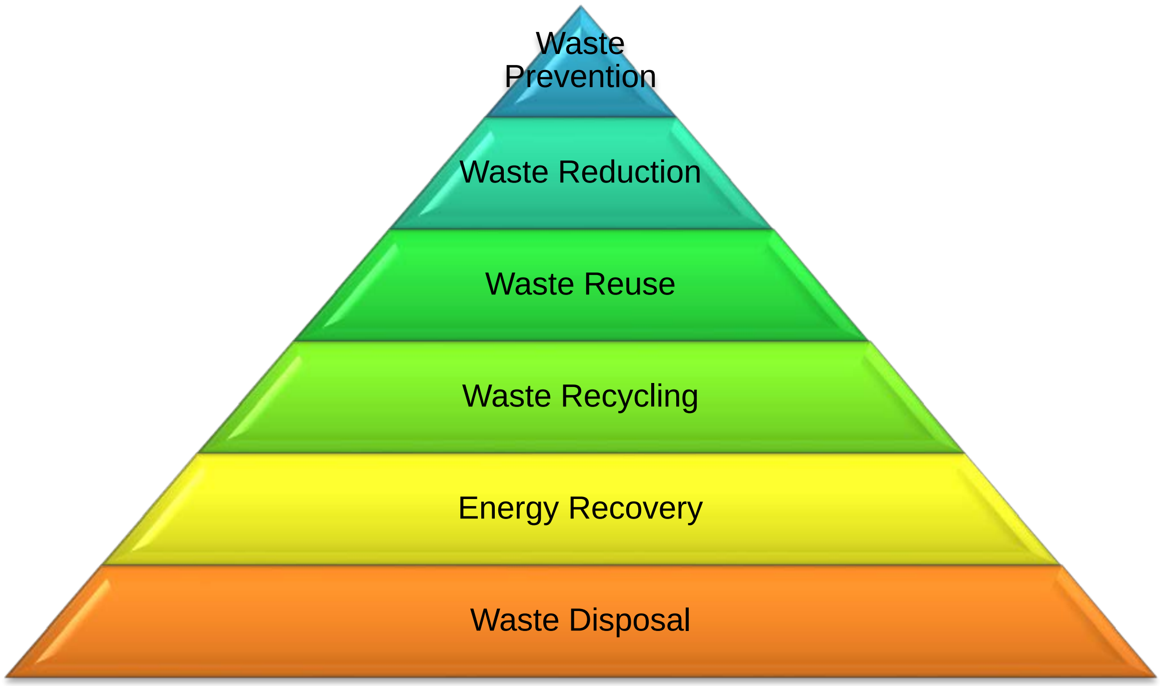


Figure 2.2 An iIllustration of a waste management hierarchy (*Source*: own)

The next sections present reviews of key waste management terminologies in order to differentiate between these terminologies and waste-reduction, which is specifically the focus in this study.

2.4.1.1. Waste prevention

Waste prevention is the preferred first step in the waste management hierarchy (Kirkeby *et al.* 2006:17; Batayneh *et al.* 2007:1870). Notwithstanding this, cleaner production provides a mechanism for managers either to prevent or reduce the generation of waste. According to the DEA's Cleaner Production Background Information Document, cleaner production is a business strategy to enhance productivity and environmental performance for overall socio-economic development (DEA 2010b; South African Waste Information Centre (SAWIC) 2010). Admittedly, cleaner production processes support the use of few resources that produce less waste; whether in the form of liquid waste discharged to waterways, solid waste dumped on landfills, or gaseous waste released into the atmosphere (Guide 2000). Eventually, the type of waste created within an organisation is likely to influence the choice of its waste management option.

Van Berkel (2005:259) argues that the choice of waste prevention in quantitative terms means a reduction in the volume or mass of the residual waste, through the implementation of waste-prevention options. Similarly, he indicates that waste prevention in qualitative terms results in the reduction of environmental risks and improvement in recyclability. Accordingly, he listed the contributions that can be derived from the combination of quantitative and qualitative waste-prevention options as the reduction in the whole life-cycle accumulation of waste, reduction in hazards and risks of business operations and waste management; and improved eco-efficiency. Sharp, Giorgi and Wilson (2010:257) define eco-efficiency as the production of products in a sustainable manner without having a negative impact on the natural environment. Furthermore, Tanner *et al.* 1996:301) argue that the lack of adequate measures for waste costs and the related benefits of pollution and waste prevention programs present a barrier to the full implementation of an appropriate waste management strategy. Subsequently, corporate environmental performance is viewed as the ability to efficiently transform natural resources into desirable outputs while corporate environmental preventive ability is designed to effectively cope with their undesirable outputs (Sheu & Lo 2005:86). Hence, there may be a need to adopt an improved MAS that looks beyond mere convention to reverse the impact of inadequate measures for waste costs and to improve waste prevention decisions.

Organisations do not have unlimited economic resources to implement some of their waste strategies, a proper identification, and gathering of material flow data are less expensive but useful for decision-making (Sheu & Lo 2005:86). However, corporate managers may be unlikely to consider the use of the MFCA framework to fully determine the flows and stocks material, energy, and emission throughout the production process both in quantity and costs for effective decision-making. Sheu and Lo (2005:87) continue to argue that decision-makers often have incomplete environmental information at their disposal coupled with limited time and scope for sound decision-making because of the inappropriate measure of waste information. Moreover, they suggest that decision-makers need to be informed on the general, indicative, sensitive, robust, and inter-linkage indicators that can assist them to make decisions towards an efficient waste strategy. In other words, to make an appropriate waste decision that is beneficial to the organisation and society, the cost and benefit of each waste approach should be made explicit (Jasch 2003). Therefore, the availability of appropriate and adequate waste information for managers is likely to facilitate the making of informed and improved waste-reduction decisions.

2.4.1.2. Waste-reduction

In South Africa, a waste management strategy that incorporates waste minimisation was not regarded as a national or provincial priority until 1997 (Swart 2004:1). Swart (2004) also maintains that the focus of waste management in South Africa until 1997 was mainly on waste disposal and was reactive since it addressed needs as they occurred. He furthermore states that the focus had, however, changed as new action plans and policies address the issue of source reduction, waste recovery and recycling. Likewise, environmental bodies and public interest groups are making process waste-reduction a priority, as well as its importance in trying to influence organisations' decisions and strategies. However, steadily increasing environmental regulations have resulted in a growth in organisations environmental costs (Robinson 2009:184). Conversely, solutions for reducing environmental costs include process waste-reduction which means different things to different people (So, Parker & Xu 2012). The definition given to process waste-reduction affects the design, implementation, and effectiveness of actions (DEA 2010a). Hence, in this study, process waste-reduction implies the reduction in process waste from the input stage throughout the whole production process in order to limit the overall output waste before treatment and discharge to waste sites.

For the purpose of clarity in this study, it is necessary to distinguish between the prevention of waste from being generated and controlling waste after it is generated to avoid misconception. One serious problem is that any definition included in waste management, which includes waste treatment and recycling, shifts attention away from the goal of process waste-reduction (Cheremisinoff 1995:12). For this reason, process waste-reduction in this study refers to in-plant or process practices that reduce, avoid or eliminate the generation of waste so as to reduce risks to the environment. Furthermore, Cheremisinoff (1995) states that the goal of process waste-reduction is to alter practice and to design future processes and operations in such a way that it will reduce the degree of process waste hazards and the amount to be managed, controlled, and regulated. Cheremisinoff (1995:13) also suggests that revising the accounting methods in an organisation will ensure that both short and long-term costs of managing waste, including liabilities, are charged to departments; individual processes and operations responsible for waste generation. Therefore, improving in-process waste-reduction through an appropriate Management Accounting framework for waste-capturing rather than waste treatment and reuse is the focus of this study. Next, waste reuse is discussed.

2.4.1.3. Waste reuse

Waste reuse involves using an item again after it has been used either for the same function or a new purpose. This waste management practice is promoted through social pressure to reduce the amount of waste matter that enters or leaves the society (Demirbas 2011:1281). Also waste reuse involves cleaning and using materials over and over thereby increasing the typical life span of a product (Miller & Spoolman 2010:409). Singh, Singh, Araujo, Hakimi Ibrahim and Sulaiman (2011) furthermore argue that in situations where waste cannot be prevented, and waste-reduction methods have been applied, industrial facilities have developed ways to reuse such waste. However, different organisations adopt waste reuse for different reasons (Pullman, Maloni & Dillard 2010; Yuan & Shen 2011). For example, it is less expensive to treat brewery wastewater and reuse it for housekeeping and other cleaning activities, rather than to treat the wastewater for discharge to the environment. Nevertheless there is a limit to the extent to which water can be reused since when water evaporates; it leaves non-volatile substances like salt behind (Woodard 2001:213). Hence, there may be a need to facilitate decisions through the use of an MAS by managers regarding the appropriate waste management practice through the provision of waste cost information under different waste management options.

The next section explains the concept of recycling which is often used in conjunction with reuse because of their similarity.

2.4.1.4. *Waste recycling*

Recycling of waste happens when waste had already been generated. Once waste has been prevented, reduced, and reused to the extent possible, recycling is the next option (Woodard & Curran Incorporated 2006:80). Furthermore, recycling involves the reprocessing of waste material to produce the same material again or some other product. Indeed the maximum potential of recycling equals the quantity of materials that can be captured, recovered, and recycled successfully at a cost that is feasible to the organisation (Rogoff & Williams 1994:14). However, before embarking on recycling, consideration should be given to its potential costs and benefits. Pearce (2000:297) however, indicates that, while recycling may be environmentally preferable to disposal, it does not include energy recovery by burning the waste in incinerators with heat recovery. Recycling should be preferred to disposal since it prevents the extraction of the same amount of new material and solves the problem of waste disposal to a great extent (Coelho, Castro & Gobbo Jr 2011). For the purpose of this study, focus is on process waste-reduction rather than on recycling which in turn create waste and cost.

In the next section, the concept of energy recovery is discussed since energy may be a vital input factor in any production process and the ability of an organisation to effectively manage it might ensure cost savings and reduced carbon emissions.

2.4.1.5. *Energy recovery*

Energy recovery is a process through which energy in the form of heat is recovered from the incineration of waste (Harrison 2001:433). On the other hand, energy recovered can be used to generate electricity and the energy-recovery strategy is usually combined with recycling during incineration of waste, hence, when materials are recovered during recycling, energy can also be recovered (Massarutto, Carli & Graffi 2011). Likewise energy recovered in this process needs further segregation into clean fuel for use (Harrison 2001:433). Furthermore, the decision to combine recycling with energy recovery requires an informed decision (Wilson 2013). Yet, energy recovery should be preferred to outright waste disposal (Grosso, Motta & Rigamonti 2010). However, energy recovery alone does not meet the requirement of the current study since waste cost analysis cannot be generated from it. The next section discusses waste disposal, which is the last option in the waste management hierarchy.

2.4.1.6. Waste disposal

Environmental concerns as well as the cost of waste disposal are reasons for the acceptance of this practice by both the society and organisations (Sandhu 2009:55). Waste disposal is the transfer of waste from collection points to the landfill sites under protection from hazardous discharges to the environment, however, current practice indicates that many landfill sites are filled up and abandoned for new sites. He argues that clean-up costs are expensive, the task enormous, and almost impossible. With this in mind, this study contends that the effects of pollution caused by this practice are visible all around in form of damage to human health (skin diseases and contaminated water), climate change effects, and unavailability of landfill sites due to excessive waste dumps (Hardoy, Mitlin & Satterthwaite 1992). Jasch (2003:671) agrees when he states that the costs of waste disposal of organisations are increasing since costs such as waste treatment costs, transportation costs, environmental levies and landfill site fees paid to municipalities increase product costs. Equally these costs have increased organisations' environmental costs over the years placing constraints on their budgets. Admittedly, the challenge to organisations is to reduce waste generation, increase shareholders profit, and improve environmental performance (Hart, Milstein & Caggiano 2003:56). Deciding on an appropriate waste minimisation strategy may require an informed analysis of the available options and it may therefore be the responsibility of the MAS within individual organisations, whether small or large, to provide adequate waste information for informed decisions. Hence, the next section discusses the major environmental impact of the brewery industry.

2.5. MAJOR ENVIRONMENTAL IMPACT OF THE BREWERY INDUSTRY

Brewing processes and the environment are seemingly unlikely partners since the amount of water and other resources used in the brewing processes; pose a great risk to climate change (Buchanan 2010). Environmental issues associated with the brewery process include energy consumption; water consumption; wastewater; solid waste and by-products; and emissions to air (IFC 2007). The energy consumption in brewery processes is relatively intensive in terms of both electrical and thermal energy and is influenced by process design and the utility system which can vary from 100-200 mega joules per hectolitre (MJ/hl), depending on size and sophistication (IFC 2007). Therefore, this study argues that the availability of a contemporary Management Accounting framework is likely to assist brewery managers to understand, manage and utilise resources efficiently thereby providing opportunities for cost savings and increased profitability.

The brewing process involves high consumption of good-quality water which is a scarce resource in South Africa (Momba *et al.* 2006:289; WWF 2012). For instance, water is used for the production, heating and cooling, cleaning packaging vessels, production machinery, cleaning of delivery vehicles, and sanitation (European Commission (EC) 2006; Fillaudeau *et al.* 2006). Water consumption in beer production takes between 4-7 litres (*l*) to produce 1 litre of beer (EC 2006). Brewery processes also generate a lot of liquid waste such as the weak wort and residual beer (Fillaudeau *et al.* 2006; IFC 2007). The main source of residual beer includes process tanks, diatomaceous earth filters, pipes, beer rejected in the packaging area, returned beer, and broken bottles in the packaging area (The Brewers of Europe 2002). Furthermore, solid waste and by-products in beer production result in a variety of residues such as spent grains, which can be sold at a value to local farmers; and odour and dust, are considered the most significant air emissions from breweries. The wort boiling process is the main source of odour emissions from a brewery, while the use and storage of grains, sugar, and kieselguhr are sources of dust emissions (Fillaudeau *et al.* 2006; IFC 2007). Figure 2.3 portrays the material and energy flow in a brewery process. The figure depicts the flow of materials and energy in a brewery process, indicating stages at which waste and emissions occur, until the final product (beer) is reached.

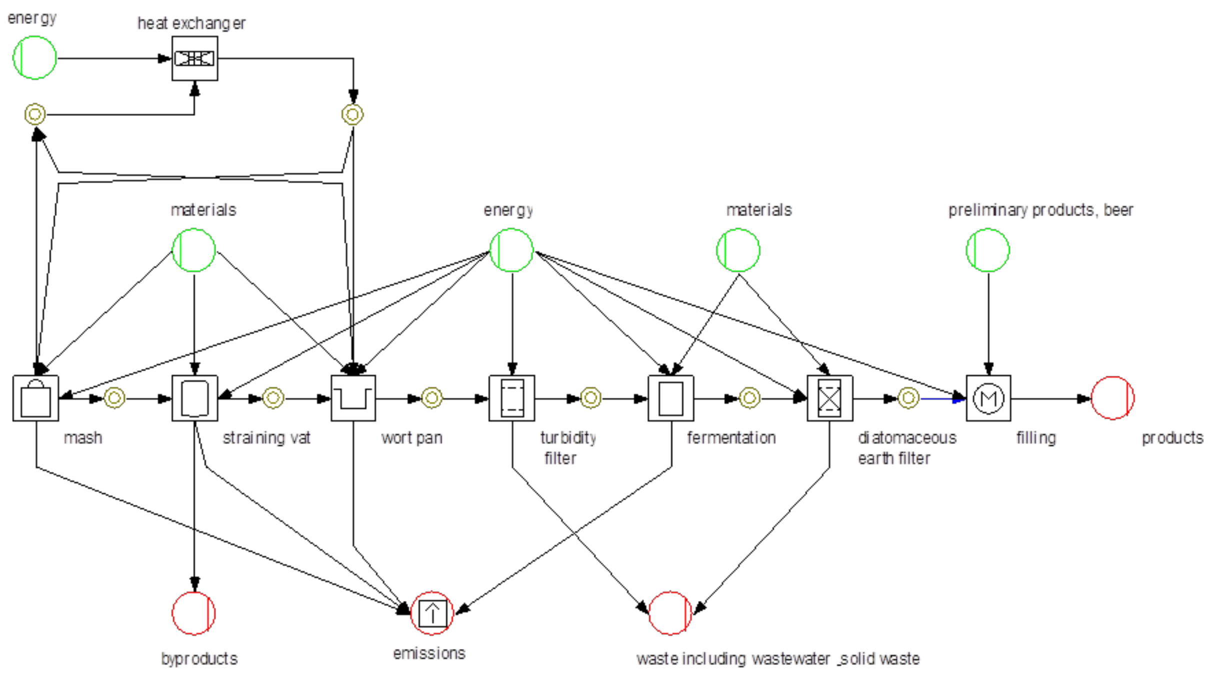


Figure 2.3 Material and energy flow in a brewery (Source: Umberto's e!Sankey diagram)

Although, brewery process waste can be considered a good source of nutrients for agriculture, it is a potentially harmful environmental pollutant. Furthermore, the vast majority of waste from breweries is organic (Fillaudeau *et al.* 2006). Nevertheless, organic by-products from brewing can be used as a useful resource; however, opportunities in this area are yet to be exploited to the fullest (Aghajanzadeh-Golshani, Maheri-Sis, Mirzaei-Aghsaghali & Baradaran-Hasanzadeh 2010:44). Consequently, breweries need to make an effort to reduce the environmental impact of beer not only in the way it is packaged, but in the entire brewing process (Parawira *et al.* 2005). For example, these efforts are likely to include a reduction in the irrigated water used to grow the crops used to make beer, and a reduction in emissions from transporting the end product.

In the South African brewery industry, a brewery like SAB Ltd has undertaken some projects aimed to reduce the impact of water used in the beer-making process through partnership with the World Wildlife Fund (WWF) (SAB Ltd 2012). Hence, there may be a need for these efforts to be strengthened in breweries in South Africa through the adoption of a Management Accounting waste information system that is able to analyse brewery process waste into quantity and cost items. Analysing brewery waste may be an essential safety standard in food processing industries.

The non-adherence to food safety standards have led to an increasing food safety crisis around the world (Arvanitoyannis, Palaiokostas, Panagiotaki 2009). To this effect, the International Standards Organisation (ISO 2012) has issued number standards to ensure the safety in food processing to avoid food crisis and waste. Therefore, a more specific waste-costing system for breweries in South Africa to provide separate waste information may be needed to facilitate an improved waste-reduction decision-making process. The next sections discuss specific standards related to food safety (ISO 22000 and ISO 14001) and another standard that relates to resource efficiency (ISO 14051 - MFCA).

2.5.1. ISO 22000

ISO 22000 is the new standard that replaces the Hazard Analysis and Critical Control Point (HACCP) on issues regulating food safety as food safety is an increasingly important issue because of the numerous food crises around the world (Arvanitoyannis *et al.* 2009). A significance of this standard is the effect it has if applied to prevent, totally remove or destroy all pathogens that could be present during a typical food preparation process (Faergemand & Jespersen 2004). The standard can be applied on its own, or in combination with other management systems (Frost 2005). There may be a need to apply this standard in conjunction with the proposed Management Accounting framework to facilitate improved waste-reduction decisions within the brewery industry.

2.5.2. ISO 14001

ISO 14001 is the most widely adopted environmental regulation which encourages organisations to take environmental action beyond what domestic governments' regulations require (Prakash & Potoski 2006). ISO 14001 is a requirement for any organisation in the food chain. The ISO 14001 environmental management system (EMS) standard has been designed to help organisations in the creation of structured mechanisms for continuous improvement in environmental performance (Kitazawa & Sarkis 2000). However, critics contend that the adoption of ISO 14001 does not ensure either legal compliance or continued performance improvements rather it may merely be an image-building or public relations effort (Rondinelli & Vastag 2000). Hence, if organisations such as the brewery industry adopt a

Management Accounting framework (i.e. a structured mechanism as per ISO14001) specifically designed to capture waste information it is likely to assist managers to continuously improve the organisations' environmental performance beyond mere compliance with environmental regulations.

2.5.3. ISO 14051

ISO 14051 was developed in relation to resource efficiency, any form of waste, undesired by-products, or even product outputs that need follow-up treatment or recycling as an indication of production inefficiency (ISO 14051 2011). MFCA is a costing approach that focuses on the proper assessment of such inefficiency or material loss related costs (Kokubu *et al.* 2009: 15) and treats waste and emissions like products or cost objects according to Nakajima (2003). More importantly, MFCA has recently been standardised as the international standard ISO 14051 (ISO 14051:2011). Therefore, there may be a need for brewery managers to adopt the MFCA framework to attain production efficiency through proper and careful documentation of waste cost information for improved waste-reduction decisions.

2.6. THE CHALLENGE OF ACCOUNTING FOR WASTE

Organisations particularly find it difficult to fully embrace the necessary environmental changes, which also require that conventional accounting systems undergo and incorporate this change for improved waste capturing (Gray, Bebbington & Walters 1993:10; da Silva Monteiro & Aibar-Guzmán 2010:405; Barquet *et al.* 2011:333). The slow response of the conventional MAS to incorporate environmentally-related costs in its analysis does not provide managers the opportunity to make informed waste-reduction decisions (Fritsche *et al.* 2010:68). Moreover, MASs have a responsibility to reduce the level of environmental devastation by providing the necessary physical and monetary waste information so that informed waste-reduction decisions can be made by managers (Wagner 2003a). Accordingly, Cardinaels and Veen-Dirks (2010:566) argue that conventional MASs should provide both financial and non-financial information for managements' environmental decision-making. In this study it is argued that since productive activities within organisations affect the external environment; including detailed information about an organisations' environmental impact in the annual financial statements would facilitate improvements to the production processes so that areas of inefficiencies and resource wastage can be identified for corrective action. Consequently, a conventional MAS that provides useful waste cost information to management on a daily basis through the adaptation of MFCA may be needed to improve access to environmental information for inclusion in annual reports.

A more specific MAS designed to provide waste generation data is plausible in the present circumstance. Schaltegger and Synnestvedt (2001:5); and Paulraj (2009:458) state that an organisations' environmental impact has an influence on its costs and income in two directions, namely, improved environmental performance and economic performance. This may indicate that an organisation's environmental impact has a direct influence on the financial success of the organisation. The focus of contemporary MAS is to report an organisation's polluting activities to its external stakeholders for corporate evaluation, investment decisions, and compliance with environmental regulations (Dascalu *et al.* 2010:18; and Sisaye 2011:395). Consequently, organisations adopting MASs are likely to facilitate the generation of detailed records of inefficiencies in a production process. In this regard, a Management Accounting framework adopted to assist mangers to have a transparent flow of material and energy flows information for improved waste-reduction decisions may be needed.

Loew (2003:41) suggests that in order to identify the type of environmental cost accounting approach that would be most suitable for adoption by an organisation, it is necessary to identify an approach that is similar in concept and purpose to the specific needs of the organisation. However, environmental issues such as whether to introduce green products or change the production technology to a more efficient process can be a far reaching strategy to an organisation (Figge, Hahn, Schaltegger & Wagner 2003:17). There are divergent opinions between environmental management practice and science on the approaches that are best suited to an organisation's practice and goals regarding environmental cost management (Burnett & Hansen 2008:551). In most instances, environmental management practices have been the yardstick in the determination of an organisation's environmental protection costs in relation to environmental accounting (Darnall, Henriques & Sadorsky 2008:365). More importantly, Loew (2003:54) further argues that the determination of environmental protection cost is not, as a rule, sufficient for identifying possibilities for cost reduction. Therefore, the selection of an organisation's environmental management practice when aligned to an appropriate environmental Management Accounting framework is likely to assist managers to identify possibilities for waste cost reduction.

The next section discusses the relevance of MASs to the environment.

2.7. MANAGEMENT ACCOUNTING SYSTEMS FOR THE ENVIRONMENT

The MAS provides information to assist managers to make informed decisions and to improve the efficiency and effectiveness of existing operations (Drury 2008:7). According to Drury (2008) it is also responsible for the provision of vital information on how best to make use of an organisation's resources in an efficient manner. However, natural resource extraction is under threat from the continuous use by organisations for production purposes, while environmentalist, scientists, and civil societies are putting pressure on organisations to reverse negative environmental impacts caused through unsustainable practices (Institute of Chartered Accountants of England & Wales (ICAEW) 2004:7). Indeed, reversing the negative environmental impact should be the responsibility of the organisation whose activities result in adverse environmental impact. Organisations happen to be the greatest users of natural resources to create goods to meet customers' needs (Ahuja & Khamba 2008). There has been increasing pressure on organisations to ensure that their activities do not continue to impact negatively on their host communities and the natural environment in which they operate as required by the Global Reporting Initiatives (GRI 2013) and in South Africa, the King III requirement on sustainability reporting (IOD 2009).

The reason being that organisations tend to see the use of natural resources as a free gift from nature and have therefore failed to address or limit its continued depletion (Abbott 1970:1214). Hence, this study argues that the continuous depletion of natural resources without provision for its replacement has a negative impact on the environment. The adoption of a Management Accounting framework like MFCA for the capturing waste information to provide an analysis on resource inefficiency to enable managers in the brewery industry to make appropriate and sound waste-reduction decisions which may result in efficient resource usage and reduce the pressure on natural resources consumption.

Peat (2007:1) indicates that while accounting practitioners have been more comfortable in dealing with readily quantifiable information, they tend to handle environmental related issues in their reports with reluctance. The time has come for the accounting function to become more environmentally responsible by providing the necessary environmental information to improve waste-reduction decisions (Dascalu *et al.*, 2010:26). However, progress has been made in recent years on the issue of Corporate Social Responsibility reporting (CSR) with important developments to address organisations' CSR issues towards its stakeholders, such as the Global Reporting Initiative (GRI) and the Carbon Disclosure Project (Kolk, Levy & Pinkse 2008:720). More importantly, the MAS has the responsibility to provide adequate financial and non-financial information to managers for improved waste-reduction decisions (METI 2007). Above all, such information should be made available to both external and internal stakeholders because of their diverse information needs (Dascalu *et al.* 2010). Hence, this study maintains that an appropriate Management Accounting waste information system may be needed to generate adequate waste-related information for improved waste-reduction decisions.

Yakhou and Dorweiler (2004:69) suggest that the Management Accounting function should work within an inter-disciplinary approach to minimise organisations' environmental impact by providing necessary and adequate environmentally-related information to managers for an improved resource-efficiency strategy. While the conventional MASs includes environmental costs in overhead accounts, such costs are not separated in the annual financial statements to enable a transparent view of the inefficiencies in the process for corrective actions to be taken (Yakhou & Dorweiler 2004:69). Eventually, to manage both internal and external environmental issues effectively, adequate and accurate data should be made available to decision-makers since waste creation is the result of inefficiencies in the production system (Nakajima 2003). The MAS adopted by an organisation may need to facilitate the provision of adequate waste information at specific points in the material flow process to enable managers to make informed decisions and to take appropriate strategies to reduce identified waste source.

Conversely, the conventional MASs fail to provide adequate and necessary environmentally-related information to assist managers separate between normal costs and costs related to inefficiencies led to the development of environmental accounting (EA) (Bebbington 1997:366; Schaltegger & Burritt 2000:63). Furthermore, in order to improve environmentally-related decision-making of managers, the Management Accounting function was modified to include and provide separate environmental-related costs in its analysis (Jasch 2009). This led to the development of EMA a subset of EA (United Nations Division for Sustainable Development, UNDSD 2001:4). Therefore, in order to make informed waste-reduction decisions, there may be a need to encourage managers to adopt a Management Accounting framework that is capable of separating environmentally-related costs to reveal areas of inefficiencies in production.

2.7.1. Environmental Accounting (EA)

Unless environmental activities of organisations are constantly reported in the annual financial statements, it would be difficult to determine which organisation is environmentally responsible. EA is an accounting tool designed to report an organisation's environmental activities within an accounting period (Bebbington 1997:366). On the other hand, Lamberton (2005:7) and Gray (2010:51) indicate that the failure of organisations to meet the challenges of providing comprehensive environmental reports means that organisations will continue to be unaccountable for their unsustainable practices. Whereas Crosbie and Knight (1995:3) and Tompkins, Adger, Boyd, Nicholson-Cole, Weatherhead and Arnell (2010:629) explain that most organisations believe that environmental protection and management is the sole responsibility of governments. Despite the fact that some organisations mention sustainability in their environmental policies, only a limited number of these organisations set out to achieve sustainability in any systematic or comprehensive way (Gray 2010:51). Many of these organisations lack the necessary Management Accounting framework to actually translate their sustainability efforts into quantitative form (Wagner 2003a). The adoption of an appropriate Management Accounting framework within the organisation may be the starting point to gather and analyse its sustainable development efforts (Jasch 2003). In short, this study encourages the adoption of a waste capturing Management Accounting framework among organisations to facilitate improved waste-reduction decisions for improved environmental performance.

Furthermore, Schaltegger and Burritt (2000:63) indicate that environmental accounting involves activities, methods, and systems as well as the recording, analysis and reporting of environmentally induced financial impacts and ecological impacts of a defined system such as an organisation, plant, region, or nation. This definition provides insight into the framework of EA as a useful accounting subset that captures and reports an organisation's environmental activities to its stakeholders (Schaltegger & Burritt 2000). Firstly, it presents an organisation with interaction between environmentally and socially induced economic impacts (Gray 2010). Secondly, it analyses the effect of an organisation's ecological and social impacts from its productive capacity (AICPA 2004). Thirdly, it measures an organisation's interactions and links between social, environmental and economic objectives (Schaltegger & Burritt 2000). Lohmann (2009:499), however, suggests that in EA, the calculation and internalising of externalities is the solution to environmental problems. The American Institute of Certified Public Accountants (AICPA) (2004) defined EA as the identification, measurement, and allocation of environmental costs, the integration of these environmental costs into business decisions, and the subsequent communication of the information to an organisation's stakeholders. In this study, the term environmental cost refers to the cost that is incurred to generate waste by an organisation in the production process as defined by Jasch (2003). Therefore, the determination of all relevant environmental cost may be crucial to the survival of an organisation and furthermore, if the potential cost savings that would have remained obscured in overhead accounts or otherwise overlooked might be captured and analysed.

In essence, effective monitoring of environmental costs can result in improved environmental performance and profitability of the organisation (Guoyou, Saixing, Xiaodong & Chiming 2012:130). Hence, proper documentation of all environmentally-related costs in a production process will promote a more accurate product costing and pricing (Wagner 2003a). This may indicate the need to employ a Management Accounting waste information system within the organisation. Hence, the study contends that the development of a more contingent MAS to capture waste-related costs specifically may address the global issue of waste from an accounting perspective.

The next section discusses the concept of environmental Management Accounting (EMA).

2.7.2. Environmental Management Accounting

Environmental Management Accounting (EMA) involves the generation, analysis and use of financial and non-financial information in order to optimise corporate environmental and economic performance and to achieve sustainable business (Bennett *et al.* 2002:1; Holt 2009). According to Nakajima (2003), EMA integrates both physical and monetary accounting to analyse environmental costs and these analyses would ensure the availability of appropriate environmental cost information to enhance quality waste-reduction decisions. Furthermore, the UNDSD (2001:4) simply describes EMA as accounting done in both monetary and physical terms. Alternatively, Bouma and Correlje (2003:259) provide a more compatible EMA definition for the purpose of this study. They define EMA as a subset of EA, which refers to accounting systems and techniques that provide decision-makers and management with financial and non-financial information about the organisation and its environment.

Yet Gale (2006:1228) suggests that understanding the material purchase value of waste and emissions and its related processing costs is the essential contribution of an EMA system. He went further to mention that data on pollution prevention and environmental management costs are difficult to access since it overlaps with, or is sometimes confused with the cost of waste and emission treatment. Moreover, Gale (2006) mentions that obtaining information on the material purchase value of waste and emissions and related processing costs is sometimes difficult to access from the production records. In other words, efforts to track waste generation in the production process through the use of a Management Accounting waste information system will help decision-makers to identify inefficient processes and allow a proactive waste-reduction strategy to be adopted (Jasch 2003). Therefore, there may be a need to understand EMA as contemporary MAS in the provision of separate environmental costs in order to assist managers to improve their waste-reduction decision-making process.

2.7.2.1. Understanding EMA

Jasch and Schnitzer (2002:6) identify the lack of a standard definition for environmental costs as the main problem of EMA. They contend that the definition of environmental costs by an individual organisation is determined by the pursuit of different environmental interests in different organisations. Subsequently, Jasch and Schnitzer (2002) define environmental costs to include a variety of costs such as disposal costs or investment expenditure, and other external costs which includes environmental protection costs and good housekeeping costs. They explain that some of these environmental costs cannot be systematically traced or attributed to responsible processes and products; but are simply summed up in the general overhead costs. Additionally, EMA is designed to help decision-makers to eliminate arbitrariness in reducing environmental costs through the development of a Management Accounting waste information system (UNDSD 2001). Therefore, through an EMA tool like MFCA, waste-related costs are likely to be separated and analysed to give support to the decision-making process.

Jasch and Schnitzer (2002:6) contend that environmental costs are not fully recorded but hidden in overhead accounts - something which often leads to distorted calculations for waste-reduction improvement options. They reflect that, in most instances, management and operational level managers are unaware that the cost of generating waste is usually more expensive than the cost of disposal. Jasch (2001:6) indicates that EMA represents a combined approach that provides the transition of data from financial accounting and cost accounting to increase material efficiency in production; reduce environmental impact and risk; and reduce costs of environmental protection. In other words, EMA combines both physical data and monetary data, which are internal to the organisation, to achieve improved social, environmental, and economic performance (UNDSD 2001). With regard to achieving these goals, the triple bottom line of sustainability accounting, which includes social, environmental and economic responsibilities, is promoted (Bouma & Correlje 2003). Hence, the need for managers in organisations to prioritise and achieve its social, environmental, and economic responsibilities may be addressed through the availability of sufficient accurate waste information provided by a Management Accounting framework.

2.7.2.2. The need for EMA within the organisation

Both conventional and other developed methods of environmental assessment such as life cycle costing, input-output analysis, and the balance scorecard have been adopted in the past to generate environmental information (Bouma & Correlje 2003:258). Jasch (2003:78) contends that the conventional environmental cost assessment methods have failed to provide material flow data in production, since they mainly consider waste treatment and disposal costs and investments in end-of-pipe technologies. But even so, Jasch (2003) acknowledges that conventional environmental cost assessment is useful for cleaner production projects, as well as the disclosure of environmental performance in environmental reports, and in material flow balances such as input-output analysis. More importantly, Jasch (2003:78) explains that the disclosure of environmental performance in reports are usually done without systematically integrating the two information systems of material flows information and waste treatment and disposal cost information.

Bouma and Correlje (2003:257) assert that EMA generate better environmental cost information by analysing environmental information into both financial and non-financial information. The growing concern for a safe and clean environment by governments and pressures from environmental activists have made some organisations to seek alternative methods like EMA to reduce the environmental impact in their operations (Bouma & Correlje 2003:258). Hence, the use of an alternative method for capturing waste-related cost information may be needed through the adaptation of the existing MAS to address more specific but contingent environmental needs such as waste-reduction.

2.7.2.3. The focus of EMA

The accounting need of managers in relation to improving corporate environmental performance through appropriate waste-reduction decisions is the main focus of EMA (Burritt 2005:19). Likewise Nakajima (2003:48) asserts that EMA is essential in an Environmental Management Systems (EMS) in order to reduce environmental impact in concrete terms and at the same time support management decision-making and improve corporate profit. Osborn (2005: 94) reiterates that the adoption of EMA by an organisation as a process of innovation requires both radical and incremental change and, therefore, proposes that this process of innovation should be integrated throughout the mainstream MAS and should not be isolated. In contrast, Bewley and Magness (2008:61) argue that in most instances organisations usually believe that environmental costs are insignificant to the operation of their businesses since such costs can be passed on to consumers. Therefore, this study highlights the potential benefits to an organisation that adopts and incorporates the MFCA framework into its MASs and its impact as a support tool for sound waste-reduction decisions.

The identification of environmental costs through EMA systems enables decision-makers to justify their waste-reduction strategies and discover new means of cost savings and be able to improve environmental performance at the same time (Jasch 2003). Jasch and Stasiskiene (2005:77), however, express concern that organisations are often not able to precisely identify their environmental or social costs and even less the benefits and savings from improved environmental and social performance. Despite this shortcoming, Staniskis and Stasiskiene (2003:62) argue that EMA provides an essential set of information which supports internal decision-making and programs that could minimise environmental impacts such as in process waste-reduction. In other words, environmental costs are a sub-set of the larger cost incurred by the organisation that is useful for decision-making (Jasch 2003). Rather environmental costs should be seen as a part of the integrated system of material and energy flows throughout the organisation (Jasch & Stasiskiene 2005:77). EMA is simply doing better environmental cost analysis than conventional MASs by revealing hidden environmental costs (Jasch 2003). This means that the integration of conventional MASs to include environmental cost analysis is likely to assist to improve waste-related decisions.

Staniskis and Stasiskiene (2003:67) warn that merely updating the conventional MASs and enlarging it to include EA will not help to solve environmental problems; unless the information management systems of the organisation are integrated with EMS. Furthermore Staniskis and Stasiskiene (2003) insist that EMA is helpful in the internal decision-making process both in physical procedures for material and energy consumption flows and final disposal, as well as in monetary procedures for cost savings and revenues relating to activities with potential environmental impacts. The focus of EMA is to improve resource efficiency, save production costs, and increase profitability through improved waste-reduction decisions (Nakajima 2003:48; Staniskis & Stasiskiene 2003:62; Burritt 2005:19; Osborn 2005:94). Hence, to integrate the conventional MAS with EMA may facilitate the capturing of adequate waste information for improved waste-reduction decisions.

