

# Evaluating the awareness of environmental management accounting in the South African chemical industry

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Mini-dissertation submitted in *partial* fulfilment of the  
requirements for the degree *Master of Business  
Administration* at the Potchefstroom Campus of the North-  
West University

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November 2014



## **Acknowledgements**

It is my privilege to acknowledge the contribution and assistance of the following individuals to this mini-dissertation:

- My lovely wife, Annemarie, and awesome boys, Markus and Ivan, for their support, encouragement and sacrifices all along this challenging path – you are the best!
- Prof Anet Smit, my study leader, for her patience, time and guidance and for providing invaluable input into this research.
- Shawn Liebenberg of the Statistical Consultation Services of the North-West University for his guidance regarding the empirical research and for providing insight into the data.
- Antoinette Bisschoff for performing the language editing of this mini-dissertation in a highly professional manner.

Last, but definitely not the least, to my Heavenly Father for providing me the strength and wisdom to apply my skills and knowledge during this wonderful opportunity.

## Abstract

Environmental issues are of increasing concern to citizens, governmental personnel and corporate leaders in most countries all around the world. There is a growing consensus that conventional accounting practices simply do not provide adequate information to support decisionmaking in environmental management.

Simply defined, environmental management accounting is management accounting with a focus on physical information on the flow of energy, water, products and materials as well as monetary information on environmental costs and revenues, and projects related to environmental protection. It is not a different method, but simply a mechanism of doing management accounting in an improved manner. When environmental management accounting is well designed and implemented it should ensure better internal management and value-added decisionmaking. Ultimately, environmental management accounting is simply doing better comprehensive management accounting while wearing an environmental hat.

This study evaluates the awareness of environmental management accounting in the chemical industry. A questionnaire was administered to a selected group of participants. All participants in the study are employees from the chemical industry in South Africa. The selection of participants was based on their knowledge, expertise and understanding of environmental practices, challenges and problems in their respective organisations. Different functional roles from different types of chemical companies were identified to participate.

The findings of this study indicated that there is a good level of awareness of environmental management accounting in the South African chemical industry. Most organisations are applying sound environmental practices and are adopting environmental strategies and different tools to improve their current status. Different levels of awareness exist between different types of chemical industries and between different functional roles in the respective organisations. Operational and capital environmental information are disclosed and organisations do generate and record information on physical and monetary environmental management accounting.

**Key terms:** Environmental management accounting, chemical industry, emissions, environmental practices, ISO 14000, sustainable development.

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## List of Abbreviations

CAIA	Chemical and Allied Industries' Association
CAPEX	Capital Expenditure
EIA	Environmental Impact Assessment
EMA	Environmental Management Accounting
EMS	Environmental Management System
IFAC	International Federation of Accountants
IISD	International Institute for Sustainable Development
ISO	International Organisation of Standardisation
IUCN	International Union for Conservation of Nature
LCA	Life-Cycle-Assessment
MES	Minimum Emissions Standards
NFSD	National Framework for Sustainable Development
NSSD	National Strategy for Sustainable Development
OPEX	Operational Expenditures
UNCED	United Nations Conference on Environment and Development
UNSD	United Nations Division for Sustainable Development
USEPA	United States Environmental Protection Agency
WCED	World Commission on Environmental and Development

# CHAPTER 1

## NATURE AND SCOPE OF THIS STUDY

### 1.1 Introduction

The global profile of environmental issues has significantly risen during the past two decades and has been advanced by two recent major incidents; the Gulf oil spill (April, 2010) and the Fukushima radiation leak (March, 2011). According to Winston (2011:1) these events received worldwide media attention and concerns have escalated over major issues such as global warming, depletion of non-renewable resources and the loss of natural habitats. Frequently these disasters are related to poor industrial oversight and unfortunately in both these cases all evidence led to man-made failures. Because of these incidents and in recognition that our current way of life poses a threat to us and our planet, global agreements have been signed to prevent possible future environmental damages. The Kyoto Protocol for Greenhouse Gas Emissions, the World Summit on Sustainable Development held in Johannesburg, South Africa, in 2002 and the United Nations Change Conference held in Copenhagen, in December 2009 is an indication of the concern that stakeholders have about the negative impact industries have on the environment and humans (Ambe, 2007:54).

As a result of these agreements and the fact that countries are pressured to act, businesses have become increasingly aware of the environmental implications of their operations, products and services. Environmental risks can simply not be ignored anymore. They are now as much a part of running a successful business as product designs, marketing strategies and sound financial management. The growing importance of environmental and social issues has put some pressure on companies to implement environmental and social systems (Laurinkevičiūtė, Kinderytė, & Stasiškienė, 2008:69). The consequences however, of poor environmental behaviour may have a real adverse impact on the business and its finances. Some actual examples are huge fines, destruction of brand values, loss in sales, inability to secure finance, loss of insurance cover, law suits and damage to corporate image.

The real challenge for all organisations is to identify and find ways to reduce their impact on the environment in a sustainable manner. Stakeholders, such as customers

and shareholders, increasingly want to see that businesses are actively reducing environmental risks and the impact thereof before continuing to offer support (Savage & Jasch, 2005:10). Nearly all aspects of business are affected by environmental pressures, including accounting. From an accounting perspective the initial pressures were felt in external reporting, including environmental disclosures in financial reports and/or the production of separate environmental accounts. However, environmental issues cannot be dealt with solely through external reporting. Environmental issues need to be managed before they can be reported on and this requires changes to management accounting systems.

In an ideal world, organisations would reflect environmental factors in their accounting processes through the identification of the environmental costs attached to products, processes and services. However, many existing conventional accounting systems are unable to deal adequately with environmental costs and as a result simply attribute them to general overhead accounts. According to Jasch (2006:1195), the main problem of environmental management accounting is that there is not a proper standard on the definition of environmental costs. Depending on various interests it might include a variety of costs, for example, disposal costs, investment costs and even sometimes external costs. In addition, most of these costs are usually not traced systematically and attributed to the responsible processes and/or products. The fact that environmental costs are not fully recorded often leads to distorted calculations for improvement projects.

Jasch (2006:1196) further states that consequently, many managers are unaware of these costs, have no information with which to manage them and have no incentive to reduce them. It must be emphasized that many management accounting techniques significantly underestimate the cost of poor environmental behaviour. On the other hand many overestimate the cost and underestimate the benefits of improving environmental practices. Some organisations are even unaware of the impact that environmental-related activities can have on the profit and loss accounts and the balance sheet. They miss out on identifying cost reduction and other improvement opportunities. This leads to a failure to enhance customer value, while increasing the risk profile of investments and other decisions with long-term consequences. Environmental management accounting is an attempt to integrate best managerial accounting thinking and practice with best environmental thinking and practice (Ambe, 2007:60).

The term environmental management accounting serves as a mechanism to identify and measure the full spectrum of environmental costs of current production processes and the economic benefits of pollution prevention or cleaner processes, and to integrate these costs and benefits into day-to-day business decisionmaking (Savage & Jasch, 2005:3).

## **1.2 Problem statement**

The chemical industry is one of the largest manufacturing industries in all developing and emerging countries. It create an immerse variety of products which impinge virtually every aspect of our lives (Clements, Dunn, Firth, Hubbard & Waddington, 2010:2). The encyclopaedia Britannica defines the chemical industry as a complex combination of processes, operations and organisations that is engaged in the manufacturing of chemicals and its derivatives.

Because of the complexity of the manufacturing processes, many of the products are potentially very hazardous at certain stages. These processes often require high temperatures, high pressures and reactions which can be dangerous unless carefully controlled. Raw materials are converted to finished goods and certain by-products like carbon monoxide, effluent and solid waste are generated. These are the harmful products that are most often seen as pollutants and should be managed. However, many organisations do struggle to measure and contain these harmful by-products (Clements *et al.*, 2010:15).

Research simply shows that many organisations do not identify and separate environmental costs adequately. They have a definite lack of awareness and understanding of the magnitude of the environmental costs generated and hence proper environmental management is lost in the process (UNSD, 2001:1). There is often a divergence between environmental management and financial management. Financial managers often do not appreciate the risks and financial implications associated with poor or reactive environmental management while environmental managers do not always fully appreciate the economic imperatives that determine the viability of a corporation (Ambe, 2007:59).

In the chemical industry it is very important to understand the cost of poor environmental behaviour and secondly to continuously improve on environmental

performance. According to Jasch (2006:1194) the most significant problem of environmental management accounting lies in the absence of a clear definition of environmental costs. Therefore to investigate, identify and allocate environmental costs would probably increase information needs of managers and provide sound decisionmaking in the long run.

The following research questions can be derived based on the above-mentioned overview of the research problem:

- Does the chemical industry record and disclose environmental related information?
- Does the chemical industry apply environmental practices?
- Is the chemical industry (specifically staff in the finance, production and environmental functions) aware of environmental management accounting?
- Is the chemical industry aware of the potential benefits when environmental management accounting principles are applied correctly?

### **1.3 Background to the study**

According to Burrit, Schaltegger and Zvezdov (2013:1) the interest in sustainability and its implications for organisations has increased steadily since the issue first became topical two decades ago. It is increasingly recognised that sustainability not only poses ethical issues but also has a direct consequence for economic performance.

Sustainable development focuses on improving the quality of life for all of the earth's inhabitants without increasing the use of natural resources beyond the capacity of the environment to supply them indefinitely. It requires an understanding that inaction has consequences and that society must take action, develop or change policies and practices at all levels (Ambe, 2007:18). More and more companies are being pressurised to act responsible on environmental factors. Stricter environmental legislation and regulation imposes a compliance burden and organisations are forced to monitor activities and outputs even more closely (Burrit *et al.*, 2013:2).

According to the International Federation of Accountants (IFAC, 2005:13) environmental accounting is defined as a management tool that integrates financial implications of environmental issues to enhance more effective decisionmaking and to promote

environmental and economic sustainability. It is divided into three components, namely, environmental management accounting, environmental financial accounting and reporting, and auditing for environmental aspects in the financial statements.

Environmental management accounting is a very important tool to identify environmental costs and benefits in an organisation. This information can be used for better decisionmaking on a strategic level (Bennet, Rikhardsson & Schaltegger, 2003:2). Many production costs have an environmental component. By identifying and controlling environmental costs, environmental management accounting systems can help environmental managers to reduce costs and to improve environmental performance at the same time. Environmental management accounting focuses on physical and monetary information. The physical component is about the flow of energy, water products and materials whilst monetary information is about environmental-related costs and revenues (Jasch, 2006:1194).

Many organisations have conventional accounting systems that allocate environmental costs to general overhead accounts. This often results in environmental costs being kept from the attention of management (Ambe, 2007:70). The United Nations Division for Sustainable Development (UNSD, 2001:1) specifically indicate that most often environmental costs are not separately identified by organisations. This causes decision makers to struggle in making a link between environmental information and environmental costs. Opportunities for cost savings are lost because organisations do not understand the magnitude of environmental costs.

The advantage of environmental accounting is the ability to determine and create awareness regarding costs related to the environment. It also helps to identify techniques for reducing and avoiding related environmental costs (Farouk, Cherian & Jacobs, 2012:36).

When relating all of the above information the chemical industry can only benefit by applying sustainability and environmental management accounting principles. Many organisations in the chemical industry that are certified according to the International Organisation of Standardisation (ISO14000, 2014) have already an environmental management system for collecting and recording environmental information. This data and information can be applied into environmental management accounting practices.

## **1.4 Research objectives**

### **1.4.1 Main objective**

The primary objective of this study is to evaluate the awareness of environmental management accounting in the South African chemical industry. The study will further evaluate the current environmental management practices that do exist in the chemical industry as well as how effective the principles of environmental management accounting are incorporated into their conventional accounting systems.

### **1.4.2 Secondary objectives**

The secondary objectives of this research are to:

- Define the significance of an environmental management system (EMS);
- Describe the chemical industry;
- Conceptualise environmental management accounting in the chemical industry; and
- Provide decisive conclusions on the research.

## **1.5 Research method**

This research consists of two phases, namely, a literature review and an empirical study.

### **1.5.1 Literature review**

The purpose of the literature review is to gain valuable insight into sustainable development, the South African chemical industry and environmental management accounting. This will enable the researcher to collect important data and information that will be required to provide conclusions to this study.

Very few studies related to environmental management accounting have been done in the chemical industry. The chemical industry is a very complex process that uses different chemicals to manufacture a variety of products. Certain uses and applications already exist and this should be evaluated to control current limitations. The purpose of this study would be to gain as much information possible and then evaluate the awareness of environmental management accounting in this industry.

The sources that were consulted for the research includes:

- Text books;
- Scientific journals;
- Reports;
- Legislative sources; and
- Internet sources.

### **1.5.2 Empirical research**

The empirical study consists of the research design, participants, measuring battery and statistical analysis.

### **1.5.3 Research design**

The methodology used to collect data is based on the quantitative approach. A structured questionnaire was designed to gather the required data (Annexure A). The questionnaire was used to determine the level of awareness of environmental management accounting in the South African chemical industry. It was administrated to participants.

### **1.5.4 Participants**

People that participated in the study are predominately employees in the finance, production and environmental functions. The rationale for the chosen participants is based on their involvement in budgeting and costing but also due to their level of knowledge, expertise and decisionmaking in the chemical environment.

### **1.5.5 Statistical analysis**

The analysis and interpretation of the research data form a major part of this study. Measuring tools that were used include statistical analysis and descriptive statistics according to the Statistical Consultation Services at the North-West University. The study will further investigate the relationship between variables using correlations, t-tests and ANOVA. Effect sizes and factor analysis will be used to reflect substantive significance of the acquired research results.

## **1.6 Limitations of the study**

### **1.6.1 Participation of respondents**

The study is limited to a concentrated area of chemical companies in South Africa. It will be further limited to employees in the finance, production and environmental functions.

Environmental pollution is a very subtle issue in the chemical industry. This might cause many participants to be suspicious of the survey and it is expected that not all respondents will complete and return the questionnaire.

Environmental management in the chemical industry is regarded as a very important, though sensitive topic and some respondents may be afraid to expose, incriminate or implicate their employer in environmental non-compliance. This may limit the honesty of respondents in completing the questionnaire.

Both reliability and validity are important to the outcome of the questionnaire.

### **1.6.2 Ethical considerations**

There are no major ethical considerations because the questions will evaluate the level of knowledge and understanding of environmental management accounting in the chemical industry. No detailed measurements are required on emissions and waste streams.

## **1.7 Chapter division**

This mini-dissertation consists of four chapters. The layout is as follows:

**Chapter 1:** Chapter one serves as the background of the proposed research. It will focus on the introduction, the background of the study, the problem statement, objectives and research methodology.

**Chapter 2:** This chapter will be an investigation into the chemical industry and environmental management accounting. It will discuss physical and monetary environmental management accounting, its potential benefits and challenges.

**Chapter 3:** The aim of chapter three is to do an empirical research on different organisations in the chemical industry. This will be done to determine the level of

awareness and significance on environmental management accounting in this industry. Data will be accumulated using a set of questionnaires and this will be analysed. A clear explanation on the data gathering and interpretation methods will be described.

**Chapter 4:** Final conclusions will be formulated through information obtained from literature and empirical research. The final conclusions should answer the proposed problem statement and research objectives. Certain recommendations will be made based on the results and conclusions.

## **1.8 Summary**

This first chapter is an introduction about the purpose and scope of this study.

Organisations in the chemical industry are constantly facing environmental challenges due to the nature of the various processes to convert raw materials into finished products.

Environmental management accounting is a management tool that should, if applied correctly, supports and enhances both the financial and environmental disciplines (Ambe, 2007:65). However, the application of environmental management accounting remains an exception rather than the rule. As a consequence, very few organisations can readily access information on their environmental costs, liabilities and benefits. Environmental management accounting can assist in presenting a decisionmaking system for organisations concerning measures to promote better environmental performance by identifying effective cost assessment structures.

This chapter will be followed by a literature review on sustainable development, the chemical industry and environmental management accounting. Definitions and detail will be discussed.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

The purpose of this chapter is to review the literature on environmental management systems, how it fits into the chemical industry and how environmental management accounting is being applied. This chapter begins with a discussion on sustainable development and how different world protocols and national requirements are derived from it. This is followed by an overview on the chemical industry, its process requirements and how it is measured. The last section focuses on environmental management accounting and its framework. From an internal perspective an overview on physical environmental management accounting and monetary environmental management accounting are being shared. The chapter lastly discusses the potential benefits and challenges of environmental management accounting that are typically experienced in the industry.

A management system that can be implemented by organisations should safeguard sustainable management of resources. According to Burrit *et al.* (2013:3) the term sustainability accounting is used to refer to the process of the collection, analysis and communication of sustainability-related information. It has emerged from a combination of philosophical discussions on the nature of accounting and conceptual developments in accounting. Sustainable accounting is much more improved than traditional measures as it also takes different inputs and processes into consideration (IFAC, 2005:27). The sustainable accounting methods present more benefits. In particular with regards to cost and benefit analysis where risk control, adjustment costs, overhead costs and disclosure notes can be identified in a more effective manner. These benefits will ensure better sustainable practices (Burrit & Christ, 2013:168).