EMA provides internal management with reports on waste generation through MFCA to support decision-making by analysing output waste into good product and non-product output (Jasch 2003; METI 2007). It is profitable to incorporate environmental performance evaluation into departmental performance measurement so as to provide information that will be useful in choosing appropriate production capital investment and budget to ensure that environmental costs and losses are well optimised (Nakajima 2003; METI 2007). Furthermore, EMA ensures that environmentally-conscious cost management elements are considered and incorporated into the design and development stages of product making (METI 2007). In this study, the application of a Management Accounting waste information framework is considered relevant to provide an appropriate analysis of process waste information to achieve resource efficiency and increased environmental performance.

2.7.2.4. The conceptual framework of EMA

Conventional MASs tends to neglect the fact that information interest varies to a large extent between different stakeholders (Schaltegger, Hahn & Burritt 2000:13). The distinction between monetary and physical information (see Figure 2.4) provided by EMA, leads to the fundamental criterion for structuring environmental accounting information for both internal and external stakeholders (Schaltegger & Burritt 2000:58). The EMA framework is based on the following assumptions. Firstly, the belief that the tools associated with EA, including EMA, can assist the drive towards a sustainable society (Schaltegger & Burritt 2000:46). This study creates an understanding to facilitate the communication and promotion of EMA tools and philosophy among stakeholders to improve process waste-reduction decisions.

Secondly, as Bennett, James and Klinkers (1999:32) suggest, a conceptual separation between internal and external accounting should be based on the level of detail and aggregation of information, and the extent to which confidentiality differs between the needs of management and other stakeholders. Bennett *et al.* (2002) argue that EMA promotes a separate focus on the accounting needs of management, rather than on the needs of external stakeholders. They maintain that focus should be on internal Management Accounting rather than on external reporting, which can lead to distortions in the collection and use of information for decision-making in order to assist managers improve their process waste-reduction strategies. Thirdly, Schaltegger and Burritt (2000:67) found that different types of managers rely on and have their performance assessed using either physical, or monetary or both types of information. Furthermore, they mention that different managers have different criteria on which their performances are evaluated.

Specifically, the criteria include:

- Identifying environmental improvement opportunities;
- Prioritising environmental actions and measures;
- Environmental differentiation in product pricing, mix and development decisions;
- Transparency about environmentally relevant corporate activities;
- Meeting the claims and information demands of critical environmental stakeholders, to ensure resource provision and access; and
- Justifying environmental management decision and environmental protection measures.

Therefore, it is plausible that the MAS to be adopted is one that facilitates the analysis of all necessary corporate environmental information to support sound process waste reduction decision-making through data integration.

Furthermore, Schaltegger and Burritt (2000) explain that decision-makers require different forms of information to help meet their goals. These include information on:

- Physical measures of material and energy flows and stocks and related processes and products, and their impacts upon the environment;
- Monetary measures about the economic impact of environmental initiatives such as pay-back-periods and return on capital or investment; and
- Qualitative measures of stakeholder claims.

The above contrasts the needs of a production manager, whose concern is to have control over operations, optimise energy and material consumption, and the reduction of environmentally-induced risks and in need of physical measures of material and energy flows and process records (Burritt & Saka 2006). Hence, a Management Accounting framework that supports process waste-reduction decisions in the South African brewery industry is likely to assist managers to measure materials and energy flows and to inform on areas needing improvements.

Finally, Schaltegger and Burritt (2000:17) maintain that managers have always been concerned with the need to improve materials and energy efficiency in order to improve economic results in their organisations. For instance, the derivation of physical material and energy flows are necessary information before it is expressed in monetary terms (Schaltegger & Burritt 2000). This means that physical information derived in conventional MASs could be of great use in EMA, and it is plausible for decision-makers to understand the information provided by physical units and monetary value from the point of view of environmental impact. This study, therefore, argues that the use of a Management Accounting waste information system could probably ensure the availability and analysis of the environmental impact of process waste to support and promote efficient production.

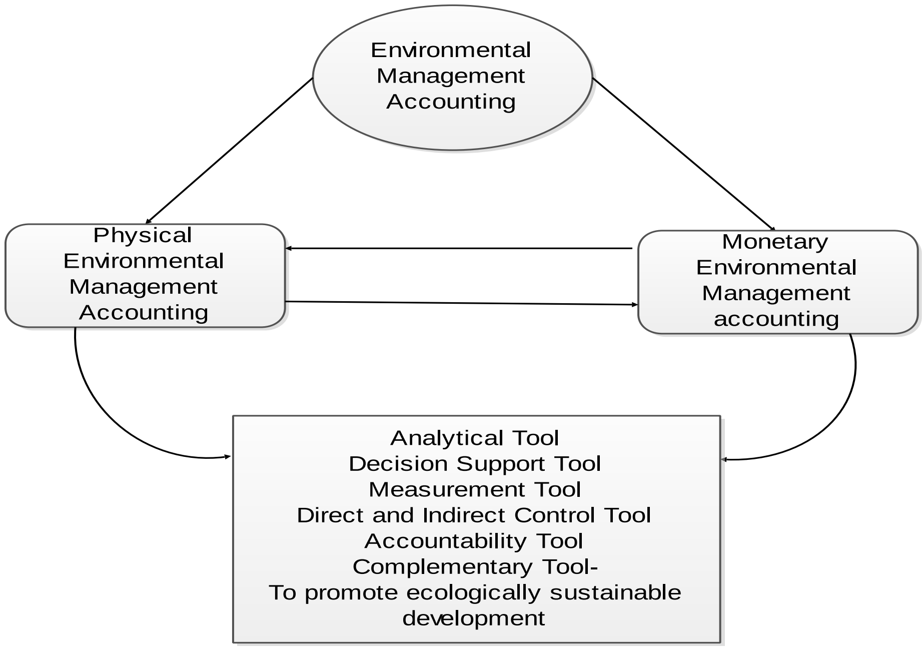


Figure 2.4 Researcher's illustration of a conceptual EMA framework

2.7.2.5. Physical environmental management accounting

Physical environmental Management Accounting (PEMA) focuses on an organisation's impact on the natural environment which is expressed in terms of physical units such as kilograms, barrels, or tonnes. In addition, PEMA collects physical environmental information for internal decision-making and is designed to collect the environmental impact in physical units for internal use (Schaltegger & Burritt 2000:61). Moreover, Schaltegger and Burritt (2000:61) classify PEMA as an internal environmental accounting approach that serves the following purposes:

- An analytical tool designed to detect ecological strengths and weaknesses;
- Decision-support technologies concerned with highlighting relative environmental quality;
- A measurement tool that is an integral part of other environmental measures such as eco-efficiency;
- A tool for direct and indirect control of environmental consequences;
- An accountability tool providing a neutral and transparent base for internal and, indirectly, external communication; and
- A tool with a close and complementary fit to the set of tools being developed to help promote ecologically sustainable development.

In essence, the determination of physical environmentally-related information is likely to assist managers to place value on the process waste created during production, thereby providing opportunity for cost savings and improved environmental performance.

Above all, to assess costs correctly, an organisation must collect both physical and monetary data on material usage, personnel hours and other costs drivers (International Federation of Accountants Committee (IFAC) 2005:20). EMA's emphasis is on materials and material-driven costs. The use of water, energy and materials, as well as the generation of waste and emissions, are directly related to the environmental impact of an organisation. Indeed, material purchase costs are a major cost driver in many organisations (Strobel 2001). Most organisations purchase water, energy, and other materials which are converted into final products, though, some of these items fail to become the intended final product, but instead become waste which may be as a result of deficiencies in product design, operating inefficiencies, or quality issues. Consequently, this study argues that the use of a Management Accounting waste information system is likely to make all operating inefficiencies visible, thereby enabling managers to improve their process waste-reduction decisions.

Managers within organisations are required to know the quantities of materials, water, and energy introduced at the beginning of production and the quantities that became good products or waste at the output stage (Jasch 2000). Similarly, Gibson and Martin (2004) advocate that, to effectively manage and reduce the physical amount of waste generated in any production process, managers require accurate data on the physical amount and destinations of all the materials, water, and energy used during production in order to make informed waste-reduction decisions. Hence, the availability and accuracy of such physical waste data and its corresponding monetary value provided through a Management Accounting waste information system is likely to assist managers to effectively manage and reduce the potential environmental impact of waste.

2.7.2.6. Monetary environmental management accounting

As previously stated, organisations define environmental costs differently to suit their intended environmental information needs. Two most widely used schemes for defining and categorising environmental costs at the organisational level for EMA purposes are those of the United States Environmental Protection Agency (USEPA 1995) and the Japanese Ministry of Environment (MoE 2002). USEPA (1995) describes environmental cost as the costs incurred to comply with environmental laws which are clearly environmental costs and also listed costs of environmental remediation, pollution control equipment, and noncompliance penalties as unquestionable environmental costs. Furthermore, other costs incurred for environmental protection are likewise clearly environmental costs, even if they are not explicitly required by regulations or go beyond regulatory compliance levels (USEPA 1995:11). Environmental cost refers to the investment and costs, measured in monetary value, allocated for the prevention, reduction, and/or avoidance of environmental impact, removal of such impact, restoration following the occurrence of a disaster, and other activities (MoE 2002:10). Consequently, this study's focus is to make visible to decision-makers all related waste information both in quantity and costs such that improvements could be made to the existing system of process waste-reduction decisions.

By the way, Monetary Environmental Management Accounting (MEMA) deals with environmental aspects of corporate activities expressed in monetary units and generates information for internal management decision-making (Schaltegger & Burritt 2000: 59). MEMA adopted the conventional MAS by extending and adapting it to measure an organisation's environmental impact in monetary value. With regard to this, Schaltegger and Burritt (2000) indicate that MEMA is the central, pervasive tool that provides the basis for most internal management decisions on environmental matters and, furthermore, MEMA is used to track and trace costs and revenues resulting from an organisation's environmental impact. Therefore, by providing the needed cost information on the amounts of materials, water, and energy flows, MEMA contributes to the strategic and operational planning decisions of the organisation. Hence, there may be a need that such information needs of managers be better accessed when a Management Accounting waste information system is used which may result in sound process waste-reduction decisions. The MFCA framework is a subset of EMA and is specifically developed to measure process waste in terms of quantity and cost by separating output into good and negative products for proper analysis so that corrective actions can be taken to reverse process inefficiencies (Jasch 2003).

The next section presents discussions on the different environmental cost approaches or tools under EMA which culminate in the latest tool MFCA framework. This is important since MFCA is the foundation on which this study is based.

2.8. ENVIRONMENTAL COST APPROACHES UNDER EMA

Different approaches have been used to assess environmental costs at different times under EMA framework. Some of these approaches include activity-based costing, full costing, life cycle costing, and most recently, Material Flow Cost Accounting which is the focus of this study.

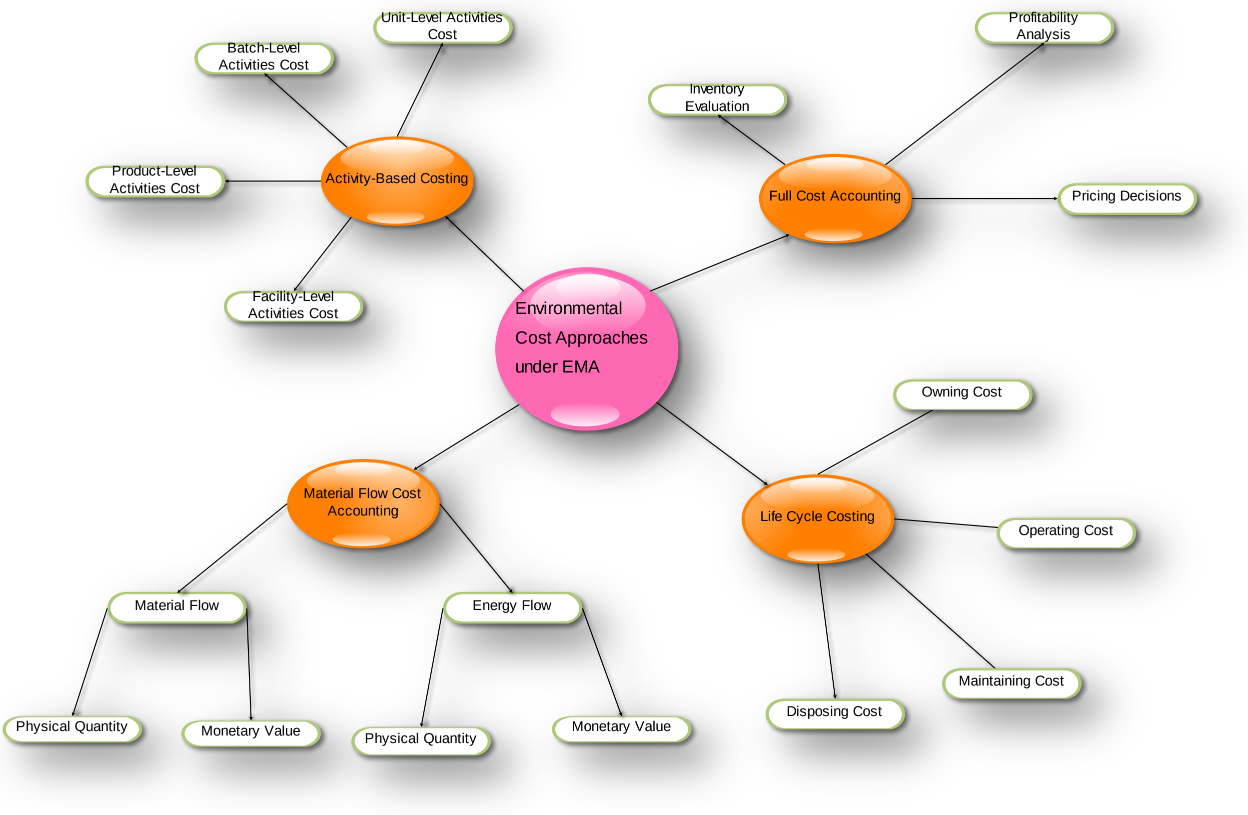


Figure 2.5 Researcher's illustration of environmental cost approaches under EMA

The following sections briefly discuss each of these approaches in the following sub-sections (see Figure 2.5).

2.8.1. Activity-based costing

The Activity-Based Costing (ABC) approach attempts to assess environmental costs by integrating EMA into the strategic management process and the linking of management objectives and activities (Schaletegger & Wagner 2005:53). On the other hand, Bartolomeo, Bennett, Bouma, Heydkemp, James, de Walle and Wolters (1999:194) state that ABC collects, reports, and allocates, as directly as possible, costs to the activities that cause the costs. Notably, this costing method shows the costs, including environmental costs that are made for those specific activities. As an EMA systems approach, it encourages managers to try and trace environmental costs to products responsible for those costs by calculating the costs of organisation's environmental activities using volume as cost drivers (Burritt & Saka 2006). According to Bartolomeo *et al.* (1999:54), the superiority of the ABC approach to the direct costing approach includes the ability to distinguish between:

- Unit level activities, whereby costs vary with the number of units of products processed;
- Batch level activities in which costs vary with the number of batches processed;
- Product level activities whereby costs vary with the number of product in the range of products; and
- Facility level activities, which include costs of services like administration and cleaning of buildings.

Despite its superiority over the direct costing approach, it is considered expensive for most organisations, and it fails to consider future environmental cost, which is under consideration by the current study (Dascalu *et al.* 2010). However, the ABC approach is unsuitable for the current study since it does not provide specific environmental costs to support process waste-reduction decisions. Hence, an approach that considers future environmental cost may be required to support organisations' process waste-reduction decisions.

The next section discusses the full cost accounting approach of assessing environmental costs.

2.8.2. Full cost accounting

In the context of EMA, the full cost accounting refers to the allocation of both direct and indirect costs to a production process for the purpose of inventory evaluation, profitability analysis, and pricing decisions (USEPA 2000:80). Full Cost Accounting (FCA) is a term often used to describe desirable environmental accounting practices. Also, FCA seeks to monetise externalities. In this study, full cost accounting is expressed as an environmental cost accounting concept that allocates both direct and indirect environmental costs to a production process to identify and analyse specific environmental costs such as process waste costs. Moreover, full cost accounting can be used to measure the value of a product in comparison to environmental damage caused by its production (Jones 2010:124). Total environmental costs include any commitment of or use of materials, energy, time, physical resources such as equipment, and any other assets of the organisation used in production (USEPA 2000:80). Furthermore, FCA assigns value to all commitments related to production whether they are paid for immediately or at a later date. In relation to the current study, it may indicate that all costs relating to production are considered while related expenses incurred are recorded and presented to managers to make improved process waste-reduction decisions.

The next section discusses the life cycle costing approach.

2.8.3. Life cycle costing

Life Cycle Costing (LCC) refers to the economic analysis of a product or project in which all costs arising from owning, operating, maintaining and ultimately disposing of the project are considered to be potentially important to that decision (Grant 2009:28). However, the impact of LCC into the future becomes lesser as a result of discounting of future monetary flows. Even more, LCC calculated on projects are associated with different stakeholders with cost data often represented by price at specific points in the supply chain (Grant 2009). More importantly, the motivation for LCC is to fully account for the financial costs of life-cycle environmental aspects and impacts that ultimately result from a decision (Swarr, Hunkeler, Klöpffer, Pesonen, Ciroth, Brent & Pagan 2011:390). Either way, this can be achieved by internalising costs such as polluter pays or using information to make the impact visible at the time of the decision (Swarr *et al.* 2011). Whereas only the costs that are likely to be internalised at the time of making decisions are then internalised. As such, these costs reflect only real monetary flows linked to the production process. Yet the LCC approach conflicts with generating process waste information to improve waste-reduction decisions because it focuses on internalising environmental output costs through the polluter pays principle (Bennett, Bouma & Wolters 2002:4). However, the current study focuses on the reduction of process waste before it actually becomes output waste through improvements of processes and designs through appropriate capturing of waste cost information during production using the MFCA framework.

2.8.4. MATERIAL FLOW COST ACCOUNTING

The MFCA framework is developed to measure the flows of materials and energy in the production processes both in physical quantity and monetary value (Onishi *et al.* 2009:398). Also, as an accounting tool it captures the material flows and monetary flows in the production process, and makes clear any inefficiency in the production process by using physical and monetary information (Hargroves & Smith 2012). Moreover, in the MFCA analysis, operation costs of production are allocated to material flows (Hyršlová *et al.* 2011:6). Additionally, it provides cost and quantity information on resource productivity for environmental management as well as production management (METI 2007). More importantly, by applying MFCA, all input materials in the production process can be traced and categorised either as positive or negative products (Jasch 2009). However, the environmental costs to be managed include raw material costs and all related overheads charged to waste (non-product) output (Jasch 2006). Although, the scope of the environmental costs is very wide, through MFCA, high environmental costs are often identified, drawn to the attention of managers and managed once their size is realised (Jasch 2003). The use of MFCA information to improve brewery process waste-reduction decisions is the focus of this study and is expanded in Chapter three.

2.9. SUMMARY

In this chapter, the theoretical perspective for this study was described. This contingency approach to Management Accounting is based on the premise that there is no universally appropriate management accounting system applicable to all organisations in all circumstances. Again, the study suggests that contingency theory needs to be designed to identify specific aspects of an organisation's accounting system that is associated with certain defined circumstances and to demonstrate appropriate matching to specific needs within the organisation such as its environmental impact and resource utilisation.

The impact on the environment by organisations due to unsustainable use of natural resources and production inefficiencies extends beyond compliance with waste-management regulations and raises a major challenge and implications to the Management Accounting function. Conversely, waste management approaches, as well as the challenge and relevance of Management Accounting information in environmental decisions, pose a challenge to organisations to reduce waste generation, increase shareholders profit, and improve environmental performance. Consequently, deciding on an appropriate waste minimisation strategy requires informed analysis of available options. Therefore, it is the responsibility of the accounting systems within individual organisations, whether small or large, to provide adequate waste information for informed decisions.

Environmental issues associated with the brewery process include energy consumption, water consumption, wastewater, solid waste and by-products, and emissions into the air. However, breweries in South Africa can intensify efforts to reduce the environmental impact of beer not only in the way it is packaged, but in the entire brewing process.

Even more, the MAS has a responsibility to provide quality environmental information to assist managers to make informed decisions and to improve the efficiency and effectiveness of existing operations. Yet the failure of organisations to meet the challenges of comprehensive environmental reporting is the reason most organisations continue to be unaccountable for their unsustainable practices. Nevertheless, EMA has been developed to provide managers with adequate financial and non-financial environmental analysis in order to optimise corporate environmental and economic performance and to achieve sustainable business. There are different environmental cost approaches used to assess environmental costs at different times by organisations including activity-based costing, full cost accounting, and life cycle costing. However, the failure of these environmental cost approaches at analysing waste cost sufficiently informed this study. This study advocates the use of material flow cost accounting (MFCA) to sufficiently capture and analyse all related waste cost and facilitate improved waste-reduction decisions among organisations. The next chapter provides discussions on material flow cost accounting.

CHAPTER THREE

MATERIAL FLOW COST ACCOUNTING

3.1. INTRODUCTION

Chapter One introduced the scope of this research, Chapter Two reviewed the literature on the link between Management Accounting and waste management, discussed various waste management concepts, the major environmental impact of the brewery industry as well as relevant standards by the International Standards Organisation (ISO) that regulates the issue of waste in the industry, reviewed the challenges of accounting for waste, and the interventions and recent developments in the accounting discipline to incorporate and report environment-related information like waste separately for improved decisions. This chapter reviews the relevant literature on the development of Material Flow Cost Accounting and the effects of integration between enterprise resources planning (ERP) and MFCA. MFCA which is a major concept in this study is discussed. It links to objectives one and two of this study.

The debate about resource efficiency especially relating to process waste-reduction is not only a concern for scientists, environmentalists, and environmental activists. In an effort to contribute to the waste-reduction issue from a different perspective, contemporary Management Accounting developed a waste specific collection tool, MFCA to provide both financial and non-financial waste information to support waste-reduction decisions by managers.

3.1.1 GOAL OF THIS CHAPTER

The aim of this chapter is to discuss MFCA that was developed to provide waste cost information by making visible waste related costs hidden in overhead accounts in the conventional accounting system. MFCA was developed to analyse production output into good and negative products. This enables managers to identify and determine the sources of waste generation and its corresponding value to improve decision-making. Hence, this chapter argues that, an understanding of the MFCA approach will make stocks and flows of materials and energy in production processes visible and transparent so that managers can initiate corrective actions to reverse identified areas of inefficiency.

3.1.2 LAYOUT OF THE CHAPTER

The previous chapter provided a general understanding of Management Accounting information systems for waste management. This chapter provides a detailed discussion on material flow cost accounting which is the focus of this study, and Figure 3.1 provides a visual representation of the chapter's layout. A review of the development of MFCA is provided in Section 3.2. Types of waste information, such as positive and negative product costs included in MFCA calculations, are explained in Section 3.3. In Section 3.4, the application of MFCA is discussed. Material flow analysis approaches, such as environmental costing and waste costing, are discussed in Section 3.5. In section 3.6, the true cost of waste is addressed. The benefits of MFCA are the topic of Section 3.7, while Section 3.8 discusses the differences between MFCA and conventional Management Accounting Systems. An analysis of the findings in the literature is presented in Section 3.9 and the steps for introducing and utilising MFCA, which include identifying the need for an alternative waste reduction technique; determining waste-reduction targets for product lines and processes; collection and compilation of brewery output through MFCA calculation; comparing and analysing planned and actual waste-reduction targets through MFCA; and responding to divergence from planned waste-reduction targets, are provided in Section 3.10. The potential of MFCA to the organisation and its external environment is presented in Section 3.11. The integration of MFCA with enterprise resource planning is presented in Section 3.12, including relevance of data integration to brewery waste-reduction decisions, and the effects of integrating MFCA and ERP are addressed in Sub-sections 3.12.1 and 3.12.2 respectively. The chapter is summarised in Section 3.13.

This layout is represented in Figure 3.1.

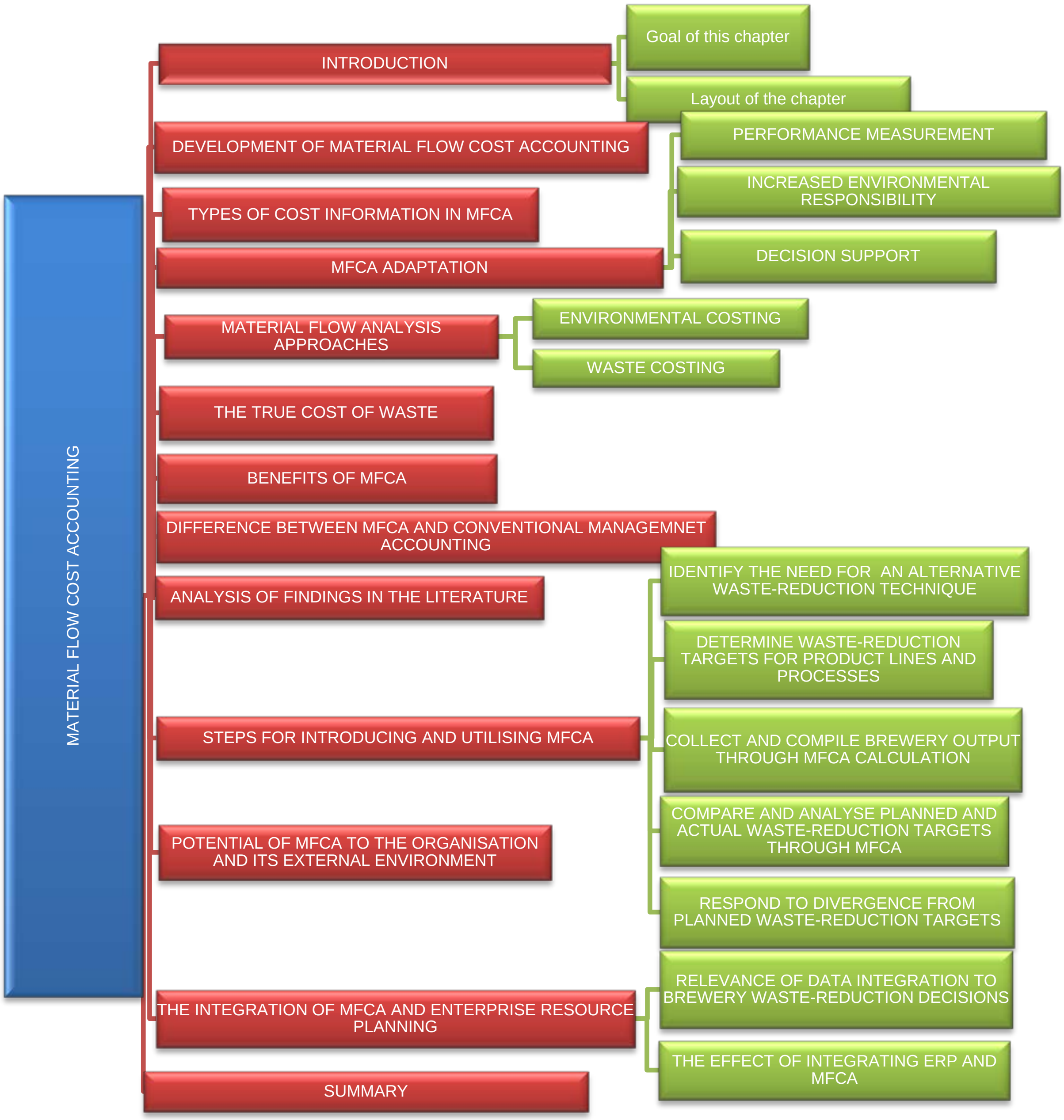


Figure 3.1: A visual representation of the layout of Chapter 3

3.2. DEVELOPMENT OF MATERIAL FLOW COST ACCOUNTING

MFCA as an EMA tool was developed in Germany by Bernd Wagner and colleagues at the Institute für Management und Umwelt (IMU) and has been adopted in Japan since the year 2000 by industries (Kokubu *et al.* 2009:15). MFCA was developed to provide both financial and non-financial waste information that is necessary to improve and facilitate process waste-reduction decisions (Burnett & Hansen 2008:555; Burritt & Schaltegger 2010:835; International Federation of Accountants Committee (IFAC) 2010). On the other hand, the ability of MFCA at improving process waste-reduction decisions is becoming apparent (Ministry of Economy, Trade, and Industry (METI) 2007). Indeed, MFCA has attracted increased attention and interest as a support tool for improving process waste-reduction decisions (Jasch 2003; Nakajima 2003). MFCA's objective is to reduce environmental impact and costs at the same time, and as a tool of decision-making by business executives and on-site managers (METI 2007:2). However, the focus of MFCA is to trace and track waste, emissions and non-products as they occur in a production process in order to reduce costs through waste-reduction, thereby improving business' productivity (METI 2007:2; Schaltegger, Bennett, Burritt & Jasch 2009:4). It is plausible that an organisation's economic and environmental performance is likely to receive improvement when its output is analysed into good and negative products through the adoption of MFCA.

Kokubu *et al.* (2009:16) state that MFCA is a management information system that traces all input materials through production processes, and categorises the output into good product and non-product output or waste. More importantly, the essential focal point of MFCA is the recognition of waste as a non-marketable product (Kokubu *et al.* 2009:16). There may be a need to analyse process output into marketable and non-marketable product which in turn may assist managers to improve on their waste-reduction decisions when waste and emissions are expressed both in value and physical terms and positively increase organisations' environmental performance. Furthermore, the availability of precise waste data may motivate managers to enhance material productivity and significantly reduce process waste more effectively rather than reliance on conventional production and cost accounting information.

The conventional cost accounting systems that are widely used in the manufacturing and other industries such as the brewery industry are usually based on established standard costs to which actual costs are compared where after the resulting cost variance is analysed and addressed (Rasid, Zaleha, Rahman & Rahimet 2009:103).

This may indicate that materials consumed above the standard are considered as waste. In contrast, MFCA attributes all materials that do not become saleable product as waste and this non-output product is labelled as negative product and all related costs are recorded as negative product costs (METI 2007:9). In essence, MFCA identifies all material losses as waste or non-product output, while the conventional standard costing system failed to account for losses beyond the established standard. This study argues that cost variance in the standard costing system is not likely to reflect all material losses, since the established standard costs include materials lost as waste, often referred to as normal loss.

3.3. TYPES OF COST INFORMATION IN MFCA

Losses caused by inefficiency in the production process are not limited to material cost (Allwood, Ashby, Gutowski & Worrell 2011) since all productive activities require labour input, energy, water, depreciation of equipment, waste treatment, all of which have to be accounted for in production (Le Net, Bajric, Vötter, Berg, Anderson & Roux 2011). In addition, MFCA includes all these costs throughout the material flow, from input to output, which include waste treatment by tracking the flow of each raw material and accumulating the quantity and cost information to that flow (METI 2007). However, to constantly improve process waste-reduction decisions there may be a need to adjust the current MFCA calculations without subsuming major waste categories as presently done.

MFCA categorises product costs into the following (see Figure 3.2):

- **Positive product costs:** these are costs of all activities in a production process transferred to the next process. The positive product costs are added to new input cost of the next process until the final output.
- **Negative product costs:** these are costs of all activities wasted or recycled items in a production process.

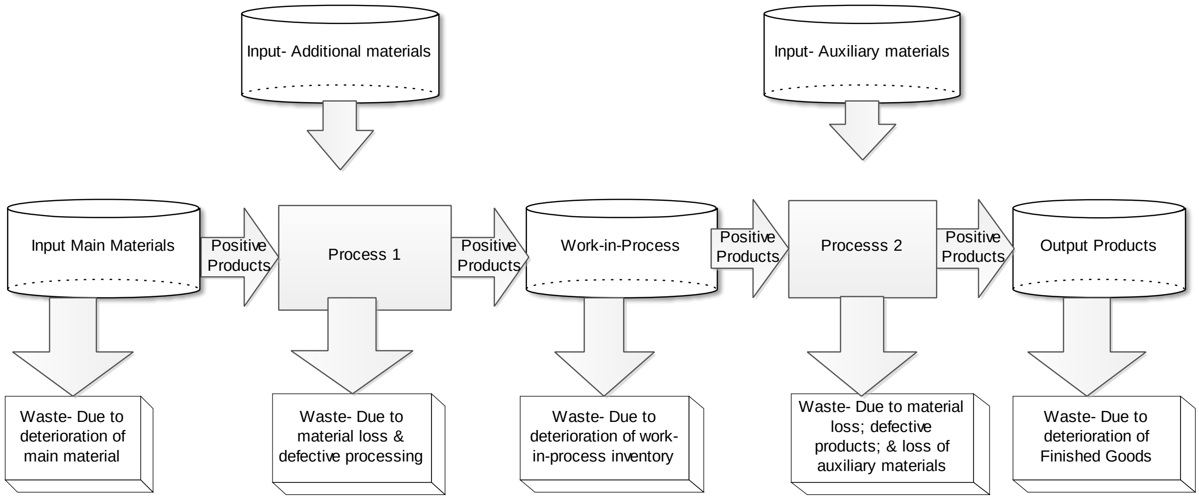


Figure 3.2: MFCA analysis of waste into positive and negative products *(Source: Adapted from METI (2007: 3)*

More importantly, MFCA categorises all costs into material costs, systems costs, energy costs, and waste treatment costs (METI 2007). According to METI (2007),

- Material costs include costs of input materials, additional material costs, and auxiliary materials costs like detergents, solvents, and catalysts;
- Systems cost includes labour cost, deprecation charges, and other overhead costs;
- Energy costs are the cost of electricity, fuel, utility, and other energy costs; and
- Waste treatment costs are costs incurred in converting process waste to an acceptable standard before it is discharged to the environment.

It could be said that the MFCA generates better and more comprehensive waste cost information to inform sound waste-reduction decisions. However, this study argues that certain waste related costs may have been subsumed or neglected in MFCA calculations. The study therefore attempts to bridge this gap.

3.4. MFCA ADOPTION

Organisations are required by regulations such as the International Standard Organisation (ISO) series 14000 to give priority to reducing their environmental impact throughout the various phases of their operations (ISO, 2007). This might be the reason why many organisations are promoting environmental management in their facilities just to comply with regulations and environmental laws. However, some organisations are promoting environmental management through waste recycling (Morrow & Rondinelli 2002:168). Waste recycling is an important waste management measure that promotes effective use of resources (Geng, Zhu & Haight 2007:146). The recycling process often requires incurring substantial expenses on input acquisition and the consumption of kilowatts of energy during the conversion of recyclable materials for eventual use as input materials (van Berkel 2005). In addition, recycling expenses include amount spent on material resource from input to output to waste generation (Smith & Ball 2012). Consequently, waste-reduction may seem a logical option since it avoids such expenses as in a recycling.

The adoption of MFCA in an organisation will assist to capture material and monetary flows in a production process, and makes any inefficiency in the production processes clear by using physical and monetary information (Jasch 2003:669). This is since MFCA identifies the quantities and costs of materials, processing, and waste treatment so that decision-makers can have a look at the very source of waste generation with a transparent view of impending challenges in its reduction, which leads to reduction of waste generation itself (METI 2007). Consequently, there may be a need to adopt the MFCA framework in an organisation to facilitate environmental performance, increase environmental accountability in terms of regulatory compliance, and support informed environmental and waste-reduction decisions (see Figure 3.3).

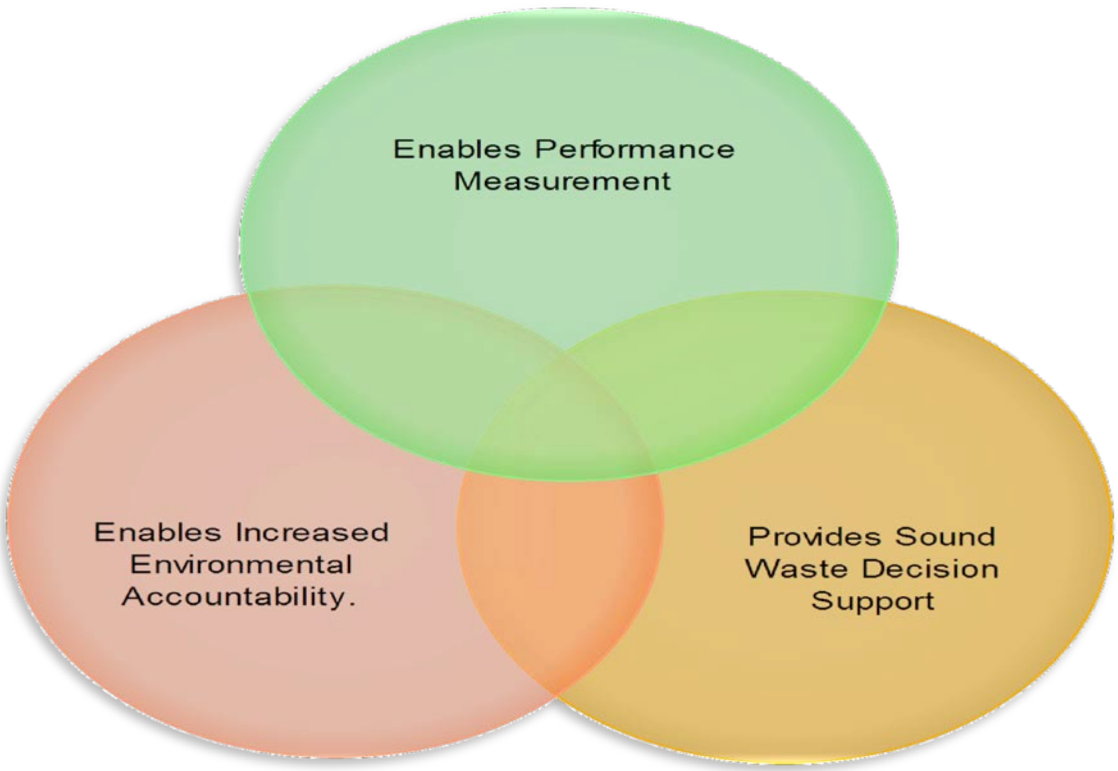


Figure 3.3: Researcher's illustration of improvements from adopting MFCA for an organization

3.4.1. PERFORMANCE MEASUREMENT

Bartelmus (2009:1850) indicates that the difficulties of measuring the utility of economic goods and aggregating it are more pronounced for ecological or environmental services, which, in most cases, are not traded and priced by market forces. Alternatively, MFCA is a valuable tool to measure and internalise environmental performance results and improvements with regard to established waste-reduction targets (Jasch 2006). MFCA can provide the needed physical and monetary process waste information in creating environmental performance indicators that will enable environmental performance measurement (Nakajima 2003). An objective of waste-reduction from an environmental point of view is to eliminate inefficiency in resource usage throughout the whole production process (Gray & Bebbington 2001:143; Schiliephake *et al.* 2009:1258). In contrast, this study argues that the end-of-pipe approach to waste management is the treatment of output waste to reduce its hazardous content for safe disposal to waste sites. However, the need to identify; measure and assign costs to processes generating waste, thereby assisting operational managers to achieve improved environmental performance and make sound process waste-reduction decisions is plausible to be filled through the adoption of the MFCA framework that is specifically.

3.4.2. Increased environmental accountability

Nevertheless the provision of environmental-related information is seen as a responsibility of the MAS (Jasch 2006). Hence, waste information generated through the MFCA framework reflects this responsibility which promotes organisations' accountability to its society (Kokubu *et al.* 2009:17). Even more the MASs facilitate the provision of adequate financial and non-financial waste information to support waste-reduction decisions (Jasch 2009). Indeed, such information should be useful to both the external and internal stakeholders with diverse information needs (ICAEW 2004). As a result, organisations can improve their accountability role through the inclusion of MFCA information in external reports as provided by Canon Incorporated (Canon 2011). As such, the information provided by MFCA may be instrumental in the provision of support for sound process waste-reduction decisions. However, this study contends that greater improvements can be made to current systems for better process waste-reduction decisions.

3.4.3. Decision support

Many organisations have failed to consider the full range of environmental costs in their decision-making in the past (van der Vorst, Grafe-Buckens & Sheate 2010:172). However, with increasing regulations and tightening of environmental laws, organisations may need to select an appropriate Environmental Management System (EMS) or a combination of approaches to fulfil their environmental responsibilities. Although, the adoption of MFCA is still in its early stage, it can assist decision makers within organisations to achieve improved environmental performance (Schaltegger *et al.* 2012). Most often, organisations are unaware of the loss incurred from recyclable waste, since such waste is reused as resources and sometimes can be sold to external recyclers for a fee (van Berkel 2005). Yet processing costs lost in waste such as labour, depreciation, fuel, utility, and materials discarded due to deterioration of quality or because of the introduction of new product designs are difficult to identify and do not usually form part of the environmental costs used in waste-reduction decisions (METI 2007:7). However, not all of these costs may be captured by the MFCA approach and therefore it becomes necessary to develop an adjusted MFCA waste information system to provide more comprehensive waste information to further improve waste-reduction decisions.

The waste-reduction decision process requires that waste generating sources are identified and the necessity for improvement is recognised. An organisation will be able to identify the existence of material loss and its monetary value through MFCA which it could not have recognised on a conventional basis (METI 2007). Quite often, organisations lay claims that they monitor their materials yield whereas in actual fact, only part of material losses in processes is covered in the scope of such monitoring. Indeed, losses arising from the main materials may be covered without monitoring the amount of auxiliary material costs lost (METI 2007). Regardless of this, decision-makers are often not aware of such losses, and opportunities for cost savings are lost (Jasch 2003:668). This is likely to happen if organisations concentrate their waste-management efforts on waste treatment only. Consequently, there may be a need to identify and uncover such uncontrolled material losses through an adjusted MFCA so that informed waste-reduction decisions can be made.

3.5. MATERIAL FLOW ANALYSIS APPROACHES

In Table 3.1 are different material flow analysis approaches and their levels of engagement. In addition, the table explains the level of waste information captured by the different material flow analysis approaches. MFCA provides comprehensive waste cost information in comparison to other approaches. Conversely, the conventional environmental costing approach provides the least comprehensive waste information, which includes systems costs after material losses and disposal costs while the waste-costing approach excludes both material costs in the product and systems cost incurred in generating waste in its calculation.

Table3.1: Material flow analysis approaches

	Environmental costing	**Waste costing**	**MFCA**
Material costs in the product (product & packaging)			X
Material costs in material losses		X	X

System costs for products			X
System costs before material losses occurs		X	X
System costs after material losses occurs	X	X	X
Disposal costs	X	X	X

Source: Researcher's illustration of material flow analysis approaches

Different material flow analysis approaches were presented in Table 3.1 indicating their extent of inclusion of important waste-related costs. As has been noted from Table 3.1, MFCA may a more comprehensive approach to material flow analysis with ability to improve waste-reduction decisions.

3.5.1. Environmental costing

The environmental costing approach is borne out of the importance of generating accurate cost information in making environmental decisions (Jasch 2003:667). Most often, environmental costs are difficult to define from a business point of view. But even so environmental costs are a subset of the operating costs of an organisation which give rise to externalities (Figge, Hahn, Schaltegger & Wagner 2002:271). This may indicate that when substances are released into the air, water, or land, the resulting environmental impact is considered a social cost or externality. However, environmental regulations have resulted in the internalisation of some of these environmental externalities by organisations (Libecap 2009:130). Therefore, with an appropriate Management Accounting waste information system within the organisation, there may be no need to incur some of these environmental costs.

As environmental externalities are internalised, investors begin to pay more attention to organisations' environmental risks to make investment decisions (Cagnin, Loveridge & Saritas 2011:285). Subsequently, these costs have to be captured by the conventional accounting system, in order for product costs to remain accurate to facilitate sound decisions (Balakrishnan, Labro & Sivaramakrishnan 2011). As such, improved waste treatment cost like wastewater plants and incinerators is likely to reflect in the costs of processes responsible for waste generation (Cordell, Rosemarin, Schröder & Smit 2011; Boesch, Vadenbo, Saner, Huter & Hellweg 2013). The environmental costing approach captures system costs after material losses had occurred as well as disposal costs (Jasch 2009:33). Waste costing and MFCA approaches may therefore provide more comprehensive cost coverage for material flow analysis which in turn provides better and improved waste information for informed waste-reduction decisions.

The next sections discuss the waste costing and MFCA approaches to material flow analysis for improved waste-reduction decisions.

3.5.2. Waste costing

An effective approach to become a waste-less business should be based on problem solving and helping the organisation understand why waste is generated (Van Berkel 2005:265). He opined that the successful transition to more sustainable waste management is conditional on finding practical ways for organisations to minimise and possibly eliminate their waste generation. Van Berkel (2005) furthermore reiterates that a more concerted innovative effort is required such as the development of products which prolongs the product life cycle; or the development and application of new technologies which reduces the generation of waste during product manufacture. Therefore, decision-making on brewery waste-reduction may require a clear understanding of waste generating sources in order to develop new products or technologies to minimise its generation.

Gray and Bebbington (2001:146-148) mention three ways in which organisations tend to account for waste. These are, namely:

- The identification of the total actual and potential cost of waste management borne by the organisation either on activity or site basis;
- Non-financial accounting drivers such as kilograms and watts can be used to capture record and communicate the physical quantities of waste; and
- The use of an environmental index to charge waste management costs such as disposal cost and cost of insurance to product costs.

In practice, the conventional accounting system is designed to satisfy the information needs of management and external stakeholders without consideration for environmental issues. The information provided have a strong economic interest in standardised comparable data and in receiving true and fair information about the actual economic performance of the organisation (Jasch 2003:668). Meanwhile, Schaltegger and Burritt (2000:45) opine that an important function of any accounting system is to provide information that is useful to the different stakeholders for evaluating their own needs. Whereas the conventional MASs do not fully allow for the assessment of environmental costs and has failed to provide information on an organisation's impact on the environment (Schaltegger & Burritt 2000:45).

Consequently, environmental costs such as environmental levies, fines, legal fees, cost of waste recycling equipment and other consultancy fees are included or hidden in overhead costs of organisations (Gray, Bebbington & Walters 1993:11). In addition, the limitation of the waste-costing approach is that it fails to include wasted material costs in product and product-packaging in waste cost valuations. Therefore, there may be a need for a Management Accounting waste information system such as an adjusted MFCA that captures all waste-related cost is most desirable to improve process waste-reduction decisions.

3.6. THE TRUE COST OF WASTE

The cost of waste in an organisation are categorised into two parts. These are costs associated with the generation of waste and the costs of disposal and management (Ahluwalia & Nema 2009:136). However, most waste costs are often hidden in overhead accounts for instance raw material cost included in waste, opportunity cost of wasted products, conversion cost of the non-product output like energy and labour costs, waste treatment cost, cost of recycling, lost time in production, storage and clean-up costs (METI 2007). In other words, these costs may likely have been accepted as inevitable production costs which include costs of rejects, change over losses, over-specified products, and costs of spills. Therefore, this study advocates the development of a more inclusive Management Accounting waste information system that will capture waste related information more comprehensively to provide support for improved waste-reduction decisions.

In the production process, the raw material cost takes up to 60% of the total manufacturing cost while disposal cost takes only 10% of the total cost of producing waste inclusive of the hidden costs (Sustainability Victoria 2009). Moreover, MFCA is concerned with input-output costing, waste costing, material-only costing, and pollution prevention costing. Likewise it measures environmental matters, material flows in physical terms such as in kilogram or kilowatt per hour and, also in monetary

terms in order to meet the information needs of the organisation's decision-makers (Wagner 2003a:54). Hence, the availability of appropriate waste-related information may be of great value to provide support to the decision-making process for the prevention of material wastage and reduction in production costs for effective product pricing.
The increasing consumption of non-renewable resources such as raw materials and the disposal of waste makes it necessary to increase material efficiency in production processes and product development (Heubach, Jurgens, Doring & Loew 2002:1). Furthermore, Gale (2006:1235) stresses that most polluting organisations pay up to three times for non-product output such as wastes and emissions. He listed such costs as the cost of purchasing raw materials, operational costs such as labour and infrastructural investment, a proportion of which ends up as wastes and emissions; and the cost of disposal of the wasted materials purchased or for the environmental licences. Hence the inability to fully recognise necessary waste costs in a production process could lead to inappropriate waste-reduction decisions which mean that cost savings opportunities may be lost.

According to Jasch (2003:669), costs such as factory labour, indirect material cost, water, electricity or energy, wastewater treatment and waste disposal costs on non-product output are quite alarming and could be considerably reduced when an appropriate tool is applied to provide decision-makers with the required information. She mentions that other costs such as environmental levies, fines, legal fees, cost of waste recycling equipment, and other consultancy fees could have been drastically reduced as well. Similarly, once the source of waste generation and the volume at that source have been identified, and the appropriate data have been collected, recorded, grouped or summarised and analysed, adequate measures of control can be put into effect. Consequently, the inability to accumulate environmentally related costs in a production process by tracking, monitoring, and documentation may be the reason for inappropriate process waste-reduction decisions thereby leading to the occurrence in high environmental costs within organisations.

3.7. BENEFITS OF MFCA

The development of MFCA has brought improvements to waste-reduction decisions, as well as increased the opportunity for cost savings to organisations that have implemented this system (Nakajima 2003). For example, in Japan, many organisations have improved their resource efficiency by adopting MFCA (Kokubu *et al.* 2009). Similarly, in Austria, a brewery, Brewery Murau saved the sum of $186 000 in 2006 (Jasch 2003:77) by implementing MFCA in its waste-reduction drive. MFCA is effectively used in Germany where it was developed by organisations (Wagner 2003a). Specifically, the adoption of the MFCA framework in a production process such as in the brewery industry may have possibilities for improvements in resource usage that benefits the organisation as a whole.

Some of the benefits of resource efficiency include the following:

- To begin with, information generated through MFCA allows for appropriate and accurate evaluation of investment items which result in increased production efficiency through capital investment (Jasch 2009:33);
- Secondly, MFCA provides internal and external benefits that enable organisations to make greater profit with less environmental impact (Kokubu *et al.* 2009:17). Such benefits include the strengthening of an organisation's competitiveness through the delivery of both increased profit and material productivity (Jasch 2009:33). External benefits may include the production of same quantity of finished products with less input. This will lead to a reduction in environmental impacts from carbon emissions (CO2) and less consumption of natural resources (Jasch 2009:33);
- Thirdly, the possibility of evaluating production process cost accurately and the reduction in waste costs by adapting changes to existing product designs and the type of raw materials used (Jasch 2009: 33);
- In addition, MFCA enables revitalising productivity through provision of specific targets for on-site improvement activities such as Total Quality Costing (TQC) and compliance with International Standards (ISO) (Wagner 2003b:368);
- Also, MFCA promotes improvements in supply-chain management for less environmental impact and reduced social cost (METI 2007);

- More importantly, the MFCA framework leads to effectiveness in processes where input materials, listing from work-in-process and defective products occur in each process to generate waste by identifying products that have a short life-cycle or where stocks of expired products are generated or wasted;
- Additionally, where losses generated in production processes are shared by multiple departments or divisions, MFCA will be effective in identifying the respective department's responsibilities (METI 2007); and
- Finally, MFCA is effective in the identification of quantity and costs of discontinued products by calculating relevant costs of raw materials and work-in-process in discarded product (Wagner 2003a:52).

Consequently, environmental cost information generated through the MFCA framework may encompass all the functional areas within the organisation through data integration.

3.8. DIFFERENCES BETWEEN MFCA AND CONVENTIONAL MANAGEMENT ACCOUNTING SYSTEMS

An organisation is required to have environmental consideration at different stages of its operations as required by South Africa's King III on sustainability (IOD 2009). In making this type of decision, an organisation's environmental impact needs to be measured both in quantity and cost so that it could be managed and controlled. Usually, the conventional accounting systems are designed to calculate profit on business investments by matching revenue and cost in a particular accounting period (Drury 2008:7). Likewise, costs incurred during production are compiled to arrive at the production cost for each product (Roy, Souchoroukov & Shehab 2011) which means that the scale of loss in the production process is not identified (Duflou, Sutherland, Dornfeld, Herrmann, Jeswiet, Kara, Hauschild & Kellens 2012) and opportunities to improve efficiency are lost and it is unlikely that such type of accounting information will facilitate improvements to organisations' waste-reduction decisions (Christ & Burritt 2013). Admittedly, the standard cost accounting method is widely used in organisations (Drury & Tayles 1995:268). This method compares standard costs with actual costs to determine and analyse causes for cost variance so as to initiate corrective actions. However, cost variance as portrayed by the standard cost accounting method may be unlikely to reflect all material losses since the pre-determined standard cost already contains material loss or waste considered as normal loss. As such, only material costs used above the standard cost is probably regarded as waste.

MFCA regards all materials that do not become saleable products as loss (Nakajima 2003). Regardless of this, the MFCA framework analyses an organisation's economic loss by material loss not only in terms of material cost but also as loss of the entire production cost including processing, energy, waste treatment and all other related costs (Nakano & Hirao 2011). Furthermore, MFCA calculates the cost put into negative product as negative product cost, which represents economic loss caused by material loss (Kokubu & Kitada 2010). This enables an organisation to make the negative product or material loss visible throughout the production processes and for each process by using the quantities of lost materials and the overall costs including processing costs input into such materials (Schmidt & Nakajima 2013). This is likely the most remarkable characteristic of MFCA in contrast with other cost accounting methods. In the next section, the study presents an analysis of benefits of MFCA; the shortcomings and challenges of brewery waste management; the shortcomings of the conventional accounting system, and the development a framework to fill the gap in the study from the Table 3.2.

3.9. ANALYSIS OF FINDINGS IN THE LITERATURE

Table 3.2: An analysis of findings in the literature

Shortcomings of the conventional accounting system	Shortcomings of brewery waste management	Challenges of brewery waste management	Benefits of MFCA
The conventional cost accounting system does not have the ability to adequately monitor the increasing material costs and overheads with sufficient transparency (Gale 2006).	Brewery process produces large quantities of wastewater which contains high concentration of biodegradable organic pollutants (Parawira *et al.* 2005:593). The brewery industry is amongst the industries that produce great quantities of contaminated water as a result of production inefficiencies (The Brewers of Europe 2002).	As brewery managers strive to improve on their environmental performance, they discovered that traditional pollution prevention techniques that are no longer cost effective and that reducing brewery process waste altogether is a much better cost effective solution to the traditional end-of-pipe strategies such as waste treatment (Seadon 2010:1640).	The information generated through MFCA would allow for the appropriate and accurate evaluation of investment items resulting in increased production efficiency through capital investment (Jasch 2009:33). MFCA can provide an internal and external benefit which enables an organisation to make greater profit with less environmental impact Kokubu *et al.* (2009:17).

(Source: Researcher's illustration of the steps for introducing and utilising the MFCA framework are presented in Section 3.12.

On the whole, Table 3.2 indicate some of findings from literature review about the inadequacies of the conventional management accounting system to separate waste-related information from overhead accounts; the environmental impact of the brewery industry on the environment and the ineffectiveness of traditional end-of-pipe strategies to curtail breweries environmental impacts; and the benefits of the MFCA framework to provide appropriate waste-related information to improve waste-reduction decisions in organisations.

3.10. STEPS FOR INTRODUCING AND UTILISING MFCA

This section discusses the steps for introducing and utilising MFCA in an organisation. While the focus of this study is to adjust the existing MFCA framework for breweries in South Africa, it is essential to understand the steps involved in its implementation to provide insights on how it could be adopted and to provide explanations about issues covered by the MFCA framework. In context, a careful adoption of the MFCA framework can ensure that all necessary waste-related data is captured and this may reveal costs incurred as a result of production inefficiencies in order for corrective action to be taken. This study proposes a five step structure. The major objective of these steps is to describe the collection and compilation of data from input to wasted material quantities in each production process in accordance with METI Guidance Document (METI 2007). These wasted material quantities are measured at the production level in the organisation (Smith & Ball 2012). As such, theoretical unit estimates or calculated figures are used, as long as they have some degree of accuracy to avoid waiting for a too long time to get all measurements from the production level (METI 2007). However, when inappropriate measurements are used, losses may become difficult to identify and process waste-reduction decisions would probably be based on inappropriate waste information.

According to Kokubu and Kitada (2010), the introduction of MFCA depends on the accuracy of the waste quantity calculation in the production process and the type of waste accepted as a theoretical value should be clearly examined. However, quite often production process input is based on the numbers and other units of materials. According to METI (2007) an MFCA framework that utilises production generated data as parameters facilitates accuracy of waste quantity calculations. In other words, establishing an MFCA framework that makes use of theoretical units is likely to differ from the actual process. As a result, if the theoretically defined unit is too large, the resulting negative product cost will become inappropriate (Kokubu & Kitada 2010). Also, if the theoretically defined unit is too refined, capturing waste data will take too long, therefore, the theoretical unit need to be appropriately defined (METI 2007). The adoption of the MFCA framework enables a clearer identification of the cost-saving effect through individual improvements (Jasch 2003) and may, therefore, assist brewery managers to make sound waste-reduction decisions. Consequently, a more accurate evaluation and improvements may be achieved by carefully applying the steps of the framework.

Figure 3.4 provides a brief overview of all steps in the MFCA framework.

Figure 3.4: Steps in the MFCA framework for waste information *(Source: Adapted from METI (2007)*

The sections below provide explanations on the steps in the MFCA framework for waste information.

3.10.1. Identify the need for an alternative waste-reduction technique

Brewery managers may need to identify and understand the importance of applying an alternative waste-reduction technique and according to (Hassan 2013) on both the organisation in terms of profitability and the environment in terms of a reduction of the negative environmental impact. Inasmuch as they may need to consider the importance of quick intervention by ensuring that waste-reduction decisions are timely and appropriate; Simpson (2012) argue that consideration should be given to the effect of making appropriate and inappropriate waste-reduction decisions. Brewery managers may require information on process waste quantity and costs in order to choose an appropriate waste-reduction strategy and, therefore, as Jasch (2003) indicates this can be provided by MFCA. However, decision-makers need to be aware of the consequences of their waste decisions on the environment and the resources of the organisation (Pfeffer 2010). Hence, the failure to explore all available options before reaching a waste-reduction decision is likely to have negative impact not only on the environment but also on the organisation's profitability.

3.10.2. Determine waste-reduction targets for product lines and processes

METI (2007) indicates that to benefit from the application of MFCA, managers should be cautious not to match quantity centres with cost centres. It may therefore imply that brewery managers are unlikely to match a theoretical unit for the MFCA calculation with a unit of allocating processing costs. In other words, matching these two units in the calculation and compilation of process data will result in inappropriate negative product costs which become useless for improvement purposes (Bautista-Lazo & Short 2013). Likewise, managers may need to avoid matching a theoretical unit for the MFCA calculation with the actual process quantity as according to METI (2007) this will result in excessive time and labour spent on data collection and compilation. While this action will undermine the benefits of applying MFCA to waste cost-reduction efforts (Kokubu & Kitada 2010); Jasch (2009a) recommends that in order to ensure that the MFCA calculation is not in vain, a clear identification of waste cost is necessary for improvements to be initiated.
Alternatively, to avoid some of the above problems, organisations applying MFCA for the first time, in this instance in breweries, METI (2007) recommends that product lines that are easy to improve should first be selected. However, in situations where an organisation outsourced some of its processes, cooperation of such partners should be sorted (Mudambi & Tallman 2010) to avoid readily available process data delay in data collection and compilation. Therefore, the need to determine waste-reduction targets for each process may be likely to support and improve brewery managers' waste-reduction decisions for better environmental performance.

3.10.3. Collect and compile brewery output through the MFCA calculation

The MFCA framework analyses the process output into good product and non-product (Nakajima 2003). This is essential in order to determine the percentage of resources in waste or non-product output. In addition, the analysis of non-product output helps to determine the amount of waste generated in each process or production batch (Christ & Burritt 2013). In the brewery process this analysis may be able to facilitate effectiveness in resource usage on the amount of raw materials such as barley, hay, oats and water as well as the associated production costs in non-product output. The determination of the percentage of the quantity and costs of non-product output reveals the level of inefficiencies in the production process (METI 2007). Hence, instead of seeking out technological solutions which is expensive and prone to the creation of waste, efforts to determine the source of waste generation in order to initiate corrective actions are likely to be employed (Lee, Min & Yook 2012). Therefore, a detailed analysis of brewery output into good and non-product output is likely to make the flow of materials in the process to be transparent and visible for corrective actions to be initiated.

Particularly, MFCA defines the input and output quantities of every material type in each process, in terms of hectolitres, kilolitres, or litres (Jasch 2006). Hyršlová *et al.* (2011) also acknowledge that output quantity is divided into the positive product quantity, which is the quantity of materials transferred to the subsequent process, and the negative product quantity, which refers to the quantity of wasted materials. Moreover, the intention of the MFCA calculation is that the overall input quantity should equal overall output quantity (ISO 14051: 2011). Likewise, according to Hyršlová *et al.* (2011), systems and energy costs should be allocated to positive and negative product costs, in accordance with the proportion of positive and negative product quantities. Whilst the units of materials vary by process and material type, in this study - the numbers of beer bottles; cubic meters; kilograms; and hectolitres; it is necessary to convert such materials units into the MFCA quantity units in accordance with METI (2007) guidelines. This may indicate that such conversion methods could likely be incorporated into the MFCA calculation framework, so that the required operations will be performed using the process data as parameters. This in effect implies that improvement in percent of defective and yield rates is likely to become easier to simulate following the calculation of the present figures by MFCA (METI 2007). In such circumstances, MFCA calculations may probably be easily performed if process units are used as parameters, and the MFCA calculation is done on a monthly basis.

Incidentally, the data available from the systems and energy costs are based on manufacturing costs; collection and compilation of costs allocated by cost centre and should necessarily form the basis of this step (Schmidt & Nakajima 2013).

Furthermore, METI (2007) recommends that systems and energy costs allocated by cost centre requires pre-processing before the MFCA calculation since the cost centre units may differ from the MFCA processes, that is, quantity centres. Therefore, it may probably be essential to assign system and energy costs allocated by cost centre to individual MFCA processes. Yet it is likely effective to collect and compile the data of equipment operating status at the same time for improvement planning (Zhao, Murray, Ramani & Sutherland 2012). The fact that Total Productive Maintenance (TPM) is in place in an organisation according to METI (2007), is to facilitate the effectiveness of this step with no additional time because basic data are readily available (Baglee & Knowles 2010). Hence, TPM is maintenance activities that are productive and implemented by all employees (Wireman 2004:1). Eventually, the availability of TPM data may be likely to assist brewery managers to evaluate the equipment operating loss (time loss) at the same time. However, if the equipment is not operating at a maximum capacity, the organisation may expect improved material efficiency or reduced per cent defective by slowing the production (Stephens & Meyers 2013). Hence, the assumption is that the available data becomes effective for improvement planning as well. This will, in the future, assist to develop better equipment and production technology that will help to realise improved material efficiency, more stability in quality and a faster production time (Pusavec, Krajnik & Kopac 2010). Hence, this study advocates that utilising the MFCA framework in calculating waste information may be a positive step to improve current waste-reduction decisions.

3.10.4. Compare and analyse planned and actual waste-reduction targets through MFCA

Difficulties may arise in performing the actual MFCA computation, such as in the allocation of input systems and energy costs in each process by the proportion of positive and negative product quantities, and including the positive product cost into the input cost of the subsequent process (Hyršlová *et al.* 2011). Nevertheless, it is necessary to define main, sub and auxiliary materials before the allocation is done (Schaltegger *et al.* 2012). They continue to define main materials are the principal materials in the initial process and the work-in-process from the previous process in the following processes and sub-materials are those materials added to the main materials to form part of the organisation's products in each process. Furthermore, auxiliary materials are materials used in each process but does not form part of the organisation's products, e.g., cutting oil. However, the quantities of auxiliary materials should not be included to calculate the positive or negative product system costs in principle since sub-materials are mixed into main materials before processing (Jasch 2009a).

In view of the fact that in any manufacturing organisation the production process generates positive products that is released to subsequent process as work-in-process and the negative products that becomes waste; calculating positive and negative product system costs in addition to the positive product contained work-in-process from previous processes may require that positive product systems cost from any previous process should be included in the next (Bortolotti & Romano 2012). Hence, the determination of input positive product system cost from previous processes should be allocated in proportion to the positive and negative product quantities respectively from the previous processes, which are calculated for the positive product system costs and for the negative product system costs (Hyršlová *et al.* 2011). Therefore, the adoption of a Management Accounting framework like MFCA to analyse production output information may be needed to facilitate ease of comparison between negative and positive products for improved waste-reduction decisions.

The processing cost for any previous process is regarded as system cost input in the new process and such processing cost can be used for combining and processing main and sub-materials (METI 2007). This is likely to result through the addition of the work-in-process and sub-materials put into the process respectively. They recommend that the positive and negative product system costs should be calculated respectively. However, according to Trappey, Yeh, Wu and Kuo (2013) for specified objectives of the MFCA introduction, all system costs put into a process should be regarded as negative product costs. The next step will be to prepare the MFCA simplified calculation tool by defining and inputting the data of material quantities and costs to include data of system and energy costs (METI 2007). Moreover, results of the MFCA calculation using raw data of input materials, yields, losses, and costs of each process should be for a specified period (Onishi *et al.*

2009) and there is furthermore the requirement that data should be provided for the MFCA calculation on individual processes for relevant time unit (Kokubu & Kitada 2010). In addition, basic MFCA principles including positive product cost of a process into a subsequent process and in its input cost should be taken into account in its calculation (Weigand & Elsas 2013). This may indicate that the positive product cost of a process shall agree with the cost handed over from previous processes at that point.

While positive product cost in a previous process may not agree with the cost handed over to a subsequent process; it may happen since the yield of completed products in a previous process may differ from the completed products handed over to and put in a subsequent process (Onishi *et al.* 2009). Inasmuch as the difference could result from an increase or decrease in work-in-process inventory, which is defined as a quantity in the MFCA calculation; the calculation is intended to support managers when making crucial waste-reduction decisions.

According to Kokubu *et al.* (2009) a calculation framework is likely to become too complex if stock of the work-in-process is incorporated in the definition that uses the simplified MFCA calculation tool. However, if the stock of work-in-process is not wasted as material loss, it will not produce any negative product cost and probably have no impact on the overall calculation process (Nakajima 2003). Alternatively, an analysis of loss and cost improvements will become easier by excluding the impact of decrease and increase in inter-process work-in-process thereby enabling the MFCA calculation that is based on unit quantity of final products (METI 2007).

Furthermore, the positive product cost of each process cost handed over from the previous process is to be agreed with the subsequent process and this inter-process integration according to METI (2007) can be performed through the following conversion process:

- Calculate the integrated input quantity of the main material in the previous process and the integrated yield of the completed product that is required to produce the specified yield of completed product in the final process;
- Multiply all the material, system, energy and waste treatment costs by the conversion factors to give the integrated quantities; and

- Perform the above operations in the descending order starting with the final process.

Alternatively, another approach is to perform the computation by using the actual yield of products, i.e., in this instance the beer volume or on the number of units produced, instead of the theoretical yield of completed products in the final process (Kokubu & Kitada 2010). More importantly, using the number of production units requires the calculation of the quantity value for the relevant number of products to perform the computation (Wang, Li, O'brien & Li 2010). However, after the MFCA calculations and results have been obtained, there is a need to identify the improvement requirements which should focus on processes with large losses and input costs, as well as material loss quantities and occurrence rates by causes (Jasch 2009a). Even more, processes generating negative product costs need to be identified according to types, causes, and degree of losses (Mena, Adenso-Diaz & Yurt 2011). This may imply that there may be a need for brewery manager to examine different improvement methods and identify the direction as well as focus of the required improvement, and set improvement targets. However, in analysing the methods and feasibilities of improvement, brewery managers may need to anticipate the effects of expected improvements and identify the items to improve on. Therefore, in this study, the generation of number of production units are necessary for meaningful and sound process waste-reduction decisions and for improvements to processes.

Achieving brewery process waste-reduction targets is a gradual process with targets set at realisable and achievable limits. Brewery managers are likely to evaluate their progress on a six-monthly or yearly basis to see if the target waste-reduction level has been achieved. This process is to facilitate continually monitoring of the level of achievements recorded. Moreover the achievement of a desired level of waste-reduction is a process that spreads over a period of time. In reality, no waste-reduction strategy is a quick fix (Boos 2013); however, determining the quantity and costs of waste in a process is the starting point to improved decision-making (Lehr, Thun & Milling 2013). What cannot be measured cannot be managed (Davila, Epstein & Shelton 2012). Hence, when the MFCA framework is adopted by an entity in conjunction with existing waste-reduction strategies it is likely to lend support to the improvement of the process waste-reduction decisions until the desired and realisable waste level is achieved.

3.10.5. Respond to divergence from planned waste-reduction targets

The final phase of the MFCA framework requires that managers, in this study specifically brewery managers, respond to the feedback on divergences arising from the planned waste-reduction target to ensure that the process of decision-making is monitored and controlled in accordance with METI (2007). The MAS has a responsibility to measure waste both in quantity and cost (Jasch 2006), provide an elaborate waste-performance report (Gray 2010:51), and suggest corrective actions to ensure that the waste-reduction targets are achieved (Drury & Tayles 1995:268). Moreover, the MAS is responsible to monitor waste performance in relation to the planned targets at regular intervals determined by brewery managers for corrective actions to be initiated (de Bruin 2013). Therefore, it may be argued that the process of applying corrective actions signifies that the MFCA framework is dynamic and emphasises its interdependence between various existing waste-reduction strategies.

MFCA is a tool used to calculate the negative product costs as a comprehensive evaluation of the present process productivity by making the negative product costs in processes visible (Hyršlová *et al.* 2011). Hence, there may be a need to make the negative product costs visible in production processes, specifically the brewery processes in this study, in order for improvements to be made to the relevant causes of process inefficiency such a discussed in the next sub-sections.

3.10.5.1. Utilising MFCA in day-to-day management in the manufacturing process

MFCA can be used in the day-to-day improvement activities in the production process to promote pre-determined standard or target values which is based on performance indicators such as yield rates identified through the MFCA calculation (Jasch 2006). Hence, by translating the yield rates as targets or achievements of day-to-day management into cost changes through MFCA, the significance of such improvement becomes more visible to managers (Schmidt & Nakajima 2013).

Therefore, brewery managers may be able to improve on existing waste strategy by making sound waste-reduction decisions based on available MFCA calculations.

3.10.5.2. Utilising MFCA for improvement in engineering and production engineering departments

MFCA can be used to improve activities in production process or its production engineering departments, by shifting managers' focus to changes needed in the existing equipment and design or on process improvements (Nakajima 2003). Such improvement can be promoted through the production process or production engineering departments, for the items identified through MFCA calculation by carrying out changes to existing equipment and design or for process improvements (Onishi *et al.* 2009). This may enable brewery managers to estimate comprehensively cost-reduction effects using MFCA. Where there is numerous improvement requirements, MFCA can be an effective tool to set priorities and in the assessment of ROI (METI 2007). Hence, this study assumes that the availability of more comprehensive waste information may also assist brewery managers to reach better process waste-reduction decisions.

3.10.5.3. Improvement in the development and design stages of a new product

The application of MFCA will make the impact of process yield rates on costs visible, and allow product designers to recognise how improvement in material yield rates in each process contributes to cost reduction (METI 2007). This means that there will be improvement activities led by product development and design departments in the development stage of a new product from the MFCA calculation and analysis (Kokubu & Kitada 2010). For drastic improvement in material efficiency and cost reduction, Kokubu and Kitada (2010) furthermore suggest that there is a need to review product design specifications. MFCA is therefore an effective tool for examining improvements in the cost planning stage (Onishi *et al.* 2009). Therefore, this may indicate that in order for brewery managers to make sound process waste-reduction decisions that will drastically improve process efficiency, all waste related information is necessary to support the decision-making process.

3.11. THE POTENTIAL BENEFITS OF MFCA FOR THE ORGANISATION AND ITS EXTERNAL ENVIRONMENT

This section discusses the potential benefits of MFCA for an organisation as well as for external Environmental Management evaluation. The relevance of MFCA has an EMA tool designed to reduce both environmental impact and costs at the same time and one that provides waste information to support management decision making cannot be overemphasised (Papaspyropoulos, Blioumis, Christodoulou, Birtsas & Skordas 2012). However, the main focus of MFCA as an EMA tool is to reduce environmental costs through waste-reduction for improved productivity and it can be modified by organisations willing to embrace its usage (ISO/DIS 14051 2011). Moreover, this study suggests that MFCA can be adapted to fulfil individual organisational needs so as to provide detailed information on material flow through processes by measuring and capturing material flow data into its raw materials and energy components. This is to ensure that improvement plans are well coordinated. Potentially, MFCA can assist managers, in the case of this study, brewery manager, to identify the costs of process loss by defective products, waste, and emissions through its calculation in terms of assigning monetary value to up quantities and resources used in the production process (METI 2007). Eventually, production managers will become aware that waste costs or losses recorded during production can be computed on the same basis as factory production cost (Jasch 2003).

Alternatively, MFCA will assist managers to understand that loss in any process means inefficiency rather than attributing such to normal or abnormal losses as is the practice in the conventional standard costing approach (Jasch 2006). Hence, waste generated within the production process becomes visible as negative product and may, therefore, provide brewery managers with informed waste-related data about how the resources of the organisation have been expended in order to make improved waste-reduction decisions.

At any rate, MFCA calculation makes production loss visible in each process so that corrective action can be initiated as soon as possible (Jasch 2009). Furthermore, losses that are made visible by the MFCA calculation include occurrence and materials yield loss by process, causes of material loss in each process such as loss

resulting from tests, swarf, listing, set-up, and defects (Nakajima 2003). Moreover procurement cost for materials loss in main materials, sub-materials, and auxiliary materials; as well as waste treatment costs for material loss become transparent through the MFCA calculation (METI 2007). This is confirmed by Kokubu and KItada (2010) who argue that other production losses that are revealed through the MFCA calculations include procurement costs for lost materials which is sold to recycling organisations; and processing costs expended on lost materials such as labour, electricity, fuel, depreciation, utility, and other processing costs. Also revealed through the MFCA calculation is processing cost spent in reprocessing or recycling lost materials within brewery processes (Jasch 2003). Furthermore, material costs for discarded inventory due to spoilage or deterioration in quality and unusable or aging materials become visible through the MFCA calculation (Onishi *et al.* 2009).
Although, waste recycling has been used as a measure for effective use of resources, it should be noted that the recycling process requires substantial expenses as well as energy consumption in addition to the initial cost of waste to be used as resource input (Gale 2006). He further indicates that to organisations without a waste recycling facility, it means new investment into building a waste recycling plant. Since recycling itself does not totally eliminate waste, it is essential to reduce its generation by monitoring and capturing all necessary waste information the first-time resources are used (Nakajima 2003).

Moreover, MFCA is an appropriate Management Accounting framework to identify the quantities and costs of waste generated from each brewing process (METI 2007) and this is to enable the manager to examine the very source of waste generation and crystallise any difficulty in reducing it which allows for the selection of an appropriate waste-reduction strategy (Onishi *et al.* 2009). Hence, this study advocates that the selection of an appropriate waste-reduction strategy like waste-reduction may need to be accompanied by an MFCA framework to support the capturing of waste information for improved waste-reduction decisions.

Another potential benefit from adopting MFCA is that when waste generation are reduced, consumption of other resources are correspondingly reduced, thereby enabling the organisation to become more environmentally responsible and create a lower environmental impact (Jasch 2009). This may facilitate an increase in processing efficiency with fewer waste treatment operations and lower production cost (Wei, Van Houten, Borger, Eikelboom & Fan 2003). Equally the MFCA analysis reveals hidden waste costs in overhead accounts thereby prompting sound waste-reduction decisions and enhanced environmental consideration in the production process (Jasch 2009). On the other hand, MFCA has the potential to assist organisations to realise its environmental and profitability objectives through simultaneous improvement of its environmental impact and achieving reduction in production costs (Norton 2012). Hence, this study advocates that while MFCA has the ability to support process waste-reduction decisions, extending the current framework to include other waste-related information would drastically improve waste-reduction issues in organisations.