Over the past years environmental management accounting has formed part of an increased literature search and approach that is helping organisations to use accounting information for environmental sensitive internal decisionmaking (Kurniati, Rahadi & Danial, 2010:405). Damages and disturbances to the original state of the environment are unavoidable and will require sound decisionmaking processes informed by credible

data. Environmental management accounting principles, tools and new methods designed by researchers and practitioners can be used to generate information, containing economic as well as environmental sensitive costs, and support management to enable environmentally-sensitive decisionmaking (Debnath, Bose & Dhalla, 2012:44).

A conclusion could be made after studying Ambe (2007:59) that an opportunity exists to improve current conventional accounting systems. Due to traditional internal processes and systems some organisations experience a lack of environmental costs awareness and in the process opportunities for cost saving is lost. Burrit *et al.* (2013:163) describe it as a matter of potential benefits often downplayed or ignored.

## **2.2 Sustainable development**

Sustainable development has been defined in many ways, but the finest inclusive quoted definition is still from *Our Common Future* which was developed and published in 1987 by the World Commission on Environment and Development (WCED, 1987:46), also better known as the Brundtland Report. It states:

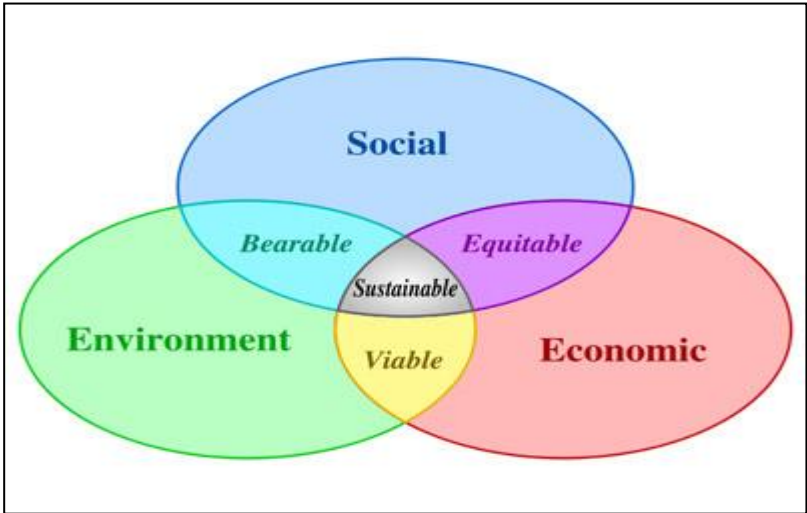
*“Sustainable development is development that needs the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world’s poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environment’s ability to meet present and future needs.”*

According to the International Institute for Sustainable Development (IISD) all definitions of sustainable development should require that we see the world as a system – a system that connects space but also a system that connects time. The practicality thereof is that when someone thinks of the world as a system over space, they would ultimately understand that there is a high probability that air pollution in North America can affect the air quality in Asia, and pesticides sprayed in Argentina could harm fish stocks of the coast of Australia. Furthermore the environmental policies we endorse today will definitely have an impact on the future of our children and grandchildren. The IISD strongly believes the concept of sustainable development is rooted in this sort of systems thinking. It helps everyone to understand firstly ourselves and secondly our

world or planet we live in. The problems we face today are complex and serious. Unfortunately we cannot address them in the same way we created them, but we can definitely address them going forward (IISD, 2013).

According to The World Conservation Union (IUCN, 2006:1) the idea of sustainability dates back more than 40 years ago when a new mandate was adopted by the IUCN in 1969. It was also a key theme of the United Nation Conference on the Human Environment in Stockholm in 1972. During this conference the concept was coined explicitly to suggest that it was indeed possible to achieve economic growth and industrialization without environmental damage. Over the past decades the core of sustainable thinking has evolved and the concept of 'Triple Bottom Line' has become widely accepted as one approach to sustainability accounting at company level. Organisations should not just be concerned with their financial performance but also their environmental and social performance (Burrit *et al.*, 2013:5). They should therefore aim to manage and account for all three aspects. The IUCN Programme (2006:2) used the interlocking circles model to demonstrate the three different aspects. Figure 2-1 depicts the need for these aspects to be integrated but also emphasize the balance that there should be between them.

**Figure 2-1: Three dimensions of sustainability development**



Source: IUCN (2006)

To meet the needs of future generations these three dimensions need to be integrated to address the balance between the dimensions of sustainability (IUCN, 2006:4). According to Chase and Jacobs (2011:58), in terms of a social perspective an

organisation relates to fair and beneficial business practices towards their people, community and region in which it conducts business. From an economical perspective the organisation is obliged to compensate shareholders who provide capital but also promote growth and value in the form of profit. And in terms of environmental standpoint a company should protect the environment as much as possible. An organisation should reduce its ecological footprint by managing its consumption of natural resources and by reducing waste. Many organisations are already conducting a 'cradle-to-grave' assessment of products to determine what the true environmental costs are. In simple terms, it is a valuation from the initial processing of the raw material to the point where it is eventually disposed by the final customer and/or consumer.

### 2.2.1 World protocols and global initiatives

According to International Institute for Sustainable Development (IISD) 2010 the concept for sustainability all started in 1962 with the publicity of Rachel Carson's book *Silent Spring*. This book's release was considered by many to be the turning point in our understanding of the interconnections among the environment, the economy and social well-being. Since then, many milestones have marked the journey towards sustainable development. Table 2-1 depicts a few major milestones of the past 40 years:

**Table 2-1: Major milestones of sustainable development**

1970	First Earth Day is held in the United States as a national teach-in on the environment – 20 million people participated in peaceful demonstrations.
1984	An international conference on environmental and economic issues is held. This conference concluded that the environment and economics should be mutually reinforced. It also assisted to shape our common future.
1987	<i>Our Common Future</i> is published. Also referred to as the Brundtland Report. It is a comprehensive report that basically weaves together social, economic, cultural and environmental issues and global solutions.
1990	The International Institute for Sustainable Development (IISD) is established in Canada.

1992	The very first Earth Summit is held by the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro. A few agreements are reached: Agenda 21, the Convention on Biological Diversity, the Framework Convention on Climate Change, the Rio declaration and non-binding Forest Principles.
1997	United Nations General assembly review of Earth Summit. This session acts as a sober reminder that little progress has been made in implementing Agenda 21 and the discussions ends without any significant new comments.
1999	The first global sustainability index gets launched. The purpose is to track leading corporate sustainability practices worldwide. The Dow Jones Sustainability Group Indexes provides a bridge between those companies implementing sustainable principles and investors looking for trustworthy information to guide investment decisions.
2002	Second World Summit on sustainable development is held in Johannesburg. In the climate of frustration at the lack of government progress, the summit promotes partnerships as a non-negotiated approach to sustainability.
2005	The Kyoto Protocol is signed. Developed countries are legally bound into goals to reduce greenhouse gas emissions and to establish the Clean Development Mechanism for developing countries.
2009	The Copenhagen climate negotiations are held. The specific outcomes are unclear and the process might be in trouble but the Copenhagen Accord itself may be in terms of engaging developing countries.
2012	Third Earth Summit is held in Rio de Janeiro. During the Rio+20 Summit the international community decides to establish a high-level Political Forum on Sustainable Development to subsequently replace the commission on Sustainable Development.
2013	The high-level Political Forum on Sustainable Development held its first meeting on 24 September 2013.

Source: IISD (2014)

According to Adams (2006:8) the earth is at a tipping point and business as usual is no longer an option. The present global dilemma offers huge risks, but also outstanding opportunities. He further states that the need to create a sustainable 'post fossil-fuel' society and economy has never been more widely recognised, although the challenges on the road to achieving it remain breath-taking.

The recent Global Sustainable Development Report (2013:9) indicates that even if the suggested sustainable pathway is being followed moving into the future the world in 2050 will still has its share of problems and challenges. Billions of people would still be under water stress and flood risks will have worsened in many places. Chemicals would likely continue to pose serious threats to human health, despite great efforts to improve the current situation. The problem today is that many countries continue to face great capacity constraints in assessing and advancing sustainable development knowledge. The assessments also indicate big differences in terms of national priorities under the sustainable development agenda.

### **2.2.2 South African perspective on sustainability**

The World Bank ranks South Africa as an 'upper-middle-income country' with one of the largest economies in Africa (SA yearbook 2012/13:134). The reasoning is that the country has a well-capitalized banking system, abundant natural resources, well developed regulatory systems, very good research and development capabilities and also a well-established manufacturing base. South Africa has adopted first-world class standards in its environmental policies, introducing regulations to promote co-operative environmental management and providing useful guidelines for the disposal of hazardous waste.

South Africa's yearbook (2012/13:222) further states that the government is committed to protect the country's rich biodiversity heritage for the benefit of all. They are also committed to create a prosperous and equitable society that lives in harmony with its natural resources. The department of Environmental Affairs is mandated to formulate, coordinate and monitor the implementation of national environmental policies, programs and legislation. One of their main strategies is to plan, manage and prevent pollution and environmental degradation to ensure a sustainable and healthy environment. They also have to provide leadership on the climate change adaption and mitigation.

According to Diemont, Rapson and Gilmour (2012:1) Section 24 of the Constitution of South Africa, 1996 provides that everyone has the right to an environment that is not harmful to their health or well-being. It further states that the environment needs to be protected for the benefit of present and future generations through reasonable legislative and other measures.

In 2008 the Cabinet approved the National Framework for Sustainable Development (NFSD). The approval of this framework signalled a new wave of thinking aimed at promoting the effective stewardship of South Africa's natural, social and economic resources. Following the approval of the NFSD, the National Strategy for Sustainable Development and Action Plan (NSSD) was approved in November 2011 by the Cabinet. It basically builds on to the NFSD as well as on several other initiatives that will address issues of sustainability in South Africa. It marks a continuation of national partnership for sustainable development and five important strategic objectives were identified during this process:

- (1) Enhancing systems for integrated planning and implementation;
- (2) Sustaining our ecosystem and using natural resources efficiently;
- (3) Grow towards a green economy;
- (4) Building sustainable communities; and
- (5) Responding effectively to climate change.

Other legislative requirements that is important and meaningful to the chemical industry include the: National Environmental Management Act (No.107 of 1998) (NEMA) (SA, 1998a), Environmental Conservation Act (No.73 of 1989) (SA, 1989), National Water Act (No.36 of 1998) (SA, 1998b), Atmospheric Pollution Prevention Act (No.45 of 1965) (APPA) (SA, 1965), National Environmental Management: Air Quality Act (No.39 of 2004) (SA, 2004) and Occupational Health and Safety Act (No.85 of 1983) (SA, 1983).

South Africa has also taken a number of steps to promote environmentally sound management of chemicals and waste throughout its entire life cycle (SA yearbook, 2012/13:238). Included in these steps is to be an active member in different programs and initiatives on chemicals and wastes. Substances that may cause injury or ill-health

by reason of their toxic, corrosive, irritant, strongly sensitising or flammable nature are largely controlled by the Hazardous Substance Act (No. 15 of 1973) (SA, 1973)

Diemont *et al.* (2012:7) are of the opinion that while environmental management in South Africa is highly regulated, the implementation of environmental laws and the enforcement of environmental prohibitions have been largely inconsistent.

### **2.2.3 Environmental management systems**

Due to sustainable growth and development, organisations around the world, as well as their shareholders, are increasingly becoming aware of the need for environmental management and social responsible behaviour (Anon, 2009:3). Because organisations are these days more focused on environmental aspects than before it becomes increasingly important for them to work towards common and comparable environmental management practices. This is purely done to support the sustainability of their organisations, products and services.

The United States Environmental Protection Agency (USEPA, 2014) defines an environmental management system as a framework that helps a company to achieve its environmental goals through consistent control of its operations. The assumption is that this type of framework will improve the environmental performance of a company in general. The USEPA further states that the environmental management system does not dictate the level of environmental performance that must be achieved. The environmental management system rather assist a company to address its regulatory demands in a systematically and cost-effective manner. This is a pro-active approach that can help to reduce the risk of non-compliance and improve the health and safety practices for employees. It also addresses non-regulated issues, such as energy conservation, and can promote stronger operational control and employee stewardship. There are a few basic elements that fit an effective environmental management system:

- Reviewing the company's environmental goals;
- Analysing the company's environmental impact and legal requirements;
- Setting environmental objectives and targets to reduce environmental impacts comply with legal requirements;

- Establishing programs to meet these objectives and targets;
- Monitoring and measuring progress in achieving the objectives;
- Ensuring employees' environmental awareness and competence; and
- Reviewing progress of the environmental management system and making improvements.

According to Ambe (2007:40) organisations that have implemented an environmental management system are more likely to embrace new environmental technologies and are more aware of the environmental impacts of their activities than those organisations that did not implemented an environmental management system.

#### **2.2.4 ISO 14000**

With regards to the concept of environmental management systems many organisations are considering specifically the International Organisation for Standardization (ISO) standards to provide a framework to ensure alignment and consistency, both nationally and internationally.

ISO was established in 1947 when delegates from 25 countries decided to create a new international organisation to facilitate the international coordination of industrial standards. It has members from 162 countries and 3 368 technical bodies to take care of standard development. It also has a portfolio of more than 18 000 standards which provides practical tools in all 3 dimensions of sustainable development – economical, environmental and societal. ISO standards make a positive contribution to the world we live in and as an organisation it facilitates trade, spread knowledge, and shares technological advances and good management practices (ISO, 2014).

The main purpose of these standards is to provide international accepted state of the art specifications for product and service practices. These standards ensure that products and services are safe, reliable and of good quality. It also assists organisations to take a pro-active approach to manage environmental issues. These are called the ISO 14000 family of environmental management standards which can be implemented in any type of organisation. It provides practical tools for organisations who want to identify and control their environmental impact. It also assists in meeting the challenge of climate

change with standards for greenhouse gas accounting, verification and emissions trading. It also provides mechanisms for measuring the carbon footprint of products. It has developed normative documents to provide organisations with environmental tools with the following characteristics:

- Technical credibility – sum of knowledge from broad pool of international experts and shareholders;
- Satisfy stakeholder needs;
- Facilitate the development of uniform requirements;
- Promote efficiencies when standards are implemented;
- Support regulatory compliance; and
- Enhance investor confidence.

ISO 14004 (2004) specifies detailed criteria for an environment management system. It basically maps out a framework that a company can follow to set up an effective environmental management system. Using these standards can provide assurance to all stakeholders that the environmental impact is being measured and improved. If applied accordingly an organisation can reduce cost of waste management and save on consumption of energy and materials (Živković, Takić & Živković, 2013:541). It is a recognised framework for environmental management systems. It assists organisations to manage the impact of their activities on the environment and to demonstrate sound environmental management practices. This standard not just addresses the environmental aspects of an organisation's processes, but also those aspects regarding its products and services too. Therefore the technical committee has also developed some additional tools to assist organisations to address these aspects. Typically, the Life-Cycle-Assessment (LCA) is such a tool that identifies and evaluates the environmental aspects of products and services from 'cradle to the grave'.

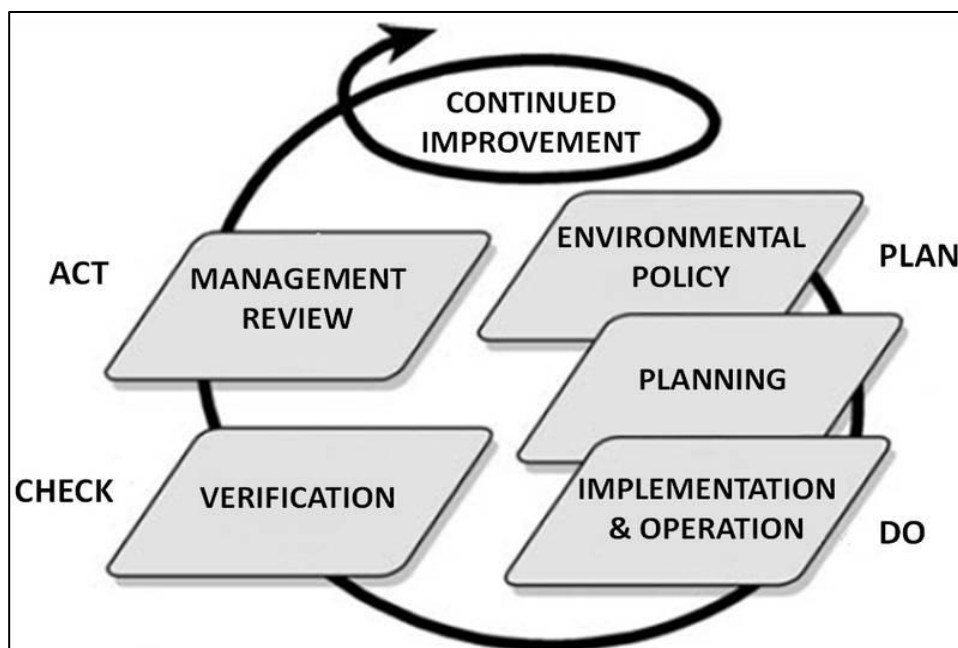
An integral part of an organisation's environmental management system (EMS) is the commitment to continual improvement (Anon, 2009:7). ISO takes this principle to heart and is constantly improving their processes to identify and respond to new standardisation needs. The entire ISO 14000 family of standards provides management

tools for organisations to manage their environment aspects and to assess their environmental performance. Some of the tangible economic benefits include the following:

- Reduced raw material/resource use;
- Reduced energy consumption;
- Improved process efficiency;
- Reduced waste generation and disposal costs; and
- Utilisation of recoverable resources.