3.12. THE INTEGRATION OF MFCA AND ENTERPRISE RESOURCE PLANNING

The integration of enterprise resource planning (ERP) and MFCA systems into waste-reduction decisions will provide a transparent view of resource flow within an organisation and access to good information to reveal where waste is created (Samaranayakea, Laosirihongthongb & Chanc 2011:3128). It may be possible for a brewery to achieve lower costs and improved decision-making, if, accurate, consistent and timely information is centrally available. The ERP system is an integrated suite where individual operating systems fit together to serve the particular needs of all units within the organisation (Chen 2009:298; Yen & Idrus 2011:53). Furthermore, ERP driven software generates information engineered to work together through a database designed to provide clear and accurate information on raw material input and other resource usage through the system including all transactions and customers' data (Samaranayake 2009:506). As such, the availability of a central database system will ease the flow of information within an organisation for quick and prompt corrective intervention (Mikurak 2011). This may indicate that the MFCA waste information system can access the necessary and prompt waste data from the central database system to support waste-reduction decisions on a regular basis.

Establishing a database system is essential to making sound decisions. A solid data foundation generated by the ERP system will assist managers to have access to both historical and current data (Lynch & Zhu 2011:78). This, in turn, is useful in identifying process waste trends and helps to predict future outcomes (Jalonen & Lönnqvist 2011). However current systems for waste-reduction decisions in many industries tend to separate economic, social, and environmental factors at the planning and management levels (UNDSD 2009). This means that the current system of process waste-reduction decisions in organisations may have implications for efficiency and sustainability development priorities. As such, it may have become necessary for organisations to adjust their database systems to reflect the specific process waste-reduction needs of an individual organisation.

3.12.1. Relevance of data integration to waste-reduction decisions

The success of an organisation is dependent on the quality of its decision-making process through an integrated data management system which combines separate data management systems (Chang & Wang 2009:356; Fresner & Engelhardt 2004:623). Nonetheless, managers need to understand that productive activities need to be systematically planned, implemented, controlled and improved for resource efficiency (Fresner & Engelhardt 2004:623). Decision-makers need to ascertain that appropriate actions to build upon their success are taken by effectively reversing inefficiencies in production by adopting measures to reduce process waste (Iraldo, Testa & Frey 2009:1446). Hence, breweries endeavouring to install an appropriate database system to generate up-to-date information may be likely to initiate effective corrective actions whenever inefficiencies are reported to fast track their process waste-reduction decisions.

Data integration provides a clear organisational outlook for sound and dependable business decisions to be made (Rabaa'i 2010). However, quality decision-making may depend on the availability of complete and accurate data. Hence, there may be a need for the integration of all data sources, such as ERP and MFCA within the brewery, to be the starting point of getting together the whole picture of where resources are wasted and the right step to enable brewery managers to make well-informed decisions. Figure 3.5 represents an individual operating system for the different functional units within an organisation that exists without data integration. This may facilitate individual decision-making by the managers responsible for the different units which have no relationship with other units and therefore sub-optimisation will be achieved. Such an approach may make it difficult to achieve an organisation's overall objective.

Figure 3.5: Researcher's illustration of an un-integrated database system

A brewery as any other organisation should have a complete picture of the resource flow in its operations. Sometimes the required data are contained in different databases that are not necessarily integrated; while some of these databases contain current data with no link available to past records required for trend analysis (Calì, Calvanese, De Giacomo & Lenzerini 2013). The lack of harmonised databases often hinders the collection of suitable data (Koroneos, Roumbas, Gabari, Papagiannidou & Moussiopoulos 2005:445). However, the integration of databases such as ERP and MFCA will assist decision-makers to consolidate historical data with current data to enhance decision-making through the use of trend analysis (Liu, Duffy, Whitfield & Boyle 2009:261; Wang, Xu, Wang, You & Tan 2009:357). The availability of an ERP system in a brewery may be likely to provide a data warehouse to facilitate quick data access to assist in decision-making. Either way, for managers to make valid decisions on process waste-reduction, they need to analyse both current and historical input-output data provided through the ERP system (Thomson 2010:433). Furthermore, data captured through the ERP system should be populated periodically to augment its content with new data without tampering with historical data (Jain, Monch, Jahnig, & Lendermann 2010:442). Therefore, there may be a need for such a database that can facilitate the provision of appropriate waste information for quick reference and enhance waste-reduction decisions in a brewery.

However, the capturing of a wide variety of organisational data within the ERP system may probably assist decision-makers to address diverse organisational problems including waste-reduction. This data may exist in different forms like operational data sources and data marts which contain both current and historical values (Kadam & Fonseca 2009; Rai, Dubey, Chaturvedi & Malhotra 2008:113). The availability of integrated data within ERP systems may probably provide decision-makers in the brewery industry with a constructive analysis to facilitate sound waste-reduction decisions.

3.12.2. The effect of integrating ERP and MFCA

Decision-making requires successful integration of an organisation's information flow (Li & Li 2011:168). Besides, decision-makers are required to effectively integrate business information systems such as ERP into daily work flow to generate relevant and actionable information for effective waste-reduction decisions (Gecevska, Veza, Cus, Anisic & Stefanic 2012). Therefore, it may be essential that an organisation's information system be integrated at user level by embedding information into its everyday application. This will enable users such as production managers and accountants to access information whenever it is required (Verdouw, Beulens, Trienekens & Verwaart 2010:836; González *et al.* 2009:137). Consequently, the integration of ERP and MFCA may facilitate prompt waste-reduction decisions, maximised resource usage and the generation of useful information in the brewery industry. Figure 3.6 depicts the integration of individual operating systems through the ERP system.

Figure 3.6: Researcher's illustration of an integrated database system

The value of information available to an organisation may be enhanced by integrating both ERP and MFCA systems to assist decision-makers. However, most operating systems within organisations are historically created to solve a particular set of needs, with each system evolving into an independent brand of information (Biffl, Schatten & Zoitl 2009). In fact, these needs include production and inventory information; customer support; order entry; transportation and receiving; and payroll (de Benedetto & Klemeš 2009:901). On the other hand, having different databases within an organisation makes it difficult to achieve optimal use of organisational information. In this study, the researcher advocates that it may be necessary to bring all databases within an organisation together by means of a single database, like an ERP, for increased access to data flow of the different units so as to maximise efficiency, increase data effectiveness, and analysis capabilities. Hence, this researcher advocates that having a single database rather than disjointed systems may likely promote efficiency in production since managers will be able to have access to adequate and more comprehensive waste information for improved waste-reduction decisions.

Furthermore, the integration of data sources across organisations will assist managers to analyse current values and trends (Framinan & Molina 2009:2959).

However, in an operating environment, organisations would deploy the use of query and reporting tools with production records to determine the current status of its data (Power & Sharda 2009: 1540). Yet this system summarises and maintains historical data values for a limited time in most cases (Sahay & Ranjan 2008:30). Although, an operating system provides recent data and values, this is inappropriate to track and analyse changes in data and values over time; still an integrated system like ERP can improve the level of detail and the amount of historical data stored to aid decision-making (Al-Mashari, Al-Mudimigh & Zairi 2003). Notwithstanding this system also has the effect of keeping multiple summarised data such as daily input usage and output; daily sales by customer; and daily store issues to production for future analysis (Rajasekar & Moore 2001:74). Consequently, decision-makers may be likely to streamline large-scale operational processes that results from complexities in expansion.

More importantly, data and values are constantly changing as transactions are updated within an organisation. However, it can be very frustrating to do an analysis of waste generation in a production process without adequate data (Fresner, Jantschgi, Birkel, Bärnthaler & Krenn 2010:129). This situation may be avoided by capturing data snapshots and storing all the data in the ERP system, which invariably ensures the validity of comparison from one period to another (Broda, McGraw & Powers 2012). Nevertheless, the ERP system will assist managers to improve decisions on specific business units such as inventory efficiency, input-output analysis, customer care services, and an increase in an organisation's overall return on investment (ROI) (Radhakrishnan, Zu & Grover 2008:1105). Therefore, it is plausible that the availability of data integration within an organisation is likely to eliminate frustrations that decision-makers constantly encounter in conducting a proper waste analysis in breweries.

While the volume of data an organisation can store is unlimited; as such, it should be treated as a corporate asset; the ERP system can store unlimited data regarding multiple aspects of the brewery with the ability of reproducing itself spontaneously with each new extract requested (Brooks & Meredith 2010:196). However, data mutations may be likely to occur if proper control is not instituted when new data is added to the system. A careful integration of data sources from different operational systems into the ERP system will ensure the availability of a single version of data in one location, which becomes an essential asset to the organisation (Su 2009). Hence, this approach may be likely to generate consistency of data within the brewery, thereby leading to consistent decision-making. In order to achieve such consistency, the ERP system has been designed effectively to store data in a lineage by including data origin and its derivation (Madnick, Wang, Lee & Zhu 2009). Therefore, there may be a need to adopt the MFCA framework within an organisation to facilitate the availability of consistent data generated from the ERP system to provide brewery managers with the required quantity and costs of brewery process waste necessary for decision-making.

The ERP system can integrate data from multiple operational systems whereby a complete view of the entire organisation is then made possible (Chen 2009: 298; and Yen & Idrus 2011:53). Therefore, a complete picture of the whole brewery process may be made transparent, such that a complete business environment is created where the whole outlook is worth far more than the sum of the individual operating systems. Whereas waste occurs within the individual production processes and other units within the organisation; managers are able to determine by what quantity and at what costs waste is generated in order to develop an organisation-wide waste-reduction strategy to redress its occurrence (da Silva & Amaral 2009:1340).

On the other hand, the ERP system integration with MFCA can probably assist to minimise communication errors if rigorously tested and protected from human error regarding waste generation by ensuring that every individual process and unit have access and usage to the same data (Wang, Wang & Zhang 2010:337). However, one obvious error in having different operational information generated from different units is that such data do not speak the same business language since they do not use the same data collection system (Chen 2009:299). Hence, with a system like ERP in place within a brewery, standardisation of data may be likely.

The long-term effect of having a standardised system can greatly improve process efficiency, effectiveness, and decision-making (Morton & Hu 2008:392). Instead of each operational unit producing a different analysis that will result in sub-optimality, an organisation-wide standard of comparison is established which addresses the organisational goal (Majumdar & Chattopadhyay 1999). It is probably impractical to modify the individual operational system data to conform to organisational standards; however, there is the possibility to transform data extracted from these operational systems to an organisation-wide standard. Data provided by the ERP system are useful for comparing likes with likes rather than comparing data from different operational systems, which usually results in a disjointed analysis (Jiang & Xu 2011). Hence, having an ERP system may likely enable brewery managers to compare the level of waste-reduction targets achieved from one year to the other for improvements in material flow management.

Similarly the ERP system may capable of assisting brewery managers to respond to queries more quickly and to prepare reports accurately about material, energy and other aspects of the business. However, checking on input-output flow of organisation's resources becomes achievable within the set time for corrective actions (Norton & Reckhow 2008). As such, the use of the MFCA framework to process waste makes material flow transparent since data are readily available in terms of quantity and costs of waste (METI 2007). This, in turn, may facilitate an organisation-wide strategy to reduce process waste and any other waste generating activity within brewery operations. In this respect, the integration of ERP and MFCA systems afford organisations a framework that assists managers to have a complete or transparent view of the whole production process for effective and efficient use of resources (Schaltegger *et al.* 2009:5). Therefore, there may be a need to integrate the ERP system to ease the burden of having different operational systems in a brewery.

While the integration of ERP and MFCA systems ensures that data generated in production is standardised rather than left in a disparate form (Jiang & Xu 2011); data integration promotes smooth flow of data between historical and current sources (Bagchi & Skjoett-Larsen 2003:90). As such, this study assumes that the adoption of the MFCA framework is likely to ensure that data provided by the ERP system to make each brewery process waste-generating source visible by calculating actual volume of waste and associated costs. This could be beneficial since MFCA requires data on raw material input; quantity and cost of transfers from one process to another; quantity and costs in actual or final output; the number of labour hours and rates used in production; the units of energy used per kilowatt-hour in a batch; and other associated costs made available through the ERP system (Wagner 2003a). Hence, as a step to resolving process waste-reduction in production, an organisation could consider introducing a Management Accounting waste information system that fully captures waste-related information comprehensively to improve it waste-reduction decisions.

3.13. SUMMARY

This chapter provided a review of MFCA as an EMA tool specifically developed to capture waste-related information to improve waste-reduction decisions. The development of MFCA has gained increasing importance and interest in its implementation and usage by organisations in Japan since it has assisted many organisations to reduce waste generation, promoted resource efficiency in production, and has translated into an increase in profitability in these organisations. Different types of waste-cost information provided by the MFCA framework are categorised into positive and negative product costs. Such categorisations provide better and more comprehensive waste-cost information to inform sound waste-reduction decisions. MFCA's usefulness include performance measurement, increased environmental accountability, and waste decisions support. Different material flow approaches are environmental costing and waste costing, however, MFCA provides more comprehensive waste-cost information in comparison to other approaches. True cost of waste is that which comprise costs associated with the generation of waste and the costs of disposal and management.

The potential benefits of adopting the MFCA framework include accurate evaluation of overall investment options; strengthening an organisation's competitiveness through the delivery of both increased profit and material productivity; evaluating production process cost accurately and the reduction in waste costs through adaptations to existing product designs and type of raw materials used. Other benefits include on-site improvement activities such as TQC and compliance with International Standards as well as improvements in Supply-Chain Management. The integration of the ERP and MFCA systems may improve waste-information generation and provide a transparent view of resource flow within an organisation.

The availability of a central database system may ease the flow of information within an organisation for quick and prompt corrective intervention. The success of an organisation is dependent on the quality of its decision-making process which can be achieved through an integrated data management system that combines individual data management systems. The effect of such integration is to assist managers to analyse current waste values and trends; and promote prompt waste-reduction decisions for optimum resource usage and use of information more effectively. Consequently, the integration of ERP and MFCA systems may ensure that data generated in production are standardised rather than in a disparate form to support waste-reduction decisions. Data integration may promote smooth flow of data between historical and current sources. This may ensure the constant availability of comprehensive waste-related information at all times for improved waste-reduction decisions.

The next chapter discusses the research method used in this study.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1. INTRODUCTION

This chapter addresses the research design used in this study. Contemporary Management Accounting research often requires that researchers make an inquiry in order to understand and evaluate participants' perception of their experiences of the phenomenon being investigated, by providing participants with the opportunity to tell their story. The in-depth interview and case study methods were chosen for this study and were supported by direct observation from the researcher. This chapter provides justification for the choice of these methods.

4.1.1 Goal of this chapter

The goal of the chapter is to discuss the research methods that were employed in this study. The two main research methods used were particularly described and discussed.

4.1.2 Layout of the chapter

The previous chapter provided discussions on MFCA. This chapter sets out to outline the research methodology used for this study as provided in a visual representation in Figure 4.1. It begins with the research paradigm in Section 4.2, research design in Section 4.3, and justifying the adoption of qualitative research in Section 4.4. It explains the use of the case study, and in-depth interview approaches as the research strategy in Section 4.5. The use of in-depth interviews as the main data collection method is discussed in Section 4.7. It provides a discussion on the research design hierarchy in Section 4.8 by introducing the research objectives in Section 4.6, research questions in Section 4.9, and addressing the in-depth interview questions and use of direct observation for the study in Section 4.10. The research method is discussed in Section 4.11 while explanations are provided for sampling in Section 4.12, data collection in Section 4.13 and transcribing data in Section 4.14. An explanation on how the research was conducted and data were analysed are discussed in Section 4.15. Section 4.16

presents the justification for using only two cases and the research limitations are presented in Section 4.17. The validity and reliability checks for the study are discussed in Section 4.18. The chapter concludes with a summary in Section 4.19.

The above layout is represented in Figure 4.1.

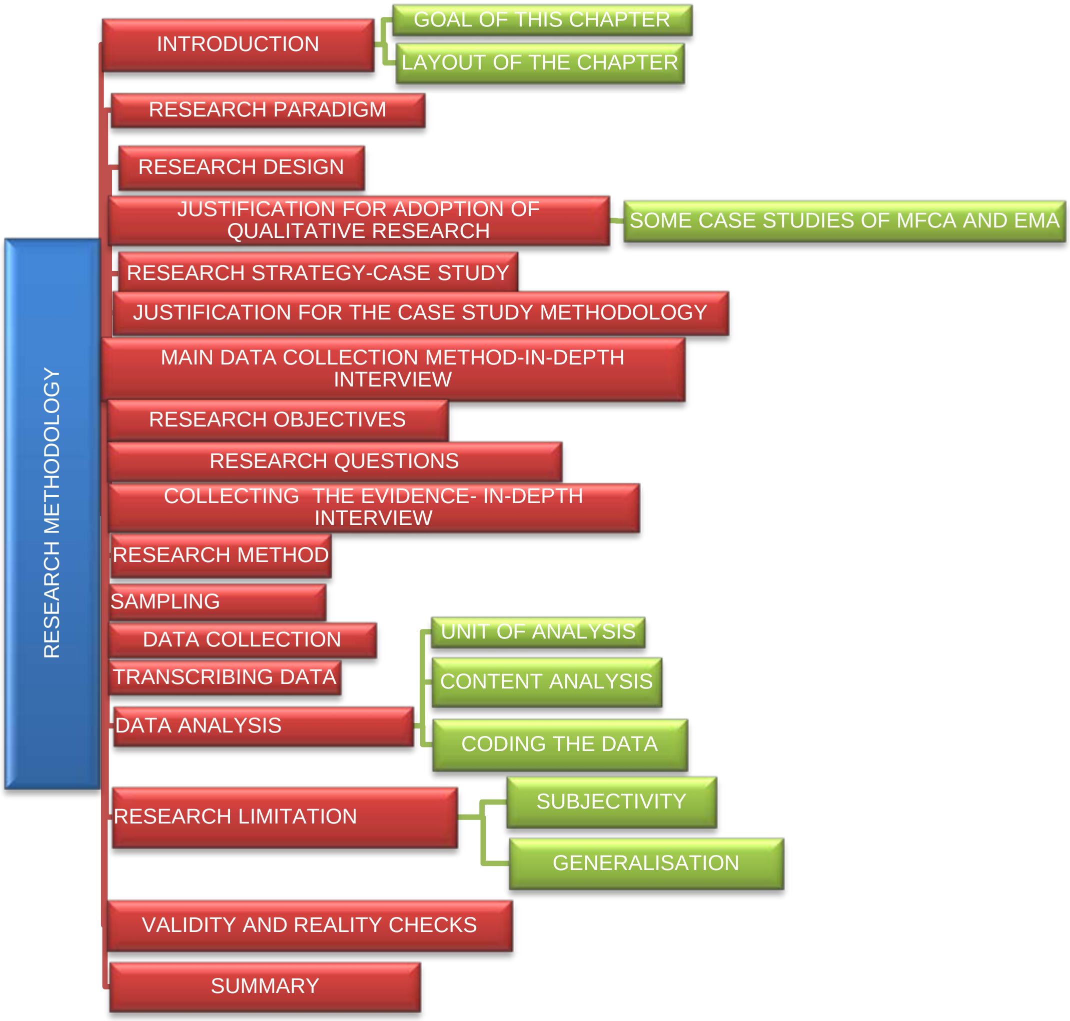


Figure 4.1: A visual representation of the layout of Chapter 4

4.2. THE RESEARCH PARADIGM

Rossman and Rallis (2003:37) define paradigm "as shared understandings of reality". In addition, Weaver and Olson (2006:460) reveal how research could be affected and guided by a certain paradigm by stating that "paradigms are patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished". To clarify the researcher's structure of inquiry and methodological choices, an explanation of the paradigm adopted for this study is discussed in the next sections.

4.3. THE RESEARCH DESIGN

Maykut and Morehouse (1994:64) state that the design of a research study includes the overall approach to be taken and detailed information about how the study will be carried out, with whom and where. The study adopted a qualitative research method. Denzin and Lincoln (1994:1) define qualitative research as a multi-method in focus, involving and interpretive, naturalistic approach to its subject matter. This study adopted the emergent research approach. Maykut and Morehouse (1994:174) indicate that an emergent research design means that data collection and analysis are simultaneous and on-going activities that allow for important understandings to be discovered along the way and then pursued in additional data collection efforts.

The focus of inquiry in this study is to understand and evaluate how brewery managers have been using information provided by the conventional MASs for brewery process waste-reduction decisions. This qualitative approach to inquiry uses a case study approach, whereby participants and the brewery settings were explored in depth and described in detail in the study. It is believed that the case study approach will help to evaluate and understand how the conventional accounting systems have assisted brewery managers in process waste-reduction decisions. The following sections provide justification for adopting a qualitative research method; discussed some case studies relevant to the studies albeit not within the South Africa context since research output related to MFCA was found scarce during the literature survey that was conducted; provide a comprehensive discussion on the research strategy - case study as well as justification for the adoption of the case study research method in this study; a discussion of the main data collection method - in-depth interview approach was provided; a description of the research objectives is represented along with the research questions.

4.4. JUSTIFICATION FOR THE ADOPTION OF QUALITATIVE RESEARCH

Some countries such as Japan, Austria and Germany have been practising the use of MFCA as a support tool for process waste-reduction decisions for over a decade

(Jasch 2003; Nakajima 2003). A review of literature reveals that the South African brewery industry in particular, fails to be the focus of any MFCA-related research and case studies. Furthermore, research on the use of MFCA as a framework to support process waste-reduction decisions is scarce in South Africa (see Table 4.1). Due to the low level of research in this area, little may be known about the circumstances in which MFCA should be applied.

Table 4.1: Summary of related EMA/MFCA research in South Africa

Author	Year	Title of work/research
Seakle Godschalk	2011	The relationship between environmental reporting and financial reporting in South African listed mining companies (Mcom Accounting, University of Pretoria, South Africa).
Cosmas Ambe	2007	Environmental Management Accounting in South Africa: status, challenges, and implementation framework (DTech Cost and Management Accounting, Tshwane University of Technology, South Africa).

Churchill and Iacobucci (2009:61) emphasise that the strengths of using an exploratory research approach is that it is appropriate for any problem about which little is known and a foundation for a good study. Merriam (2009:5) agrees that qualitative researchers are interested in understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences. Hence, a qualitative research is appropriate for this study using the exploratory method to evaluate and understand participants' experiences about their process waste-reduction efforts and the potential benefits from adopting MFCA.

In this regard, the study adopted a qualitative research method using an exploratory approach that assists to address the research problem from reality. A typical exploratory research is less structured with the objective to develop an understanding of some phenomenon, relationships, clarify concepts, and provide new insights (Zikmund & Babin 2009:93). To conduct this qualitative exploratory research, a case study approach is adopted and it uses in-depth interviews as the main data collection method to test the applicability of the MFCA framework at Hope Brewery.

4.4.1. Some case studies of MFCA and EMA on breweries around the world

In a study that utilises the case study approach, the MFCA framework was adapted in a large Austrian brewery; Jasch (2009) notes that conventional accounting systems have provided insufficient waste cost information to managers to make informed waste-reduction decisions. Jasch (2009) analysed data from Brewery Murau using the MFCA framework that provides highlights to areas within the brewery that requires improvements. In the study, the brewery saved the sum of $186 000 in 2006 after adopting MFCA in its waste-reduction drive. In another study, Schaltegger *et al.* (2012) did a case study whereby they focused on the use of Environmental Management Accounting (EMA) tool for generating information to improve cleaner production decisions on a medium-sized brewery in Vietnam. They found that a specific measurement is required to establish and determine the magnitude of environmental costs beyond compliance, for cost savings and improved decision-making. Both these studies are significantly different from the current study which focuses on a micro-brewery and a large brewery (SAB Ltd) in South Africa in terms of size, annual turnover, production volumes and location. The Austrian brewery is a large-sized brewery and the Vietnam brewery, a medium-sized brewery. However, the current study is meant to demonstrate the adoption of the MFCA approach in both small and large-sized organisations.

4.5. THE RESEARCH STRATEGY – A CASE STUDY

Hopper and Powell (1985) believe that Management Accounting and control research can be executed through three theoretical perspectives: positivist, interpretative or critical. The positivist research perspective objectively addresses society, takes individual behaviour as deterministic, and resorts to positivist methodology to deploy research (Hopper & Powell 1985; Ryan, Scapens, & Theobold 2002). When using the interpretative research methodology, the researcher assumes that social practice, including Management Accounting and control are social phenomenon, and not a natural phenomenon (Ryan *et al.* 2002). Researchers using the interpretative methodology usually develop their research based on social theories such as the institutional theory (Wickramasinghe & Alawattage 2007). Otley and Berry (1994) argue that the researcher use these theories to explain Management Accounting practice and also to explain and modify existing theory. Wickramasinghe and Alawattage (2007) posit that the critical persperctive emerges due to the limitations of both the positivist and interpretative perspectives. The proponents of the critical perspective considers the relationship between the organisation and the social-economic context (Baker & Bettner 1997).

According to Ryan *et al.* (2002), Management Accounting research is based on ontological assumptions that social practices can be changed by current participants and reality which results from a process of social construction. As a consequence of these ontological assumptions, Ryan *et al.* (2002) argue that these researchers believe that knowledge of reality is obtained through its interpretation, that is, episemological perspective. These researchers favoured the use of the qualitative and interpretative research methodlogy since qualitative research is based on direct data collection in the field through interviews or observation (Ahrens & Chapman 2006), by direct and sometimes long contact with the study reality (Miles & Huberman 1994), or by detailed description of events, situations and interactions among people and objects (Patton 1987). Ahrens and Chapman (2006) state that the distinguishing factor in a qualitative research is the unique approach to understand and study reality. In addition, the researcher that uses the qualitative methodology need to understand social reality as an emerging methodology, one that is built on subjectivity, and objectified through human interaction (Chua 1986). As such, Ryan *et al.* (2002) suggest that the researcher must have a holistic vision that includes an integrated, systemic, and global context of where the research will be conducted. The implication of this for a qualitative researcher is the ability to make judgement on the collected data and relating this to theory to answer research questions and to develop new research questions as well (Ahrens & Chapman 2006).

In contrast, Chua (1986); Ryan *et al.* (2002); and Ahrens and Chapman (2006) observe that the positivist research methodology addresses reality as objective and as something that is independent from the researcher (Berry & Otley 2004). Hence, from an epistomological approach, positivists research perspectives assumes that knowledge results from observation and generalisation of observed phenomena (Ryan *et al.* 2002). This is the reason a significant set of positivist studies resort to quantitative approaches that relate both dependent and independent variables to test predefined hypothesis (Ahrens & Chapman 2006), and mostly based on a hypothetical-deductive process to explain perceived casual relationships (Chua 1986; Ryan *et al.* 2002; Scapens 2004). On the contrary, Mason (2002) argues that the qualitative research method usually defines research questions to be explored and developed during the research process; since a significant feature of this approach is that it provides contribution to the theorisation process (Ryan *et al.* 2002; Berry & Otley 2004; Ahrens & Chapman 2006; Vaivio 2008). As such, the interpretative resarch approach does not seek generalisation, it is based on the explicitly or implicitly rule to structure and shape social behaviour (Ryan *et al.* 2002; Scapens 2004).

Since the interpretative research perspective seeks to structure and shape social behaviour, it allows the research to interpret Management Accounting and control studies as a social practice based on an inductive research process rather than an hypothetical-deductive research process (Ryan *et al.* 2002; Scapens 2004). The interpretative research perspective is based on the assumption that theory is used to explain the actions of study participants and to understand how social organisation is created and replicated (Chua 1986; Ryan *et al.* 2002). Within the Management Accounting research context, the main objective of the interpretative research perspective is to build a theory, criticise existing theories, or understand the processes and practices of Management Accounting (Ryan *et al.* 2002; Wickramasinghe & Alawattage 2007; Vaivio 2008).

Therefore, Vaivio (2008) explains that in choosing the qualitative research methodlogy, the researcher need to be aware of additional complications that may include:

- Identification of the relevant theory;
- Formulation of the research questions;
- Access to the field work, to relevant people and documents;
- Processing of large amounts of data;
- Conflict resolution among several interpretations;
- Identification of theoretical direction; and

- Formulation of credible reasoning.

In addition, Patton and Appelbaum (2003) point that the main criticism to the choice of a qualitative research is the lack of objectivity as compared to the quantitative research methodology.

4.6. JUSTIFICATION FOR THE CASE STUDY METHODOLOGY

Yin (2003) contends that the type of research questions raised in the study defines the research method; this in turn, defines the specific research techniques to be adopted (Silverman 2013). Yin (2003:13) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." The justification for the case study research method is based on three conditions:

- The research questions are of the how and why type;
- The phenomenon being analysed is contemporary; and
- The researcher assumes the visitor role by not holding any control over the phenomenon under study nor over the behaviour of the main participants (Yin 2003; Blaikie 2007).

Berry and Otley (2004) and Berry, Coad, Harris, Otley and Stringer (2009) present the case study research method has a good research method in Management Accounting research since it provides a better understanding and content theorisation of processes and the context in which Management Accounting practice takes place. However, Scapens (2004) argues that depending on the research objectives, the case studies research method in Management Accounting may take several forms without being able to clearly identify the boundaries between each of them. Scapens (2004) notes that it is the intention of the researcher that determines the classification of case studies as used in accounting research as exploratory, explanatory, experimental, illustrative or descriptive. An exploratory case study research represents a preliminary investigation intending to generate ideas or hypothesis for rigorous empirical testing at a later stage. Explanatory case study research focuses on the specific case and uses theory to explain and understand the specifics rather than provide generalisation.

It is convenient in an exploratory research to use case studies as a research technique because of its qualitative in approach (Chetty 1996:73). Although, a case study is appropriate in exploratory research, it can be used in other research types. Yin (1981:97) explains that case studies can be used for exploratory purposes and the approach also may be used for either descriptive or explanatory purposes as well, that is, to describe a situation for example, a case history, or to test explanations for why specific events have occurred. In the explanatory function, the case study can therefore be used to make causal inferences.

While reviewing the case study research approach, Scapens (2004: 258) reiterates that case study research remain a controversial subject which raises both methodological and practical questions especially of its use in accounting research. He contends that most often, case studies are sometimes thought as an easier alternative when compared to quantitative accounting research that requires mathematical expertise and statistical knowledge. Scapens (2004) agrees with the submission of Yin (1984: 26) that: "Case study research is remarkably hard, even though case studies have traditionally been considered to be 'soft' research. Paradoxically, the 'softer' a research technique, the harder it is to do." The case study research approach has often been criticised as a proper scientific method of inquiry (Dubois and Gadde 2002). The main argument against it is that it provides little basis for generalisation (Yin 1994) since a case study approach is too situation-specific. In contrast, Otley and Berry (1994) state that the case study method can be useful in a wide variety of contexts, however greater clarity is needed in the way such work is written-up so that maximum benefit is gained. They argue that it is incumbent upon researchers using case-based methods to be clear about their initial theoretical positions, and to interpret their results in a way which indicates the theoretical modification which the empirical observations have triggered.

The case study research method was chosen for this study since the phenomenon, MFCA which is the existing framework or model, under the current study is yet to be explored in the South African context and therefore require being adopted in a real life situation to evaluate its potential. As such, a case study approach is the most suitable and convenient approach for this inquiry. Adopting the MFCA framework requires that the researcher understands existing practice whereby the conventional accounting system is used to capture waste information in a real production process.

The cases could not be considered out of context, which is process waste-reduction decisions, particularly in the brewery setting. It was in this setting that the decisions were made and utilised. Getting a true picture of process waste-reduction decisions would have been impossible without considering the context within which it occurred, the brewery. Yin (2010) believes that a case study research may be about a single or multiple cases. This is since it is possible to generalise from single cases in some analytical way, but multiple-case studies can strengthen or broaden such generalisations in similarity to conducting multiple experiments in natural science researches (Seidman 2006). A multi-case studies approach is selected since it enables the researcher to explore differences within and between cases (Yin 2003). The aim is to replicate findings across cases and make the overall study more robust.

4.7. MAIN DATA COLLECTION METHOD - IN-DEPTH INTERVIEWS

In-depth interviews are a useful qualitative data collection technique that can be used to understand the experiences and aspirations of participants (Karsak & Özogul 2009:660). It is suggested that three main sources of data collection for qualitative research methods are in-depth interviews, direct observation, and documents (Merriam 2009:216; Chattopadhyay 2011:172). In-depth interviews are most appropriate for situations in which open-ended questions that elicit depth of information from relatively few people are asked. In contrast, surveys tend to be more quantitative and are conducted with a larger number of people. Stacks (2010:174) indicate that an in-depth interview provides rich detail and the ability to understand what the participant really thinks about something. Moreover, in-depth interviews minimises the chances of the researcher to report own perceptions, unlike when direct observations and documentary evidence are used (McBurney & White 2009:222; Stangor 2010:129). Likewise, Hesse-Biber and Leavy (2010:94) indicate that in-depth interviews can be used as a stand-alone method or in conjunction with a range of other methods such as surveys, focus groups, or ethnography. This study used in-depth interviews as the main data collection method, however, additional information connected to the research issues were sourced through direct observation and from the organisations websites.

4.8. RESEARCH OBJECTIVES

The role of the MFCA framework in the provision of information to improve an organisation's process waste-reduction decisions cannot be over-emphasised and has attracted increasing attention. Many organisations in Japan have been included in related research and case studies (METI 2007). The review of literature reveals a lack of considerations given to MFCA as a cost accounting tool to provide both financial and non-financial information to improve brewery process waste-reduction decisions (see Table 4.1). Hence, extending its applicability to support process waste-reduction decisions in South African breweries remains unexplored.

Therefore, the research objectives of this study are, namely, to:

- understand the extent to which conventional management accounting systems provide process waste information to support waste-reduction decisions in the South African brewery industry;
- assess the impact of insufficient process waste information by the conventional management accounting systems on brewery waste-reduction decisions; and
- develop a management accounting model to improve brewery process waste information to support waste-reduction decisions; and explain the potential benefits of the management accounting model on environmental performance, cost savings and profitability.

4.9. RESEARCH QUESTIONS

Blaikie (2009:57) argues that formulating research questions is the most critical component of any research design by which choices about the focus and direction of research can be made. Research questions allow boundaries to be clearly delimited and managed so that a successful outcome can be anticipated. Research questions state a problem in a form that can be investigated (Blaikie 2004:966). Furthermore, Blaikie (2007:28) states that there are three main types of research questions, namely: 'what', 'why' and 'how' questions, in that order. Within the scope of this study, three research questions were posed to achieve the three research objectives.

The research questions are as follows:

- **Research question 1:** To what extent do conventional management accounting systems provide process waste information to support waste-reduction decisions in the South African brewery industry?
- **Research question 2:** Why is process waste information provided by conventional management accounting systems insufficient to improve brewery waste-reduction decisions?
- **Research question 3:** How can the existing MFCA framework be adjusted to provide sufficient process waste information to improve brewery waste-reduction decisions?

The purpose of these research questions is to inform the research and guide data collection. In a qualitative research, initial or grand-tour questions represent an initial substantive question (Yin 2010:139). Maykut and Morehouse (1994:88) stress that the primary consideration for qualitative research is that the questions be open-ended. An unstructured, open-ended, and interactive question is used in this study since it offers the participants the opportunity to tell their story. Morse and Richards (2002:93) argue that unstructured interviews are most appropriately used in studies where the researcher seeks to learn primarily from respondents what matters or how procedures are understood. Moreover, Seidman (2006:8) notes that those who urge educational researchers to imitate the Natural Sciences seem to ignore one basic difference between the subjects of inquiry in the Natural Sciences and those in the Social Sciences is that the subjects of inquiry in the Social Sciences can talk and think while those in the Natural Sciences are inanimate. Furthermore, he contends that the subjects of inquiry in the Social Sciences can 'talk and think' unlike a planet, or a chemical, or a lever, if given a chance to talk freely, people appear to know a lot about what is going on. This study agrees with what Seidman (2006) says about qualitative Social Sciences' research and would argue that the statement applies to the current study.

The next section explains the interview guide design for the in-depth interviews.

4.10. COLLECTING THE EVIDENCE: IN-DEPTH INTERVIEW AND OBSERVATION

Yin (1994) listed interviews as one of the major sources of collecting evidence in a case study research. Other sources of evidence in a case study research includes documents (letters, agendas, and progress reports); archival records (service records, organisational charts, and budgets); direct observation (formal or casual but more useful when there are multiple observers); participant observation (whereby the researcher assume a role in the situation to get an inside view of the events); and physical artefact. The interview source of collecting evidence in a case study research, according to Yin (1994), can be done through a typical open-ended but also through focused, structured survey questions divided into focal themes. The in-depth interview is not just to get answers to questions, nor to test hypotheses, and not to evaluate, but to understand the lived experience of participants and the meaning they make of that experience (Seidman 2006:9; Creswell 2007). The in-depth interviews are not only meant to understand the participants perfectly, but will strive to comprehend and understand the meaning of participants' action and behaviour.

Seidman (2006:10) suggests that the primary way a researcher can investigate an educational organisation, institution, or process is through the experience of individual people. The other ways are through examining personal and institutional documents, observation, exploring history, experimentation, questionnaires and surveys, and a review of existing literature. He argues that, if the researcher's goal, however, is to understand the meaning people involved in the process make of their experience, then interviewing provides a necessary, if not always, completely sufficient avenue of inquiry.

The in-depth interview questions were used as the main data-gathering instrument for this study. The reason for this choice is borne out of the research questions that seek to understand existing waste information gathering approach in the two breweries. In order to understand why certain practice or approach is followed by an organisation, Blakie (2004) suggested the use of the in-depth interview method in a case study research to collect data. This approach Blakie (2004) observes will allow the participants to tell their story and provide a deep understanding to the researcher on why the action was preferred choice and how successful it has worked for them. The in-depth interview questions were semi-structured which allowed the participants to ask for clarity where the questions need clarity. In addition, participants' responses may prompt other questions not included in the semi-structured questions. The interview questions were divided into main themes: Management of brewery process waste, Accounting for brewery process waste, adequacy of waste information, waste accountability, integrated database system, and availability of information options (see Appendices C and D).