The ISO family is also designed to be implemented according to the same Plan-Do-Check-Act cycle that is applied by all other ISO management systems standards. The environmental management system model and the ongoing process of continual improvement are illustrated in Figure 2-2. This system is best viewed as an organising framework that should be continually monitored and periodically reviewed to provide effective direction for an organisation's environmental management in response to changing internal and external factors (ISO 14004:2004).

**Figure 2-2: Environmental management system model**



Source: ISO 14004 (2004:5)

## 2.3 Chemical industry

According to Clements *et al.* (2010:1) the chemical industry uses a wide range of raw materials to create an immense variety of products, which impinge on virtually every aspect of our lives. Interestingly, while many of these products (paints, plastics, soaps and more) are purchased by consumers directly, a majority of chemicals manufactured are used to make products for other industries, including other branches of the chemical industry itself.

The industry utilizes a wide range of raw materials to convert to finish goods. Due to an ever increase in competition worldwide, innovation have seen some incredible changes in the industry over the past 10 years. Many new ideas and concepts have surfaced the industry satisfying the increasingly sophisticated, demanding and environmentally-conscious consumers (Clements *et al.*, 2010:5). The products of the chemical industry can be divided into three categories:

- Basic chemicals;
- Speciality chemicals; and
- Consumer chemicals.

Basic chemicals are divided into: chemicals derived from oil, known as petro-chemicals, polymers and basic inorganics. The term 'petro-chemical' can be misleading as the same chemicals are increasingly being derived from sources other than oil, such as coal and biomass. An example is methanol, commonly produced from oil and natural gas in the US and Europe but from coal in China. Another is polythene, derived from oil and gas in the US and Europe but increasingly from biomass in Brazil. Speciality chemicals cover a wide variety of chemicals such as crop protection, colorants, catalysts and paint. Consumer chemicals are sold directly to the public and this includes soaps, detergents and toiletries.

**Figure 2-3: This is a view of one of the largest chemical sites in the world (Ludwigshafen, Germany)**



Source: Clements, Dunn, Firth, Hubbard & Waddington (2010:26)

According to Tullo (2014:1) the 2013 sales of the top 50 global companies in the world is estimated at \$980.5 billion. Although two thirds of the output of the chemical industry is in the developed world, production in China has already taken second place after the US in country ranking. The actual manufacturing of chemicals has traditionally been located in the US and Western Europe. However, lately many large investments have been made in the Middle East and Asia. In other words, the chemical industry is becoming increasingly multi-national. A major factor determining location is mainly the availability of a sizable and growing market for the products.

When assessing the South African context it reflects more or less the same picture as the rest of the world. According to the Chemical and Allied Industries' Association (CAIA, 2014) the chemical industry in South Africa is the largest of its kind in Africa. It is highly complex and widely diversified, with end products often being composed of a number of chemicals which have been combined in some way to provide the required properties and characteristics. It can be divided into four broad categories:

- Base chemicals;

- Intermediate chemicals;
- Chemical end-products; and
- Speciality end-products.

Base chemicals including the petrochemical building blocks, ethylene, propylene, butadiene, benzene, toluene, xylenes, and methanol, which are all important chemical building blocks sourced from the petrochemical industry. Inorganic chemicals such as ammonia, caustic soda, sulphuric acid, chlorine, sulphur, soda ash and phosphorus, to name but a few, are also base chemicals. Intermediate chemicals is a term which can be used to describe a plethora of products such as ammonia, waxes, solvents, phenols, tars, plastics and rubbers. Chemical end-products include process-able plastics, paints, explosives and fertilisers. Speciality chemical end-products tend to be lower volume, higher added-value chemical products. Many pharmaceuticals, agro-chemicals, bio-chemicals, food-, fuel- and plastic additives fall into this category (CAIA, 2014).

CAIA is a South African association which forms part of a world-wide network of chemical industry associations which seeks to promote the efficiency, productivity and competitiveness of the chemical and allied industries in South Africa. They promote a proactive relationship with government, particularly the Departments of Trade and Industry, Environmental Affairs, Education, Labour, Energy and Science Technology.

South Africa's chemical industry is of substantial significance to the South African economy and a key component of the country's industrial base. According to Statistics SA (2014), petroleum, chemical products, rubber and plastic products contributed R421 million to the GDP in 2013, which is about 25.1% of total manufacturing sales.

However, the industry has also a very distinctive negative image when it comes to pollution (Figure 2-4). According to the 2012 report of the World's Worst Pollution Problems the chemical industry is listed as one of the top 10 polluters. The report states that chemical manufacturing is a large source of pollution worldwide and can be directly tied to close to 200 of the polluted sites in the Blacksmith Institute database (Blacksmith, 2012). Potentially, this is putting approximately 5.3 million people at risk of exposure.

**Figure 2-4: Black smoke filled with carbon particles coming from a chemical plant's stack**



Source: Blacksmith Institute (2012)

### **2.3.1 Process requirements**

According to Germain, Arnold, Rowan and Roane (1998:223) chemical companies have the responsibility to manage and safeguard all of their assets. These assets include personnel, plant, equipment, materials and the environment – both inside and outside the plant. Plant management must ensure that their personnel have the required knowledge and skills to manage each facet of the business effectively and efficiently or face the risk of substantial losses. In order to achieve a reliable operation, well trained, properly supervised, knowledgeable and highly skilled workforce is required. It also implies that in order to control harm to people, processes, property and the environment an organisation must have equipment and materials that is properly formulated, designed and maintained.

Relevant systems and procedures need to be in place to ensure plant personnel do succeed in their daily activities (Germain *et al.*, 1998:259). Facilities and equipment can be reviewed and analysed at every stage of the lifecycle using hazard analysis techniques to recognise, evaluate and control hazards and risks within the operation. Frequent hazard identification and analysis assist in developing risk management

strategies to eliminate or reduce hazards to the employees, facilities, equipment, environment and the community.

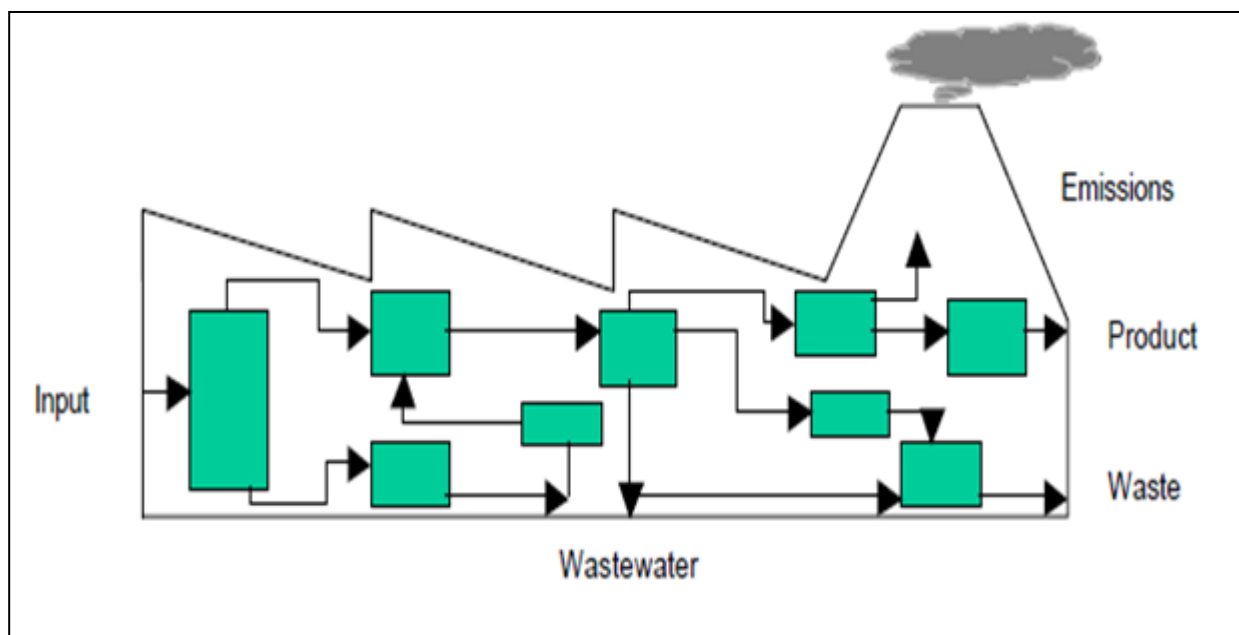
From a legislation point of view the Environmental Conservation Act (No. 73 of 1998) requires that an Environmental Impact Assessment (EIA) is conducted on a proposed development, activity or project to determine, assess and evaluate the consequences (positive and negative). The key purpose of an EIA is to identify solutions, approaches or options for development that best meets sustainability objectives. The process contributes to giving effect to the objectives of integrated environmental management as decision makers are informed of the desirability of such activities and on the conditions which authorisation of the activity should be subject to, where relevant.

### **2.3.2 Emissions and waste**

According to UNDSO (2001:27) everything that leaves the company that is not classified as product is a sign of ineffective production and is by definition waste and emissions.

A chemical plant is a typical value chain where inputs are transformed into value-added products through different processes of work activities. It is mainly supported by resources such as land, labour, money and information (Evans & Collier, 2007:43). The success of the entire value chain depends on the design and management of all aspects of the value chain. During the transformation process of a chemical plant, raw materials are converted into finished product. Waste and emissions are generated during the conversion process. Process flow charts can give insights into company-specific processes and make provision to determine the losses, leakages and waste streams at the originating source (UNDSO, 2001:71). These process flows as seen in Figure 2-5 trace the inputs and outputs of material flows (solid, liquid and volatile) on a technical process level.

**Figure 2-5: Process flow of a chemical plant**



Source: UNDS (2001:72)

Clements *et al.* (2010:3) explain that manufacturers around the globe try to generate as little waste as possible, mainly through reaction choice, process design and recycling. The industry aims to use chemical reactions and processes that make the most effective use of available resources and generate the smallest possible amount of waste material. One way of measuring the efficiency of a process is to calculate the yield, which compares the expected product quality with the actual amount obtained.

### **2.3.3 Control measures**

As part of plant operations material balances are used as the basis to measure unit performance. A material balance is taken over the complete process to determine the quantities of raw materials required and products produced. Material balances are also very useful to check the actual plant performance against the original design and engineers are using material balances on a daily basis to do trouble shooting, to improve plant efficiencies and to reduce environmental discharges (Coulson & Richardson, 2007:34).

For any chemical plant that produces a physical product it is extremely important from an environmentally-related point to measure the following product and non-product outputs (Savage *et al.*, 2005:36):

- Products including packaging – any physical finished goods.
- By-products including packaging – these are minor products that are incidentally produced during the manufacturing of the primary product.
- Non-product outputs (waste and emissions):
  - Solid waste is defined to be non-hazardous waste in a solid form such as waste paper, plastic containers, food waste and non-hazardous scrap;
  - Hazardous waste is defined to be more hazardous waste in a solid form such as discarded batteries, liquid form such as solvents and/or mixed form such as effluent;
  - Wastewater is defined to be waste streams whose primary component is water but contains contaminants of some kind; and
  - Air emissions are air streams contaminated with problematic levels of pollutants such as carbon monoxide and volatile organic compounds.

## **2.4 Environmental management accounting**

With increasingly stringent environmental regulations the costs for industry of environmental protection, including pollution reduction, waste management, monitoring, regulatory reporting, legal fees and insurance have rapidly increased during the past 20 years (UNSD, 2001:1). Many of these environmental costs are allocated to general overhead accounts, with the consequence that product and production managers have no incentive to reduce environmental costs, and more often than not, executives are unaware of the extent of environmental costs.

Godschalk (2008:250) defines environmental management accounting as the identification, collection, analysis and the use of physical information and monetary information for internal decisionmaking. According to Burritt *et al.* (2013:163) environmental management accounting provides a pragmatic response to criticism that conventional management accounting has failed in its ability to provide explicit consideration of environmental issues. Environmental costs are frequently hidden in the general overhead accounts and potential benefits are often downplayed or ignored. By providing data on the physical and financial elements of environmental performance, it

has been suggested that environmental management accounting will provide the information that can be used by managers to assess opportunities for economic and environmental improvement (Gale, 2006:1128).

Environmental management accounting normally involves life-cycle costing, full cost accounting, benefits assessment and strategic planning for environmental management (Savage *et al.*, 2005:10). Environmental management accounting information is used for internal organisational calculations and decisionmaking. Internal decisionmaking include physical information for material and energy consumption as well as monetary information for costs and revenues related to activities with a potential environmental impact (UNSD, 2001:1). It is important to note that environmental costs are just a subset of costs and all costs need to be considered when making decisions. Environmental management accounting is a very important tool to identify environmental costs and benefits in an organisation. Environmental costs are defined as both internal and external costs occurred that is related to environmental damage and protection (UNSD, 2001:11).

Burrit, Hahn and Schaltegger (2002:39) have developed a comprehensive framework for environmental management accounting, linking business actions and environmental management accounting tools. The framework in Table 2-2 below provides structures for managers to understand and assess the variety of environmental management accounting tools that have been developed over time in order to encourage the adoption of environmental management accounting.

**Table 2-2: Proposed framework of environmental management accounting**

		<b>Environmental Management Accounting (EMA)</b>			
		<b>Monetary Environmental Management Accounting (MEMA)</b>		<b>Physical Environmental Management Accounting (PEMA)</b>	
		<b>Short Term Focus</b>	<b>Long Term Focus</b>	<b>Short Term Focus</b>	<b>Long Term Focus</b>
<b>Past Oriented</b>	Routinely generated information	Environmental cost accounting (e.g. variable costing, absorption costing, and activity based costing)	Environmentally included capital expenditure and revenues	Material and energy flow accounting (short term impacts on the environment - product, site, division and company levels)	Environmental (or natural) capital impact accounting
	Ad hoc information	Ex post assessment of relevant environmental costing decisions	Environmental life cycle (and target) costing Post investment assessment of individual projects	Ex post assessment of short term environmental impacts (e.g. of a site or product)	Life cycle inventories Post investment assessment of physical environmental investment appraisal
<b>Future Oriented</b>	Routinely generated information	Monetary environmental operational budgeting (flows) Monetary environmental capital budgeting (stocks)	Environmental long term financial planning	Physical environmental budgeting (flows and stocks) (e.g. material and energy flow activity based budgeting)	Long term physical environmental planning
	Ad hoc information	Relevant environmental costing (e.g. special orders, product mix with capacity constraint)	Monetary environmental project investment appraisal Environmental life cycle budgeting and target pricing	Relevant environmental impacts (e.g. given short run constraints on activities)	Physical environmental investment appraisal Life cycle analysis of specific project

Source: Burrit, *et al.* (2002:39)

The framework integrates systematically two important components of environmental management accounting, which is physical and monetary environmental management accounting. The suggested framework highlights the past and future and short versus long-term dimensions of the various tools. Furthermore, it provides information that is necessary for any successful environmental management accounting implementation.

### **2.4.1 Physical environmental management accounting**

Internal management accounting focuses on physical resources and monetary resources. The first part of environmental management accounting, namely the tracking of physical information, is a very important tool in environmental accounting as it allows the company to analyse and manage their environmental performance (Savage *et al.*, 2005:30).

Information such as energy usage, water consumption and quantity of waste is an example of physical information that will be analysed and reported on. It is essential that physical as well as monetary data on material used, should be collected to assess costs appropriately in a company. Unfortunately, the physical accounting information is not always easily available to accounting personnel. Personnel in areas, such as production or environmental will have more detailed information and accountants need to work more closely with them in order to improve accuracy of physical environmental management accounting information.

Under the physical accounting side an organisation should attempt to track all physical inputs and outputs to ensure that significant amounts of energy, water and other materials are accounted for. Many chemical companies refer to this as either material or mass balances. Many organisations conduct energy and water balances separately for improved measurement purposes. The underlying assumption is that all physical inputs must eventually become outputs – either as physical products or waste and emissions. Table 2-3 below describes the input and output types under physical environmental management accounting and the flow of materials until the final product is complete that will help in categorizing costs in their different types of cost categories.

**Table 2-3: Physical materials accounting: Input and output types**

<b>Material Inputs</b>	<b>Product Outputs</b>
Raw and Auxiliary Materials	Products (including Packaging)
Packaging Materials	By-products (including Packaging)
Merchandise	<b>Non-Product Outputs (Waste and Emissions)</b>
Operating Materials	Solid Waste
Water	Hazardous Waste
Energy	Wastewater
	Air Emissions

Source: Savage and Jasch (2005:33)

The physical categories described are in line with the standard practice of mass balancing and the general structure of ISO 14031 for environmental performance indicators for operational systems. However, these physical categories may be adjusted as needed to suit specific sectors or individual organisations. Environmental performance indicators can assist organisations to assess and report the material-related aspects of its environmental performance (Henri & Journeault, 2008:168).

#### **2.4.2 Monetary environmental management accounting**

Monetary environmental management accounting is accounting that focusses on the financial impact it has on environmental performance (Savage *et al.*, 2005:37). It allows management to make a better evaluation of the monetary aspects of products. However, different companies view environmental costs differently, depending much on the company's view on environmental matters such as economic and environmental goals (Ambe, 2007:82). Jasch (2006:1207) confirms that the problem with environmental management accounting is that it lacks a standard definition for environmental costs. The United States Environmental Protection Agency (USEPA) and the Japan Ministry of Environment (Japan MOE, 2005) are two of the organisations that are most commonly referred for defining environmental-related costs in a company. Japan MOE defines environmental costs as the investments and expenses related to the prevention, reduction and avoidance of environmental impact, removal of such impact and restoration of the environmental impact that is measured in monetary value.

According to Jasch (2006:1196) environmental protection costs include costs for prevention, disposal, planning, control and damage repair that can occur at companies, government or people. All expenditures for environmental protection, such as expenditures to prevent, control or reduce waste as well as disposal, clean-up and treatment for environmental related aspects, form part of environmental expenditure. To ensure that environmental management accounting is accurate and consistent, physical inputs and outputs must be linked with their appropriate cost categories. If environmental costs are linked to their specific cost categories, then this will enable management to effectively identify and manage environmental costs (Savage *et al.*, 2005:37). Environmental cost categories form part of monetary environmental management accounting.

One of the most important goals is to clarify the types of environment-related cost information that managers need to manage both their organisation’s environmental performance and its associated economic performance. It is also important to review the varying cost guidelines in different countries in order to be consistent with international practices. Consideration should be given not just to current accepted cost categories but also to emerging best practices. Table 2-4 is a good example of environmental-related cost categories.

**Table 2-4: Environmental related cost categories**

<p><b>1. Materials Costs of Product Outputs</b></p> <p>Includes the <i>purchase costs</i> of natural resources such as water and other materials that are converted into products and packaging</p>
<p><b>2. Materials Costs of Non-Product Outputs</b></p> <p>Includes the <i>purchase (and sometimes processing) costs</i> of energy, water and other materials that become Non-Product Output (Waste and Emissions)</p>
<p><b>3. Waste and Emission Control Costs</b></p> <p>Includes costs for: <i>handling, treatment and disposal</i> of Waste and Emissions; <i>remediation and compensation</i> costs related to environmental damage; and any control-related <i>regulatory compliance</i> costs.</p>
<p><b>4. Prevention and Other Environmental Management Costs</b></p> <p>Includes the costs of <i>preventative environmental management activities</i> such as cleaner production projects. Also includes costs for <i>other environmental management activities</i> such as environmental planning and systems, environmental measurement, environmental communication and any other relevant activities.</p>
<p><b>5. Research and Development Costs</b></p>

Includes the costs for *Research and Development* projects related to environmental issues.

## **6. Less Tangible Costs**

Includes *both internal and external* costs related to less tangible issues. Examples include *liability, future regulations, productivity, company image, stakeholder relations and externalities*.

Source: Savage and Jasch (2005:38)

Monetary information collected can be used to assist in environmental performance leading to cost and savings in the organisation. Some stakeholders may prefer to see environmental performance indicators expressed in monetary rather than physical terms. Cost information and physical accounting data can be combined together to create environmental performance indicators known as eco-efficiency indicators. The concept of eco-efficiency links monetary and physical environmental management accounting for decisionmaking in a systematic manner (IFAC, 2005:38).

### **2.4.3 Distribution of costs by environmental domain**

After environmental costs are linked to their different categories, it can also be helpful to distribute environmental costs by their different environmental domains (Table 2-5). Environmental domain categories are not just useful for reporting purposes but also for internal management purposes. Environmental domain categories are used by many companies to benchmark environmental costs by domain on an annual basis amongst different departments (Savage *et al.*, 2005:53). It is important to note that the total environmental costs do not necessarily reflect the environmental performance of a company.

**Table 2-5: Environmental-related costs by environmental domain**

<b>ENVIRONMENTAL DOMAINS</b>									
<b>ENVIRONMENT-RELATED COST CATEGORIES</b>	<b>Air &amp; climate</b>	<b>Waste water</b>	<b>Waste</b>	<b>Soil, surface &amp; groundwater</b>	<b>Noise &amp; vibration</b>	<b>Biodiversity &amp; landscape</b>	<b>Radiation</b>	<b>Other</b>	<b>Total</b>
<b>1. MATERIAL COSTS OF PRODUCT OUTPUTS</b>									
- Raw and auxiliary materials									
- Packaging materials									
- Operating materials									
- Water									
<b>2. MATERIAL COSTS OF NON-PRODUCT OUTPUTS</b>									
- Raw and auxiliary materials									
- Packaging materials									
- Operating materials									
- Water									
- Energy									
- Processing costs									
<b>3. WASTE AND EMISSION CONTROL COSTS</b>									
- Equipment depreciation									
- Operating materials									
- Water and energy									
- Internal personnel									
- External services									
- Fees and taxes									
- Fines									
- Insurance									
- Remediation and compensation									
<b>4. PREVENTITIVE AND OTHER ENVIRONMENTAL MANAGEMENT COSTS</b>									
- Equipment depreciation									
- Operating materials, water, energy									
- Internal personnel									
- External services									
- Other									
<b>5. RESEARCH AND DEVELOPMENT COSTS</b>									
<b>6. LESS TANGIBLE COSTS</b>									

Source: Savage and Jasch (2005:55)

#### **2.4.4 Potential benefits of environmental management accounting**

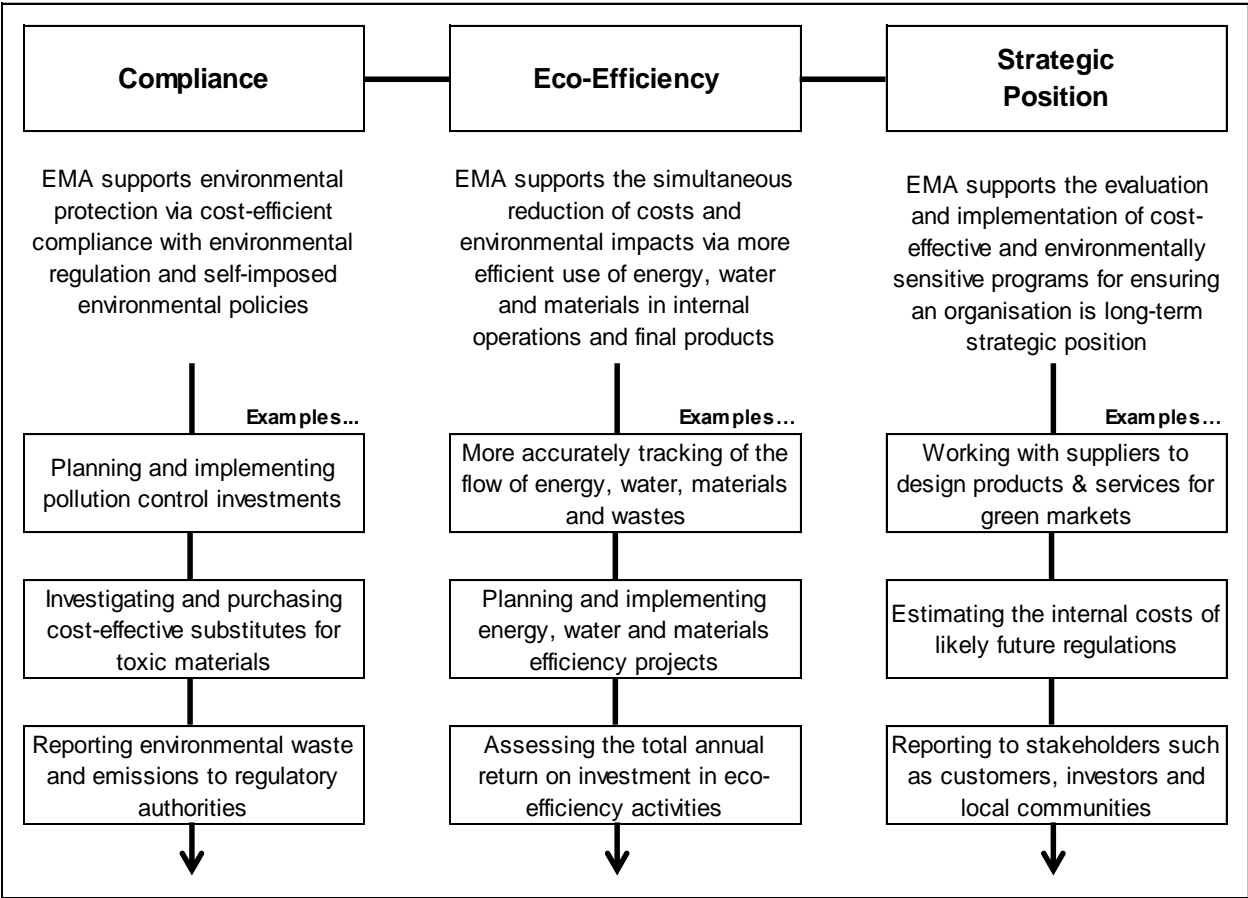
According to Burrit *et al.* (2013:164) there are many definitions of environmental management accounting in the literature and recent times have tended towards a consensus on what environmental management accounting entails. It is now readily

accepted that environmental management accounting seeks to bring together both financial and physical information regarding the environmental impacts and performances of an organisation.

Savage *et al.* (2005:23) indicate environmental management accounting is particularly valuable for internal management initiatives with a specific environmental focus, but this type of information is also increasingly being used for external reporting purposes. Hence, environmental management accounting is a broad set of principles and approaches that provides the data that is essential to the success of many other environmental management activities, and not just for internal decisionmaking purposes.

According to Table 2-6 the specific uses and benefits of environmental management accounting are numerous and can be organised into three categories, namely compliance, eco-efficiency and strategic positions.

**Table 2-6: Uses and benefits of environmental management accounting**



Source: German Environment Ministry (2003)

It should be noted that there is no strict dividing lines among the three categories because many initiatives and drives for continuous improvement can be inter-related to all three categories at once.

According to the United Nations for Sustainable Development (UNSD, 2001:9) environmental management accounting data can also be used for the following:

- Assessment of annual environmental cost/expenditure;
- Product pricing;
- Budgeting;
- Investment appraisal, calculating investment options;
- Calculating costs, savings and benefits of environmental projects;
- Design and implementation of environmental management systems;
- Environmental performance evaluation, indicators and benchmarking;
- Setting quantified performance targets;
- Cleaner production, pollution prevention, supply chain management and design for environmental projects;
- External disclosure of environmental expenditures, investments and liabilities;
- External environmental or sustainability reporting; and
- Other reporting of environmental data to statistical agencies and local authorities.

#### **2.4.5 Challenges of environmental management accounting**

Many limitations of conventional management accounting systems and practices can make it difficult to effectively collect and evaluate environmental-related data. These limitations can easily lead to inaccurate decisionmaking by management, based on missing, inaccurate and/or misinterpreted information (Ambe, 2007:6). As a result, these can have negative financial consequences on the company and environmental performance will reflect poorly.

Savage *et al.* (2005:26) have identified some specific environmental management accounting challenges that can be experienced in companies:

- Communication between accounting and other departments are often not well developed – very frequently accounting personnel are withholding accounting information that can be useful for environmental and technical personnel. Also, many of times the goals and perspectives of these two groups are totally different and their information systems do not even correlate, causing no consistency.
- Environmental-related cost information is often hidden in overhead accounts – there are several examples where potentially important environmental-related costs are being accidentally hidden in the accounting records. Managers who would benefit from this hidden data cannot find it easily. Allocating these hidden costs to overheads is most probably also not the solution as it can skew process and pricing costs.
- Materials use, flow and cost information often is not tracked adequately – although powerful ERP systems exist in companies, the available information is often still not sufficiently accurate or detailed for environmental, efficiency and other decision-making purposes.
- Many types of environmental-related cost information are not found in the accounting records – records typically do not contain much information on future environmental-related costs, even though they may be quite significant. Traditionally, accounting systems are looking towards the past. Less tangible environmental-related costs are also many times missing in the detail of these records, which can be both real and significant to a company's financial health.
- Investment decisions are often made on the basis of incomplete information – management decisions on investment projects, materials choices, product pricing and product mix suffer when comprehensive, consistent environmental-related information is not available in a timely fashion. Companies need to consider all potentially significant environmental-related costs that may influence the return on investment.

## 2.5 Chapter summary

In order to increase profitability and long-term sustainability, organisations need to take social and environmental factors into account when making decisions. Environmental management accounting focuses on material and energy flow information, environmental costs and other related cost and physical information, which are identified, collected, estimated, analysed and reported. These are tools and methods that will assist organisations to reduce expenses and improve their decisionmaking processes (Betianu & Briciu, 2010:13).

The chemical industry is very complex and the adoption of environmental management accounting will ensure the accurate determination of the production costs related to environmental issues. It will also help managers to properly identify and allocate environmental costs to preserve products that are actually profitable and acceptable to environmental requirements.

The literature review has shown that there are challenges in different industries with regard to applying the proper environmental management accounting principles. This normally causes incorrect decisionmaking by management which leads to negative financial consequences and the environmental performance will reflect poorly.

The literature chapter is followed by an empirical study. In the empirical study the research design and the development of the questionnaire is discussed. Data collected from the questionnaire is analysed statistically to evaluate the awareness of environmental management accounting in the South African chemical industry.

## CHAPTER 3

### EMPIRICAL STUDY

#### 3.1 Introduction

This chapter outlines the methodology and systems that was used to conduct the research study. Data gathered from the survey is analysed by means of statistical analysis and followed by a discussion of the results obtained. The information presented is from different respondents from different chemical organisations. The research study utilises collected data to evaluate the awareness of environmental management accounting in the South African chemical industry.

#### 3.2 Research methodology

This study used a survey questionnaire, compiled and distributed to selected participants. It is a modified questionnaire and adopted from Ambe, 2007, where the main objective was to show a South African perspective on the theory and practice of environmental management accounting.

A survey questionnaire was distributed to production personnel, environmental- and accounting practitioners in the chemical industry within selected organisations. Selected participants were targeted according to their roles, expertise and understanding of the chemical industry. Many of the chemical companies in the Sasolburg area were included in the sample. The questionnaires were completed manually and returned.

The questionnaire was designed to evaluate the awareness of environmental management accounting in the chemical industry by formulating questions on environment, accounting and chemical production related aspects. It is divided into five sections, namely organisational characteristics, environmental issues, compilation of sustainability reports, physical and monetary environmental information.

**Section 1** focused on the organisational characteristics of the chemical organisations that employed the participants. It includes the legal status (Public (Ltd), Private (Pty, Ltd), Joint Venture or Close Corporation) of the organisation, the geographical location, approximate annual turnover, number of employees and the different functions of the selected participants in the organisation. Although many companies in the Sasolburg

area were targeted, selections of geographical location of the organisations were included in the questionnaire, for example Gauteng, North West and others. The participants selected were according to expertise but the ultimate focus was on personnel working in the production, environmental and accounting environment.

**Section 2** relates to environmental practices occurring in the organisation. The main objective is to determine existence of environmental strategies and tools, drivers of organisations' environmental management system, priority of acceptance of the broad environmental issues and level of current and future importance of environmental issues faced by chemical organisations. Drivers for environmental management system include compliance with regulation, certification of international standard and corporate citizenship. Environmental strategies and tools assessed are environmental policy, environmental management system, environmental improvement plan, environmental goals and targets and ISO 14001 certification.

**Section 3** focuses on the compilation of sustainability reports used by organisations for annual reporting and informing investors of the care for the environment. The main objective is to assess the awareness of participants with regard to environmental information disclosed by the organisations in their annual reporting.

A Yes or No response was expected on the disclosure of environmental objectives, environmental impact and risk, quantitative non-financial information, financial information, key environmental performance indicators, negative aspects of environmental activities and incidents, fines or non-monetary sanctions for non-compliance. A 5-point Likert-type-scale, ranging from (1) to (5), where (1) is extremely low and (5) extremely high, is used to assess the level of disclosures on environmental expenditures (such as operating and capital expenditures).

A disclosure on operating environmental expenses are related to liquid effluent treatment, waste gas and air treatment, pollution prevention, and solid waste treatment. Capital environmental expenses are related to compliance to liquid effluent treatment, waste gas and air treatment, pollution prevention, solid waste treatment, research and development and equipment improvement.

**Section 4** addresses the physical information of environmental management accounting. A 5-point Likert-type-scale, ranging from (1) to (5), where (1) is extremely

low and (5) extremely high, is used. It is used to rate the level at which organisations generate and record physical environmental information with regard to raw and auxiliary materials, operating materials, water, energy, solid waste, hazardous waste, waste water and air emissions.

Raw and auxiliary material refers to input materials that become part of an organisation's final product or by-product. Operating materials are input materials purchased and used by the organisation, but which do not become part of any tangible product delivered to the customer. Water and energy means all water and energy used by an organisation from all sources. Solid waste is relatively non-hazardous waste in solid form whilst hazardous waste contains more hazardous waste materials. Waste water is basically streams whose primary component is water but which also contain contaminants of some kind. Air emissions are air streams that are contaminated with problematic levels of pollutants.