Interviews took place on the premises, that is, the breweries of the participants. The researcher made contact with the participants to establish the day and time for the interview. The questions for the in-depth interviews were mainly derived from the research questions. The interview was divided into research themes. The purpose for dividing the interview into research themes is to ensure comprehensive and consistent coverage in each theme under study (Brenner 2006:362; Bernard 2011:156). The research themes enable the interviewer to guide the participants through the research questions, yet it allows participants to elaborate on issues they think are relevant to the study. The design of the interview gives participants the space to express meaning in their own words and to give direction to the interview process (Blaikie 2004). This helps to lay a solid foundation to facilitate data collection and analysis for the study.

The next section provides an explanation on how the study was conducted.

4.10.1. Direct observation

In case study research, multiple rather than single methods of data collection are employed (Benbasat, Goldstein & Mead 1987). Direct observation as a source of evidence can contribute to the development of a strong case study. Direct observation provides an opportunity for researchers to observe directly what is happening in the social setting, interact with participants, and participate in activities (DeWalt & DeWalt, 2010). Direct observation may be referred to by other terms, including participant observation, site visits, or field work (Yin 2010). Patton (1987) who has written extensively on qualitative research, indicated that direct observation provides insight into the taken-for-granted aspects of everyday activities that may go unreported by participants, gives the researcher direct experience of the phenomena being studied, and creates an opportunity to see and hear what is happening in a social setting rather than focusing solely on narrative descriptions of participants. To understand fully the complexities of many situations, direct participation in, and observation of, the phenomenon of interest may be the best research method (Yin 2010). The data collected must be descriptive so that the reader can understand what happened and how it happened (Creswell 2007). However, in most applied projects, there is not enough time to carry out a detailed observational study, but some observation, as part of daily work, will help. Observational data are also very useful in overcoming discrepancies between what people say and what they actually do and might help you uncover behaviour of which the participants themselves may not be aware (Patton 1987). Hence, this researcher combined direct observation with in-depth interview method to help minimise any perceived discrepancies between participants' response and actual pattern.

4.11. RESEARCH METHOD

The in-depth interviews are guided by the research questions, but allow participants at the same time to express themselves on matters relevant to the study. An abductive research strategy is used in this study (see Figure 4.2), and enables new perspectives to be discovered in the interview process as evident by the unstructured questions. Abduction is the logic used to construct descriptions and explanations that are grounded in the everyday activities of, as well as in the language and meanings used by, social actors (Blaikie 2007). Abduction refers to the process of moving from the way social actors describe their way of life to technical, social scientific descriptions of that social life (Dubois & Gadde 2002). It has two stages: (a) describing these activities and meanings and (b) deriving categories and concepts that can form the basis of an understanding or an explanation of the problem at hand (Blaikie 2007). Abduction is associated with interpretivism. The logic of abduction is used to discover why people do what they do by uncovering largely tacit, mutual knowledge and the symbolic meanings, motives, and rules that provide the orientations for their actions (Lewis-Beck, Bryman & Liao 2004). Dubois and Gadde (2002: 559) state that while an abductive approach is to be seen as different from a mixture of deductive and inductive approaches; it is a useful approach when the researchers' objective is to discover new things.

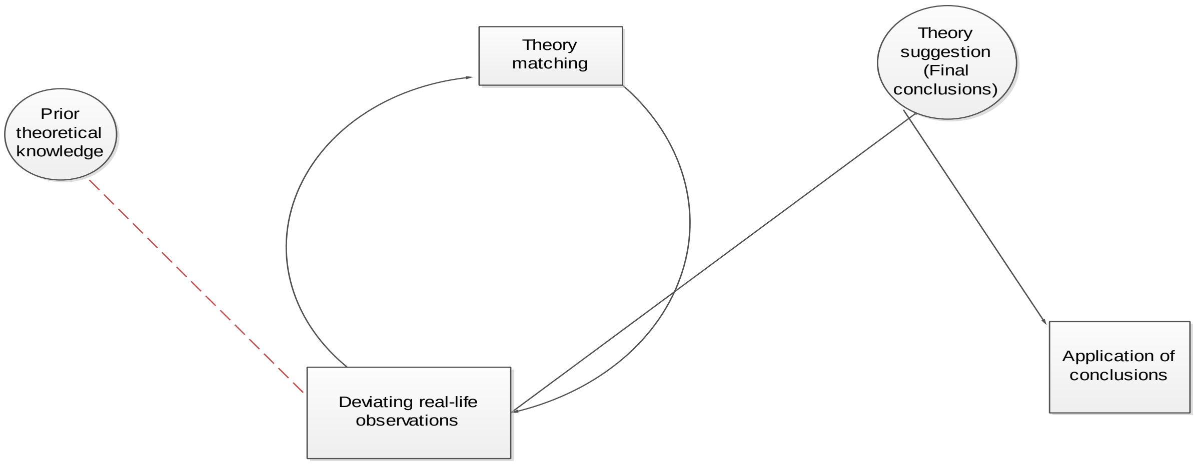


Figure 4.2: The abductive research process *(Source: Adapted from Kovacs and Spens (2005))*

Blaikie (2007:10) explains that the starting point of the abductive strategy is getting to understand the experience of the participants when they share their experience. He states that the aim is to discover their constructions of reality, their ways of conceptualising and giving meaning to their social world and their tacit knowledge about a phenomenon. The researcher endeavoured to comprehend and understand the participants' construction of reality through knowledge and insight provided from recounting of their experiences of the phenomenon under investigation. The next section describes the sampling strategy.

4.12. SAMPLING

The sample for this study was obtained based on the context of inquiry which is the South African brewery industry. The South African brewery industry consists of breweries from the backyard brewers to the large breweries such as South Africa Breweries Limited (SAB Ltd). In this study, Hope brewery which is a micro-brewery and SAB Ltd, a large brewery was selected as case study sites. SAB Ltd has a 98% market share of the beer market (SAB Ltd 2012). Access and time considerations associated with the collection of qualitative data limited the study's choices. About six breweries were initially approached. These two out of the initial six agreed to participate after persuasions for almost 4 months for the micro-brewery and 13 months for the large brewery. In-depth interviews were carried out with the participants from the two breweries at their premises. The micro-brewery requested for anonymity and is hereby named ‘Hope Brewery’ for the purpose of this study.

The financial planner and brew master of the large brewery made up the participants for the interview because their role and nature of their positions is critical to addressing the objectives of the study. In the micro-brewery, the owner and brewer is the sole participant. This is since the owner is in charge of brewing and manages the whole process including distribution.

The first objective required an understanding of how the participating breweries account for process waste cost, and how this specific type of costs provided by the conventional accounting systems have been supportive in waste-reduction decisions. Both the management accounting system and the process waste-reduction decision-making strategy are of special interest and concern to this study. Accordingly, it is required that, at least, one participant from the accounting division and production division could participate. The large brewery met this criterion while the only qualified participant in the micro-brewery who doubles as owner and manager is responsible for all activities due to the size of the organisation.

The second objective was to assess the impact of insufficient process waste information by the conventional management accounting systems on brewery waste-reduction decisions. Clearly, the conventional management accounting systems do not have the ability to adequately monitor the increasing material costs and overheads with sufficient transparency (Gale 2006:1231). Both financial planner and brew master are included to address this second objective.

In addressing the third objective, the study develops a Management Accounting waste information framework to incorporate current MFCA into the conventional accounting systems and highlighted the potential benefits arising from such inclusion. The study’s attempt to build a framework for an improved Management Accounting system to support brewery process waste-reduction decisions is not to underestimate the complexity of existing waste management systems, but to provide a model for the generation of process waste specific information from an accounting perspective. An important approach to this study is to identify and address current and emerging brewery process waste issues and seek to understand the key processes that drive and connects to waste-reduction decisions. Insights gained from the study will be applied to process waste-reduction decision strategies in the future.

4.13. DATA COLLECTION

As explained earlier, the main method of data collection is in-depth interviews to capture participants' perceptions of the research objectives of this study. Interviews were held between July 2011 and July 2012. The participants were informed that the interview would take approximately two hours and it would be confidential if required. Only the participant from the micro-brewery requested anonymity. Both breweries are within the South African brewery industry. Participants were also informed that they could refrain from answering any question during the interview. Questions were designed to meet the research objectives and to suit the different participants based on their size. The interview guides were designed with open-ended questions (see Appendixes C and D). This enabled the researcher to ask follow-up questions where necessary.

Participants were informed that interviews would be recorded on video and were asked to object if they wish not to be recorded. Only the participant from the micro-brewery objected to the video recording. The participants from the large brewery accepted to do the interview while being recorded on a video. All participants were informed that any information provided during the interview would be used strictly for the purpose of the research which they all agreed to. Issues relating to transcribing are addressed in the next section.

4.14. TRANSCRIBING THE DATA

Rendle-Short (2006:21) indicates that the primary task of researchers interested in talk-in-interaction is to collect, transcribe and analyse naturally occurring data. Ten Have (2007:77) furthermore noted that through repeated listening to recordings of naturally occurring interactions, it is possible to translate speech into language which eventually results in a written version of the data to be analysed. Rendle-Short (2006) argues that the transcript of talk-in-interactions must be in an easily readable form both for the analyst and the reader alike. The analyst should aim to transcribe as much detail as possible. Also, when presenting the transcripts to the reader, Rendle-Short (2006) advises that only the details that are important to the analysis should be included, in other words, only the distinctions relevant to the analysis should be presented in order to make the material more accessible. For the reader not to be overwhelmed by unnecessary detail, the researcher has to select those transcripts (see Appendixes F and G) that are more useful rather than having too much detail that makes it more difficult to follow and assess.

Transcription was done by the researcher to ensure accuracy of transcriptions for appropriate inferences and interpretation. All participants in this study have given permission to be quoted extensively in order to manage and cope with the inherent limitations and to allow readers to consider not only the potential explanations that the researcher has suggested; but also other explanations. Easterby-Smith, Thorpe and Lowe (2002:119) argue that whatever means is used to conduct the research, the method should allow the researcher to draw key features out of the data, whilst at the same time allowing the richness of some of the material to remain in order to be used as evidence to the conclusions drawn and to let the data speak for itself. For the purpose of quotation in this study, all quotes typically represent the views of participants. The next section describes the data analysis approach for this study.

4.15. DATA ANALYSIS

Yin (2010:107) states that the process of analysing the evidence resulting from data collection in a case study research consists of examining, categorising, charting, testing, and relating qualitative and quantitative information, in order to respond to the initial research questions. A data analysis strategy needs to be tailored to reflect the research objectives. The analysis of evidence has been identified as the most complex phase of case studies (Miles & Huberman 1994; Mason 2002; Yin 2003), because of the significant amount of data generated in the collection phase and also as a result of its descriptive and narrative nature (Ryan *et al.* 2002). Munhall (2011:366) states that for the divergent nature of the case study method, researchers need to familiarise themselves with the data collection and analysis approaches that is appropriate to the level or type of case study research. Yin (2003) suggests three approaches to analyse case study research data:

a) Follow the study's theoretical questions;
b) identify alternative explanations; and
c) develop a structure or themes to describe the case.

Since this study focuses on the understanding of individual experience regarding a phenomenon, that is, how conventional management accounting systems are used to collect and analyse waste information to support brewery process waste-reduction decisions in the South African brewery industry; a suitable data analysis approach is the phenomenological approach by developing a structure or a set of themes to describe the cases in this study. Within this scope, Miles and Huberman (1994) suggest that simultaneous to developing a set of themes, the researcher should use methodlogies of qualitative data analysis that enables the reduction of data, data representation, the identification of conclusions, and verification.

The type of data collected by the researcher should reflect the research questions as well as what one expects to understand from conducting the research (Creswell 2013). This means that the type of evidence or data collected by the researcher depends on the research question and the methodological approach (Mays & Pope 1995). For instance, the phenomenological case study approach used in the current study required the use of open-ended questions in the interviews to collect primary data in order for the data analysis to be rich in description of the lived experience. To reach a better understanding of the data collected, Miles and Huberman (1994), Mason (2002), and Ryan *et al.* (2002) suggest that the researcher may opt to represent data and information in diagrams. As such, Miles and Huberman (1994) suggest that the researcher may use other methods in parallel to getting feedback with the interviewees to discuss the interpretations and conclusions made by the researcher. This is to reinforce the confidence of the researcher on the choice of the adopted approach.

4.15.1. Unit of analysis

Yin (1994) clearly states that in a case study research, the unit of analysis is the actual source of information: individual, organisational document or artefact. This implies that the unit of analysis defines what the case is. The unit of analysis are the major entities (Hope Brewery and SAB Ltd) analysed in the study. Yin (1994) advocates the use of embedded designs whereby the phenomenon under study will include multiple units of analysis, that is, the study may include larger and smaller units on different levels which allows for consistent patterns of evidence across units. The flexibility of case study design lies in the selection of different cases without changing the objectives of the study to suit the cases (Yin 2003). Such a phenomenon relates to the way the initial research questions have been defined (Yin 1994:22). It follows therefore that an appropriate unit of analysis is critical since it influences the subsequent line of inquiry within a case study. As such, the unit of analysis should be clearly defined by the researcher at the beginning of the study to avoid collecting data from many perspectives just because the case study approach allows it. Yin (2003:114) indicates that the unit of analysis has a critical significance in a case study research since the findings of the case study will pertain to specific theoretical propositions about the defined unit of analysis.

Yin (2003) furthermore argues that such propositions will be the means for generating the findings of the case study. Therefore the entire case study design and its potential theoretical significance are heavily dependent on the way the unit of analysis is defined (Yin 2003:114). The first research objective of this study has as a focus the understanding of the extent to which conventional management accounting systems provide process waste information to support waste-reduction decisions in the South African brewery industry. Two research questions (RQ1 and RQ2) were developed to achieve this objective. The research questions assisted to define the unit of analysis which is the brewery industry. However, the second research objective is to assess the impact of insufficient process waste information by the conventional management accounting systems on brewery waste-reduction decisions. In achieving this objective, it is the participants' personal view or perception that was used. Hence, the unit of analysis was the individual participant from the two breweries. The next section explains the use of content analysis to code the interview data.

4.16. JUSTIFICATION FOR USING THE TWO CASES

Although, the two case breweries are different in size, management, and the amount of waste they generate, this study considers that both breweries share some similarities which make comparability possible. The first is that both are in the same industry producing beer. Secondly, they both generate similar waste, though of different volume, they are considered to have the same environmental impact. Thirdly, both use the conventional MAS to capture waste information. Fourthly, both are addressing the same research questions to achieve the same research objectives. According to Yin (2003), a multiple case study enables the researcher to explore differences within and between cases since the goal is to replicate findings across cases. However, he recommends that since comparisons will be drawn, it is imperative that the cases are chosen carefully so that the researcher can predict similar results across cases, or predict contrasting results based on a theory. In this study, the aim is to predict similarities and differences between the cases as per Section 8.5.

4.16.1. Content analysis

Content analysis is a data analysis approach used to identify and measure, describe and make inferences about specified characteristics reflected by written or verbal text (Waltz, Strickland & Lenz 2010:279). It can be used as a technique in both quantitative and qualitative research (Myers 1997). In a qualitative research like the approach of this study, content analysis is used as a step to identify themes that are present in open narrative or textual data (Joffe 2011). The purpose here is to discern the meaning in the narrative so that the result of a qualitative content analysis is expressed as ideas rather than numbers as expressed by the quantitative content analysis.

Waltz *et al.* (2010:279) indicate that qualitative content analysis tends to be inductive since the themes for describing the data evolve during the analysis. It should be noted that inductive approaches to content analysis focus on developing the themes and interpretation as closely as possible to the recorded material. In contrast, quantitative content analysis tends to be deductive such that theory-based categorical schemes and coding rules are developed before conducting the analysis of data from documents (Waltz *et al.* 2010:279). Moreover, quantitative content analysis is highly structured. Both inductive and deductive approaches to content analysis can be used in qualitative studies. This study focused on summarising the themes rather than reporting all details of the text and video recordings to demonstrate the relative importance of the primary themes identified.

4.16.2. Coding the data

Data gathered during this study were systematically analysed by the researcher. This required the coding of the data. Lodico, Spaulding and Voegtle (2010:35) indicate that coding involves the examination of the data to look for themes that emerge from the data. Yin (1994:102) argues furthermore that analysing case study evidence is difficult when the strategies and techniques have not been well defined. According to Denzin and Lincoln (2003:37), qualitative research is endlessly creative and interpretive with the researcher not just leaving the field with mountains of empirical materials so he can easily write his findings but to construct qualitative interpretations.

Brice (2005:157) attests that analysing data is undoubtedly one of the most difficult aspects of qualitative research because of the nature of the research and lack of adequate discussion of data analysis procedures in the existing literature. Invariably, Kelle (2004:475) indicates that the coding of data seems to be a feasible way to deal with large amounts of transcribed interviews. In this study, a literature review assisted to generate a list of initial questions for data collection. The initial codes are categorised into research themes that were used to group interview questions. For construct validity, the initial codes were derived from the relevant literature. Two themes were derived from the literature to address the first objective on the extent to which conventional management accounting systems provide waste information to support waste-reduction decisions. The themes are *management of brewery process waste information* and *accounting for brewery process waste information.* To address the second objective, four themes are identified. It includes *adequacy of waste information, waste accountability, integrated database system,* and *the availability of waste information options.*

4.17. RESEARCH LIMITATION

As explained in the previous sections, the research design assisted to achieve the research objectives, however, the case study may suffer from inherent limitations just like any other research method (Patton 1987; Miles & Huberman 1994; Yin 2003) such as:

- Case studies are conducted in an individual organisation or in a reduced set of organisations which are included in a larger population with difficulties in defining the study frontiers;
- The interpretation of social reality depends on the researcher which may prevent the researcher from being an independent observer;
- Confidentiality questions about the organisation under study may hamper the realisation of the study report;
- The case study can be time-consuming and this may result in the collection of a significant amount of information; and
- The case study does not allow results generalisation.

Therefore, this study utilises direct observation and a pilot study to support the in-depth interview to strenghten the findings.

4.17.1. Subjectivity

On the criticism for the lack of objectivity, accuracy of case study research and the eventual result of the researchers' subjective perception, Scapens (2004) argues that case studies represent the interpretation of social reality which needs to be deduced by the researcher. The primary method of inquiry was an in-depth interview for this study. The outcome that emerged from the data collected was just for a moment in time and the findings may not necessarily reflect reality. Machan (2004:7) notes that knowledge versus opinion is an essential distinction for understanding the importance of objectivity and subjectivity is inherent in all human inquiries and interpretations. This study is subject to this subjectivity limitation during the conduct of the interview and analysis stage. Despite this limitation, the participants gave elaborate responses which provided a basis for the description of the how and why features of the phenomenon investigated. This has provided a richer and more contextual overview of the phenomenon than would have been obtained from the initial proposed survey method of data collection. In this study, the researcher has provided not only a carefully documented research and analytical procedure, but has strived to ensure consistency in the conduct of the interview to reduce the level of subjectivity.

4.17.2. Generalisation

Generalisation or external validity is concerned with the extent to which findings can be applied to individuals or organisations beyond the sample (Smith 2002:69). In a case study research, generalisability is the most controversial issue since many opponents to case study generalisability claim that a case study provides a poor basis for the generalisation of the findings (Jaworska 2009:51). However, Yin (1994) argues that a case study is concerned with the exploration of particularity, unlike a hypothesis or theory testing enterprise that represents a sample with the objective of expanding and generalising theories. Yin (1994) furthermore contends that research findings obtained from a single case may not work in other cases as every case is distinctive and unique. He indicates that each case study may involve a number of commonalities. Furthermore, Yin (1981) argues that where cases are different to each, an alternative approach must be used which may be called a case-comparison method.

In his proposition of the concept of naturalistic generalisation, Stake (2000) indicates that a case study research increase the awareness of the reader on a particular phenomenon. However, Scapens (2004) reiterates that the purpose of interpretative research is to develop a theoretical framework to explain from a holistic point of view, the social systems and the observed practices. This is the reason for adopting the explanatory approach since it is considered as the most adequate when using an interpretative research perspective (Ryan *et al.* 2002). This study acknowledges that the interaction between organisational and institutional contexts are not necessarily simple nor linear (Nor-Aziah & Scapens 2007). In addition, Scapens (2004) explains that in the explanatory case study research, the existing theory is what enables the researcher to identify convincing explanations over the observed practices.

Scapens (2004) contends that if existing theories do not lead to satisfactory explanation, some modifications to the theory or the development of new theory will be required that will be used leater on in other case studies. This means that the objective of a case study research is to transfer knowledge obtained from a particular situation to a new situation. This may imply that the generalisability of any case study findings ultimately depends on what the reader can learn from it. Due to this, the explanatory case study research expresses theoretical and analytical generalisations in contrast to the usual statistical generalisation of positivist research (Ryan *et al.* 2002; Yin 2003). Theoretical or analytical generalisation exists when a previously developed theory is used as a theoretical framework to compare the empirical results of the case study (Yin 2003), since a significant characteristic of the case study research is its contribution to the development of theory (Ryan *et al.* 2002; Berry & Otley 2004; Scapens 2004; Vaivio 2008). In this study, the existing theory or framework is MFCA. Hence, the study intends to make adjustments to the existing MFCA framework. The researcher furthermore, in order to provide external validity of the case study findings, has provided a thorough step-by-step description of the study's context so that the reader can interpret the findings.

4.18. VALIDITY AND RELIABILITY CHECKS

A major concern for the case study researcher is the credibility of the case study from the preparation phase for evidence collection until the case study report is writing. Yin (2003) suggests the use of three types of validity tests and one reliability test to judge the quality of case study research. These include construct validity, internal validity, external validity, and reliability tests. Based on Yin's (2003) recommendation, the use of a multiple-case study in data collection shows the appropriateness of this study's construct validity. Internal validity in a case study research measures the confidence that can be placed on the cause and effect relationship in the study. The causal relationship between two variables should be properly demonstrated to ascertain that a particular inference has internal validity. This ensures that results of a study are not affected by unaccountable influences, but only by the particular phenomenon being studied. In this study, the phenomenon investigated is the extent to which conventional management accounting systems provide brewery process waste information to support and improve waste-reduction decisions in the South African brewery industry.

External validity refers to establishing the domain to which a study's findings can be generalised (Seale 1999:40). That is, the extent to which causal propositions is likely to hold true in other settings to warrant generalisation of findings. In this study, external validity is demonstrated through the use of a multiple-case study approach. Reliability assesses the reproducibility of results and conclusions. This may therefore imply the ability to obtain the same results from a different application. In a case study research, reliability requires that attention is given to both consistency and stability. It relates to the extent to which the research is authentic and true to life (Kumar 2008:51). It should be admitted that a new researcher investigating the same phenomenon to that of an earlier researcher will essentially be studying a different case since time and context would have changed. This may imply that different conclusions may be reached.

4.19. SUMMARY

The research methods used in this study has been explained in this chapter. A case study and an in-depth interview approach were adopted to address the research objectives. The in-depth interview method was used as the main data collection method. The open-ended questions employed in the interviews were used for data collection in order for the data analysis to be rich in description of the lived experience. The unit of analysis has been the brewery and individual participants from the two breweries. The study used research themes to summarise findings rather than reporting all the details. The next chapter presents the findings of the case study at the micro-brewery in South Africa.

CHAPTER FIVE

FINDINGS – THE CASE OF HOPE BREWERY

5.1 INTRODUCTION

This chapter addresses the first two objectives of this study by using a case study in Hope Brewery to understand the extent to which existing conventional MASs provide process waste information to support its waste-reduction decisions; and to assess the impact of the insufficiency of the process waste information provided through the conventional MASs on its brewery waste-reduction decisions. It is necessary to understand the current state of conventional management accounting systems used in the brewery industry to support process waste-reduction decisions, since extending and adjusting the use of MFCA to improve process waste-reduction decisions in the South African brewery industry is an unexplored area of research (see Table 4.1). In Hope Brewery, it was found that there are no established MASs to capture brewery waste-related cost information. Using a case study approach, this study demonstrates the relevance of MFCA to improve brewery waste-reduction decisions.

5.1.1 Goal of this chapter

The goal of this chapter is to discuss the findings, as well as lessons learned, in the micro-brewery during the conduct of the study. These include improvements made from the case study.

5.1.2 Layout of the chapter

This chapter presents the findings from interviews held with the participant of the micro-brewery, Hope Brewery which is provided in a visual representation in Figure 5.1. Section 5.2 presents a general background of Hope Brewery and an overview of its environmental obligations in relation to waste-reduction in the context of the National Environmental Management Act of 1998, South Africa (DEA 2010b). In Section 5.3, waste-management practices at Hope brewery are discussed. Then, the findings from the in-depth interview, as well as the pilot study, are addressed and discussed in Section 5.4. The extent of Hope Brewery's current conventional MASs to provide waste information to support waste-reduction decisions, and its perceived insufficiency, accounting for waste costs and management of waste information, are discussed in Section 5.4.1. An in-depth interview and the case study for Hope Brewery were conducted between 2011 and 2012 the data collected therefore are presented in Section 5.5. In Section 5.6, a summary of lessons learned from the in-depth interview and the case study was presented. The chapter concludes with a summary in Section 5.7.

The above layout is represented in Figure 5.1.

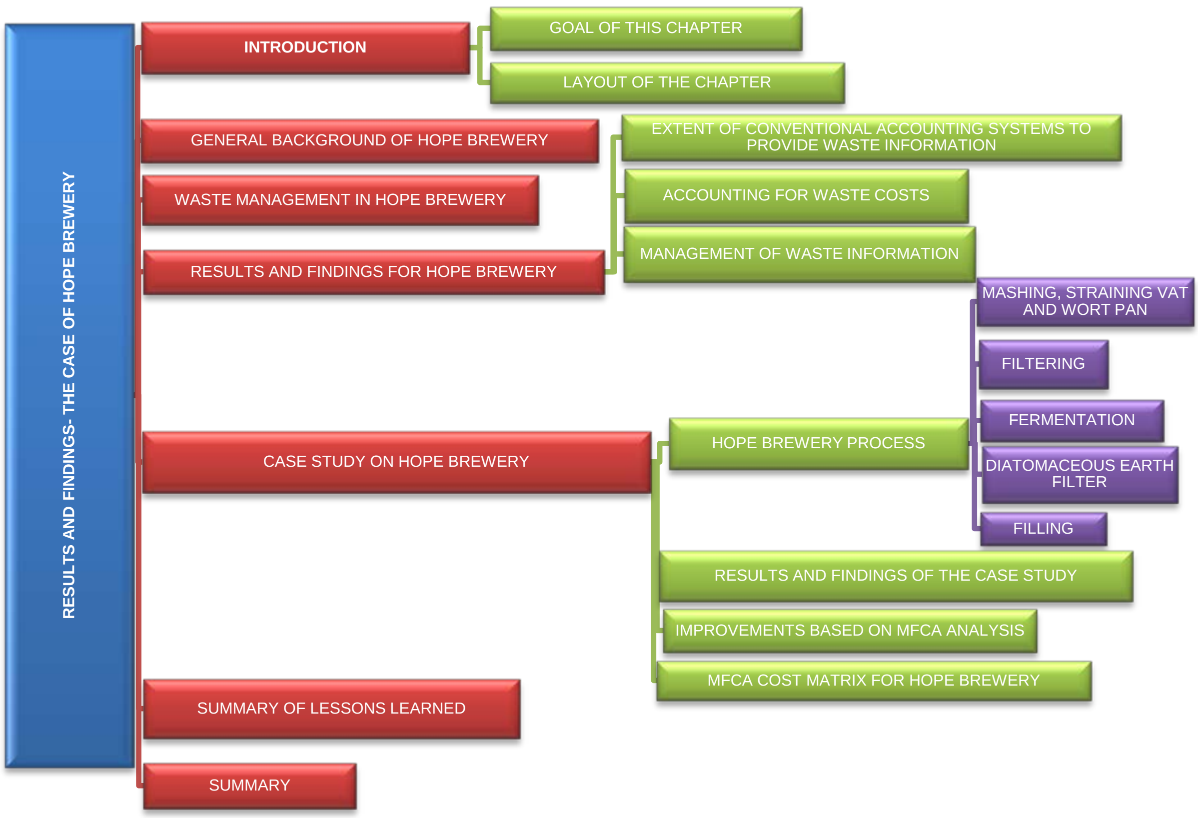


Figure 5.1: A visual representation of the layout of Chapter 5

5.2 GENERAL BACKGROUND OF HOPE BREWERY

Hope Brewery is a micro-brewery that has been in operation at its site situated in Mpumalanga Province of South Africa since the year 2001 with each batch being handcrafted. Just like most micro-breweries in South Africa, Hope brewery is located at the tip of a valley between two mountains. This is a common characteristic among micro-breweries in South Africa, which is meant for easy access to natural spring water which is an important ingredient in beer production. Hope Brewery is rated as one of the best six micro-breweries in South Africa (Davies 2011). Hope Brewery is planning to expand its facilities to cater for its increasing clientele. Each batch of beer produced by Hope Brewery cannot be predictable because of its changing nuances; a shortcoming that has once resulted in entire batches becoming unsalable.

The brewery is a major producer of handcrafted beer in the Mpumalanga Province of South Africa, servicing well-known drinking pubs in its geographical area with a yearly output of about 104 000 litres packaged in returnable crates. The brewery had five employees at the time of the study that supports its operation and distribution, as well as a Bed and Breakfast to provide accommodation for travelling clients and those on holiday. Hope Brewery produces four different types of malt draught beer with absolutely no enhancers or unnatural additives. The beer is coarse filtered and not pasteurised, however it contains a small percentage of active live yeast.

As explained in Chapter Four, the data were coded using prerequisite themes that emerged during the interview process. The in-depth interview process resulted in the sets of themes that matched the study’s first two objectives; that is, the one relating to the extent that conventional management accounting systems generate waste information to support waste-reduction decisions and the impact of insufficient process waste information on waste-reduction decisions.

Appendix A provides a set of coded data on how brewery process waste information is managed and how the existing accounting systems have been used to provide brewery process waste information. This set of themes was used to capture the participants’ understanding of the topic and to describe their experience on these topics. The contributions from this set of coded data were used to address the objectives of this study.

Due to the size of Hope Brewery as a micro-brewery, a case study was undertaken in conjunction with the in-depth interview on the request of the owner. The findings are presented later in the chapter. This was done because of the enthusiasm and willingness of the owner to experience how MFCA can be useful in decision-making as it claims. However, the case study presented in Chapter Six on the large brewery cannot be used in direct comparison with this micro-brewery since they both differ in size, production capacity, management, and quantity of waste generation. However, the arguments and findings will be aggregated to address the two research objectives and a framework can be developed to improve existing waste-reduction decisions. The frequency of the references and comments cannot be determined by the quotes contained in this chapter. Hence, the quotes are provided to support the researcher's interpretations of the findings.

The next section discusses waste-management practices at Hope Brewery.

5.3 WASTE MANAGEMENT AT HOPE BREWERY

Hope Brewery's commitment to environmental responsibility is low as a result of its location and lack of proper discharge of wastewater and brewery solid waste which is dumped into a nearby canal. Moreover, Hope Brewery had no defined environmental system in place at the inception of the study. This discovery has eliminated any opportunity to improve waste-reduction, which is fundamental to fulfilling its social, environmental, and economic responsibilities. Although, brewery waste, such as wastewater occurs when beer remains in conduit pipes, there is no measure in place to redress this situation.

To address the research objectives, the discussion is divided into two main sections. The first section describes the current practices of managing waste information at Hope Brewery, while the second section provides MFCA suggestions made in this study for Hope Brewery.

5.4 FINDINGS AT HOPE BREWERY

The first research objective is to understand the extent to which conventional MASs provide process waste information to support waste-reduction decisions in the South African brewery industry. The second research objective is to assess the impact of insufficient process waste information by the conventional MASs on brewery waste-reduction decisions.

The study found that, currently, there is no management accounting system in place to monitor waste information at Hope Brewery. The clear lack of a management accounting system indicates that waste information is unavailable and waste-reduction decisions were not pursued by Hope Brewery at any time in the past and at present.

5.4.1 Extent to which conventional MASs provide waste information

To determine the extent to which conventional MASs at Hope Brewery provide waste information to support waste-reduction, the study attempts to understand the current practice of generating waste information. The next section provides discussions on the two themes used in the Hope brewery case study.

5.4.2 Accounting for waste costs

Hope Brewery relies on arbitrary or crude judgement to determine what percentage of product has been wasted in the process since there is clearly no sign of record keeping of material flows during the production of beer. The owner relies heavily on his experience over the years as a means of record keeping. On whether or not there is a MAS to capture waste-cost information, he responded with this statement:

> *We don't have any accounting system to record waste here. We know how many litres of beer we get from every batch we make. I don't think it is necessary to record these things, you see we don't have the kind of money like SAB (SAB Ltd) to hire an accountant for such a thing.*

Waste-management practices at Hope Brewery have never been an issue, since waste is considered useless and unimportant to receive any special attention. This seems to be the attitude judging from the response of the owner to issues on whether or not an attempt is made, at least, to document the input and output quantity in any form. The manager responded in this way:

> *Waste is useless; I don't think recording it will change anything.*

Waste is assumed to be a necessary part of the brewery process and can be controlled by being careful during production to avoid unnecessary spillage during transfer from one process to the other. This has been the practice at Hope Brewery for a long time.

The manager at Hope Brewery is aware of municipal regulations that require them to pay for wastewater pollution on their activities, but is unaware of the National Environmental Management Act of 1998 (Republic of South Africa 1998) that requires that producers adopt minimisation strategies to limit the amount of waste that leaves their premises. Hope Brewery pays a monthly levy to the municipality on wastewater pollution. This amount is included in the expenditure of the organisation that comprises the Bed and Breakfast's as well as a tourist site close by. The manager does not see the necessity of separating waste-related costs from the main overhead account of the organisation since the brewery is small in size and cannot afford to keep a separate record. Hope Brewery's wastewater is discharged into the nearby canal and for this the municipality charges a pollution levy. Since the municipality charges this levy, the researcher intended to establish whether or not the manager has ever thought of reducing its level of wastewater discharges. The manager gave this reply:

> *There is always going to be waste. We are trying to find usefulness for the solid waste like giving it to pig farmers to use in feeding their pigs. But we can't do anything about the wastewater.*

Hope brewery gave a thought to consider the recording of its waste information since the focus study; which seems to be the appropriate thing to do.

5.4.3 Management of waste information

There is a lack of consciousness on capturing waste information in any form by Hope Brewery. This has made waste-reduction decisions non-existent in the brewery. Although, the manager at Hope brewery explained that this is because of its small size, it does not absolve them from being socially and environmentally responsible. The manager at Hope Brewery attests that the waste practice among micro-breweries are almost identical because of their size and location which is usually outside populated areas where they can easily access natural water like spring water. According to the brewery manager, the reason for choosing a location outside populated areas may be to avoid the heavy costs of water, which is a main ingredient in beer production. By the nature of its location, size, and capacity, issues relating to wastewater control are not considered a priority. Moreover, the manager of Hope Brewery is convinced that it is more preferable to pay wastewater pollution costs to the municipality than to stress about waste-reduction that requires time and effort. Invariably, waste-reduction decisions are accorded little or no attention in the decision-making process of Hope Brewery.

The use or lack of the use of accounting systems at Hope Brewery is a fundamental problem since its accounts are prepared by a consultant who is not present most of the time to verify transactions. Accounts are prepared to fulfil tax obligations since the business is registered as a Close Corporation where the owner is the brew master and management in one. On the tracking of waste within the process, the manager thinks that it would be a difficult task measuring the actual waste quantity and cost. He responded:

> *I think separating the waste quantity and cost would be a difficult task for me because waste always occurs in the pipes.*

Understanding the amount of waste in a process will help to reduce its generation. The manager agrees with this but expressed concern that there is no waste strategy in place at present. He responded as follows:

> *Obviously, you will be looking at your waste more closely and the money to be saved will make you to pay attention to the amount of waste generated. The focus will be on the large cost of waste in order to reduce it. The amount of savings will make the decision to be quicker.*

The manager at Hope Brewery believes that knowing the amount of waste and at what process it is generated will assist in doing things differently. He reasons therefore that:

> *It is going to help stop unnecessary waste because the focus is on the cost. Because of the drive to save money, the reduction in waste will be high. There will be greater control on waste by nailing down exactly*

where waste happens. Knowledge of waste cost will improve beer quality and waste decision.

Knowing the cost of the brewery process waste would lead to better waste-reduction decisions as attested to in the above statement made by the manager at Hope Brewery. The production system at Hope Brewery is not the most efficient; however, waste-generation levels at present can be reduced if adequate waste information is made available. Although, waste generation is inevitable in beer production, it can be controlled. For every waste created, there is a corresponding loss of energy cost, systems cost, and labour cost. It is important that micro-brewery managers know the right costs and its calculation for effective waste-reduction decisions. The manager of Hope Brewery indicated that:

From a micro-brewery point of view, I think the brew master can provide the physical waste information while I get someone who can help do the costing.

The potential benefit of this study to the micro-breweries in South Africa is the creation of awareness of the importance of determining the amount of waste costs on future waste-reduction decisions. After the researcher performed a case study on the site, the manager agreed that this study has great potential to redirect micro-brewers' attention to an important aspect of their operations which has long been neglected, that is, waste-reduction decisions to make them socially, environmentally, and economically responsible. Micro-brewery managers' attitude to waste-reduction would have been attended to differently before now had they had such awareness in the past of the importance of capturing all relevant waste costs. He states that:

It obviously would bring more insight to aspects which we have not looked into before.

To show that this study has great potential in practice, the manager at Hope Brewery advised the researcher to consider setting up a consultancy company to assist organisations to account for their waste generation. In response to this request, the researcher agreed to conduct a pilot study to show the practicability of MFCA on supporting brewery process waste-reduction decisions. The next section provides discussions on the pilot study.

5.5 PILOT STUDY OF MFCA AT HOPE BREWERY

MFCA was applied to the Hope Brewery processes for a period of six months between August 2011 and February 2012 throughout the whole flow process. The brewing process as described above makes use of materials and energy in producing any of the four types of beer produced by Hope Brewery. In the production of beer, barley, ale, water, sugar, and yeast are input materials. The input for packaging is the bottle and crates for transporting. The brewery flow process is explained in the next section.