**Section 5** in the questionnaire design is about the monetary information of environmental management accounting. A 5-point Likert-type-scale, ranging from (1) to (5), where (1) is extremely low and (5) extremely high, is used to determine the level at which organisations generate and record monetary environmental information with regard to cost of product outputs, cost of non-product outputs, waste and emission control costs and prevention and other environmental management costs.

Parts of environmental practitioner's duties are to collect and record environmental information. They are also responsible for the implementation of the environmental management system of the organisation. Production personnel, responsible for running the operations, generate physical environmental information through chemical operation activities. Accountants record monetary environmental information and allocate a budget to ensure compliance to legislation on environmental issues in the chemical industry.

The number of questionnaires distributed to participants in the chemical industry were 150 and 77 were completed and returned. This results in a response rate of 51%.

### **3.3 Data analysis and discussion**

A quantitative research approach was followed to evaluate the data. The data that was collected was analysed through statistical and practical analysis methods by the

Statistical Consultation Services of North-West University. Additional analyses include the relationship between variables using correlations, t-tests, ANOVA, effect sizes, cross tabs and factor analysis.

These analytical methods were useful to investigate the validity of the questionnaire and to evaluate the awareness of environmental management accounting in the South African chemical industry. The questionnaires were specifically distributed amongst environmental, financial and production staff because of their interaction from different perspectives on environmental management accounting. The data collected from the questionnaire is reliable with Cronbach's Alpha values on questions ranging from 0.68 to a maximum of 0.90 (Annexure B).

### **3.4 Results**

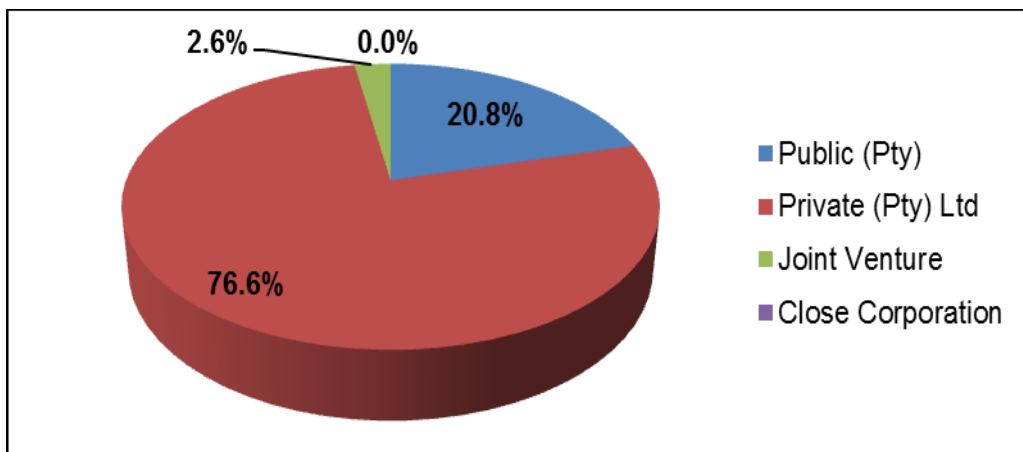
#### **3.4.1 Organisational characteristics**

This is section 1 of the questionnaire and consists of six different questions. The objective of section 1 is to understand the differences that might exist in organisations and their related perception and practices regarding environmental management accounting. Organisations in the chemical industry are different according to the type, size and operational practices. For the purpose of this study, organisational characteristics that are of interest in chemical organisations are the legal status, geographical location, approximate annual turnover, number of employees, type of chemical industry and functional responsibilities of the selected participants.

##### **Legal status of the organisation (section 1, question 1)**

The majority of the respondents in this study are from private (76.6%) organisations. Figure 3-1 indicates the percentage proportions of all participants. Only a small percentage of the participants are from a Joint Venture (2.6%) and none are from a Close Corporation. The study indicates that many of the chemical organisations in South Africa are owned by the Private sector (76.6%). Some participants are also from a Public listed organisation (20.8%).

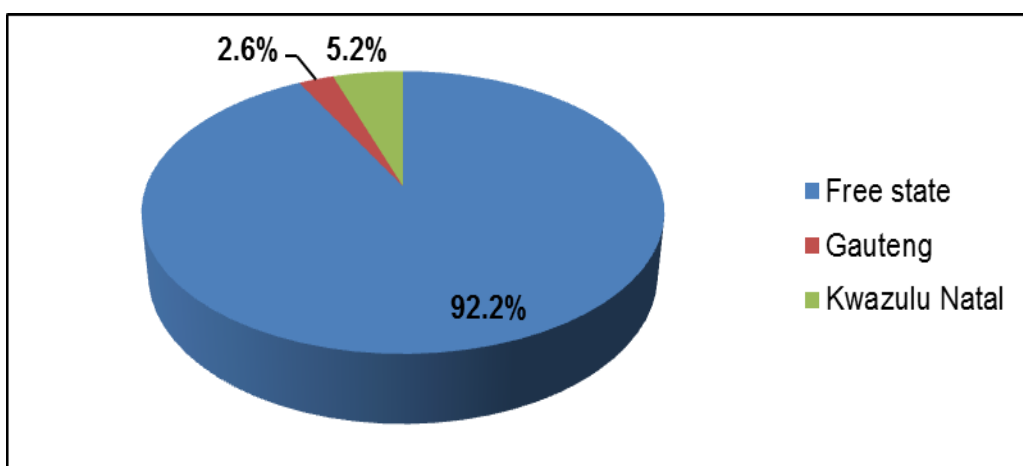
**Figure 3-1: The legal status of the organisations**



**Geographical location of the organisation (section 1, question 2)**

Many chemical organisations and subsidiaries of chemical organisations were established in the Sasolburg area during the early 1950's. This led to a highly concentrated area for chemical industries as a whole. The objective of this question was to include as many of these chemical organisations in this area but also to include chemical organisations from other provinces. Figure 3-2 indicates that the majority of respondents are from the Free State (92.2%) province and a small percentage of respondents are from chemical organisations in Gauteng (2.6%) and KwaZulu-Natal (5.2%).

**Figure 3-2: The geographical location of the chemical organisations**

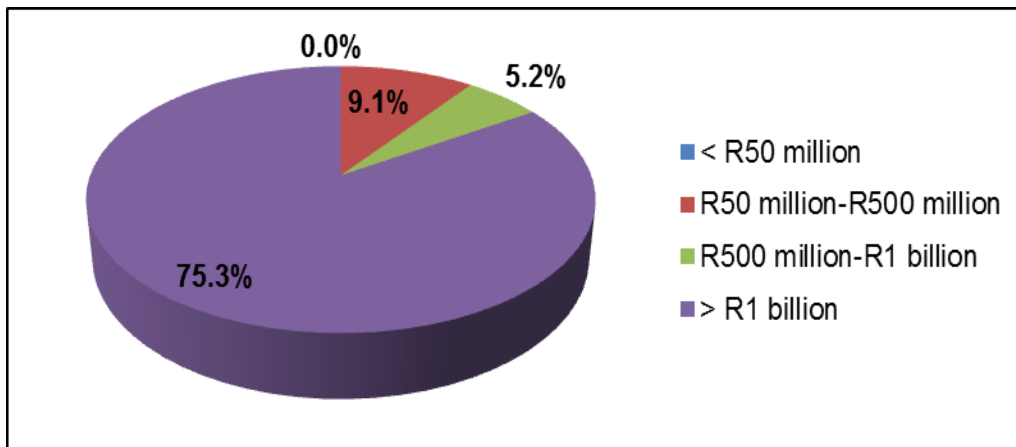


### Approximate annual turnover of the organisation (section 1, question 3)

The chemical industry contributes a significant portion to the GDP of South Africa. The profitability of the organisation may affect the practices of the company towards the environment. Shareholders are mostly concerned in maximising their returns on their investment and very often social responsibilities are neglected in this regard.

The approximate annual turnover of the majority of participants in this study are employed by organisations with a turnover of more than R1 billion (75.3%). Figure 3-3 indicates the proportional split in percentage between organisations with approximate annual turnovers of R50 – R500 million (9.1%), R500 million – R1 billion (5.2%) and more than a R1 billion (75.3%).

**Figure 3-3: Approximate annual turnover of the organisations**

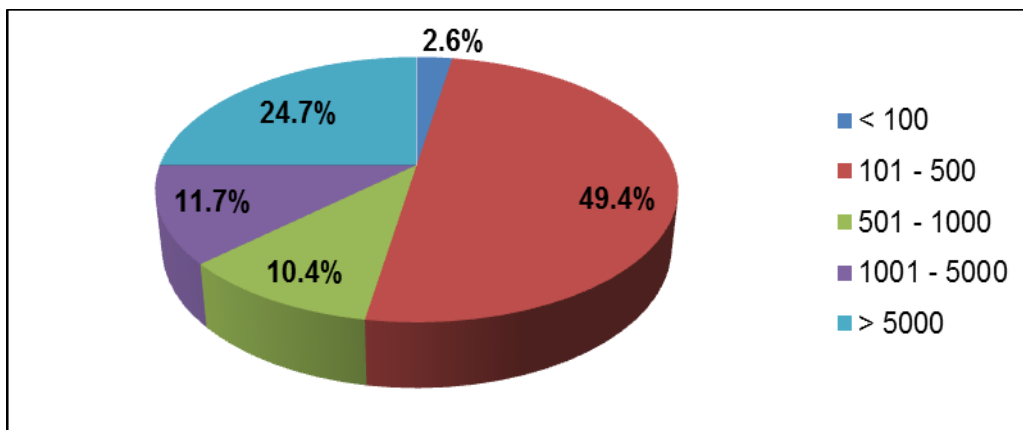


### Number of employees in the organisation (section 1, question 4)

The number of employees required in a chemical organisation is based on the process requirements but also on the number of activities required to run the process. Many organisations are constantly applying process automation principles and other means to optimise the number of employees to run a safe and productive organisation.

The study indicates that there is a spread of very small but also very large chemical organisations in South Africa. Figure 3-4 indicates the proportional percentages according to the responses and are as follows: smaller than 100 (2.6%), 101 – 500 (49.4%), 501 – 1000 (10.4%), 1001 – 5000 (11.7%) and greater than 5000 (24.7%).

**Figure 3-4: Number of employees in the organisations**



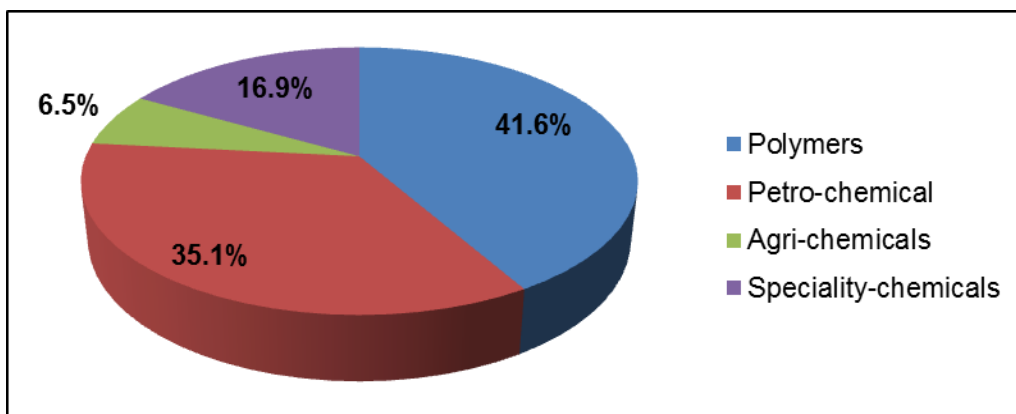
Almost half of the respondents (49.4%) are employed by medium size organisations (101 – 500). More people do not necessarily means more focus on environmental management accounting. Normally only a small number of employees on a certain level are involved in cost decision making. It all depends on the empowerment levels that are established in the organisation.

#### **Type of chemical industry (section 1, question 5)**

The chemical industry in South Africa is very differentiated and diverse. Chemical organisations produce either finished or intermediate products. Intermediate products are further processed at other chemical organisations into end products.

Figure 3-5 indicates that most respondents are from the polymers (41.6%) and petro-chemical (35.1%) industries. A small percentage of respondents in the agri- (6.5%) and speciality (16.9%) chemicals participated in the research study.

**Figure 3-5: The type of chemical industry to which respondents resides**



## Functional roles in organisations (section1, question 6)

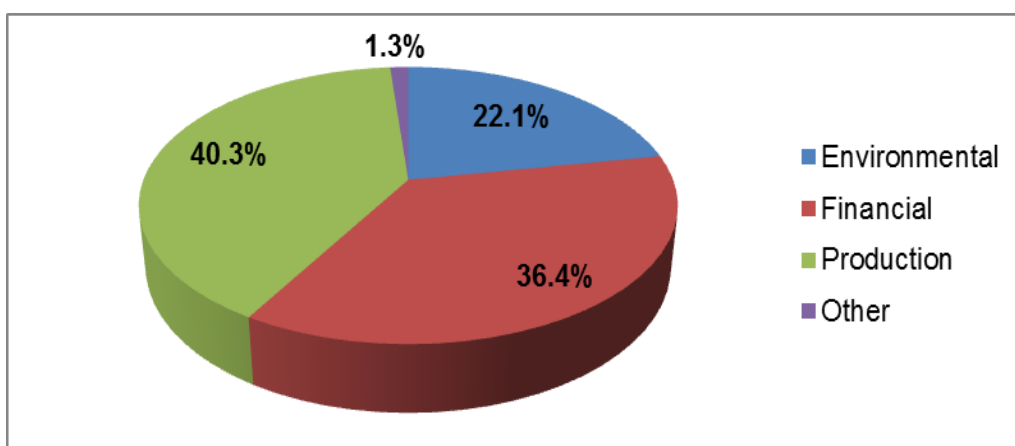
This study is focusing on a certain level of knowledge, skill and decisionmaking abilities. Environmental management is a known concept to environmental practitioners because they are the people that collect and record environmental related information to ensure compliance to the environmental management system.

Production supervision/support are managing and controlling the production unit. Environmental management is also a known concept to most of them because they are the people that ensure the production unit is efficiently being operated. Emissions and waste needs to be controlled and accounted for at various levels in the production process.

Financial practitioners might be the group to whom environmental management is the least known. Many chemical organisations apply conventional mechanisms to manage their finances and environmental management accounting might be an unfamiliar concept to many.

Figure 3-6 indicates a decent spread of different participants in different functions. The proportionate percentage split is environmental practitioners (22.1%), financial practitioners (36.4%) and production supervision (40.3%).

**Figure 3-6: Functional role of respondents in the organisations**



### **3.4.2 Environmental practices**

This is section two and consists of 4 questions with sub-questions.

The purpose of this section is to determine in various chemical organisations the level of existence of the following key environmental aspects: (1) environmental strategies and tools, (2) drivers of the environmental management system, (3) priority of environmental issues faced, (4) priority given to key themes of environmental information requirements and (5) current and future importance of environmental issues.

#### **Environmental strategies and tools (section 2, question 7.1 – 7.7)**

Part of an organisation's goal setting is to develop and establish strategies that provide guidance towards profitability and long-term sustainability. The same applies on the environmental front where compliance to regulation and legislation is of utmost importance. Most chemical organisations apply some sort of environmental management system and strategies and tools are required to ensure the drive for continuous improvement is established.

The purpose of the sub-questions is to evaluate the level of awareness of environmental strategies and tools in chemical organisations. The aspects that are focused on are: environmental policy, environmental management system, environmental goals and targets, environmental improvement plan, ISO 14001 certification and lastly for how many years have the organisation been ISO 14001 certified and who is typically their ISO 14001 accredited body.

Table 3-1 reflects the results of the respondents. Respondents had to choose a yes or no to indicate if their respective organisations do have these strategies and tools in place. These are the strategies and tools needed to ensure a proper environmental management system is established.

**Table 3-1: Environmental strategies and tools**

Environmental strategies and tools		Rating	Yes	No
7.1	Environmental policy	Frequency	77	0
		Percent	100	0
7.2	Environmental management system	Frequency	77	0
		Percent	100	0
7.3	Environmental goals and targets	Frequency	77	0
		Percent	100	0
7.4	Environmental improvement plan	Frequency	74	2
		Percent	96.1	2.6
7.5	ISO 14001 certification	Frequency	75	2
		Percent	97.4	2.6

All respondents (77) indicated that their organisation does have an environmental policy (100%), they do have environmental goals and targets (100%) in place and they do have an environmental management system (100%) in place. Some small percentage of respondents indicated that there are no environmental improvement plan (2.6%) at their organisation and that they are not ISO 14001 certified (2.6%).

### **Drivers for environmental management systems (section 2, question 8.1 – 8.3)**

All organisations in the chemical industry are being guided by South African legislation. The organisations that are certified according to international standards will have an environmental management system in place to ensure compliance. Communities and governing authorities expect chemical organisations to display adequate corporate citizenship in their daily business activities and practices.

For this study, the drivers identified for an organisations environmental management system is: (1) compliance with regulation, (2) certification to international standard and (3) corporate citizenship. A 5-point Likert-type-scale, ranging from 1 to 5, where (1) is extremely low and (5) is extremely high, was used to rate these different aspects. The purpose is to evaluate the awareness amongst responders regarding the level at which these environmental-related aspects serve as drivers for their organisation's environmental management system.

Table 3-2 reflect the 5-point Likert-type-scale scoring of all participants.

The respondents have rated compliance with regulation as the biggest driver for the organisation's environmental management system. More than half of the respondents (43) have rated it as extremely high (55.8%) with a mean of 4.5 and a standard deviation of 0.53. Certification to international standard is rated as second highest driver. Respondents (34) have rated it as extremely high (44.2%) with a mean of 4.3 and a standard deviation of 0.79. Respondents (21) have rated corporate citizenship as the third highest drive for their organisation's environmental management system. They have rated it extremely high (27.3%) with a mean of 4.1 and a standard deviation of 0.73.

**Table 3-2: The drivers for the organisation's environmental management system**

Drivers for your organisation's EMS		Rating	1	2	3	4	5	Mean	Std Dev
8.1	Compliance with regulation	Frequency	0	0	1	33	43	4.5	0.53
		Percent	0	0	1.3	42.9	55.8		
8.2	Certification to international standard	Frequency	0	3	6	31	34	4.3	0.79
		Percent	0	3.9	7.8	40.3	44.2		
8.3	Corporate citizenship	Frequency	0	1	15	38	21	4.1	0.73
		Percent	0	1.3	19.5	49.4	27.3		

### Priority of environmental issues (section 2, question 9.1 – 9.6)

In the chemical industry many organisations are faced with environmental issues. Some chemical plants are very old and managing of emissions and waste according to new legislation can be very challenging.

The broad environmental issues identified for this study are (1) legislation, (2) solid waste, (3) energy, (4) emissions, (5) water and (6) technology used.

Legislation in this regard is the challenge faced by organisations through compliance to international and national standards. Environmental issues with regard to solid waste refer to the management of waste; how to minimise and how to dispose waste in the correct manner. Recycling and re-use initiatives are high priority at many organisations. Global warming and carbon trading are key topics at almost all international

conferences. The drive is to save our planet for future generations, and organisations should investigate means on how to conserve energy.

Emissions (air and water) need to be accounted for. Measurements in most chemical organisations exist to optimise and reduce these emissions. Air pollution is a significant factor in any hydrocarbon facility and certain compliance regulation do exist already. Clean surface water is a scarce entity that needs preservation. Almost all chemical organisations where exothermic reactions are part of the process are dependent on water as a cooling medium. Efforts should exist to treat and re-use where possible. Older technologies find it very difficult to comply with latest legislative requirements. Investigations are needed to upscale or replace where possible.

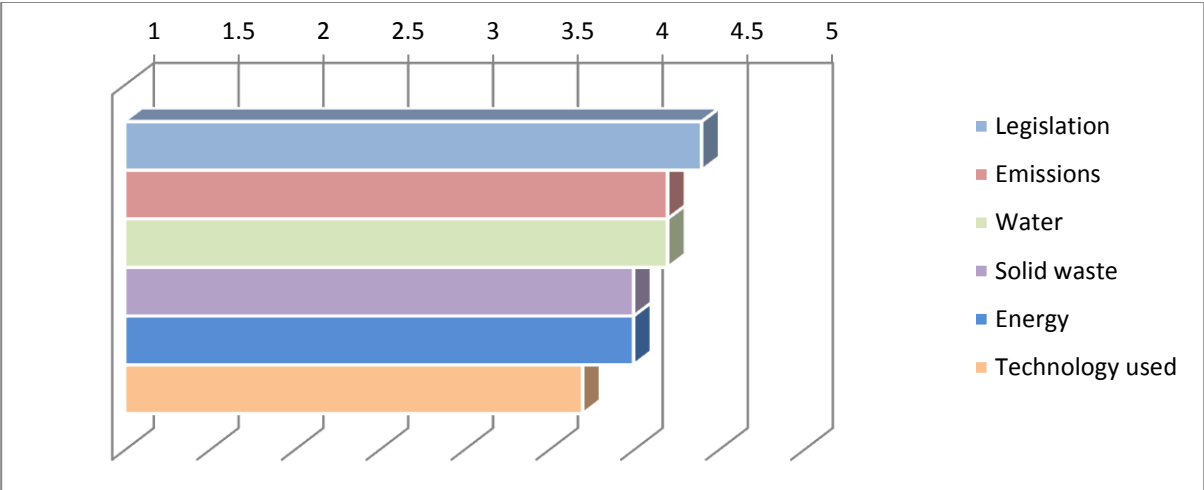
A 5-point Likert-type-scale was used to rate the priority of broad environmental issues faced by organisations. Table 3-3 show the results from all respondents.

**Table 3-3: The priority of broad environmental issues in their organisation**

Priority of broad environmental issues		Rating	1	2	3	4	5	Mean	Std Dev
9.1	Legislation	Frequency	1	1	5	30	40	4.4	0.78
		Percent	1.3	1.3	6.5	39.0	51.9		
9.2	Solid waste	Frequency	1	3	11	41	20	4.0	0.83
		Percent	1.3	3.9	14.3	53.2	26.0		
9.3	Energy	Frequency	0	1	19	34	22	4.0	0.77
		Percent	0	1.3	24.7	44.2	28.6		
9.4	Emissions	Frequency	0	2	14	30	31	4.2	0.82
		Percent	0	2.6	18.2	39.0	40.3		
9.5	Water	Frequency	0	0	10	41	26	4.2	0.66
		Percent	0	0	13.0	53.2	33.8		
9.6	Technology used	Frequency	0	2	31	25	16	3.7	0.83
		Percent	0	2.6	40.3	32.5	20.8		

Respondents have rated compliance with legislation as a priority higher than all the other issues. It has a mean of 4.4 and a standard deviation of 0.78. Technology used is rated as lowest priority of all broad environmental issues with a mean of 3.7 and a standard deviation of 0.83. Figure 3-7 indicates the ranking between these broad environmental issues based on mean values only.

**Figure 3-7: The different priority levels between broad environmental issues**



**Level of priority for environmental information requirements (section 2, question 10.1 – 10.7)**

Certain requirements exist for specific key themes of environmental management. The purpose of this question is to determine the level of priority for the following key themes: (1) carbon taxes, (2) energy issues, (3) employee health, (4) environmental liability, (5) reporting to an industry association, (6) emission from plants and (7) an improvement plan.

A 5-point Likert-type-scale was used to determine the level of priority. Table 3-4 show the results from all respondents.

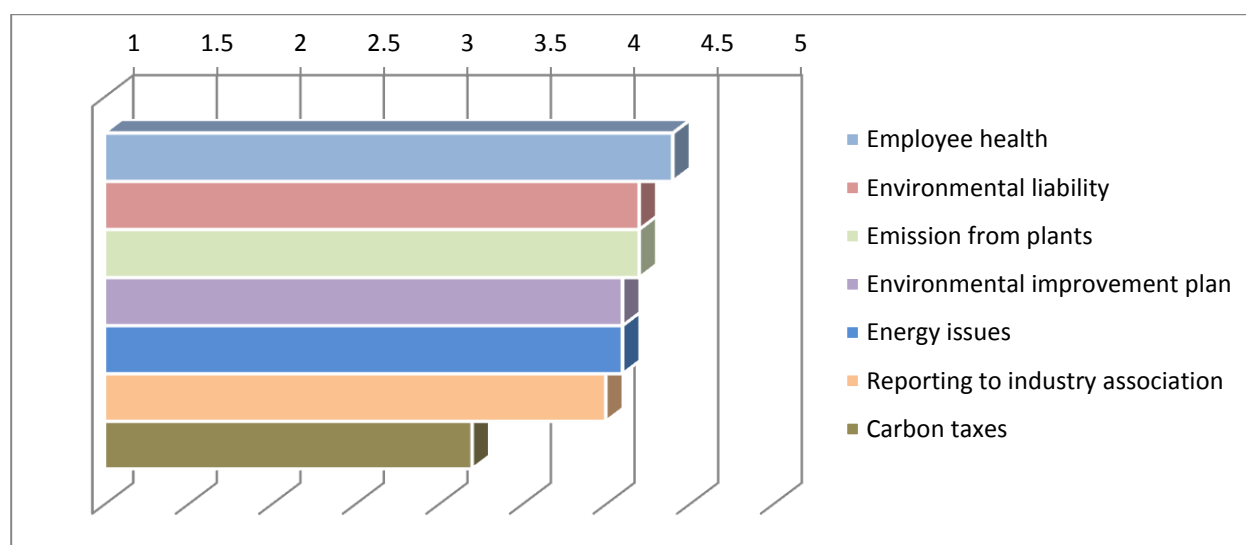
When the percentage for high and extremely high are added together the key theme that is highest on priority, is employee health (90.9%) with a mean of 4.4 and a standard deviation of 0.65. Second highest is environmental liability (87.0%) with a mean of 4.2 and a standard deviation of 0.67. In the third position as a priority is emission from plants (85.7%) with a mean of 4.2 and a standard deviation of 0.75. Environmental improvement plan (83.1%) which implies a focus for continuous improvement has a mean of 4.1 and a standard deviation of 0.69. The key theme that has the lowest priority is carbon taxes (32.5%) and a mean of 3.2 with a relative high standard deviation of 0.88.

**Table 3-4: The level of priority to key themes of environmental information requirements**

Level of priority to key themes		Rating	1	2	3	4	5	Mean	Std Dev
10.1	Carbon taxes	Frequency	2	13	37	20	5	3.2	0.88
		Percent	2.6	16.9	48.1	26.0	6.5		
10.2	Energy issues	Frequency	0	1	13	38	23	4.1	0.73
		Percent	0	1.3	16.9	49.4	29.9		
10.3	Employee health	Frequency	0	0	7	32	38	4.4	0.65
		Percent	0	0	9.1	41.6	49.4		
10.4	Environmental liability	Frequency	0	1	7	40	27	4.2	0.67
		Percent	0	1.3	9.1	51.9	35.1		
10.5	Reporting to industry association	Frequency	0	1	18	38	18	4.0	0.73
		Percent	0	1.3	23.4	49.4	23.4		
10.6	Emission from plants	Frequency	0	3	7	41	25	4.2	0.75
		Percent	0	3.9	9.1	53.2	32.5		
10.7	Environmental improvement plan	Frequency	0	2	8	45	19	4.1	0.69
		Percent	0	2.6	10.4	58.4	24.7		

Figure 3-8 indicates the ranking between these key themes environmental information requirements based on mean values only.

**Figure 3-8: The different priority levels given to key themes of environmental information requirements**



## Importance of current and future environmental issues (section 2, question 11.1 – 11.6)

Being sustainable in the long run chemical organisations should rate the current and future environmental issues to prepare for the unknown. Different chemical organisations view the current environmental issues differently. A contributing factor might be due to the type of process applied and the affect thereof on the environment itself.

The purpose of this question is to identify the level of importance on the following environmental issues: (1) waste water management, (2) protection of ground water, (3) surface water use and management thereof, (4) hazardous waste management, (5) non-hazardous waste management and (6) the protection of air quality. The rating of respondents will indicate the current and future importance of environmental issues and will assist to understand the preferences of collecting and recording of environmental information.

A 5-point Likert-type-scale was used to rate the level of importance to environmental issues faced by organisations. Table 3-5 show the results from all respondents.

**Table 3-5: The level of current and future importance to environmental issues**

Current and future importance of environmental issues		Rating	1	2	3	4	5	Mean	Std Dev
11.1	Waste water management	Frequency	0	1	5	45	24	4.2	0.63
		Percent	0	1.3	6.5	58.4	31.2		
11.2	Protection of ground water	Frequency	0	1	13	38	24	4.1	0.73
		Percent	0	1.3	16.9	49.4	31.2		
11.3	Surface water use and management thereof	Frequency	2	2	24	34	12	3.7	0.87
		Percent	2.6	2.6	31.2	44.2	15.6		
11.4	Hazardous waste management	Frequency	1	1	6	32	36	4.3	0.79
		Percent	1.3	1.3	7.9	42.1	47.4		
11.5	Non-hazardous waste management	Frequency	0	4	23	34	14	3.8	0.81
		Percent	0	5.2	29.9	44.2	18.2		
11.6	Protection of air quality	Frequency	0	3	10	34	30	4.2	0.81
		Percent	0	3.9	13.0	44.2	39.0		

When the percentages of high and extremely high are added together the current and future environmental issue with the highest importance is waste water management

(89.6%) with a mean of 4.2 and a standard deviation of 0.63. Hazardous waste (88.4%) is also identified as high importance with a mean of 4.3 and a standard deviation of 0.79. The least important environmental issues are surface water use and management thereof (59.8%) with a mean of 3.7 and standard deviation of 0.87, and non-hazardous waste management (62.4%) with a mean of 3.8 and standard deviations 0.81.

Spearman's Rank correlation coefficient which is used to identify and test the strength of a relationship between two sets of data, indicate a very positive relationship (0.757) between question 10 and question 11 (Annexure B).

A practical significance is seen between the different types of chemical industries when assessing the effect sizes. For question 9, 10 and 11 the petro-chemical industry has rated a higher effect size than the other two industries. The petro-chemical is applying a higher priority level on environmental issues and key themes of environmental information requirements. This industry is also rating the current and future importance of environmental issues higher than the polymer and speciality-chemicals industries.

**Table 3-6: The effect sizes of environmental practices between different chemical industries**

Environmental Practices		N	Mean	Std. Deviation	Effect Sizes	
					Polymers and:	Petro-chemical and:
Q9Factor	Polymers	32	3.91	0.39		
	Petro-chemical	27	4.49	0.51	1.15	
	Speciality	13	3.76	0.72	0.21	1.02
	Total	72	4.10	0.59		
Q10Factor	Polymers	32	3.83	0.46		
	Petro-chemical	27	4.31	0.46	1.04	
	Speciality	13	3.92	0.41	0.20	0.85
	Total	72	4.03	0.50		
Q11Factor	Polymers	32	3.88	0.46		
	Petro-chemical	27	4.35	0.46	1.00	
	Speciality	13	3.81	0.61	0.13	0.88
	Total	72	4.04	0.54		

### **3.4.3 Compilation of sustainability reports**

Sustainability reports are important for chemical organisations listed on the stock exchange. Environmental information is disclosed in their annual reports. This information does contribute towards the awareness of environmental management accounting in the chemical industry.

This entire part is related to section three, questions 12 to 14 in the questionnaire. The main purpose of this section is to evaluate the level of awareness amongst participants regarding the environmental information that is disclosed in their organisation's annual report.

A chemical organisation should be able to disclose information relating to: (1) environmental objectives, (2) environmental impact and risk, (3) negative aspects of its environmental activities, (4) initiatives to improve the environmental impact of their products, (5) environmental key performance indicators, (6) quantitative non-financial information, (7) financial environmental information and (8) any incidents, fines or non-monetary sanctions of non-compliance.

Financial environmental information disclosure includes operating and capital expenditures. Operational expenditures (OPEX) refers to running environmental costs related to liquid effluent treatment, waste gas and air treatment, pollution prevention and solid waste treatment. Capital expenditures (CAPEX) refers to environmental cost related to the improvement or upgrade of the liquid effluent treatment system, waste gas and air treatment system, pollution prevention program, solid waste treatment system, research and development and equipment.

#### **Environmental information disclosed by organisations in their annual reports (section 3, question 12.1 – 12.8)**

Chemical organisations that are listed on the JSE are required to set environmental objectives and report the status annually to their shareholders and the public. Other information, like environmental impact and risk, initiatives to improve environmental impacts, environmental key performance indicators, qualitative non-financial and financial information and actual incidents or fines should also be reported on.

The purpose of this question is to test the awareness amongst participants regarding their knowledge of what environmental information are disclosed annually in their organisations sustainability report. A simple yes or no was required on different aspects.

Table 3-7 shows that respondents (69) answered a yes (89.6%) to disclosing environmental objectives in their annual report. Also, respondents (70) answered a yes (90.9) to disclosing environmental key performance indicators in their annual report. All the other questions received a yes response of more than 70% except for financial environmental information (63.6%). 26 of the respondents indicated a no (33.8%) to financial environmental management not being disclosed.

**Table 3-7: Information annually disclosed in their sustainability report**

Environmental information disclosed		Rating	Yes	No
12.1	Environmental objectives	Frequency	69	6
		Percent	89.6	7.8
12.2	Environmental impact and risk	Frequency	61	13
		Percent	79.2	16.9
12.3	Negative aspects of its environmental activities	Frequency	54	19
		Percent	70.1	24.7
12.4	Initiatives to improve environmental impact	Frequency	62	13
		Percent	80.5	16.9
12.5	Environmental key performance indicators	Frequency	70	6
		Percent	90.9	7.8
12.6	Quantitative non-financial information	Frequency	58	17
		Percent	75.3	22.1
12.7	Financial environmental information	Frequency	49	26
		Percent	63.6	33.8
12.8	Incidents, fines or non-monetary sanctions	Frequency	61	14
		Percent	79.2	18.2

Table 3-8 shows the responses when different functional responsibilities are compared. Respondents from the environmental (52.9%) and production (54.8%) functions have responded lower than the financial (82.1%) function on financial environmental information. No other major difference are shown between the different functional roles and on average the yes response to the questions also indicate no big difference

between environmental practitioners (76.9), financial practitioners (81.3%) and production supervision/support (76.8%).