5.5.1 Hope Brewery flow process

The brewing flow process in Hope Brewery as described by the brewery master is presented below:

5.5.1.1 Mashing, straining vat, and wort pan

Malted barley is mixed with water to form a mash with heat applied. Here, a proportion of energy is used to convert the insoluble starches and proteins into wort, which contains fermented sugars and maltose. By-products such as spent grains are generated at this stage. Carbon emissions are generated due to the boiling and heating of the materials and water.

5.5.1.2 Filtering

The mash is filtered at this stage to separate the dissolved sugars of the wort from the spent grains which contains a large quantity of malt husks. The spent grain is rinsed with hot water to remove any residual wort, which is in turn sold to pig and dairy farmers for animal feeding since it contains some percentage of protein-rich trub. Water and energy are consumed in large amounts at this stage. The wort is further boiled in the wort pan where the beer colour and flavour is developed. The boiling in the wort pan is used to extract the bitter and aroma substances from the hop introduced at this point together with the sugar. The wort is allowed to cool to about 10ºC and prepared for fermentation.

5.5.1.3 Fermentation

Live yeast is added in the fermentation process to convert sugar into alcohol and carbon dioxide. At this stage, Hope Brewery had lost batches of production due to the addition of unsuitable yeast. However, these losses were not accounted for in its records. The fermentable sugars are allowed to convert for a period up to 5 days when most of the yeast would have sunk to the bottom of the fermentation vessel. The beer is allowed to mature below 0ºC for between 6 and 10 days to harmonise and produce the desired flavour. Hope Brewery produces four different beer types which include Draught, Ale, Porter and Black Brew.

5.5.1.4 Diatomaceous earth filter

This process is used to remove yeast residue and haze particles for a sparkling beer. Again, energy is consumed at this stage, which includes non-product output such as wastewater.

5.5.1.5 Filling

Filtered beer is dispensed into 330ml bottles ready for distribution to pubs in Mpumalanga. The quality control system of Hope Brewery is lacking at this point since from observation, due care has not been exercised to avoid dripping and sometimes spillage of finished beer.

5.5.2 Findings of the case study

Wastewater: Brewing is a water intensive process. Hope Brewery requires about 9 litres of water for every litre of beer produced. Although, Hope Brewery sources its water mainly from a nearby spring, reduction in water consumption should take priority, especially when the level of water scarcity in South Africa is considered (WWF 2012). Hope Brewery does not have the capacity and technology to reuse or recycle brewery process wastewater. Wastewater is discharged into a nearby canal which may contaminate underground water. The water source for Hope Brewery is mainly from a large storage tank and a spring water outlet close to the brewery. Therefore, the brewery manager seems not to bother about the quantity of wastewater generated. However, he failed to consider the environmental hazard and other systems cost that have gone into producing such wastewater. Water leaks occurred in production due to rusted pipes. This is a major source of water leakage apart from that occurring when cleaning brewing equipment and the factory floor.

Energy usage: All wastewater generated in the brewery process consumes energy. As such the more the wastewater and solid waste generated the more energy is wasted in production. It was discovered that energy cost accounted for about 20% of the production costs.

Abnormal production loss: During the study period of six months, inefficient application of yeast had resulted in losses of 4 batches of 1000 litres of beer becoming unsalable. These losses usually go unnoticed since Hope Brewery lacks a good system to record the flow of material in brewing process. Production control relies heavily on the experience of Edmond *(not real name)* the production manager.

Lack of proper documentation of process flow: Production records relating to the quantity of input materials and related costs used in each production batch is unavailable in the books of Hope Brewery. The record available indicates the output quantity of completed batches. Therefore, it is difficult to determine the amount of waste generated in any given batch. Reliance was on experience which has proven to be ineffective judging from the abnormal production losses suffered.

5.5.3 Improvements based on MFCA analysis

The following improvement strategies were made to the existing system in Hope Brewery after the pilot study:

- A waste record format was generated to record the quantity of input materials at the beginning of every batch. The record includes the volume of water used in each process, units of electricity consumed in the process, wages paid to the production staff during a shift, cost of any repairs, and the volume of beer that results in good product. This process enables the brewery manager to determine the loss in any particular batch. Overall water usage was calculated at 9 litres for every litre of beer produced. Subsequently, due to the purchase of a new wort pan responsible for leakages, water usage dropped to 7 litres per litre of beer produced. Further, improvements include the ability of the brewery manager to determine which process is responsible for the inefficiencies;

- A new wort pan was purchased to replace the old pan which has become obsolete to reduce the water leaks in the connecting pipes to the turbidity filter. Although, replacing the wort pan is a major investment, MFCA has made it visible that the wort pan generates a considerable number of litres of wasted water which necessitated its replacement;
- Since production takes place twice every week, wages has been re-negotiated to align with batches worked. Savings in terms of production wages attest to the importance of a MFCA analysis in the brewery production process;
- A new quality-checking device had been purchased to ensure that quality beer is produced in any batch and to avoid the incidence of total batch losses;
- Wastewater treatment equipment could not be investigated due to the lack of funds to embark on such a project and the fact that Hope brewery is a micro-brewery; and
- Housekeeping and other cleaning activities now use less water since the notion that water is almost free for brewery use has been replaced by the concern to save water consumption as a result of its scarcity, especially in South Africa.

5.5.4 MFCA Cost Matrix for Hope Brewery

Below is a summarised MFCA cost matrix for Hope Brewery from August 2011 until February 2012.

Table 5.1: MFCA Cost Matrix for Hope Brewery

	Material cost (R)	%age	Energy cost (R)	%age	Systems cost (R)	%age	Waste disposal cost	Total cost (R)
Good product	110124	39.90	31350	11	15732	5.70	0	157206
Negative product	83076	30	23650	9	11868	4.30	0	118594
Sub-total	193200	70	55000	20	27600	10	0	275800

Table 5.1 shows the costs incurred during the six-month period of the study and the portion that is attributable to both good and negative products. However, waste-disposal cost is not incurred by this brewery because wastewater and solid waste are disposed into a nearby gully. The availability of the MFCA analysis to the Hope Brewery has resulted in the improvements stated above.

5.6 SUMMARY OF LESSONS LEARNED

The lessons learned from the pilot study provided evidence on the potential benefit that could be derived from the implementation of MFCA as a decision tool to support waste-reduction decisions. Although there is no previous brewery process waste-related cost to which it can be compared, it has nevertheless shown that it is essential that brewery managers need to know how much it cost to generate waste in order to seek opportunities for its reduction. Not knowing the cost of waste generated in a production process could lead to waste-reduction decisions that are flawed. An advantage of the current findings is the sensitisation of a conscious awareness to micro-brewery managers on the continued benefit of generating adequate and accurate brewery process waste information to support their waste-reduction decisions. This in turn means that even micro-brewers can fulfil their social, environmental and economic responsibilities in line with current demands of being an environmentally-driven corporate entity as required by King III.

5.7 SUMMARY

In this chapter, the extent to which the Hope Brewery's current conventional MASs provided waste information to support waste-reduction decisions, and its perceived insufficiency were discussed. The findings from the in-depth interview as well as the pilot study indicate that there is no accounting or for that matter management accounting system in place to monitor waste information at Hope Brewery. This clear lack of an (management) accounting system shows that waste information is unavailable and waste-reduction decisions are not pursued by Hope Brewery at any time in the past or at present. However, the pilot study provides evidence on the relevance of MFCA to bridge the gap on waste information generation even in a micro-brewery like Hope Brewery. The pilot study was performed to demonstrate the potential of adopting MFCA as a support tool to improve brewery process waste-reduction decisions.

The findings indicate that a full knowledge of waste information will result in quick and sound waste-reduction decisions and cost-saving opportunities can be implemented. Improvements from the pilot study include the development of a waste record, the replacement of the old wort pan which had been a constant source of waste water through leakages, re-negotiated wages to align with batches worked, increased quality checks to avoid batch losses, and improved use of water during housekeeping. A cost matrix (see Table 5.1) which highlights these improvements indicates that the availability to measure waste cost translates to better waste-reduction decisions. The next chapter presents the findings from the case study at SAB Ltd.

CHAPTER SIX
FINDINGS –SOUTH AFRICAN BREWERIES LIMITED

6.1 INTRODUCTION

This chapter addresses the first two objectives of this study which is to: examine the extent to which existing conventional MASs provide process waste information to support waste-reduction decisions (in this instance SAB Ltd); and to assess the impact of the insufficient process waste information provided through the conventional MASs on its brewery waste-reduction decisions. In Chapter Seven, the third objective is addressed which is the adjustment of the MFCA framework for breweries. While the SAB Ltd has an accounting system to record its brewery waste information, this study conducted in-depth interviews to ascertain the extent that current MASs provides adequate brewery waste-cost information to support its brewery waste-reduction decisions. The variable standard costing method was used to capture waste cost information thereby creating a gap in the quality of brewery waste-reduction decisions process. The findings revealed the insufficiency of its current MAS; an indication that past waste-reduction decisions might have been inappropriate and unsustainable. Lessons learned from the in-depth interviews are discussed which informed the development of an adjusted MFCA (AMFCA) in Chapter seven.

6.1.1 Goal of this chapter

The goal of this chapter is to discuss the findings from the interview at SAB Ltd as comprehensively as possible by making direct and concise quotes of the responses. The findings were presented in such a way that it addresses the research objectives of the study.

6.1.2 Layout of the chapter

Chapter five provided the findings of the case study at Hope Brewery a micro-brewery in South Africa. This chapter presents the findings on South African Breweries Limited (SAB Ltd), a large brewery in South Africa in a visual representation Figure 6.1. A background description of SAB Ltd was given in

Section 6.2. A general description of SAB Ltd's sustainable development approach is presented in Section 6.3. In Section 6.4, barriers to improve brewery process waste-reduction decisions are discussed as well as drivers to improve process waste-reduction decisions in SAB Ltd in Section 6.5. The potential benefits of implementing waste-reduction in SAB Ltd are provided in Section 6.6. The findings in relation to the first and second research objectives are provided in Section 6.7 and Section 6.8 respectively. Sub-sections 6.8.1, 6.8.2, and 6.8.3 discuss the adequacy of waste information; waste accountability; integrated database systems; and availability of other waste information options respectively. A discussion of lessons learned is also presented in Section 6.9. A summary of the case study chapter is provided in Section 6.10. The above layout is represented in Figure 6.1.

In Appendix G, a set of coded data on how brewery process waste-information is managed and how the existing accounting systems have been used to provide brewery process waste information is provided. Another set of coded data consisting of four themes was used to address the second objective. These include the participants' view on the adequacy of brewery process waste information generation to support waste-reduction decisions; issues of waste accountability; the usefulness of an integrated database system for generating brewery process waste information; and the availability of other waste-information options other than accounting to support waste-reduction decisions.

This chapter presents evidence from the in-depth interview conducted at SAB Ltd which was captured on video. The evidence does not necessarily support all the findings for the micro-brewery because of the size, capacity, and degree of waste generated by each organisation. The focus of this chapter is to demonstrate similarities and differences, if any, between Hope Brewery and SAB Ltd in terms of the extent to which conventional MASs provide brewery process waste information to support their waste-reduction decisions, and to assess the impact of insufficient process waste information by the conventional MASs on brewery waste-reduction decisions.

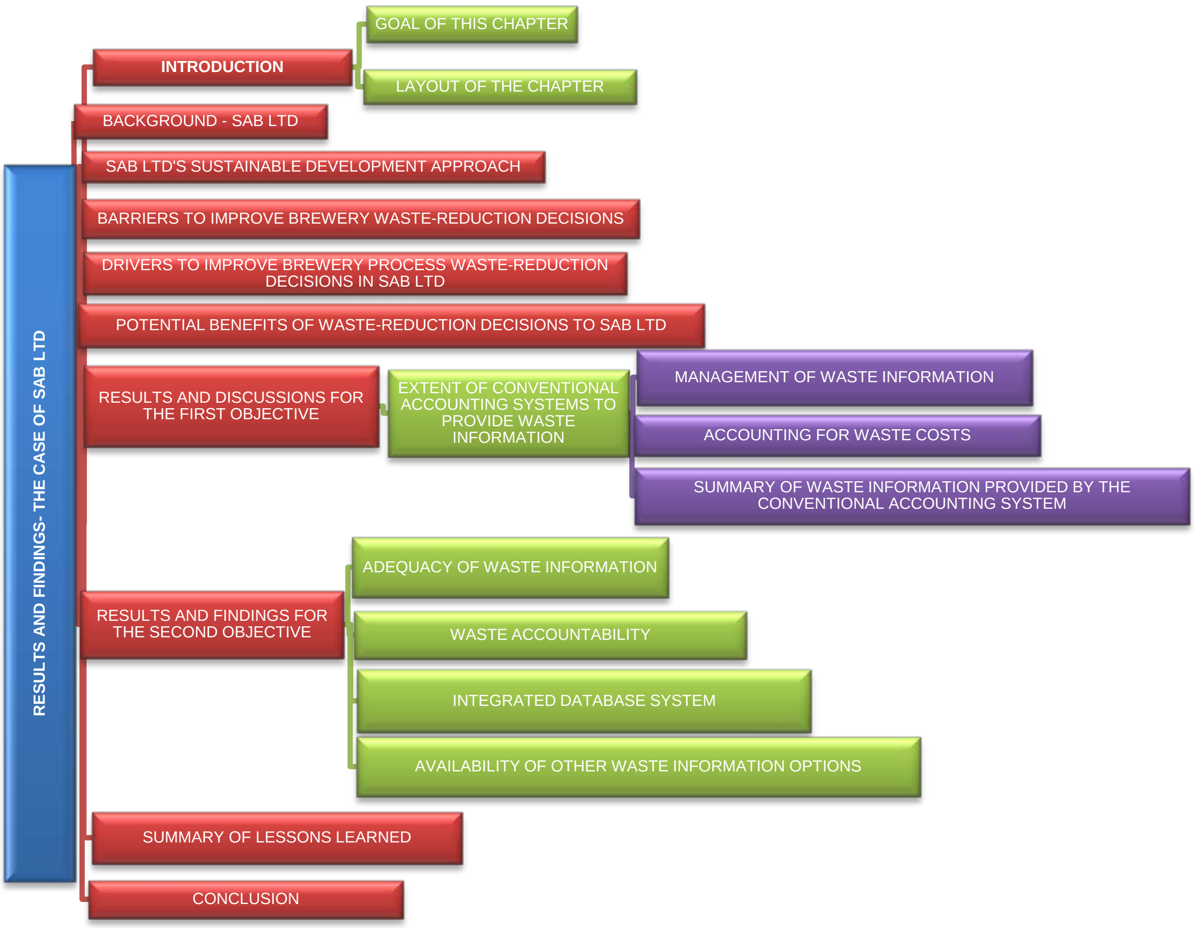


Figure 6.1: A visual representation of the layout of Chapter 6

6.2 BACKGROUND - SAB LTD

The SAB Ltd, founded in 1895, is the South African subsidiary and historical birthplace of SABMiller Plc., one of the world's largest breweries by volume with more than 200 brands and brewing interests and distribution agreements in 75 countries across six continents (SAB Ltd 2012). SAB Ltd is headquartered in Johannesburg, South Africa and has been listed on the Johannesburg Stock Exchange since 1897. In addition, SAB Ltd is a dominant brewing company in South Africa with a market share of about 98 per cent. The company operates seven breweries and 42 depots in South Africa with an annual brewing capacity of 3.1 billion litres (SAB Ltd 2012). In 2009, SAB Ltd.'s Gross Domestic Product (GDP) amounted to R66.2 billion or 3.1 percent of the country's GDP. During the 2009 tax year, SAB Ltd paid R10.2 billion in tax revenue directly to the South African National

Treasury from corporate taxes; employees personal income tax; value added tax (VAT); and excise duties (SAB Ltd 2012). This accounted for 1.7 percent of the South Africa's government's total tax take for 2009. Sales revenue in 2009 amounted to R32 billion (SAB Ltd 2012).

6.3 SAB LTD.'S SUSTAINABLE DEVELOPMENT APPROACH

SAB Ltd.'s sustainable development approach as practiced globally through the directive of its parent company, SABMiller Plc., was developed through consultation with both internal and external stakeholders (SAB Ltd 2012). In 2010, the organisation began a global programme of sustainable development tagged "Ten priorities, One Future". The objective of this programme is the integration of sustainable development into its day-to-day operations. Some of these ten priorities is the commitment to make more beer using less water, a major ingredient used to produce beer, and to achieve zero waste generation in its operations (SAB Ltd 2012). It should be recalled that water is a scarce resource in South Africa. This study focuses on improving waste-reduction decisions through the provision of adequate waste related information by the accounting systems.

Since brewing is a water-intensive process and water is especially scarce in a semi-arid country like South Africa (WWF 2012) breweries may need to be made aware of their responsibility. In its effort to reduce its water usage, SAB Ltd has, in the past two years, improved its water efficiency use by 8 per cent. Also, SAB Ltd has embarked on some initiatives to reduce its environmental impact that include the Water Neutral Partnership, which was done in collaboration with the World Wildlife Fund (WWF); the 'Let the River Flow' Project' or 'The River Trust' that intends to rehabilitate the Wilge River in the Free State Province of South Africa; and the Project Eden, an SAB partnership with the Rhodes University to treat wastewater for re-use (SAB Ltd 2012). Since environmental impact reduction is a priority of the SAB Ltd, this study conducted in-depth interviews to understand the extent to which its conventional accounting systems have provided waste information in support of it waste-reduction strategy and decisions. The next sections present the findings from the case study on the SAB Ltd to address the research objectives.

6.4 BARRIERS TO IMPROVE BREWERY PROCESS WASTE-REDUCTION DECISIONS

Certain barriers to achieve and implement a successful waste-reduction strategy exist in organisations (Lober 1998). These barriers are sometimes related to administrative preferences for different information needs (Gertsakis & Lewis 2003). While different managers prefer certain sources of information to others to the effect that all available information sources are not fully exploited (Lenox & King 2004); some managers regard accounting information as only limited to the generation of financial statements and the preparation of budgets, but not useful to environmental issues (Liu & Anbumozhi 2009:594). In SAB Ltd, managers often wait to assess waste information at the end of a batch before initiating corrective measures. This has led to substantial losses occurring, which could have been prevented if a more waste-specific framework had been applied that generates waste information as it occurs in each individual process. Moreover, the conventional MASs in use in SAB Ltd provide waste-information based on the variable costing system, thereby ignoring vital waste costs that are hidden in overhead accounts such as fixed costs.

6.5 DRIVERS TO IMPROVE BREWERY PROCESS WASTE-REDUCTION DECISIONS IN SAB LTD

The South African Breweries Ltd instituted an entrepreneur development programme that aims to reduce its waste generation and help in fulfilling its social, environmental and economic responsibilities (SAB Ltd 2012). A waste-reduction strategy was adopted to ensure that waste targets are met in terms of quantity and costs. Savings from this strategy are invested into developing local businesses by encouraging more entrepreneurship to promote beer sales. This has brought an increase in entrepreneurs and beer consumption in rural communities through the creation of drinking pubs that created employment. By encouraging the establishment of more drinking pubs, the demand for the product increased, so is the level of beer production. This has brought about an increase in the income of the organisation and led to further motivation for waste-reduction. Figure 6.2 depicts the relationship among key drivers to achieve a sustainable waste-reduction strategy by the brewery.

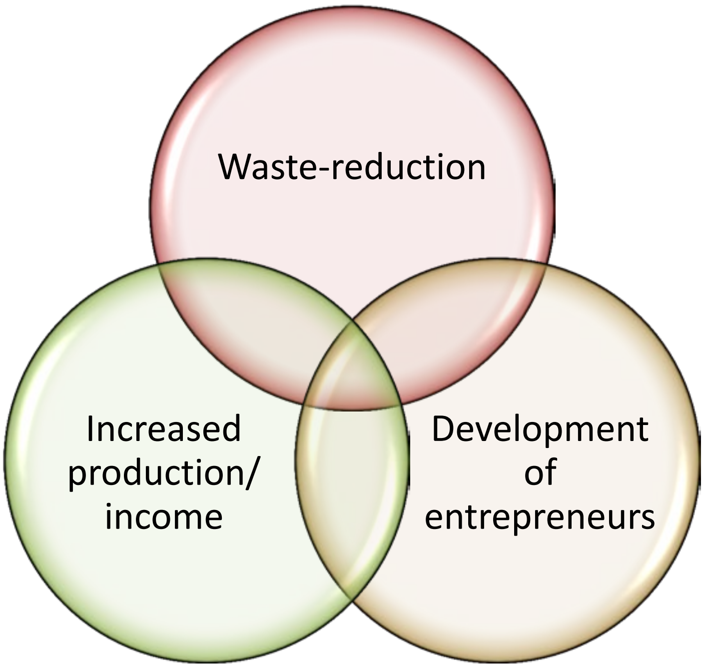


Figure 6.2: Researcher's illustration of SAB Ltd drivers to improve brewery process waste-reduction

The strategy intends that waste-reduction should be the key that drives expansion without recourse to its shareholders.

6.6 POTENTIAL BENEFITS OF WASTE-REDUCTION TO THE SOUTH AFRICAN BREWERY INDUSTRY

According to the brewery manager, SAB Ltd managers are very keen on achieving sustainable process waste-reduction because it is embedded in the organisation's code of practice. It is believed that achieving significant process waste-reduction will give them a competitive advantage over other breweries. It will also mean financial reward to line managers who had achieved their targets. Other benefits include promoting an organisation's business image as an environmentally friendly plant or organisation. Socially, breweries are seen to be responsible through their job creation initiatives, which contribute about 3.1% of South Africa's annual Gross Domestic Product (GDP) (SAB Ltd 2012). Economically, shareholders are having increased returns from year to year without having to be made to contribute more during expansion decisions.

6.7 FINDINGS AND DISCUSSIONS ON REACHING THE FIRST OBJECTIVE

The first research objective is to understand the extent to which conventional MASs provide process waste information to support waste-reduction decisions in the South African brewery industry. The study found that the level at which the conventional MASs in the brewery provides waste information is inadequate to make appropriate waste-reduction decisions. Waste information is generated on a daily basis since the brewery examined produces about 1.7 million hectolitres of beer per year. However, waste costs are calculated based on a variable costing system only. This approach may have limited the chance to improve waste-reduction decisions and opportunities to adopt a better waste-reduction strategy are lost since not all waste related costs can be captured through the variable costing system.

To address the first research objective, the discussion is divided into two main sections. The first section describes the extent to which the brewery manages its process waste information through data provided by the conventional MASs to support waste-reduction decisions. The second section describes the sufficiency of the MAS to provide adequate brewery process waste information.

6.7.1 Extent to which conventional MAS provides waste information

This section sets out to understand the extent to which the conventional MASs provide waste information to support brewery waste-reduction decisions. To understand how waste information is generated in SAB Ltd, the first research objective was divided into two themes presented in the next *subsections.*

6.7.1.1 Management of process waste information

SAB Ltd classifies the following items as brewery waste: spent grain, trub or spent hops, spent yeast and kieselguhr; which is a diatomaceous substance used to filter beer to make it brighter by removing the yeast in order to produce alcoholic beer. Other waste includes wastewater from cleaning the plants containing detergents and effluents. Although, some of the wastewater can be recovered, unrecovered wastewater is sent down the drain to be treated by the municipality for a fee. Recovered wastewater is used for housekeeping while others are treated and upgraded to international standards before being used as brewing water. Some recovered wastewater can be used for irrigation purposes. Energy is lost at the boiler or wort kettle when the grains are boiled in the form of steam with the brewery's coal heating system having an efficiency rate of about 80 percent. Steam is recoverable; however, this brewery is unable to recover lost steam since they are not equipped to do so.

Waste-reduction challenges in this brewery are to minimise the quantity of wastewater, kieselguhr, spent grain, spent hops, the yeast, and the steam. Another waste-reduction challenge is the loss of beer during transporting due to valve breakages. All of these are considered as major waste in this brewery. In the case of valve breakage during transportation of beer in process, the brewery experiences a serious waste challenge. The brew master indicated that:

> *For us we take it that seriously that any loss of product is a waste. It's huge money, in fact. So the other waste for us is time. We don't want to lose time, we don't want to lose physical product* (Brew Master)*.*

SAB Ltd has adopted to sell spent yeast to certain organisations that dries the yeast and resells to pharmaceutical companies to make drugs. Spent grains are sold to local farmers to feed their livestock. According to the brew master of SAB Ltd, the organisation undertook a project to reduce their Chemical Oxygen Demand (COD) to 2500 milligram per litre on site, since the municipality charges a penalty if the COD is in excess of 5000 milligrams per litre.

SAB Ltd.'s corporate social responsibility, according to the brew master, emphasises on aggressive waste-reduction. She indicates that thus:

> *Why do we want to pollute? It's not the right thing to do. With us, we want to reduce the waste that goes to the effluent plant. We also have to think about our reputation. We think that it is important if our reputation is intact* (Brew Master).

This action is to protect the brewery's environmental image. According to the brew master, the brewery does not have a waste-treatment plant like some of the other plants in other locations; nonetheless, the project has assisted the brewery to take precautions on things which would not have been attended to.

> *Simple things like including or doing things better or smarter. Say if you want to remove yeast, instead of opening a valve to drain the yeast, you collect the yeast into skips, you get pumps put into a vessel, and that yeast gets pumped in, and gets collected into a truck. Little things like that that didn't cost us a lot of money, but saves a lot of costs. So the guys (production department) understand that, and then we started showing the guys the cost of you leaving the yeast going into the drains. We get a result every morning, every 24 hours. We have a sampler; the samples are always shown every hour. We have our own equipment. What we do is we then double-check against the municipality's numbers, because the municipality charges us on their own numbers. So we've decided that no, we do our own numbers, so we actually check. So I can tell you on a weekly basis what I expect to be charged by the municipality* (Brew Master).

The brewery has a waste-reduction strategy to reverse beer loss. This is implemented as a divisional strategy of the brewing section. This strategy ensures that the volume of beer loss is monitored every week. Beer loss is arrived at by calculating the product's COD and effluent charges by the municipality. This brewery has a reporting process for all brewery by-products. Reports on waste from effluents and beer loss are generated on a weekly basis. This report assists the brew master to determine the extent of waste generated from the volume of kieselguhr discharged to the municipal drains every week. This helps to show the particular process where waste actually occurs and such a waste-generating process can be optimised. This may imply that having to report on waste volume helps the brew master to initiate waste-reduction strategies for specific processes. The brew master when explaining how relevant waste reporting is to her function, she states that:

> *We try and make sure that if there is waste, I can actually calculate the efficiency of a vessel, and it would tell me how much of waste has come*

> *out. I can analyse the sample and tell how much of it I've wasted or what should've gone into the next process* (Brew Master).

Brewery process waste information is collated at the end of each batch produced. Waste information is not made available at each of the processes. The procedure in this brewery is to measure target production against actual production at the end of each batch to ascertain where process waste actually occurred for corrective action. In each production batch, process and quality checks are done by vessel or wort kettle to determine where process waste had occurred. Process waste is quantified using an input-output analysis with the finance division applying the variable costs approach to measure the value of waste in a batch.

Energy lost through steam in each process cannot be quantified by the brewery, however, it is quantified at the end of each batch. This system of quantification at the end of each batch makes it difficult to initiate corrective action at that stage and time when the loss is generated. At times, when the brewery is embarking on projects, consultants are hired to provide the quantity of steam lost in production. This type of project is aimed at reducing both energy and water losses. In computing waste costs, the amount of labour lost in a production is not included in the waste costs. Assigning all related waste costs to processes ensures that brewery managers are in the possession of accurate waste data in order to make sound waste-reduction decisions. Such related waste costs will include labour, depreciation, electricity, idle time of plant and workers, and other fixed costs. This brewery includes only variable costs into calculating its waste costs while ignoring fixed costs into overhead accounts. Waste information is made available to the brewery's top management at the end of each week in order to make strategic decisions on waste-reduction.

Barriers inhibiting the generation of waste information in this brewery is the lack of vessel by vessel type of waste information. According to the brew master:

> *…..if I could come back in the morning and find a vessel by vessel waste and cost number, it'd be much easier than when I get the final number and work back, then I'll just put my signature on it. Definitely because when I walk in my problem is already identified immediately. So that would be very great. ………so if I could do that and walk into this plant*

and say, Oh, I lost it there, I lost it there, I lost it there; without having to do onerous problem solving, then it'd be great (Brew Master).

Water shortages are some of the barriers to implementing waste-reduction strategies at times when the brewery would have to resort to using water from its reservoir. Incidences of water shortages led to wastages in the past when production had to stop abruptly.

Key drivers to improving brewery waste-reduction in this brewery are summed up by the brew master thus:

> *Key drivers, I mean our strategy. Sustainable development is very important* (Brew Master).

In terms of its economic responsibility, the brewery strive to remain viable by ensuring that shareholders are happy through increasing returns from increased sales. As part of it social responsibility, the brewery provides employment to a large number of people. In furtherance of its social responsibility as required by South Africa's King III (IOD 2009), as explained by the brew master, the brewery make use of savings from its waste-reduction efforts to fund entrepreneur development programmes, provision of scholarships to students, and in-training to students in the art of brewing such as the provision of a micro-brewery to students of Biochemistry and Molecular Sciences of the University of Limpopo (SAB Ltd 2012). This is to assist in the enhancement of the corporate image of the organisation.

6.7.1.2 MASs for brewery process waste information

SAB Ltd.'s finance division basically uses the variable costing system to account for brewery process waste costs. According to the financial planner, material costs are measured from the input stage throughout the brewery process until the stage where there is beer loss and packaging loss. Waste costs are separately identified from other costs; however, value is assigned at the end of a batch using the variable costing method. Other costs that relates to production loss are included in overhead accounts. The financial planner explained the brewery's waste accounting system like this:

> *We do have a separate account for the variable costs. So you've got your variable costs which are accounted for differently and the variable*

costs are the beer process flow. We've those accounts, and then the overhead accounts are also separate. So the variable waste costs are separated from overhead accounts (Financial Planner).

The accounting system in SAB Ltd captures waste costs by applying the standard costing system. The actual output costs are compared with the standard output target in order to calculate waste costs. The financial manager states that:

How that happens is we've got standards for each process. We know for example for beer loss, there is so much that needs to be accounted for because we're going to lose no matter what (Financial Planner).

Material and energy costs are regarded as variable costs. It is a general perception in the brewery's accounting division to measure waste costs based on the input-output analysis which is generated on a weekly basis. The financial planner explains in this statement:

Electricity cost is placed under variable costs. We set standards for everything, from electricity; materials; beer loss; coal; everything is included. The standards are set and then we're usually measuring ourselves according to those two (standard costs and actual costs), vice-versa. It's obvious that we'd have these overruns (wastages), and these overruns would be the difference between the standard versus the actual usage (Financial Planner).

In the production process, provisions are made for normal beer loss. He states:

For example, we already know we're going to lose say 1% of malted barley in production. So, this is the standard (Financial Planner).

The financial planner believes that SAB Ltd has a perfect accounting system that captures all waste-related costs. According to him:

I don't see anything that we're missing currently. I can't see anything that is left out (Financial Planner).

In accounting for waste costs, however, depreciation costs of wasted plant hours are not charged to waste account but to overhead accounts. The financial planner has this to say:

> *No, no, no. those would be overheads. It's sitting in overheads* (Financial Planner).

Costs of idle production time due to production stoppages, as a result of valve breakage for instance, are included in overhead accounts. However, on a weekly basis, the accounting division calculates factory efficiency to determine the volume of losses from the previous week's production. This way, the number of hours lost to inefficient plant operations is known.

The financial planner believes that process waste information provided through the conventional accounting system does influence their waste-reduction decisions. He thinks that the provision of waste information is timeous since it is generated on a weekly basis. He puts it this way:

> *So already we have an earlier trigger (warning). Say, hello guys. Something wrong has happened last week. We can say, guys something is wrong with A, B, C go and look at this. See what the problem is there and fix it* (Financial Planner).

The accounting system relies on the data provided by the production division for quantity and volume analysis to which cost is applied to generate the week's waste cost. The cost analysis is presented to the production division to correct or fix the inefficiencies noticed from the previous week.

Basically, it seems that waste cost information provided by the MAS of SAB Ltd is measured through input-output analysis. Analysis is made of the volume of input through physical verification of the actual volume reportedly used by the production division and the actual physical count of material inventory by the accounting division at the end of producing a batch. The physical verification of inventory is done to ascertain the degree of variation in reported usage and actual usage by the production division on a weekly basis. Invariably, it appears that certain waste-related costs remain hidden in overhead accounts since most of the waste cost are computed using the variable costing approach.

The financial planner is of the opinion that the accounting system provides adequate waste information, however, he hopes that it can be improved upon such that it is more specific in providing waste information. In this regard, developing a waste-reduction decision model into existing accounting systems is necessary to improve the role of accounting information on waste. The financial planner states that:

> *I think it's adequate (that is, waste information provided by the brewery's accounting system). Look, I believe it is. But, I think it can be improved in the fact that it can be more systematic. That would free us more time to be involved in strategic problem solving* (Financial Planner).

SAB Ltd.'s accounting system provides waste cost information to line managers on a weekly basis so that they can act to correct the reported inefficiencies. There are also waste information request from the accounting division from ad-hoc committees to use when making waste-reduction decisions. As the Financial Planner puts it:

> *…..by giving this information to line managers so that they can act on them. There are also ad-hoc requests. It informs the line managers to make waste-reduction decisions* (Financial Planner).

According to the brew master of SAB Ltd, a waste-related budget is provided to line managers during budget preparations. This is to ensure that line managers are responsible for the waste generated in their responsibility centres.

6.7.1.3 Summary of waste information provided by SAB Ltd.'s conventional MAS

The level at which the conventional MASs in the brewery provide waste information is inadequate to make appropriate waste-reduction decisions. However, waste costs are calculated based on the variable costing systems. This reduces the chance to improve waste-reduction decisions and opportunities to adopt a better waste-reduction strategy are lost.

6.8 FINDINGS FOR THE SECOND RESEARCH OBJECTIVE

The second research objective of this study is to assess the impact of insufficient process waste information by the conventional MASs on brewery waste-reduction decisions. To assess this objective, four research themes were considered, namely: *adequacy of waste information, waste accountability, integration of the database* *system, and availability of waste information options.* Each of the themes is discussed in the next sections by the brew master of SAB Ltd.

6.8.1 Adequacy of waste information

There are certain environmental and legislative requirements to which the brewery industry is a signatory, such as the International Standards Organisation (ISO 2010), and the King III (IOD 2009) requirement on sustainability reporting in South Africa. These bodies require a certain degree of minimum environmental compliance and waste handling by organisations to ensure a safe environment for all people. Internal organisation pressures from management also need to be met. This is to ensure that the brewery fulfils its corporate environmental obligation. The availability of waste information is deemed a necessary backup to ensure that managers improve on production efficiency through the use of fewer resources so as to comply with legislative requirements. For instance, ISO 22000 (Bizmanualz 2008) is a standard benchmarking for the operational efficiency within the food industry. The brew master indicated that:

> *I know that we have to produce as part of the ISO 22000; we need to be able to show that you've a proper waste handling system. But I know that's a requirement* (Brew Master).

Internal management pressure had forced line managers to reduce the quantity of waste generated in their responsibility centres. This has led to an increasing demand for more comprehensive waste cost data by line managers and seems to promote stricter production efficiency as waste information becomes more detailed. The reaction of internal management to unnecessary waste generation beyond acceptable limit is captured in the response of the brew master.

> *You can have a very bad day if the calculated waste is high* (Brew Master).

SAB Ltd has a policy to reduce process waste as encapsulated in its sustainable development priorities. The handling of brewery waste is governed nationally through the National Environmental Management Act of 1998, South Africa (Republic of South Africa 1998). The provision of regular weekly waste information to inform line managers of grey waste areas has really assisted the brewery to support its waste-reduction decisions. Both ISO 22000 and ISO 14001 have considerable influence on the way the brewery handles its waste-reduction strategy. These regulations have motivated the brewery to capture all necessary waste information. The calculation and capturing of waste costs by the brewery is based on the variable costing method. Any unallocated waste cost remains hidden in overhead accounts.

6.8.2 Waste accountability

Currently, the level one production line managers collect waste information which is provided every eight hours. Subsequently, the accounting division assigns costs to the waste quantity generated by the level one production line manager. This waste information assists the managers to prioritise the use of resources. Line managers are held responsible for the waste generated in their cost centres. Waste-reduction has been enshrined in individual performance targets, especially those of line managers. Hence, they are held accountable if the waste target is not met. Waste accountability is linked to line managers' bonus packages at SAB Ltd. This may imply that the more the waste generated in a process, the lesser the benefit received by the individual line manager. As the brew master stated:

> *We all own the process and therefore we must all be accountable for the side (process) we are in* (Brew Master).

The provision of waste information should be a collective effort of all within the production process. The first set of waste information is provided by the production line staffs and then, cost is assigned by the accounting division. Waste information generation is jointly provided by the production and accounting divisions. Waste information should be made available both in quantity and costs. The brew master seems to agree as she states that:

> *It makes sense if waste information is seen in Rands and cents* (Brew Master).

On a weekly basis, reports on the seven brewing plants of SAB Ltd in South Africa is send to its headquarters in Johannesburg where comparisons are made on achievements of waste-reduction targets among them. This waste-reduction comparison is to promote efficiency among the plants and to give the organisation a global competitive edge in waste-reduction for increased profitability.

6.8.3 Integrated database system

The Systems Applications and Products (SAP) database system (SAP 2012) is used by SAB Ltd. It contains data from every division within the organisation. In order to reduce its inventory level and produce just-in-time, the divisions' database systems are integrated within the SAP system. Data regarding waste are available from each division that inform their management. The SAP has assisted managers to undertake marketing driving production whereby forecast sales are made available to production. This has reduced over-production in the past. The SAP system also reduced the risk of over-stocking of material inventory since material purchases are streamlined according to the sales forecast and improved the issue of delayed supply. Substantial losses had occurred whereby drinkable beers were produced in excess due to failure in accessing relevant data from other divisions. Although, the SAP database system has been useful, it is limited since managers cannot take quick and spontaneous actions to correct waste generation. Waste reports takes up to a week before the accounting division assigns costs to the generated waste information.