**Table 3-8: Functional responses on environmental information disclosures**

Environmental information disclosed		Rating	Environmental Practitioners	Financial Practitioners	Production Supervision
12.1	Environmental objectives	Percent	88.2	92.6	93.5
12.2	Environmental impact and risk	Percent	76.5	85.7	77.4
12.3	Negative aspects of its environmental activities	Percent	70.6	71.4	71.0
12.4	Initiatives to improve environmental impact	Percent	70.6	85.7	83.9
12.5	Environmental key performance indicators	Percent	94.1	96.4	87.1
12.6	Quantitative non-financial information	Percent	82.3	78.6	71.0
12.7	Financial environmental information	Percent	52.9	82.1	54.8
12.8	Incidents, fines or non-monetary sanctions	Percent	82.3	82.1	77.4
		Average	<b>76.9%</b>	<b>81.3%</b>	<b>76.8%</b>

**Disclosure of operating environmental expenditure (section 3, question 13.1 – 13.4)**

Operational expenditure for any organisation is the ongoing cost for running the business. This is the money the business spend in order to turn inventory into throughput. All environmental costs associated are classified as operating environmental expenditure.

The purpose of this question is to determine the level of awareness of participants if their respective organisations do disclose operating environmental expenses on specific issues.

Table 3-9 reflect the 5-point Likert-type-scale scoring of all participants.

Respondents of high and extremely high have rated the issues as follows: liquid effluent treatment at 58.5% with a mean of 3.6 and standard deviation of 0.86, waste gas and air treatment as 57.2% with a mean of 3.6 and standard deviation of 0.91, pollution

prevention at 62.4% with a mean of 3.7 and standard deviation of 0.86, solid waste treatment as 63.7% with a mean of 3.8 and standard deviation of 0.81. A small percentage (< 6%) of participants did not rate some of the sub-questions which might indicate that they are not familiar with the concept of operating environmental expenditure or with the issues underlined.

**Table 3-9: The level of operating environmental expenditure disclosure**

Disclosure of operating expenditure		Rating	1	2	3	4	5	Mean	Std Dev
13.1	Liquid effluent treatment	Frequency	1	6	21	36	9	3.6	0.86
		Percent	1.3	7.8	27.3	46.8	11.7		
13.2	Waste gas and air treatment	Frequency	0	11	17	34	10	3.6	0.91
		Percent	0	14.3	22.1	44.2	13.0		
13.3	Pollution prevention	Frequency	0	9	18	38	10	3.7	0.86
		Percent	0	11.7	23.4	49.4	13.0		
13.4	Solid waste treatment	Frequency	0	5	19	37	12	3.8	0.81
		Percent	0	6.5	24.7	48.1	15.6		

### **Disclosure of capital environmental expenditure (section 3, questions 14.1 – 14.6)**

Capital expenditure is used by an organisation to acquire, or upgrade physical assets. In more simple terms it can be explained as money used to improve an existing piece of equipment. Environmental costs associated with an upgrade or improvement will be disclosed as capital environmental expenditure.

The purpose of this question is to determine the level of awareness of participants if their respective organisations do disclose capital environmental expenses on specific issues.

Table 3-10 reflect the 5-point Likert-like scoring of all participants.

Respondents of high and extremely high have rated the issues as follows: liquid effluent treatment at 48.1% with a mean of 3.5 and standard deviation of 0.75, waste gas and air treatment as 55.9% with a mean of 3.5 and standard deviation of 0.78, pollution prevention at 58.5% with a mean of 3.6 and standard deviation of 0.76, solid waste treatment as 58.4% with a mean of 3.6 and standard deviation of 0.73, research and development as 57.2% with a mean of 3.7 and standard deviation of 0.85, equipment

improvement as 63.6 with a mean of 3.7 and standard deviation of 0.72. Again, a small percentage (< 6%) of participants did not rate some of the sub-questions which might indicate that they are not familiar with the concept of capital environmental expenditure or with the issues underlined.

**Table 3-10: The level of capital environmental expenditure disclosure**

Disclosure of capital expenditure		Rating	1	2	3	4	5	Mean	Std Dev
14.1	Liquid effluent treatment	Frequency	1	5	30	34	3	3.5	0.75
		Percent	1.3	6.5	39.0	44.2	3.9		
14.2	Waste gas and air treatment	Frequency	0	8	23	38	5	3.5	0.78
		Percent	0	10.4	29.9	49.4	6.5		
14.3	Pollution prevention	Frequency	0	5	27	37	8	3.6	0.76
		Percent	0	6.5	35.1	48.1	10.4		
14.4	Solid waste treatment	Frequency	1	2	25	39	6	3.6	0.73
		Percent	1.3	2.6	32.5	50.6	7.8		
14.5	Research and development	Frequency	0	5	25	30	14	3.7	0.85
		Percent	0	6.5	32.5	39	18.2		
14.6	Equipment improvement	Frequency	0	3	22	40	9	3.7	0.72
		Percent	0	3.9	28.6	51.9	11.7		

Table 3-11 indicate the effect sizes between the different functional respondents based on the disclosure of environmental expenditure.

Environmental practitioners and production supervision/support has rated disclosure of operational and capital environmental expenditures lower as financial practitioners. There is almost no significant difference (0.04) between environmental practitioners and production supervision/support in the level of operating expenses disclosure.

**Table 3-11: Effect sizes between different functions on the disclosure of environmental expenditure**

Disclosure of operating and capital expenditure		N	Mean	Std. Deviation	Effect Sizes	
					Environmental and:	Financial and:
Q13Factor	Environmental	17	3.57	0.65		
	Financial	28	3.81	0.75	0.32	
	Production	31	3.60	0.75	0.04	0.28
	Total	76	3.67	0.73		
Q14Factor	Environmental	17	3.51	0.48		
	Financial	28	3.71	0.67	0.30	
	Production	31	3.63	0.58	0.21	0.12
	Total	76	3.64	0.59		

#### 3.4.4 Physical environmental management accounting

This entire part is related to section 4, question 15. The main objective of this section is to evaluate the respondent's awareness regarding the level at which their respective organisations generate and record physical environmental information.

The physical information of environmental management accounting refers to information such as raw and auxiliary materials, operating materials, water, energy, solid waste, hazardous waste, waste water and air emissions that will be generated and reported on.

Raw and auxiliary materials are input materials that become part of an organisation's final product or by-product. Operating materials are input materials that are purchased and used by the organisation, but which do not become part of any tangible product delivered to the customer. Water and energy is basically all water and energy used by the organisation. Solid waste is relatively non-hazardous waste in solid form, such as waste paper, plastic containers, food waste and non-hazardous solid scrap products. Hazardous waste is hazardous materials present in solid, liquid and mixed form. Waste water is streams whose primary component is water, but which also contains contaminants of some kind. Air emissions are air streams that are contaminated with problematic levels of pollutants.

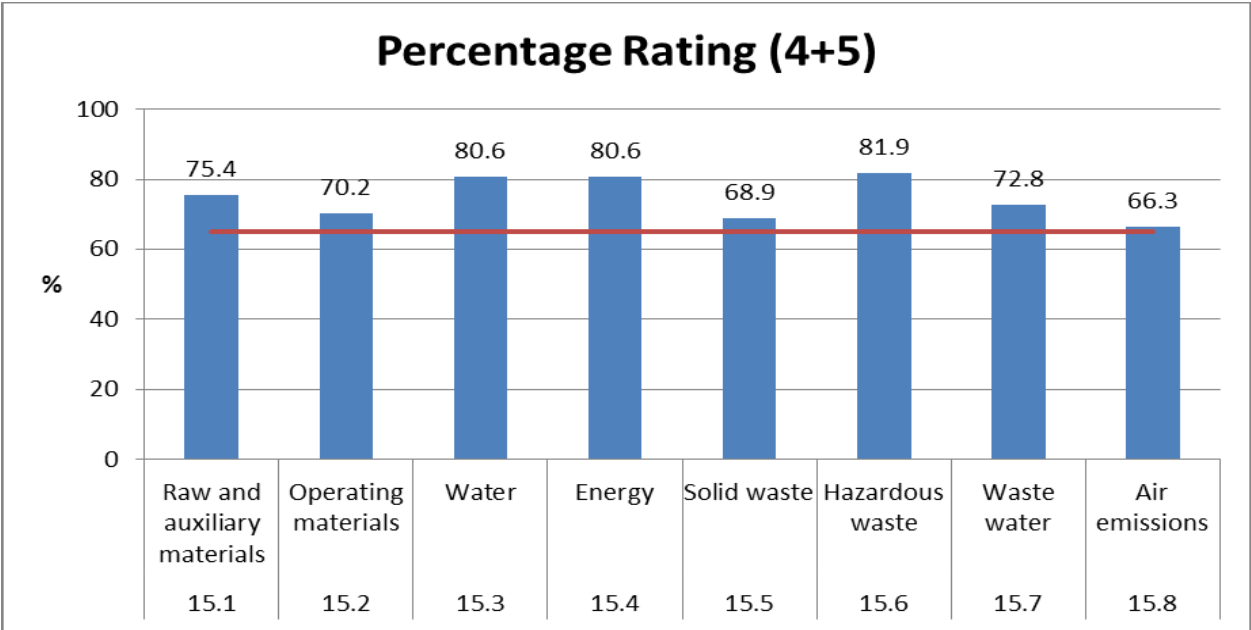
**Table 3-12: The awareness regarding physical environmental information**

Physical environmental information of EMA		Rating	1	2	3	4	5	Mean	Std Dev
15.1	Raw and auxiliary materials	Frequency	0	2	17	36	22	4.0	0.79
		Percent	0	2.6	22.1	46.8	28.6		
15.2	Operating materials	Frequency	0	4	19	31	23	3.9	0.87
		Percent	0	5.2	24.7	40.3	29.9		
15.3	Water	Frequency	0	2	13	37	25	4.1	0.77
		Percent	0	2.6	16.9	48.1	32.5		
15.4	Energy	Frequency	0	0	14	36	26	4.2	0.71
		Percent	0	0	18.2	46.8	33.8		
15.5	Solid waste	Frequency	1	1	21	32	21	3.9	0.85
		Percent	1.3	1.3	27.3	41.6	27.3		
15.6	Hazardous waste	Frequency	0	1	13	32	31	4.2	0.77
		Percent	0	1.3	16.6	41.6	40.3		
15.7	Waste water	Frequency	0	3	16	32	24	4.0	0.84
		Percent	0	3.9	20.8	41.6	31.2		
15.8	Air emissions	Frequency	0	5	20	35	16	3.8	0.84
		Percent	0	6.5	26.0	45.5	20.8		

Table 3-12 reflect the 5-point Likert-type-scale scoring of all participants. According to the responses hazardous waste (mean of 4.2 and standard deviation of 0.77) and energy used (mean of 4.2 and standard deviation of 0.71) are indicated as the more likely elements to be generated and recorded as part of physical environmental information.

According to Figure 3-9 when responses of high and extremely high are added together, the result for all identified elements is greater than 65%. Respondents (63) rated hazardous waste (81.9%) as highest to be generated and recorded as part of physical environmental information. Respondents (51) rated air emissions (66.3%) the least likely element to be generated and recorded as part of physical environmental information.

**Figure 3-9: Combined rating of high and extremely high on physical EMA**



**3.4.5 Monetary environmental management accounting**

This entire part is related to section 5, question 16. The main objective of this section is to evaluate the respondents awareness regarding the level at which their respective organisations generate and record monetary environmental information.

The monetary information of environmental management accounting refers to information such as cost of product outputs, cost of non-product outputs, waste and emission control costs and prevention costs that will be generated and reported on.

Cost of product outputs are typically the purchasing of natural resources, such as energy, water and other materials that are converted into products, by-products and packaging. Cost of non-product outputs are the purchasing of energy, water and other materials that become non-product output. Waste and emission control costs are the costs associated with the handling, treatment and disposal of waste and emissions. Prevention costs are the cost associated with the activities that would stop environmental damages.

Table 3-13 reflect the 5-point Likert-type-scale scoring of all participants. According to the responses cost of product outputs (mean of 4.2 and standard deviation of 0.71) is

indicated as the more likely element to be generated and recorded as part of monetary environmental information.

**Table 3-13: The level of awareness regarding monetary environmental information**

Monetary environmental information of EMA		Rating	1	2	3	4	5	Mean	Std Dev
16.1	Cost of product outputs	Frequency	0	1	11	40	25	4.2	0.71
		Percent	0	1.3	14.3	51.9	32.5		
16.2	Cost of non-product outputs	Frequency	0	2	11	38	24	4.1	0.75
		Percent	0	2.6	14.3	49.4	31.2		
16.3	Waste and emission control cost	Frequency	0	3	14	41	18	4.0	0.77
		Percent	0	3.9	18.2	53.2	23.4		
16.4	Prevention and other environmental mgmt. cost	Frequency	0	5	24	34	13	3.7	0.83
		Percent	0	6.5	31.2	44.2	16.9		

According to Figure 3-10 when responses of high and extremely high are added together, the result for all identified elements is greater than 60%. Respondents (65) rated cost of product outputs (84.4%) and as the more likely element to be generated and recorded as part of monetary environmental information. Respondents (51) rated prevention and other environmental management cost (61.1%) as the least likely element to be generated and recorded as part of monetary environmental information.

**Figure 3-10: Combined rating of high and extremely high on monetary EMA**

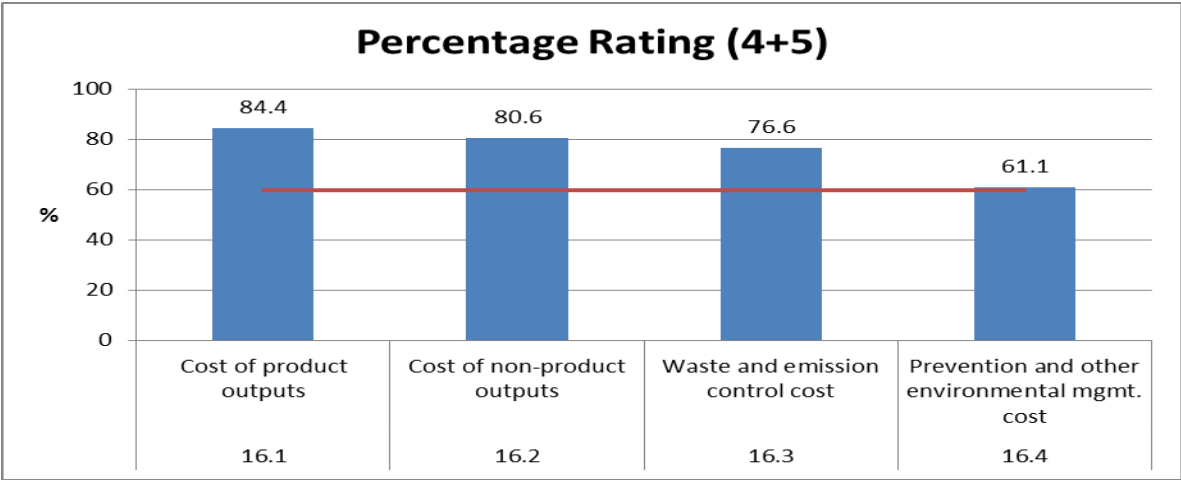


Table 3-14 indicate the effect sizes between the different functional respondents based on the generation and recording of physical and monetary environmental information.

**Table 3-14: Effect sizes between different functions on physical and monetary environmental information**

Generate and record physical and monetary environmental information		N	Mean	Std. Deviation	Effect Sizes	
					Environmental and:	Financial and:
Q15Factor	Environmental	17	4.01	0.64		
	Financial	28	4.05	0.64	0.05	
	Production	31	3.99	0.63	0.04	0.09
	Total	76	4.02	0.63		
Q16Factor	Environmental	17	3.81	0.65		
	Financial	28	4.05	0.70	0.35	
	Production	31	4.01	0.52	0.30	0.06
	Total	76	3.98	0.62		

Environmental practitioners and production supervision/support has rated the generation and recording of physical and monetary environmental information slightly lower as financial practitioners. There is almost no significant difference between them on the generation and recording of physical environmental information. However, on the generation and recording of monetary environmental information there is a small difference between environmental and the other two functional groups.

## CHAPTER 4

### CONCLUSIONS AND RECCOMENDATIONS

#### 4.1 Introduction

This chapter provide conclusions and recommendations on the research study. Conclusions on all sections are presented based on the outcome of the empirical study. The purpose of this chapter is to conclude on the primary objective that was established at the beginning of the study. A recommendation is also presented on the importance of environmental management accounting in the South African chemical industry and the level of awareness of EMA that is required in this sector.

Significant insight was gathered on what the term sustainability actual is and how important a proper environmental management system can add value by improving process efficiency, reduce waste generation, satisfy stakeholder needs and safeguard compliance to legislation.

EMA is still regarded as an unknown concept to many but the definition per se and the principles of EMA are practiced by many organisations in the chemical industry. The empirical study has shown that the majority of respondents are aware of environmental issues and that key environmental themes are important to their organisation. Environmental practices are being applied and organisations are aware of the necessity to comply with legislation. By applying the ISO 14001 principles environmental-related information is generated and reported to drive the need for continuous improvement.