At the lower production level, waste quantity is the type of waste-information required. The managerial level waste information includes both quantity and costs. It seems that integrating MFCA systems into SAP systems will actually assist to speed up the availability of waste information both in quantity and costs. Potentially, waste-reduction decisions will become faster, quicker and concise since all related waste data can be accessed and are within reach. This implies that managers can concentrate more on solving more strategic related organisational problems.

6.8.4 Availability of other waste information options

In SAB Ltd, accounting related information is crucial to its waste-reduction decisions. Although, many managers would prefer other information options, SAB Ltd relies more on accounting generated information since its decision-making process requires information either in quantity or cost. The financial planner assumes that current accounting systems provide adequate waste cost information, however an investigation has revealed that certain waste-related costs such as waste overhead costs remains hidden in overhead accounts. Current accounting systems in SAB Ltd are considered rigorous, however adopting MFCA as a specific waste costing system could provide support and improvements to its waste-reduction decisions. It seems that having a dedicated waste MAS may boost SAB Ltd.'s waste-reduction efforts for increased social relevance, improved environmental responsibility and increased organisation profitability.

6.9 SUMMARY OF LESSONS LEARNED

The lessons learned from the case study at SAB Ltd provided evidence that, despite the rigour of its accounting systems, it lacks the ability to generate accurate waste data. The use of variable costs to value waste makes the accounting system inadequate to provide necessary waste information to support and improve sound waste-reduction decisions. A significant impediment is that managers often have to wait to assess waste information at the end of a batch before initiating corrective measures. This has led to substantial losses that could have been prevented if a more waste specific framework like MFCA had been used to capture waste information in individual processes.

The waste-reduction strategy adopted by SAB Ltd ensures that waste-reduction targets are met. Savings arising from this strategy are re-invested to develop entrepreneurship by encouraging the opening of more sales outlets, especially in rural communities, to promote beer sales. This has brought an increase in entrepreneurs and beer consumption in rural communities through the creation of drinking joints, resulting in more jobs. Achieving waste-reduction targets gave SAB Ltd a competitive advantage over its rivals. Attaching financial reward to the activities of line managers who had achieved their targets has resulted in increased commitment to reduce waste. According to the brew master, the waste-reduction-entrepreneur development programme of SAB Ltd has brought about increased sales, translating to 3.1% of South Africa's GDP in the year 2009.

The availability of waste information is to ensure compliance with legislative requirements. Internal management pressure also compelled line managers to reduce the quantity of waste generated in their respective responsibility centres. However the delay in processing waste information for prompt action remains a hurdle for the brew master, whereby waste information is made available after completion of a batch. The lack of an integrated database system for capturing waste information has resulted in losses whereby drinkable beers were produced in excess due to failure in accessing relevant data from other divisions. Although, the SAP database system is operational in SAB Ltd, its usefulness is limited since managers cannot take quick and spontaneous actions to correct waste generation. Hence, the limitation of the current conventional accounting system in SAB Ltd revealed that certain waste-related costs, such as waste related fixed costs, remain hidden in overhead accounts.

6.10 SUMMARY

In this chapter, the findings of the SAB Ltd case study were presented. The results showed that SAB Ltd lacks an appropriate accounting framework to capture waste cost information accurately. The use of variable costs in calculating its waste costs has left a gap in the waste information provided to its managers for waste-reduction decisions. Calculation of waste costs using the input-output analysis method is in itself deficient and misleading. This indicates that a more appropriate, waste specific Management Accounting System is required to generate adequate waste information, both in quantity and costs, to support and improve its waste-reduction decisions. Therefore, a waste-cost management accounting framework incorporating MFCA would seem appropriate to capture brewery waste information considering the volume of waste it generates on daily basis. In this regard, this study develops a Management Accounting waste information framework for capturing waste information for the South African brewery industry.

CHAPTER SEVEN

AN ADJUSTED MFCA FRAMEWORK FOR WASTE INFORMATION SYSTEM FOR THE BREWERY INDUSTRY IN SOUTH AFRICA

7.1 INTRODUCTION

This chapter addresses the third objective of this study, which is to adjust the existing MFCA framework to include waste categories subsumed or neglected in the provision of waste information to improve waste-reduction decisions. Improving the process of waste reduction in brewery production may require the identification of all waste-related information. From a Management Accounting perspective, the availability of accurate and sufficient waste information in terms of quantity and costs may be essential to make appropriate brewery process waste-reduction decisions. There has been an increased effort by researchers in the field of Management Accounting to address waste-reduction issues in organisations through the development of frameworks such as the life-cycle costing, activity-based costing and recently Material Flow Cost Accounting (MFCA) systems to provide waste-related information in support of waste-reduction drives by managers (Romvall, Kurdve, Bellgran & Wictorsson 2011). Waste-reduction pressures may continue to be exacerbated as developing economies like South Africa increase their production rates. This chapter suggests an adjusted MFCA framework for waste-information systems that will help to address the major gap identified in the existing MFCA framework from a theoretical perspective.

7.1.1 Goal of this chapter

The aim of this chapter is to address the identified gap in the existing MFCA waste-information system by focusing on the major waste components that are either subsumed in material flow or completely neglected in its analysis. Material flows is not the only major waste component in a brewery production process that should be addressed when analysing waste information for making improved waste-reduction decisions. Hence, the development of an adjusted MFCA waste-information framework for the brewery industry is a response to the findings of the case studies and in-depth interview from the two breweries in this study.

7.1.2 Layout of the Chapter

The layout of the chapter is as follows: Section 7.4 presents the MFCA approach while Section 7.5 addresses categories of waste costs under current MFCA. In Section 7.6, a critique of MFCA is provided. The cost of quality and labour inefficiency and detailed energy, carbon and emissions costs are presented in Sub-sections 7.6.1 and 7.6.2 respectively. In Section 7.7, the development of an adjusted MFCA framework is discussed. In Section 7.8, the purpose of the adjusted MFCA framework is presented and the reason for an adjusted MFCA framework is provided in Section 7.9. The chapter is summarised in Section 7.10.

The above layout is represented in Figure 7.1.

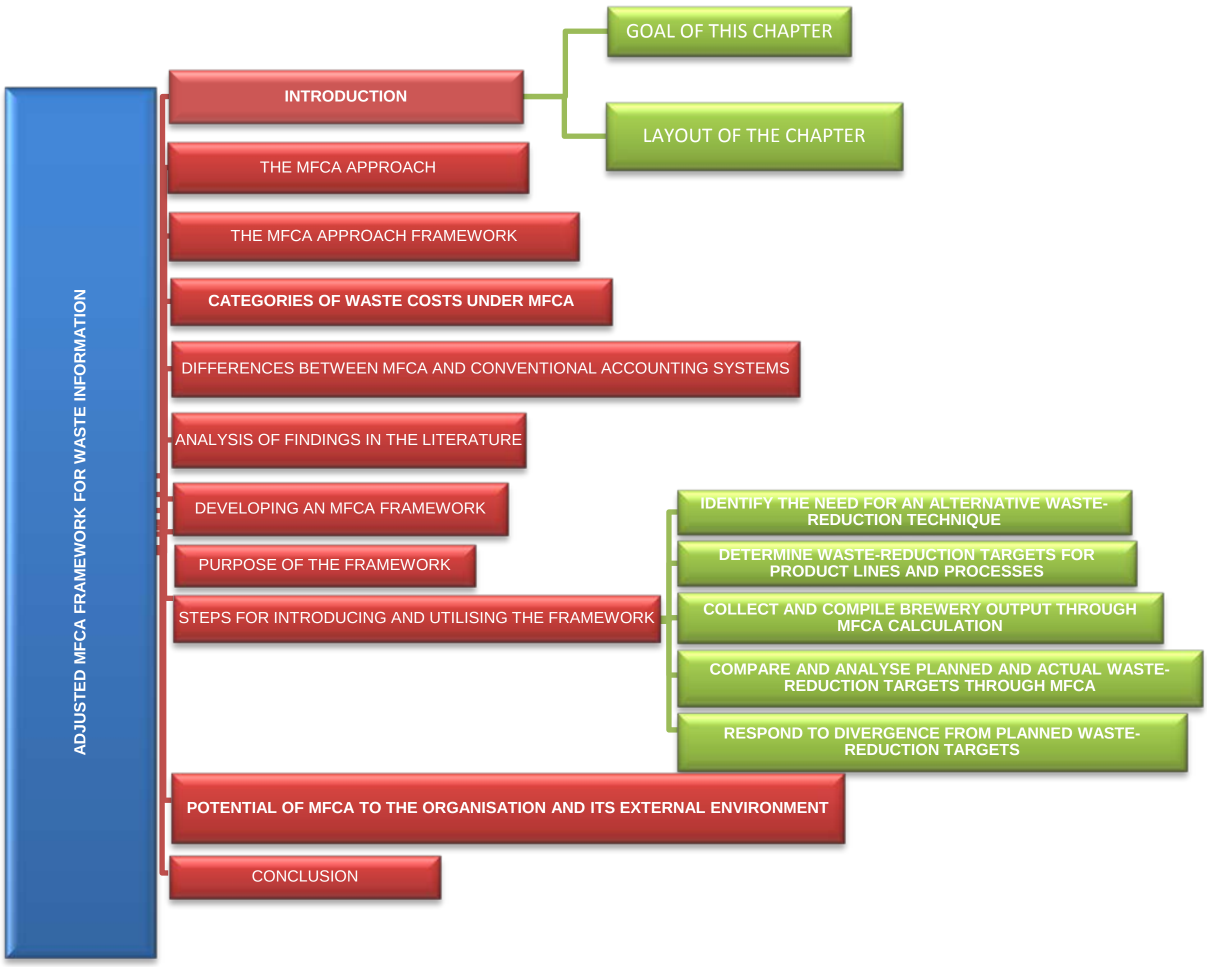


Figure 7.1: A visual representation of the layout of Chapter 7

7.2 THE MFCA APPROACH

Central to sound decision-making is the recognition that corporate data should support the information needs of all users in the organisation (Popovič, Hackney, Coelho & Jaklič 2012). However, an important aspect of a framework is the development of a framework that reflects the organisation's physical reality. The accomplishment of this type of framework is complex since different interests within the organisation view and utilise data differently.

A problem arises in meeting the needs of the different users when an inappropriate approach dominates the organisation-wide data collection process and reporting of data on resource usage (Soyland & Herstad 2011). The conventional accounting systems have been criticised for focusing narrowly on the type of accounting information it generates (Jasch 2009:33). A shift in emphasis has been suggested by researchers from the use of the conventional double-entry system, to providing useful information for decision making, and to assist organisations to identify and control environmental risk such as waste generation (Ratnatunga & Jones 2012:77). Today's managers require both financial and non-financial waste-related information to make sound waste-reduction decisions - an area where the conventional accounting systems have failed (Cohen, Krishnamoorthy & Wright 2008:175). The practice within many organisations, including those within the South African brewery industry, has been to place waste-cost information under overhead accounts (Ngwakwe 2009:403). Alternatively, they generate waste information through a method that inaccurately captures adequate waste costs (Jasch 2003:77). This has resulted in organisations implementing inappropriate waste-reduction strategies. With such inaccurate waste data, taking appropriate waste-reduction decisions has become a problem.

Unlike the conventional MASs, MFCA will permit both accounting and non-accounting waste data to be identified, captured and stored in a centralised database system (METI 2007). MFCA can be combined with the central database system to capture waste information in terms of material costs, systems costs, energy costs and waste-treatment costs (Jasch 2009:40). From this databank, an individual user's view can be constructed to meet the particular needs of that user within the organisation (Kumar, Maheshwari & Kumar 2003). The MFCA approach can be implemented within either the SAP systems (organisation-wide) or production specific database systems (Kokubu & Nakajima 2004). For the purpose of this study and to achieve the third objective, the organisation-wide database system is assumed since this is a common framework for business application.

Figure 7.2 illustrates the basic MFCA approach, which is a unique version of an organisation-wide relationship consisting of the four entity types, i.e., materials, systems, energy, and waste treatment costs.

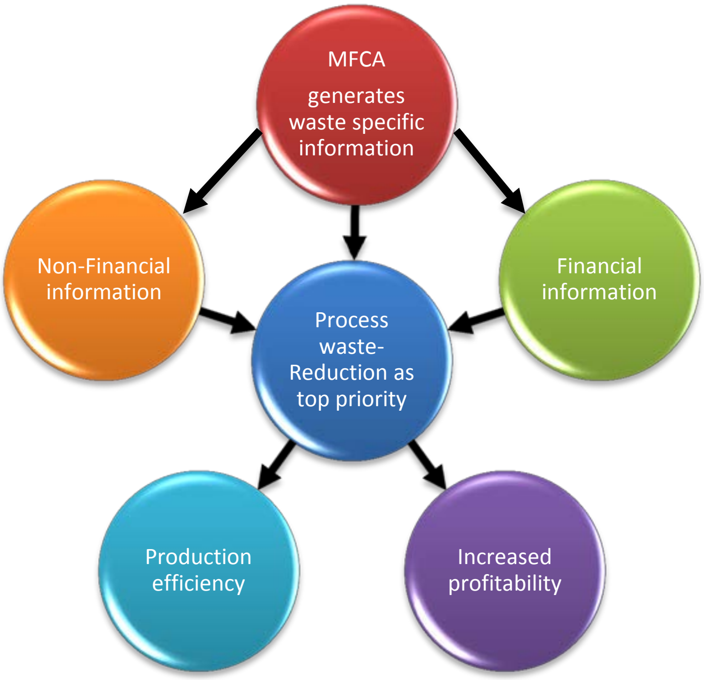


Figure 7.2: Researcher's illustration of basic MFCA approach to waste cost information

The next section explains the four entity waste types within an organisation.

7.2.1 Categories of waste costs under the existing MFCA

Material costs: Materials are input resources of economic value to the organisation. They are determined by multiplying the physical amount of the particular materials by their specific input prices (ISO 14051 2011). They are scarce and should be well controlled by the organisation. Material resources are used in production to create output product that generates income for the organisation. MFCA measures the flow and stock of materials that include raw materials, parts, and components within production processes, in terms of both physical and monetary units (METI 2007; Jasch 2009a; Jasch 2009b). In a processing-type production system, waste and resource loss occurs in various steps during the production process. Waste generated from production processes include material loss during processing such as listing swarf, defective products and impurities; materials remaining in production equipment following set-ups; auxiliary materials such as solvents and other volatile materials and detergents to wash equipment before set-ups; and raw materials, work-in-process and stock product discarded due to spillage, deterioration and other unusable reasons (METI 2007). MFCA traces equally the flows of the final product as well as emissions or waste in the process (Jasch 2009a). Emissions or waste are recognised by the MFCA approach as negative products (Nakajima 2003). The final product is known as positive products while emissions or waste is called negative products (Zhao 2012).

Systems and energy costs: The MFCA approach includes both systems and energy costs in the calculation of process waste-costs caused by material loss (Cagno, Micheli & Trucco 2012). System costs are defined as all expenses incurred in the course of in-house handling of material flows except for material, energy, and waste-management costs such labour, maintenance, and transportation costs (ISO 14051 2011; Sygulla, Bierer & Götze 2011). Also, ISO 14051 (2011) made no specific reference to energy costs except that it should be calculated similar to material costs and it is therefore regarded as part of material costs. In most cases, this researcher assumes that the scale of the identified costs is larger than can be imagined. Economic loss caused by lost materials is not limited to the material cost; the losses also include systems and energy costs, since each process requires the input of labour, depreciation, energy and other costs (Jasch 2006:1206; METI 2007). MFCA includes systems (processing) and energy costs expended on negative products or waste materials in the negative product or waste costs with such negative product cost is identified on a process-by-process basis in MFCA (Hyršlová *et al.* 2011:8). The application of MFCA will reveal lost costs including processing costs caused by material loss in order for managers to initiate more cost effective improvement activities than they could have possibly recognised (Onishi *et al.* 2009).

SAB Ltd identifies time loss due to equipment downtime, set-up, and other reasons. However, such losses are considered by SAB Ltd for inclusion in overhead accounts. The recognition of time loss costs through MFCA will promote improvement activities such as Total Productive Maintenance (TPM) which is considered as part of input costs included in equipment depreciation cost (METI 2007). The ability of MFCA to reveal waste information may further enhance process waste-reduction decision

Waste treatment cost: The overall waste-treatment cost is generally controlled on a plant basis by waste type, especially in SAB Ltd. In SAB Ltd, waste treatment cost is accounted for by each plant, separately from production cost that is identified on a product basis. Emitted waste needs to be treated, which requires treatment costs. This is the reason waste-treatment cost is considered an overhead expense (Jasch 2009a). In contrast, MFCA includes this cost in material loss, and as one of the components of negative product cost (Hyršlová *et al.* 2011:8). Despite the ability of MFCA to generate waste information with such detail in contrast to the conventional MASs, this study argues that certain categories of waste-related costs are not included but need to be included in MFCA framework calculations. The next section critiques the existing MFCA composition and provides categories of waste-related costs exempted in order to develop an adjusted MFCA framework.

7.3 A CRITIQUE OF MFCA

The successes recorded among the developed countries that had implemented MFCA motivated the researcher to embark on this study by adopting a case study method and an in-depth interview approach in a large brewery as well as a micro-brewery to evaluate the possibility of its adoption in South Africa. This section discusses the shortcomings of MFCA with a view to suggest an adjusted Material Flow Cost Accounting (AMFCA) waste information system to bridge the identified shortcomings of MFCA.

7.3.1 Cost of quality and cost of labour inefficiency

In the process of this study, it was found that certain waste-related costs are exempted from the general framework for MFCA as provided in ISO 14051 (2011). Although, ISO 14051 on MFCA listed causes for material loss by process to include defective products, testing, set-up loss, swarf, and listing, the cost of defective products is only in relation to output that becomes unsalable or unusable. This study argues that, since quality control is important in any production process, quality control costs or cost of quality should necessarily form a major cost category in MFCA. ISO 14051 (2011) assumes that cost of loss on defective products can be identified by calculating defective quantities and the resources (materials, energy, and system costs) used in each production process and converting them into monetary value. Moreover, costs of loss due to labour inefficiency in terms of time and spoilage from a new worker and on the job training process loss are exempted from the ISO 14051 MFCA waste-cost categories. However, the study contends that such a cost is important and should be included in MFCA waste-cost calculations.

In ISO 14051 (2011), it is assumed that costs allocated under defective product loss should be calculated using the same means for calculating production costs which include cost of raw materials, cost of labour, depreciation cost and other processing costs (energy and system costs). This study proposes that cost of quality control or quality costs and cost of inefficiency of a new worker in time loss and spoilage be integrated into the existing MFCA calculations as an extension of its coverage for adequate waste cost information.

7.3.2 Detailed energy, carbon and emission costs

This study contends that material loss is not only the major loss in process waste. Costs such as energy and quality costs are significant costs without which there would be no output in the first place. It argues that in certain industries, conversion costs are usually higher than material costs. MFCA subsumes energy flow loss under material flow or completely neglects them. As such, the MFCA approach lacks detailed energy related information. This neglect prevents managers from having a better understanding of the magnitude or drivers responsible for energy loss or the consequences thereof. It is therefore necessary to provide a detailed extension of energy flows and energy loss flows in MFCA. Although, ISO 14051 (2011) recommends an extension of the flow framework to analyse energy flows, however it fails to provide any methodological support for such extension. Instead, energy costs are still subsumed in outgoing material flows. This study argues that in present day manufacturing, organisations consume a fairly large percentage of energy to convert raw materials to saleable output. Hence, carbon and emissions costs should be included in total energy loss calculations to ensure the adequacy of process waste cost for improved process waste-reduction decisions.

The study argues that it is in the process of converting raw materials into finished products that cost of quality, cost of energy, cost of labour inefficiency and carbon and emission costs are incurred. Hence, it is appropriate and logical to include these costs when determining total process waste costs. The essence of inclusion of these costs in MFCA is to support and improve process waste-reduction decisions holistically for improved cost savings and increased profitability. The consequences of not capturing cost of quality control, detail energy flow cost, cost of labour inefficiency, and carbon emission cost in MFCA calculations may result in incorrect waste cost calculations; inappropriate process waste-reduction decisions; reduced environmental performance; inappropriate product pricing as a result of not capturing all necessary costs; loss of cost saving opportunities; and loss of profitability. Hence, this study suggests an adjusted Material Flow Cost Accounting (AMFCA) to include detailed quality, carbon and emissions costs, as well as detailed energy cost in arriving at product costs (which can be separated into good and negative product costs as currently analysed under MFCA).

7.4 DEVELOPING AN ADJUSTED MFCA FRAMEWORK FOR THE BREWERY INDUSTRY

The study revealed that, despite the use of MFCA in countries like Japan, Germany, and Austria, it is a relatively new waste-specific cost accounting approach that is yet to be introduced into the brewery industry in South Africa. For this reason, this study develops an adjusted MFCA (AMFCA) framework to capture brewery waste information to support and improve brewery waste-reduction decisions in the South African brewery industry. Although, there are established methods of production control, process control, and standard cost accounting systems over the years in the South African brewery industry, the introduction and development of AMFCA system will, however, assist the brewery industry to realise the yet uncontrolled material losses, energy losses, and emissions. It is evident from the case study and the interview that the concept of MFCA is unknown at present, suggesting that a gradual approach is required in its introduction. To address the third research objective, the study presents an adjusted MFCA waste-information framework that is aimed to capture all necessary brewery waste information beyond what is currently provided by the current conventional management accounting systems and the existing MFCA.

The new MFCA framework proposed in this chapter is designed to integrate with other existing brewery waste-reduction strategies to achieve an overall brewery process waste-reduction in brewery production. The development of the framework aims to improve on brewery environmental performance through the application of an adjusted MFCA to support the decision-making process for a better brewery waste-reduction strategy. Developing the adjusted MFCA framework necessitates addressing the third research objective, namely:

- To develop an adjusted Management Accounting framework to improve brewery process waste information to support waste-reduction decisions; and explain the potential benefits of the Management Accounting framework on environmental performance, cost savings and profitability.

In the process of providing answers to the research question above, the study found that there is a necessity to develop a framework that would provide a basis for the application of an adjusted MFCA among brewery managers in their effort to find an alternative approach to its waste-reduction strategies.

7.5 PURPOSE OF THE ADJUSTED MFCA FRAMEWORK FOR THE BREWERY INDUSTRY

The study develops an adjusted MFCA framework from a theoretical perspective for improved brewery process waste-reduction decisions through the inclusion of major waste components subsumed or neglected by the existing MFCA system. The new framework describes and analyses brewery process waste in relation to how the existing MFCA can be improved to support brewery waste-reduction decisions for increased profitability as well as better environmental performance. Specifically, the adjusted MFCA framework seeks to accomplish the following:

- To provide adequate and comprehensive waste data within the brewery process that need to, or should be contained in the brewery waste-reduction decision-making process. This will enable brewery managers to refer to the new framework in order to ensure that no necessary information is missing in arriving at a workable waste-reduction strategy. The new framework will also assist brewery managers to better understand the waste-generation process for which they are responsible;

- The framework will assist brewery managers to understand how the application of a decision-making framework such as the adjusted MFCA framework when integrated with other waste-reduction strategies can improve the decision-making process. The framework proposes that the adjusted MFCA is not a process waste-reduction framework in itself but one that provides support when choosing the right waste-reduction strategy;
- The new framework will assist brewery managers to have an improved understanding of waste quantity and cost in order to effectively manage process waste to reduce process inefficiencies and the lack of transparency that has characterised brewery waste-reduction decisions;
- The framework proposes that the adjusted MFCA will combine well with existing Environmental Management Systems (EMS) to enhance process waste-reduction decisions. This can be achieved through the categorisation of brewery production into good product and non-product output as provided by the existing MFCA as a framework to support waste-reduction decisions; and
- This framework will serve as a guide to provide support and improvement to brewery waste-reduction decisions. It should be noted that process waste-reduction decision-making takes place within the context of environmental and social realities. Such environmental context includes the effect of waste-water on fresh water supplies, product quality, carbon emissions, waste treatment, and waste disposal. In the social context, the effects on household health should be considered in terms of emissions and pollution.

This study suggests an adjusted MFCA framework as illustrated in Figure 7.4 which is an adjustment of the current MFCA calculations in Figure 7.3.

Figure 7.3: Researcher's illustration of the existing MFCA framework

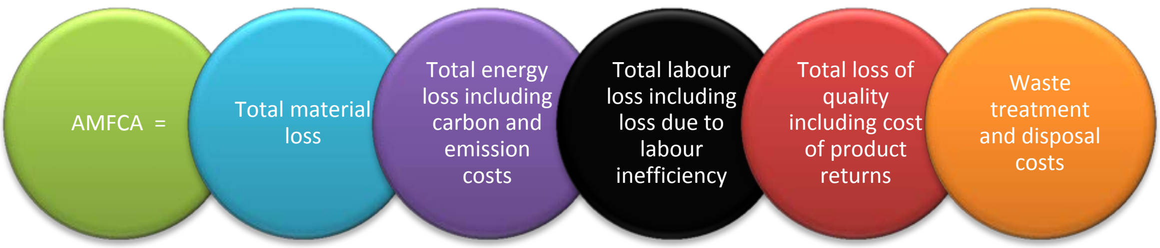


Figure 7.4: Researcher's illustration of an adjusted MFCA framework

Figure 7.4 depicts the adjusted MFCA to extend the current MFCA calculations for improved process waste-reduction decisions. The study suggests the calculation of the various waste categories independently before aggregation in the adjusted MFCA process waste calculations.

7.6 REASONS FOR ADJUSTING EXISTING MFCA FRAMEWORK FOR THE BREWERY INDUSTRY

In order to properly assess the impact of brewery process waste, a comprehensive and reliable analysis of brewery waste-related information is vital. This study aims to improve the current MFCA for process waste calculations by developing an adjusted MFCA waste information system. It argues that the non-calculation of total energy loss, total labour loss, and total quality loss for brewery processes separately will render the current MFCA calculation on energy cost (which is subsumed in material loss calculations); total labour loss including those due to labour inefficiency; and total cost of loss on quality including product returns as inadequate and inappropriate for process waste-reduction decisions. The researcher maintains that such inadequate and incomplete information included in the current MFCA waste information may have led to unsuitable process waste-reduction decisions in the past. Hence, the researcher recommends that energy flow, quality and labour experts should be used to generate the virtual amount of energy flow loss, loss of quality and labour loss data.

While appraisal costs are environmental costs incurred in monitoring and evaluation as monitored by the Department of Environment of South Africa; prevention costs are associated with workers training, research, and development (DEA 2010a). Furthermore, the researcher contends that brewery process energy usage and energy effects of carbon reaction both contribute significantly to total energy loss. The researcher suggests that brewery carbon effect costs which are not visible in physical energy statistics from energy usage efficiency should be made more explicit in process waste cost calculations. This study argues that, instead of subsuming brewery labour loss in material quantity loss, losses due to labour inefficiency as a result of introducing a new worker should be included in the MFCA calculation. Also, instead of counting the number of rejects in brewery processes and assigning the cost price of materials, as done in the current MFCA, total quality loss that includes both internal and external costs should be used to arrive at the appropriate brewery cost of quality in MFCA calculations.

The study recommends that only a clear and detailed aggregation of the various categories of waste data can reveal weaknesses in the MFCA methodologies used in brewery waste-related information analysis and support for brewery process waste-reduction decisions. The study further suggests the use of detailed independent analyses of the different brewery waste categories before its combination in the MFCA framework.

7.7 SUMMARY

An adjusted MFCA (AMFCA) framework has been developed for the brewery industry in this chapter. This framework is developed to improve the current MFCA approach, which has exempted or subsumed certain waste categories like inadequate energy cost, emission and carbon cost, labour inefficiency loss cost, and cost of quality. This framework serves as the researcher's contribution to the field of Management Accounting by extending the contemporary waste accounting framework (MFCA) to ensure that brewery managers are provided with adequate and more comprehensive brewery waste information to improve brewery process waste-reduction decisions. This study also contributes to the body of knowledge and practice through its extension of literature and categories of MFCA.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

8.1 INTRODUCTION

This chapter takes a look at what has been achieved and provide pointers for future work in this area. This study examined the extent to which current conventional MASs provide process-waste information to support waste-reduction decisions within two South African breweries. The examination revealed a lack of application of Material Flow Cost Accounting within the two case breweries. A contingency theory perspective to Management Accounting was adopted. Based on the evidence from the case study and in-depth interviews on the insufficiency and complete lack of waste information in both breweries, an adjusted MFCA approach to a waste-information framework was developed to assist brewery managers to generate and capture accurate waste information. This will provide organisations with opportunities to implement appropriate waste-reduction strategies. Having presented results and findings on the two breweries, an overall summary and conclusions on this thesis are presented in the next sections provided by a visual representation in Figure 8.1.

8.1.1 Goal of this chapter

The aim of this chapter is to take stock of the whole thesis and consider the extent to which the objectives set out at the beginning have been achieved. The research questions are revisited and the summary of achievements is given, while directions for future work are discussed.

8.1.2 Layout of the chapter

A recap of the motivation for this study is the starting point in Section 8.2 while Section 8.3 represents the research objectives of the study. In Section 8.4, the research methods used are discussed and Section 8.5 presents the findings of the thesis. Section 8.6 provides a summary of lessons learned. Suggestions on the potential benefits of adopting a waste-specific accounting framework for capturing waste information, such as MFCA; and how this is vital to achieving an organisation's environmental and profitability objectives are all discussed in Section 8.6.1. The research limitations are presented in Section 8.7, research contributions in Section 8.8, the research journey in Section 8.9, and suggested areas for future study in Section 8.10. Thesis concluding remarks are provided in Section 8.11.

The above layout is represented in Figure 8.1

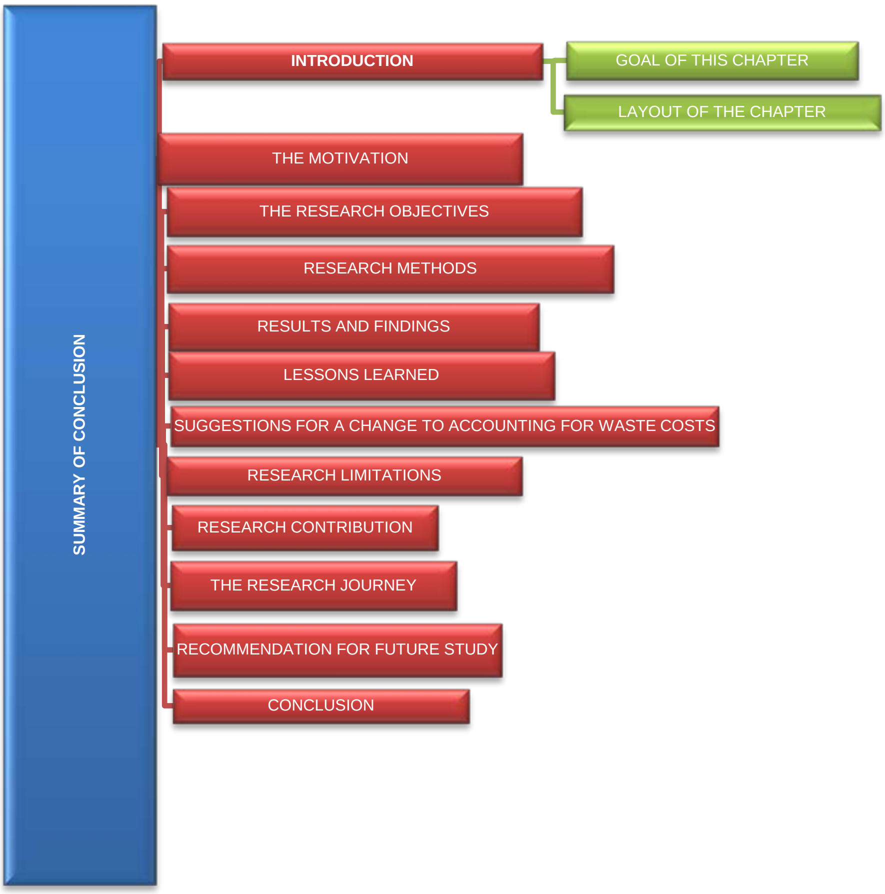


Figure 8.1: A visual representation of the layout of Chapter 8

8.2 THE MOTIVATION

The quest for a safe environment has gained momentum in recent years with the climate change debate taking a global focus. Increasing consumption of natural resources by organisations in an effort to satisfy both consumer needs and increased shareholders return has led to neglect of environmental responsibility in favour of economic gain. In pursuit of economic gain, however, inefficiencies do occur during production. These inefficiencies result in material loss which include loss of all other resources employed by the organisation to generate the loss such as total energy loss, depreciation, quality loss, labour inefficiency loss, product loss, waste treatment and disposal, and time loss.

In order to eliminate production inefficiencies, accurate process waste information is required to make sound waste-reduction decisions. The Management Accounting function has a vital role to play in generating both financial and non-financial information to inform sound decision-making. However, conventional MASs have failed to provide sufficient process waste information with most waste information hidden in overhead accounts. In response, a waste specific Environmental Management Accounting (EMA) framework, viz., MFCA, was developed to capture process waste information both in quantity and cost. MFCA-related research and case studies have been conducted in countries like Japan, Germany, and Austria, however, it has not attracted attention in South Africa and its usefulness has remained unexplored. This study is an attempt to adjust and extend the current MFCA's applicability to support process waste-reduction decisions in South African breweries. The next section explains how this was accomplished through revisiting the research objectives.

8.3 THE RESEARCH OBJECTIVES

Due to a general lack of applying MFCA for capturing waste information by breweries in South Africa, it becomes necessary to understand the extent to which current conventional MASs are used to capture brewery waste information. The research objectives for this study are to:

- understand the extent to which conventional MASs provide process waste information to support waste-reduction decisions in the South African brewery industry;
- assess the impact of insufficient process waste information by the conventional MASs on brewery waste-reduction decisions; and
- develop an accounting framework to improve brewery process waste information to support waste-reduction decisions; and explain the potential benefits of the accounting framework on environmental performance, cost savings and profitability.

8.4 RESEARCH METHODS

In-depth interviews were used as the primary data collection method in the two breweries which made up about 98% of the beer market in South Africa. These breweries are Hope Brewery and South African Breweries Limited (SAB Ltd) both in South Africa. In the micro-brewery, the owner who is manager and brew master is the sole participant while in the SAB Ltd both the brew master and financial planner were the participants. However, the scope of the interview questions were different in the two breweries because of their level of awareness, volume of waste generation, size, and extent of usage of conventional MASs to capture waste information. The questions were open-ended and divided into themes for easy of analysis. The micro-brewery's questions were divided into two themes while SAB Ltd.'s questions were divided into six different themes.

8.5 FINDINGS

The research themes formed the basis of the data analysis in this study. Two different interviews were used to collect data. The first interview with two themes relates to Hope Brewery, which is a micro-brewery with no accounting system to capture waste-related data, while the second interview with six themes relates to SAB Ltd, which has the largest brewery plants and market share in South Africa; having an accounting system that provides insufficient waste information. Data collected from the case study and in-depth interviews were used to address the research objectives as presented in the findings section.

A review of collected data revealed no similarity between the two case breweries for this study. This relates to the first two research objectives on the extent to which conventional MASs provide process waste information, and the impact of insufficient process waste information on brewery waste-reduction decisions. The findings revealed that the practice and limitations in Hope Brewery indicates a sharp contrast to the practice in the SAB Ltd. In Hope Brewery, the following were the practices and limitations:

- There were no existing accounting system to capture waste cost information, however all brewery-related costs were included in a general cost account used to record transactions for the entire business which include a bed and breakfast and a tourist site;

- In general, waste cost information was not considered necessary and has never been documented for any reason;
- Physical waste flow information cost of other resources like electricity used during production was never documented. Reliance was placed on the arbitrary judgement of quantity of input and output provided by the handymen's experience over the years;
- Operating costs such as material costs, electricity, and pollution levy paid to the municipality formed part of the total business account records; and
- There was apparently no one held accountable or responsible for waste management as waste from the brewery was dumped into a nearby canal.

The following practices and limitations were found in SAB Ltd:

- The waste information was based on an input-output method and made available to management every week;
- Waste-cost information as calculated based on variable costs only. All other cost incurred in production was accumulated in overhead accounts;
- In general, waste costs were grossly understated since the costs of other resources used in converting materials into waste were not considered;
- Cost of waste treatment by the municipality was not included in the waste cost calculation but considered as an item in overhead accounts;
- Physical waste information such as steam loss was not available within the existing accounting systems. There was generally a lack of linkage between the production systems for collecting physical waste information and accounting systems assigning monetary value to waste generated;
- Key managers were held accountable and responsible for waste generated within their product lines, except for the unavailability of waste information on process-by-process basis. Line managers would have to wait until the next week to know the cost of waste generated which is calculated through a variable costing method only. Hence, managers would not know the extent of waste costs incurred in their product line, since further breakdown of these costs was not available;

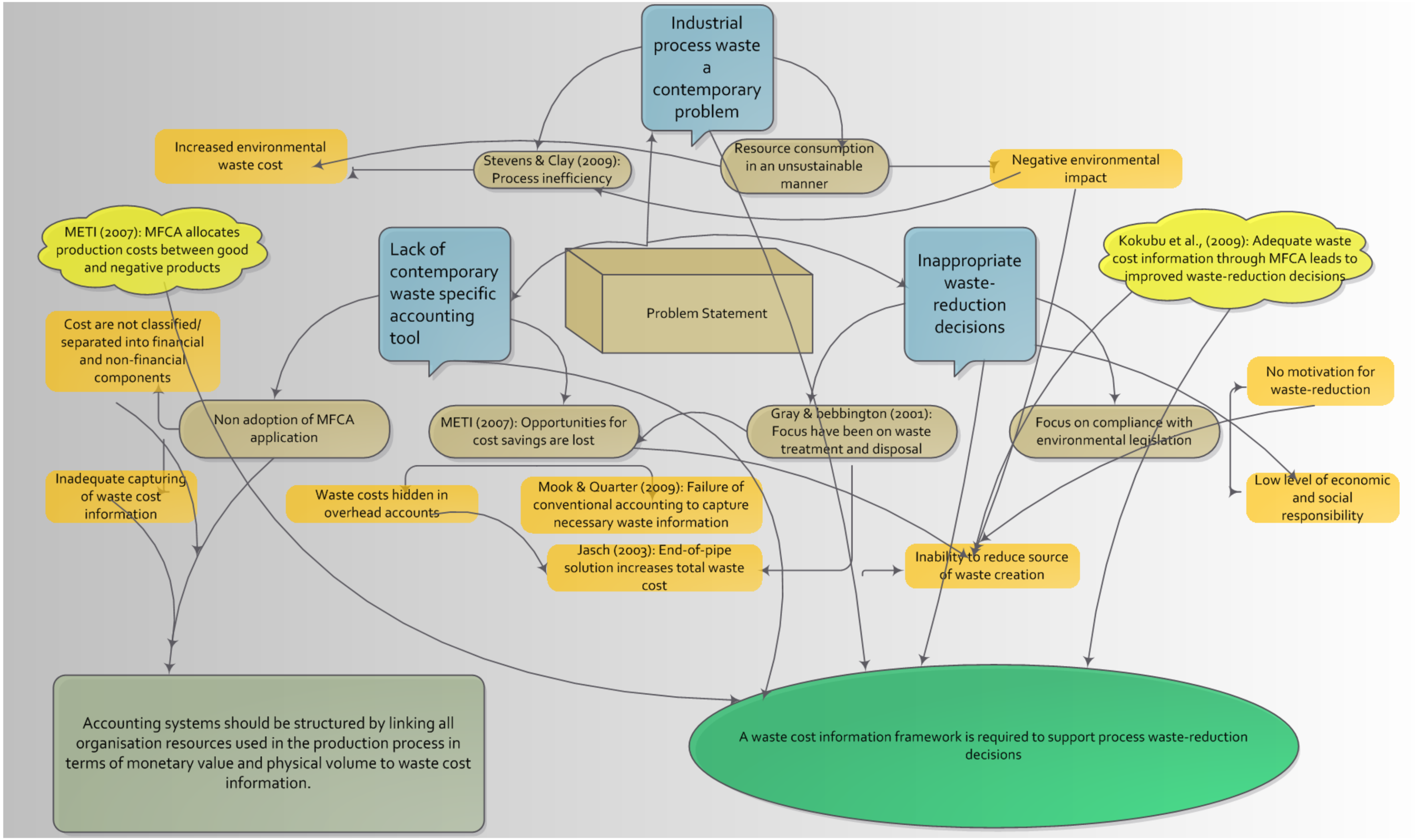
- Waste-reduction responsibility was linked to performance benefits of product line managers to encourage managers to manage waste costs responsibly. However, managers are limited by inability to analyse waste costs on a process-by-process basis; and
- The SAP database system has not been well utilised since managers could not retrieve the needed waste information for on-the-spot waste-reduction decisions. Line managers have to wait until the following week to initiate corrective actions.

The findings from Hope Brewery provide answers to the first research objective that seeks to examine the extent to which conventional MASs provide waste cost information to support waste-reduction decisions. It indicates the inability of the brewery manager to visualise the inefficiency in material usage, as well as its monetary impact thereby rendering the organisation's environmental responsibility inconsistent with ecological expectations. It became obvious that the manager lack any appropriate means to seek improvements to correct the inefficiencies in resource usage.

In contrast, the managers at SAB Ltd are aware of their environmental responsibility and social expectations - except for the inappropriateness of the method of capturing waste-cost information that appropriate waste-related cost that is not captured by the variable costing system in use to overhead cost accounts. The findings obtained from SAB Ltd provide answers to the second research objective on the insufficiency of existing conventional MASs to provide adequate waste-cost information to support waste-reduction decisions.

The findings from the literature, the case study and the interviews, as well as how the study links together with the objectives, are presented in Figure 8.2.

Figure 8.2: Visual presentation of the thesis



8.6 LESSONS LEARNED

The lessons learned from the Hope Brewery case study provide evidence on the potential benefit that could be derived from implementing of MFCA as a decision framework to support waste-reduction decisions. Although, there is no previous brewery process waste related cost to which it can be compared, it nevertheless have shown that it is essential that brewery managers need to be conversant with related waste costs in order to seek opportunities for its reduction. Not knowing the cost of waste generated in a production process could lead to waste-reduction decisions that are unsound and inappropriate. The case study served to sensitise awareness in the manager of Hope Brewery on the need to capture waste information since within the six months period of the case study. The analysis of process waste-information generated assisted the brewery manager to reflect on previous years losses. The availability of process waste information through MFCA calculations during the case study brought a few changes to the existing process waste practices in Hope Brewery.

The following are some of the changes to Hope Brewery's process after the case study:

- The old wort pan and some of the conducting pipes were replaced to reduce the volume of water leaks;
- Records of material input and beer output are recorded using a simple system of documentation. Wages of the handymen have been aligned to production hours rather than a fixed amount, thereby resulting in cost savings; and
- Although water is available from a spring nearby and a borehole during the winter period, water usage in production and housekeeping has been reduced considerably.

The lesson learned from the interview at SAB Ltd provides evidence that despite the rigour of its MASs; the organisation lacks the ability to generate accurate waste data. The use of variable costs by SAB Ltd to value waste makes the MAS inadequate to provide the necessary waste information to support and improve sound waste-reduction decisions. The calculation of process waste costs using the input-output analysis method is in itself deficient and misleading since it concentrates only on physical units in processes. It became obvious that a more appropriate, waste specific MAS like the proposed adjusted MFCA is required to generate adequate and appropriate process waste information both in quantity and costs to support and improve its waste-reduction decisions.

8.6.1 Suggestions for a change to Management Accounting for waste costs

The study found that top management and line managers were usually provided with condensed waste-cost information after a week at SAB Ltd, while Hope Brewery had no available waste record. To overcome the problem in Hope Brewery, a case study was conducted that indicated that in order to make sound waste-reduction decisions, process waste cost information need to be adequately captured. The large volume of waste generated on a daily basis at SAB Ltd indicates that an appropriate waste specific accounting framework such as an adjusted MFCA is required to capture process waste cost information for sound waste-reduction decisions to be made. Although, adopting MFCA into the existing MASs might seem difficult to achieve, brewery managers might find that once the mechanism is set up, it could provide adequate and much needed process waste cost information to support and improve brewery process waste-reduction decisions.

This study therefore suggests that:

- SAB Ltd should structure its MASs by linking all organisation resources used in the production process in terms of monetary value and physical volume to an adjusted MFCA process to generate adequate waste cost information;
- SAB Ltd should introduce a MAS that does not only include variable costs in its process waste-cost calculations, but should capture all costs related to generating the process waste; and
- Hope Brewery should, in the least, introduce a simple management accounting system to record the flow of materials and energy and other waste-related information during production processes so as to enable the manager to identify points of waste generation in the process, which can be monitored to improve waste-reduction decisions.

These suggestions do not necessitate a drastic change to existing MASs, however it suggests a small adjustment to accommodate all waste related costs not captured in the existing process waste information. Essentially, such adjustment to the existing MASs will provide opportunities to initiate corrective actions since process waste-generating sources are being monitored. The introduction of MFCA needs not be initiated as a once-off project, however, a gradual and fairly low-cost change, which could lead to significant improvement in the provision of process waste-cost information for sound waste-reduction decisions, is suggested. Furthermore, these suggestions are intended as an improvement to the existing MASs to capture waste-cost information for increased environmental responsibility of the organisation. Adapting MFCA and incorporating it into the existing MASs may assist managers to reduce production costs as well as increase profitability, which is the goal of the organisation.

Moreover, timing of process waste-cost information on a process-by-process basis, and according to an independent process waste category, may be vital to successfully benefit from these suggestions. Consequently, managers need to be informed about important changes to existing MASs and to educate all Management Accounting personnel on significant implications of such changes.

8.7 RESEARCH LIMITATIONS

Various limitations of the conventional MASs at providing necessary process waste information emerged from the study. This study may have suffered from some inherent limitations which may be researcher-related problems such as subjectivity and generalisation. The research findings obtained from the two breweries may not be applicable in other breweries or industries since every case is distinctive and unique, however, each case may involve a number of commonalities. Generalisability is a controversial issue in an exploratory study. Although attempts were made by the researcher to overcome these limitations through open-ended questions, this may not necessarily have overcome these limitations completely.

8.8 RESEARCH CONTRIBUTION

This study makes several advances on prior literature. First, an adjustment is made to current MFCA framework by integrating identified waste-related costs that have been exempted from the general MFCA framework thereby contributing to existing literature on this subject. Second, the study adopts and tests the MFCA framework through a pilot study in a micro-brewery in South Africa. Indeed there is no existing literature of any study that has adopted the MFCA framework to an owner-managed small business especially in South Africa. Also, the study conducts case studies in both a micro-brewery and a large brewery in South Africa to demonstrate the usefulness of the MFCA framework to improve waste-reduction decisions. Lastly, a significant contribution of the study to knowledge and practice is the demonstration of the potential to adopt the MFCA framework under different organisational circumstances that generally do not support systematically structured management systems.

The study provides evidence that having adequate process waste information is central to making sound waste-reduction decisions in organisations through the case studies. However, this study shows that little progress has been made by micro-breweries in South Africa to reduce their process waste generation because of the lack of an appropriate waste information capturing tool. Tracing and quantifying the costs of flows and stocks of materials within an organisation need to be carefully evaluated in order for organisations and their managers to be motivated to seek opportunities that may simultaneously generate financial benefits and reduce adverse environmental impacts. This study reiterates that to be able to track and quantify waste-related information, an adjustment to the existing MFCA framework is required to integrate into the existing ERP system in order to provide adequate and appropriate waste information to support waste-reduction decisions. Adjusting the existing MFCA framework may be a complex task since certain waste-related information may be hidden in the overhead account. The study argues that such hidden waste information needs to be separated in order for it to be effectively monitored to correct its occurrence. A significant contribution from this study to the body of knowledge is the possibility of the adoption and adaptation of the MFCA framework to capture accurate and relevant waste-related cost information within the

South African brewery industry. The study contributes to practice by adjusting the current MFCA framework to include major waste-related costs that is either subsumed or neglected in the current framework to improve process waste-reduction decisions in the South African brewery. Most importantly, the managers at SAB Ltd indicated an interest in a trial demonstration of the MFCA calculation framework for a period of six months after which to consider its adoption. Another contribution of this study is the demonstration through the case study at Hope Brewery of the applicability of MFCA to make hidden process waste costs visible which led to improvements in the existing waste information capturing.

Furthermore, the study revealed that implementing an MFCA process waste information system can assist brewery managers to improve process waste-reduction decisions through careful analysis of independent process related waste costs and separation of waste costs into positive and negative products. This may assist brewery managers to determine the percentage of production cost that actually became waste. As such, brewery managers will be able to make sound and appropriate process waste-reduction decisions that are based on adequate and accurate process waste cost information. This study has been able to identify the weaknesses of the conventional MASs in capturing accurate waste information by the two breweries in South Africa to support their process waste-reduction decisions. Consequently, the manager of Hope Brewery requested that the researcher set up a consultancy outfit to assist micro-brewers develop a MAS to manage their process waste information. The study extended the debate on MFCA to the South African brewery industry through its study of these two breweries thereby adding to existing literature from an African perspective. The study demonstrated that a simplistic approach could be undertaken to introduce MFCA as evident in the Hope Brewery case study to create awareness and indicate potential ability of an adjusted MFCA system to support and improve sound waste-reduction decisions.

8.9 THE RESEARCH JOURNEY

This study has helped me to appreciate the relevance of the research process in a way different from my experiences during my Master's research. By continually engaging in reviewing and amendment of draft chapters through the assistance of my supervisor, I have come to understand the rudiments of conducting a doctoral research.

At the beginning of the study, I had a different focus presented in the research proposal. However, as I progressed, the title changed several times before settling for this final title. The research methods had also witnessed transformations until I settled for the case study approach which is a relevant approach to the object of inquiry. The survey approach was initially used where I received assistance from the Academic Research Support Unit (ARSU) of the College of Economic and Management Sciences of the University of South Africa (UNISA), however due to the lack of adequate responses, the case study approach was thereafter applied.

I attended a doctoral research workshop at Stellenbosch University where I learnt new ideas about conducting doctoral research. In fact, this influenced me to intensify my search for case study sites. Eventually, a micro-brewery and the Polokwane plant of SAB Ltd agreed to participate in the study. My visits to these two breweries revealed the inadequacies of the waste-cost information collection system and the insufficiency of the accounting systems to provide the necessary waste information to support waste-reduction decisions. The micro-brewery manager agreed to a pilot study through which the usefulness of an MFCA approach was demonstrated.

In the process of this study, I presented three research papers at international conferences in George, South Africa (June 2011), Ankara, Turkey (April 2012), and Helsinki, Finland (September 2012); and had published two research articles from this study in accredited journals.

8.10 RECOMMENDATION FOR FUTURE STUDY

A number of possible future studies using the same research method are apparent. To generate achievable brewery waste-reduction strategies and improve on the framework developed in this study for improved brewery waste-reduction decisions; there is need to conduct case studies in several breweries to allow for further assessment of the different dimensions to process waste-information generation for improved process waste-reduction decisions. Exploring this area as a future research strategy may facilitate the attainment of this objective.

8.11 CONCLUSION

The brewery industry in South Africa has a responsibility to reduce its environmental impact through improvements in process waste generation for sustainable development. Management accounting as a function has a responsibility to ensure that appropriate process waste information is made available to responsible brewery managers to make sound and appropriate process waste-reduction decisions. Findings of this study revealed that there was a general lack of a waste specific accounting framework such as MFCA for capturing brewery process waste information within the South African brewery industry. It may be argued that this problem may not be specific to the cases in this study alone; however it may be one that may possibly be common to other breweries. This thesis has demonstrated that extending the adoption of an adjusted MFCA is potentially achievable for breweries. While this study focused on both SAB Ltd and Hope Brewery with a combined market of about 98%, the results may be generalised to the brewery industry in South Africa.

The use of MFCA for capturing process waste-cost information is lacking in both Hope Brewery and SAB Ltd. An implication of this is that, while great achievements have been recorded in the use of technology to reduce waste in brewery process, this approach in itself cannot result in the desired waste reduction targets. There is need to improve the process waste-reduction decision process in the South African brewery industry by adopting a waste-specific Management Accounting framework such as the adjusted MFCA framework to capture all waste-related information in quantity and costs. This may assist decision-makers to make sound process waste-reduction decisions; since it is more convenient to make sound decisions when the full cost implication in a decision-object is well known. However, key staff of SAB Ltd such as the brew master and financial planner expressed their readiness during the interviews to consider the adoption of MFCA as an integrative Management Accounting framework to accurately capture brewery process waste cost information. Finally, findings from this study highlighted the potential benefits of using process waste cost information provided through the MFCA calculation to improve process waste-reduction decisions within breweries. In addition, it is essential to remember that what cannot be measured in terms of its cost implications cannot be managed.

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APPENDIXES

APPENDIX A: GLOSSARY

Activity-based costing: the process whereby product costs are determined through the activities that causes the occurrence of such cost

Beginning-of-pipe: waste prevention which starts from the input stage throughout the production process

Brewing: the process of mashing, soaking, germination, boiling, and fermentation of ingredients like barley, hops, water, sugar, wheat, starch, and yeast to create a low alcohol beverage such as beer.

Case study research: a type of study that seek to understand the what, why, and how a certain phenomenon behaves in a certain way

Conventional accounting systems: traditional system of recording financial and economic transactions within an organisation

Decision-making tool: a technique that is employed to provide relevant information that assists managers to make better decisions.

End-of-pipe: End-of-pipe solution is an environmental control technology for waste and emissions that is applied to the end of production process. It operates independently from the production process in order to modify the residual products of the production process so that they are less damaging to the environment than untreated residual products.

Energy recovery: a method whereby waste is converted into energy to promote sustainability.

Enterprise resource planning: Software used to generate records of different divisions in an organisation.

Environmental accounting: the process of recording environmental activities by assigning values to it for informed analysis.

Environmental costing: the process of determining the amount applicable to environmental activities.

Environmental impact: effect of unsustainable use of natural resource by organisations.

Environmental legislation: rules that seek to ensure safety of the environment by setting standards which minimises the creation of externalities from productive activities.

Environmental Management Accounting: the process whereby environmental activities are presented in terms of physical and monetary values for informed analysis.

Environmental performance: reduction in the level of damage caused by productive activities.

Exploratory research: qualitative approach which seeks to unravel new phenomenon.

Financial waste information: assigning of value or cost to waste quantity.

Full cost accounting: the allocation of all cost incurred in a production process to the particular product.

Good product: the portion of production output costs that is ready for sale.

In-depth interview: an approach which seeks responses from participants in a study where participants describe current reality.

Life-cycle costing: the process of determining the cost of a particular product from cradle-to-grave.

Management accounting information system: information that relates costs and benefits of alternative courses of action that requires decision-making.

Material Flow Cost Accounting (MFCA): an environmental Management Accounting (EMA) tool that tracks, traces, identifies, and measures the flow and stock of materials, which include raw materials, parts and components in the production process, in terms of both physical and monetary units in order to separate waste costs into good product and negative product.

Monetary environmental Management Accounting: assigning of value to organisations' environmental impact.

Negative product: the portion of production output costs that represent material loss or waste.

Non-financial waste information: all waste-related information other than that to which cost is assigned.

Physical environmental Management Accounting: the determination of the quantity of environmental impact of an organisation on the environment.

Process inefficiency: faulty process designs resulting in wastage during production.

Process waste: non-product output that is generated in each production process from the input stage through to the output stage. It is the result of inefficiencies in equipment designs, human error in production, poor quality control, use of aging equipment, and poor factory layout.

Process waste-reduction: an attempt to limit inefficiencies in production from the input stage and throughout the process to the output or completion stage. This is a beginning-of-pipe approach rather than end-of-pipe approach.

Transparent flow of materials: making material loss visible through its quantity and cost throughout the production process.

Waste disposal: the process of transporting undesirable materials from the source of creation to dump sites.

Waste management: a strategy to control the effect of undesirable output resulting from productive activity

Waste prevention: an approach which seeks to eliminate inefficiencies in a production process.

Waste recycling: a method that seeks to extend the life of a product by reshaping of remodelling it into some other useful product.

Waste reuse: the process whereby waste generated by one organisation becomes an input resource to another organisation.

APPENDIX B: ABBREVIATIONS/ACRONYMNS USED

ABC – Activity-Based Costing

COD – Chemical Oxygen Demand

DEA – Department of Environment

EC – European Commission

ECA – Environmental Cost Accounting

EMA - Environmental Management Accounting

ERP – Enterprise Resource Planning

FCA – Full Cost Accounting

GDP – Gross Domestic Product

GHG – Green-House-Gas

GRI – Global Reporting Initiative

IFAC- International Federation of Accountants Committee

IFC – International Finance Corporation

IMU - Institute für Management und Umwelt

ISO – International Standards Organisation

LCC – Life-Cycle Costing

MFCA – Material Flow Cost Accounting

MEMA – Monetary Environmental Management Accounting

METI- Ministry of Economy, Trade, and Industry, Japan

PEMA – Physical environmental Management Accounting

ROI – Return on Investment

SAB Ltd – South African Brewery Limited

SAWIC – South African Waste Information Centre

TPM - Total Productive Maintenance

TQC - Total Quality Costing

UNDSD – United Nations Division for Sustainable Development

USEPA – United States Environmental Protection Agency

WWF - World Wildlife Fund

APPENDIX C: IN-DEPTH INTERVIEW QUESTIONS FOR HOPE BREWERY

Research Themes	Interview Questions	Research Questions
Management of brewery process waste	*Questions for the brew master*	RQ 1 RQ 2
	Do you think it is necessary to keep brewery process waste information? If yes, what do you think would be the benefit of such an exercise?	
	Do you think that tracking your brewery process waste would have help to reduce the amount of waste created? If yes, how?	
	How do you control your waste generation if you cannot measure its quantity and cost?	
	Is there any law that requires you to limit your waste quantity? If not, do you pay any levy on pollution to the municipality on your brewery wastewater discharge to the canal? If yes, how then do you think you have been evaluated?	
	Do you have an accounting system that captures waste cost? If not, why not?	
Waste accountability	Do you record the waste quantity from your brewery process in a separate waste record? If not, how do you determine the amount of waste you have created?	RQ 1 RQ 2
	Do you think it would be necessary to record separately your waste quantity and costs? If not, why not? If yes, do you think it has any benefit?	
	Do you think that the tracking of your brewery process waste would be a difficult task or even possible? If yes, is it worthwhile to track it anyway?	
	Considering that you pay wastewater discharge levy to the municipality, does that not indicate that you need to reduce the amount of your wastewater discharges?	
	Do you think that knowing the amount of brewery process waste would have made any difference in the way you do things? If yes, how?	

APPENDIX D: IN-DEPTH INTERVIEW QUESTIONS FOR SAB LTD

Research Themes	Interview Questions	Research Questions
Management of brewery process waste	*Questions for the brew master*	RQ 1
	What are the brewery's main waste-reduction challenges?	
	What efforts have been taken to improve on these challenges? Please mention any project to that effect.	RQ 2
	What effect does the project undertaken have on the brewery's waste-reduction efforts?	
	Does the brewery have a waste-reduction strategy?	
	Does the brewery have any form of reporting for process waste? If yes, please specify how it has supported waste-reduction decisions.	
	Does the brewery keep track of process waste in both quantity and costs? If yes, how has it supported waste-reduction decisions? If not, why not?	
	Do you provide any waste-related information to the brewery management for waste-reduction decision purposes?	
	Are there barriers in the provision of waste-related information? If yes, please explain.	
	What are the key drivers to improving the brewery process waste-reduction decision?	
	In your opinion, what are the potential benefits of waste-reduction to the brewery?	
Accounting for brewery process waste	*Questions for participants in the Management Accounting function*	RQ 1
	How does the brewery account for process waste costs? Are they separately identified or assigned to overhead accounts? Please explain.	RQ 2
	Do you think the accounting system used to account for brewery process waste captures the entire flow of resource loss?	
	Is the brewery process waste information provided by the brewery's accounting system able to assist management in waste-reduction decisions? If yes, to what extent? If not, why?	
	Do you think the accounting system is capable of generating adequate process waste information necessary to make sound waste-reduction decisions?	
	Has anyone in the brewery requested for waste-related cost information from you? If yes, what is purpose of the request?	
	Are waste-related costs included in the budget pool or is it allocated to responsibility centres? If not, please describe how it is done.	
Adequacy of waste information	Are you aware of any mandatory requirements on the brewery to provide information on waste-related costs? If yes, what are they? If not, why are there no requirements?	RQ 1
	Are any internal pressures forcing the brewery to account for its process waste cost information? How does the brewery react to this pressure and what are the actions taken?	RQ 2
	Are you aware of any waste-reduction related national agreements, acts or declarations signed by the brewery? If yes, what are they and do you think the brewery has been able to ensure compliance and meet the	

Research Themes	Interview Questions	Research Questions
	requirement through the provision of adequate waste-related information?	
	Do you think the provision of waste-related information is important to the brewery in its waste-reduction decisions? Is it an important issue to support and improve its waste-reduction decisions?	
Waste accountability	Who is currently accountable for providing waste-related costs information? How are they held accountable?	RQ 1 RQ 2
	Have you ever requested any waste-related cost information from accounting, or environmental management divisions? If yes, what is the purpose of requesting for such information? If not, why not?	
	Do you think it is appropriate to have someone accountable for the provision of waste-related cost information?	
	Who do you think should be held accountable for providing waste-related cost information, accounting, administrative, or production divisions? Are they currently held responsible? If yes, how? If not, why not?	
	Are you personally held accountable for the provision of waste-related cost information? If not, do you think you should be held accountable?	
	Does the brewery issue any internal report on meeting waste-reduction targets? If yes, how are the desired waste-reduction targets measured and what is the purpose of issuing such reports?	
Integrated database system	Does the brewery have a database management system? If yes, to what extent is it integrated?	RQ 1 RQ 2 RQ 3
	Do you think it would benefit the brewery to integrate its database management system? What makes you think so?	
	Do you think the database system has provided enough waste-related information to support waste-reduction decisions? If yes, explain. If not, do you think it is not well utilised?	
	Do you think the database system could be integrated with MFCA to provide appropriate waste-related information? If yes, why is this option not yet exploited? If not, do you think it is worth integrating?	
	What type of waste information, physical and/or monetary is required to support waste-reduction decisions? Do you think the integration of MFCA into the database system would provide such information?	
	How do you see the potential integration of MFCA with the database system to provide necessary waste information to support waste-reduction decisions?	
Availability of information options	Does the availability of other information options reduce the relevance of accounting generated waste information? If yes, what are these information options?	RQ 1 RQ 2
	Do you think other information sources generate enough waste-related information to inform sound waste-reduction decisions?	
	What is your opinion on the adequacy of accounting generated waste information? Do you think it provides necessary information to support waste-reduction decisions?	
	What is your reason for preference of other information source over accounting generated information?	
	Do you think waste information should be sourced from a variety of options including accounting source to support waste-reduction decisions? If yes, is this your approach in the brewery? If not, how is your waste information sourced?	

APPENDIX E: ETHICS PROTOCOL AND RELATED CORRESPONDENCE

Department of Management Accounting:

Research Ethics Clearance

(For Masters and Doctoral students of the Department of Management Accounting)

The Departmental Research Committee of Management Accounting hereby grants the following student ethical clearance to carry on with his questionnaire and interviews.

Student no: 4494167-6

Student name and surname: Michael Bamidele Fakoya

Research topic: An adjusted material flow cost accounting framework for process waste-reduction decisions in the South African brewery industry.

Regards

Prof HM van der Poll

Ms M Lotter

APPENDIX F: TRANSCRIPT OF HOPE BREWERY

Research Themes	Interview Questions	Responses	Research question
Management of brewery process waste	*Questions for the brew master*		
	Do you think it is necessary to keep brewery process waste information? If yes, what do you think would be the benefit of such an exercise?	Obviously, you will be looking at your waste more closely and the money to be saved will make you to pay attention to the amount of waste generated. The focus will be on the large cost of waste in order to reduce it. The amount of savings will make the decision to be quicker.	RQ 1 & 2
	Do you think that tracking your brewery process waste would have help to reduce the amount of waste created? If yes, how?	I think separating the waste quantity and cost would be a difficult task for me because waste always occurs in the pipes.	
	How do you control your waste generation if you cannot measure its quantity and cost?	From a micro-brewery point of view, I think the brew master can provide the physical waste information while I get someone who can help do the costing.	
	Is there any law that requires you to limit your waste quantity? If not, do you pay any levy on pollution to the municipality on your brewery wastewater discharge to the canal? If yes, how then do you think you have been evaluated?	The municipality charge environmental levies which we pay to them. This is the legislation I'm aware of. They come to assess us. The basis of assessment is unknown to me. But we end up paying the levy anyway.	
	Do you have an accounting system that captures waste cost? If not, why not?	We don't have any accounting system to record waste here. We know how many litres of beer we get from every batch we make. I don't think it is necessary to record this things, you see we don't have the kind of money like SAB (SAB Ltd) to hire an accountant for such a thing.	
Waste accountability	Do you record the waste quantity from your brewery process in a separate waste record? If not, how do you determine the amount of waste you have created?	Waste is useless; I don't think recording it will change anything.	RQ 1 & 2
	Do you think it would be necessary to record separately your waste quantity and costs? If not, why not? If yes, do you think it has any benefit?	I think separating the waste quantity and cost would be a difficult task for me because waste always occurs in the pipes.	
	Do you think that the tracking of your brewery process waste would be a difficult task or even possible? If yes, is it worthwhile to track	There is always going to be waste. We are trying to find usefulness for the solid waste like giving it to pig farmers to use in feeding their pigs. But we can't do anything about the wastewater.	

Research Themes	Interview Questions	Responses	Research question
	it anyway?		
	Considering that you pay wastewater discharge levy to the municipality, does that not indicate that you need to reduce the amount of your wastewater discharges?	It obviously would bring more insight to aspects which we have not looked into before.	
	Do you think that knowing the amount of brewery process waste would have made any difference in the way you do things? If yes, how?	It is going to help stop unnecessary waste because the focus is on the cost. Because of the drive to save money, the reduction in waste will be high. There will be greater control on waste by nailing down exactly where waste happens. Knowledge of waste cost will improve beer quality and waste decision.	

APPENDIX G: TRANSCRIPT OF SAB LTD

Research Themes	Interview Questions	Responses	Research question
Management of brewery process waste	*Questions for the brew master*		
	What are the brewery's main waste-reduction challenges?	For us we take it that seriously that any loss of product is a waste. It's huge money, in fact. So the other waste for us is time. We don't want to lose time, we don't want to lose physical product (Brew Master).	RQ 1 & 2
	What efforts have been taken to improve on these challenges? Please mention any project to that effect. What effect does the project undertaken have on the brewery's waste-reduction efforts?	We do simple things like including or doing things better or smarter. Say if you want to remove yeast, instead of opening a valve to drain the yeast, you collect the yeast into skips, you get pumps put into a vessel, and that yeast gets pumped in, and gets collected into a truck. Little things like that that didn't cost us a lot of money, but saves a lot of costs. So the guys (production department) understand that, and then we started showing the guys the cost of you leaving the yeast going into the drains. We get a result every morning, every 24 hours. We have a sampler; the samples are always shown every hour. We have our own equipment. What we do is we then double-check against the municipality's numbers, because the municipality charges us on their own numbers. So we've decided that no, we do our own numbers, so we actually check. So I can tell you on a weekly basis what I expect to be charged by the municipality (Brew Master).	
	Does the brewery have a waste-reduction strategy?	Yes. Our strategy is based on the parent body's sustainable development "Ten Priority", but we in this brewery have tried to surpass that standard. We have set a higher standard for ourselves, and that is the reason we are rated highly as the best waste-reducing plant in the whole of South Africa (Brew Master).	
	Does the brewery have any form of reporting for process waste? If yes, please specify how it has supported waste-reduction decisions.	We try and make sure that if there is waste, I can actually calculate the efficiency of a vessel and it would tell me how much of waste has come out. I can analyse the sample and tell how much of it I've wasted or what should've gone into the next process (Brew Master).	
	Does the brewery keep track of process waste in both quantity and costs? If yes, how has it supported waste-reduction	Yes, we do. The cost aspect is done by the finance department. It has helped me very much because at the end of the week, the finance guys will tell us that this is the cost of the waste we	

Research Themes	Interview Questions	Responses	Research question
	decisions? If not, why not?	created last week.	
	Do you provide any waste-related information to the brewery management for waste-reduction decision purposes?	Yes. On weekly basis. Then they tell us that we are falling below our target and that we should fix the problem.	
	Are there barriers in the provision of waste-related information? If yes, please explain.	if I could come back in the morning and find a vessel by vessel waste and cost number, it'd be much easier than when I get the final number and work back, then I'll just put my signature on it. Definitely because when I walk in my problem is already identified immediately. So that would be very great. So, if I could do that and walk into this plant and say, Oh, I lost it there, I lost it there, I lost it there; without having to do onerous problem solving, then it'd be great (Brew Master).	
	What are the key drivers to improving the brewery process waste-reduction decision?	Key drivers, I mean our strategy. Sustainable development is very important (Brew Master).	
	In your opinion, what are the potential benefits of waste-reduction to the brewery?	It would improve the quality of our product and give us a good image.	
Accounting for brewery process waste	*Questions for participants in the Management Accounting function*		
	How does the brewery account for process waste costs? Are they separately identified or assigned to overhead accounts? Please explain.	We do have a separate account for the variable costs. So you've got your variable costs which are accounted for differently and the variable costs are the beer process flow. We've those accounts, and then the overhead accounts are also separate. So the variable waste costs are separated from overhead accounts (Financial Planner).	
	Do you think the accounting system used to account for brewery process waste captures the entire flow of resource loss?	How that happens is we've got standards for each process. We know for example for beer loss, there is so much that needs to be accounted for because we're going to lose no matter what (Financial Planner). No, no, no. those would be overheads. It's sitting in overheads (Financial Planner).	
	Is the brewery process waste information provided by the brewery's accounting system able to assist management in waste-reduction decisions? If yes, to what extent? If not, why?	Electricity cost is placed under variable costs. We set standards for everything, from electricity; materials; beer loss; coal; everything is included. The standards are set and then we're usually measuring ourselves according to those two (standard costs and actual costs), vice-versa. It's obvious that we'd have these overruns (wastages), and these overruns would be the difference between the standard versus the actual usage	

Research Themes	Interview Questions	Responses	Research question
		(Financial Planner).	
	Do you think the accounting system is capable of generating adequate process waste information necessary to make sound waste-reduction decisions?	I don't see anything that we're missing currently. I can't see anything that is left out (Financial Planner).	
	Has anyone in the brewery requested for waste-related cost information from you? If yes, what is purpose of the request?	So already we have an earlier trigger (warning). Say, hello guys. Something wrong has happened last week. We can say, guys something is wrong with A, B, C go and look at this. See what the problem is there and fix it (Financial Planner).	
	Are waste-related costs included in the budget pool or is it allocated to responsibility centres? If not, please describe how it is done.	For example, we already know we're going to lose say 1 per cent of malted barley in production. So this is the standard (Financial Planner).	
Adequacy of waste information	Are you aware of any mandatory requirements on the brewery to provide information on waste-related costs? If yes, what are they? If not, why are there no requirements?	I know that we have to produce as part of the ISO 22000; we need to be able to show that you've a proper waste handling system. But I know that's a requirement (Brew Master).	
	Are any internal pressures forcing the brewery to account for its process waste cost information? How does the brewery react to this pressure and what are the actions taken?	You can have a very bad day if the calculated waste is high (Brew Master).	
	Are you aware of any waste-reduction related national agreements, acts or declarations signed by the brewery? If yes, what are they and do you think the brewery has been able to ensure compliance and meet the requirement through the provision of adequate waste-related information?	The Department of Environment often come here to assess what we do and to tell us about what they require. Actually, we meet with them from time to time. And then there is ISO 14001 which we have to comply with. But our management have set a target for us which is above the ISO 14000 standard. We try to do more than the minimum (Brew Master)..	
	Do you think the provision of waste-related information is important to the brewery in its waste-reduction decisions? Is it an important issue to support and improve its waste-reduction decisions?	We all own the process and therefore we must all be accountable for the side (process) we are in (Brew Master).	

Research Themes	Interview Questions	Responses	Research question
Waste accountability	Who is currently accountable for providing waste-related costs information? How are they held accountable?	We all own the process and therefore we must all be accountable for the side (process) we are in (Brew Master).	
	Have you ever requested any waste-related cost information from accounting, or environmental management divisions? If yes, what is the purpose of requesting for such information? If not, why not?	It makes sense if waste information is seen in Rands and cents (Brew Master).	
	Do you think it is appropriate to have someone accountable for the provision of waste-related cost information?	Yes. Every one of us is responsible for the waste created in his line of production. As the brew master, I am responsible to ensure that line managers meet their targets(Brew master).	
	Who do you think should be held accountable for providing waste-related cost information, accounting, administrative, or production divisions? Are they currently held responsible? If yes, how? If not, why not?	I think everybody should be held responsible. That way, people will not shift blames on others. Yes, we are being held responsible like I explained earlier. if a line manager does not meet his waste target, he does not receive any bonus, so they try to make sure they meet their targets (Brew Master).	
	Are you personally held accountable for the provision of waste-related cost information? If not, do you think you should be held accountable?	No, it is the finance guys who must provide that information. I do not think I should be held responsible since I can only provide the volume of waste in hecto-litres (Brew Master).	
	Does the brewery issue any internal report on meeting waste-reduction targets? If yes, how are the desired waste-reduction targets measured and what is the purpose of issuing such reports?	Yes. On a weekly basis, the reports are issued. So everyone knows that he/she is within the limit. We have waste targets that have been set, we try to work towards that target (Brew Master).	
Integrated database system	Does the brewery have a database management system? If yes, to what extent is it integrated?	Yes we have SAP. I am not sure about integration but I know that we have it (Brew Master).	RQ 1 & 2
	Do you think it would benefit the brewery to integrate its database management system? What makes you think so?	Yes, from your explanation, I think it is necessary. It means I can be in my office and be able to know what is happening in packaging division for instance (Brew Master).	
	Do you think the database system has provided enough waste-related information	I am not sure because everybody is responsible to meet his/her target. I am not sure, but I know that I provide waste record which	

Research Themes	Interview Questions	Responses	Research question
	to support waste-reduction decisions? If yes, explain. If not, do you think it is not well utilised?	is used by finance to generate cost at the end of the week (Brew Master).	
Availability of information options	Do you think the database system could be integrated with MFCA to provide appropriate waste-related information? If yes, why is this option not yet exploited? If not, do you think it is worth integrating?	From what I have learnt now, I think it is yes. we do not know about this concept yet. I sounds new to me (Brew Master).	RQ 1 & 2
	What type of waste information, physical and/or monetary is required to support waste-reduction decisions? Do you think the integration of MFCA into the database system would provide such information?	Right now we provide the finance guys with data from brewing using automated meters and they measure the readings against set standards and tell us how much it is we have wasted in Rands (Brew Master).	
	How do you see the potential integration of MFCA with the database system to provide necessary waste information to support waste-reduction decisions?	It will be good for me to sit in my office and be able to access whatever information I need at the click of my laptop right here. This will enable me to focus more on other aspects of the brewery needing attention (Brew Master).	
	Does the availability of other information options reduce the relevance of accounting generated waste information? If yes, what are these information options?	In SAB Ltd, accounting basics is a necessary platform for all managers. We cannot do anything without accounting. It has assisted us to achieve the type of progress we have made so far (Brew Master).	