Environmental information gathered is disclosed in the integrated and/or sustainability report. The primary objective is to enhance investor confidence and to satisfy stakeholder needs that the required urgency is being applied to conform to all environmental-related aspects. Operating and capital environmental expenses are being measured and this information is also being disclosed for certain elements. The awareness of physical and monetary environmental management accounting principles has been tested and there seems to be a small difference between the various functions that participated in the study. The general response is above the moderate level and a small percentage of respondents were not familiar with the concepts or not sure how these concepts are being applied in their respective organisations.

## **4.2 Conclusion**

### **4.2.1 Organisational characteristics**

Most of the chemical organisations that participated in this research are privately owned. The majority of the respondents are from the Free State and a small percentage from Gauteng and KwaZulu-Natal participated. Most of the organisations that participated have an approximate annual turnover exceeding R1 billion. This indicates that respondents from very large corporations participated in the study. It also confirms the fact that the chemical industry does contribute a large portion (R421 million in 2013) to the annual GDP of South Africa (Stats SA, 2014).

The chemical industry does employ a large number of people and according to the study the majority of organisations do employ between 101 and 500 people. These are also very large chemical organisations that participated with employee levels of more than 5000 people.

The chemical industry has many types of sectors and the two biggest contributors to this study were the polymer and petro-chemical industries. An even spread of different functional roles participated in the study with production supervision/support being the majority compared to the other two functions.

Privately owned organisations disclose more or less the same level of financial information than public owned organisations. Public owned organisations do have a higher level of awareness regarding the drivers for their environmental management system. They also indicated a higher level of priority for the broad environmental issues that are faced by their respective organisations.

### **4.2.2 Environmental practices**

The level of awareness regarding environmental practices amongst all participants was very high and the responses indicated that every respondent are aware of the existence of key environmental aspects.

All of the respondents indicated that their respective organisations do have the necessary environmental strategies and tools in place. All organisations do have an environmental policy, have established an environmental management system and do

have environmental goals and targets in place. It seems that all chemical organisations do have a very good environmental strategic intend.

Only a few respondents indicated that their organisations do not have an environmental improvement plan and that their organisation is not ISO 14001 certified.

Many of the chemical organisations are ISO 14001 certified for more than five years. This indicates that environmental practises are not a new phenomenon and organisations have established systems in place. Some of the organisations use international auditing bodies but some are using local certified institutions. This might be due to the fact that some of the organisations have a global footprint and certification requirements are standardised across businesses in the same organisation. Very interestingly is that none of the organisations utilises the South African Bureau of Standards (SABS) as a certifying body although many of the SABS standards are applied.

Respondents have rated compliance with regulation as the biggest driver for the organisation's environmental management system. It confirms that regulations and legislation are playing a vital role and there is a definite seriousness in driving the organisation's environmental management system. This is a pro-active approach that assists in reducing the risk and impact of environmental non-compliances. It improves also the health and safety practises for all employees in the organisation.

Respondents have indicated that legislation as a broad environmental issue faced by their organisation is rated as a high priority together with emission compliance and water management. The technology used is rated as lowest priority of all broad environmental issues. This indicates that most organisations do not have concerns that technology used poses an environmental risk.

With regards to the level of priority on key environmental themes, employee health is rated as highest priority and environmental liability and emissions from plants as second highest. The priority on carbon taxes are rated much lower than the other key themes. This is an indication that the well-being of employees is first priority to organisations. This is a very good signal, which implies that organisations do care about their people. However, the priority rating of carbon taxes is of a concern. Although carbon taxes are in its early stages of being applied as legislative requirement, the publication of Minimum Emission Standards (MES) in March 2010, promulgated in terms of section

21(3)(a) of the National Environmental Management: Air Quality Act (No.39 of 2004), have placed organisations under pressure to act. MES must be accomplished by 1 April 2015 for existing plants. Many organisations are already measuring and applying a carbon emission disclosure report. However, despite these actions it remains a concern that organisations are not applying enough effort to reduce carbon emissions.

Waste water management, hazardous waste management and protection of air quality are seen as environmental issues that have high levels of current and future importance to organisations. It confirms that organisations are aware of critical environmental issues and have a drive to protect their immediate environment and satisfy stakeholder needs. The fact that it is rated as high importance is very good, but the essence lies within execution of improvement plans to address and improve the management and impact thereof.

There is a high level of positive relationship between the level of priority of environmental information and the current and future importance of environmental issues as illustrated in annexure B. This means that as organisations increase their priority on key themes of environmental information requirements there will be a high probability that the level of importance on certain environmental issues will also increase.

The petro-chemical industry is applying a higher level of priority on environmental practices as their fellow industries (Table 3-6). This is a very large and very profitable industry in South Africa. According to the annual sustainability reports of this specific industry, structured processes are followed to identify environmental-related issues. Internal risk assessments identify these issues whereby capital investments are applied to improve the environmental risk and impact.

#### **4.2.3 Compilation of sustainability reports**

This part of the study observed the awareness of respondents with regards to the type and level of information that an organisation discloses in its annual sustainability report.

The first part focused on the type of information that is typically included in the annual sustainability report. The majority of respondents indicated that their organisations do disclose many items but a large number indicated that there are items that are not disclosed. Respondents from the environmental and production functions responded

lower than those of the financial function. This implies that the environmental and production functions are not fully aware of what items get disclosed on the sustainability report.

A lower rating is observed in the levels of disclosure on operating and capital expenditures. It shows that respondents are not fully aware (mean of 3.5 to 3.8) of environmental expenses being disclosed. Solid waste treatment and pollution prevention is seen as the highest issues being disclosed.

Environmental practitioners and production supervision/support has rate disclosure of operating and capital environmental expenditures lower as financial practitioners. There is almost no significant difference between environmental practitioners and production supervision/support on the level of operating expenses disclosure. The challenge would be to establish proper communication channels to ensure that all functions have the same level of environmental information that will inevitably improve integration between the different functions but also improve the level of decisionmaking in the organisation.

#### **4.2.4 Physical environmental management accounting**

In order to assess the costs correctly in the organisation, it is essential that physical data on material that is used in the process are collected. Chemical organisations continue to generate and record physical environmental information during the conversion process. Material inputs, product and non-product outputs are measured on a continuous basis to ensure the operations are effectively being operated. Involvement of production staff and environmental practitioners are very critical to assess and evaluate physical information related to environmental management accounting.

No significant difference exists between environmental practitioners, financial practitioners and production supervision/support with regards to the levels at which chemical organisations generate and record physical environmental information. Respondents rated hazardous waste, energy and water as the topics that are very high on the generation and recording of information. Air emissions are rated as the lowest. It implies that control measures are in place and environmental performances are managed. This will ultimately lead to improved efficiencies.

The general rating on average for the generation and recording of physical environmental information is high. It can be concluded that the level of awareness

amongst respondents in the chemical industry for the disclosure of physical information is very good.

#### **4.2.5 Monetary environmental management accounting**

Monetary environmental management accounting focusses on the financial impact of environmental performance. It includes costs such as cost of product and non-product outputs, waste and emissions control costs and prevention costs. If this principal is applied correctly this will lead to cost savings in the organisation.

Cost of product outputs was rated as the highest compared to the other monetary environmental information. Prevention and other environmental costs have been rated lowest, whilst cost of non-product output and waste and emission cost control was rated moderately.

Financial practitioners and production supervision/support have rated the generation and recording of monetary environmental information slightly higher as environmental practitioners. There is almost no significant difference between them on the level of generating and recording of monetary environmental information. Environmental practitioners have rated this question lower and the reason might be due to the level of exposure and knowledge regarding this topic. This topic is more associated with the financial function confirming the theoretical statement that financial practitioners often do not interact with other functions. It seems that there is definitely some interaction in the chemical industry between the financial and production functions.

#### **4.3 Recommendations**

Very good levels of understanding and awareness of certain environmental management accounting aspects do exist in the South African chemical industry.

The awareness regarding strategies and tools are very good and most organisations drive their respective environmental management systems to ensure compliance with regulation. South African chemical organisations are thoughtful about continuous environmental improvement by applying these tools and strategies.

The levels of priority regarding certain environmental issues and key themes are high but might change as legislation and regulation changes. Considering the fact that only

respondents from the chemical industry participated it is comforting to see that the environmental issue that is rated as highest importance is hazardous waste management. They are aware of the environmental risks associated with their type of industry and cannot be blamed for oversight.

Public companies are not regulated to report on all environmental-related information in their integrated and/or sustainability report. This might be the reason for a weaker response on the type of information that gets disclosed annually. The awareness of disclosure of specifically operational and capital expenses are also lower (based on mean) than all other questions. It is recommended that public owned chemical organisations do disclose all environmental-related information to a specific association. This will create transparency in the industry but will also create a standardised mechanism for reporting purposes. The mechanism can depict the type and data that is needed to ensure sustainable development and growth.

There is a high level of understanding and awareness regarding physical and monetary environmental management accounting. This information is used by chemical organisations to assess opportunities for economic and environmental improvement. There seems to be a small difference in the awareness between different functions and it is recommended that environmental practitioners get the same exposure in specifically the generation and recording of monetary environmental management accounting. This will cause improved levels of environmental cost awareness amongst this function which will stimulate new opportunities to improve the environmental performance of the organisation.

Environmental management accounting attempt to integrate best managerial accounting principles with best environmental thinking and practice. It will lead to synergism that will benefit the entire organisation. Therefore, it would be recommended that environmental costs be defined to avoid misunderstanding and incorrect reporting. Systems should be integrated, easy accessible and display real-time information to everyone in the organisation that needs to make informative decisions. Once you have created this platform the level of information generation, reporting and decisionmaking will improve significantly.

Chemical organisations in South Africa need to understand the environmental impact of their business and needs to portray responsibility and accountability in this regard. Environmental management remains a challenge and should be entrenched in the core of the organisation. Organisations should develop and empower employees in order to create a high-performing and values-driven workforce.

Ultimately, chemical organisations in South Africa should strive to institutionalise a triple bottom line responsibility that will inevitably support sustainable development.

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## Annexures

### Annexure A: Survey questionnaire

#### QUESTIONNAIRE:

#### **EVALUATING THE AWARENESS OF ENVIRONMENTAL MANAGEMENT ACCOUNTING IN THE SOUTH AFRICAN CHEMICAL INDUSTRY**

The objective and purpose of this research study is to evaluate the awareness of Environmental Management Accounting in the chemical industry.

This questionnaire is divided into the following sections:

*Section 1: Organisational characteristics*

*Section 2: Environmental practises*

*Section 3: Compilation of sustainability reports*

*Section 4: Physical environmental management accounting*

*Section 5: Monetary environmental management accounting*

The study is interested in the practice of Environmental Management Accounting at your organisation and not your personal opinion. Please read each question carefully and answer it to the best of your ability.

There are no correct or incorrect answers. It is mainly based on your understanding of Environmental Management Accounting in the chemical industry.

The majority of the questions in the survey are close-ended, requiring you to mark (with an "X") the option that best describes the situation at your organisation. The open-ended questions in the survey should be answered based on your knowledge of the specific topic.

It will take you approximately 20 minutes to complete the questionnaire.

## SECTION 1: ORGANISATIONAL CHARACTERISTICS

1. Indicate the legal status of your organisation:

Public (Ltd)	Private (Pty Ltd)	Joint Venture	Close Corporation
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2. Indicate the geographical location of your organisation:

Free state	Gauteng	North-West	Other (indicate) _____
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3. Indicate the approximate annual turnover of your organisation:

< R50 million	R50 million – R500 million	R500 million – R1 billion	> R1 billion
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4. Indicate the number of employees in your organisation:

< 100	101 – 500	501 – 1 000	1 001 – 5 000	> 5 000
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5. Indicate the type of chemical industry your organisation resides to:

Polymers	Petro-Chemical	Agri-Chemicals	Speciality-Chemicals	Explosives	Other (indicate) _____
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6. Indicate your function/role in your organisation:

Environmental manager / practitioner	Financial accountant / practitioner / manager	Production engineer / supervisor / manager	Other (indicate) _____ —
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## SECTION 2: ENVIRONMENTAL PRACTICES

7. Indicate whether your organisation has established the following environmental strategies and tools –

7.1	Environmental policy	Yes	No
7.2	Environmental management system (EMS)	Yes	No
7.3	Environmental goals and targets	Yes	No
7.4	Environmental improvement plan	Yes	No
7.5	ISO 14001 certification	Yes	No

7.6 For how many years are your company ISO 14001 certified? \_\_\_\_\_

7.7 Who is your ISO 14001 accredited auditing body? \_\_\_\_\_

8. Indicate the level at which the following serve as **drivers** for your organisation's **Environmental Management System** – where 1 is extremely low and 5 extremely high.

8.1	Compliance with regulation	1	2	3	4	5
8.2	Certification to international standard	1	2	3	4	5
8.3	Corporate citizenship	1	2	3	4	5

9. Indicate the **priority** of the broad **environmental issues** faced by your organisation – where 1 is low priority and 5 high priority.

9.1	Legislation (compliance with legislation)	1	2	3	4	5
9.2	Solid waste (management, minimisation, disposal)	1	2	3	4	5

9.3	Energy (global warming, carbon trading)	1	2	3	4	5
9.4	Emissions (reduction, compliance, pollution)	1	2	3	4	5
9.5	Water (quality, reduction, contamination)	1	2	3	4	5
9.6	Technology used	1	2	3	4	5

10. What level of **priority** does your organisation give to the following key themes of environmental information requirements – *where 1 is extremely low and 5 is extremely high.*

10.1	Carbon taxes	1	2	3	4	5
10.2	Energy issues	1	2	3	4	5
10.3	Employee health	1	2	3	4	5
10.4	Environmental liability	1	2	3	4	5
10.5	Reporting to industry association	1	2	3	4	5
10.6	Emission from plants	1	2	3	4	5
10.7	Environmental improvement plan	1	2	3	4	5

11. At what level of current and future **importance** to your organisation are the following **environmental issues** – *where 1 is extremely low importance and 5 extremely high importance.*

11.1	Waste water management	1	2	3	4	5
11.2	Protection of groundwater	1	2	3	4	5
11.3	Surface water use and management thereof	1	2	3	4	5

11.4	Hazardous waste management	1	2	3	4	5
11.5	Non-hazardous waste management	1	2	3	4	5
11.6	Protection of air quality	1	2	3	4	5

### SECTION 3: COMPILATION OF SUSTAINABILITY REPORTS

12. Indicate whether your organisation **discloses** the following information in its annual report:

12.1	Environmental objectives	Yes	No
12.2	Environmental impact and risk	Yes	No
12.3	Negative aspects of its environmental activities	Yes	No
12.4	Initiatives to improve the environmental impact of products	Yes	No
12.5	Environmental key performance indicators	Yes	No
12.6	Quantitative non-financial information	Yes	No
12.7	Financial environmental information	Yes	No
12.8	Incidents, fines or non-monetary sanctions for non-compliance	Yes	No

13. At what level does your organisation disclose its **operating expenditure** on the following issues – *where 1 is extremely low and 5 extremely high?*

13.1	Liquid effluent treatment	1	2	3	4	5
13.2	Waste gas and air treatment	1	2	3	4	5
13.3	Pollution prevention	1	2	3	4	5

13.4	Solid waste treatment	1	2	3	4	5
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14. At what level does your organisation disclose its **capital expenditure** on the following issues – *where 1 is extremely low and 5 extremely high?*

14.1	Liquid effluent treatment	1	2	3	4	5
14.2	Waste gas and air treatment	1	2	3	4	5
14.3	Pollution prevention	1	2	3	4	5
14.4	Solid waste treatment	1	2	3	4	5
14.5	Research and development	1	2	3	4	5
14.6	Equipment improvement	1	2	3	4	5

#### SECTION 4: PHYSICAL ENVIRONMENTAL MANAGEMENT ACCOUNTING

15. At what level does your organisation generate and record **physical environmental** information with regard to the following – *where 1 is extremely low and 5 extremely high?*

15.1	<b>Raw and auxiliary materials</b> (input materials that become part of an organisation's final product or by-product)	1	2	3	4	5
15.2	<b>Operating materials</b> (input materials that are purchased and used by the organisation, but which do not become part of any tangible product delivered to a customer)	1	2	3	4	5
15.3	<b>Water</b> (all water used by an organisation)	1	2	3	4	5
15.4	<b>Energy</b> (all types of energy used by an organisation)	1	2	3	4	5

15.5	<b>Solid waste</b> (relatively non-hazardous waste in solid form, such as waste paper, plastic containers, food waste, non-hazardous solid scrap products)	1	2	3	4	5
15.6	<b>Hazardous waste</b> (more hazardous waste materials, in solid form, liquid form or mixed form)	1	2	3	4	5
15.7	<b>Waste water</b> (streams whose primary component is water, but which also contain contaminants of some kind)	1	2	3	4	5
15.8	<b>Air emissions</b> (air streams that are contaminated with problematic levels of pollutants)	1	2	3	4	5

## SECTION 5: MONETARY ENVIRONMENTAL MANAGEMENT ACCOUNTING

16. At what level does your organisation generate and record **monetary environmental** information with regard to the following – *where 1 is “extremely low” and 5 “extremely high”*?

16.1	<b>Cost of product outputs</b> (the purchasing cost of natural resources, such as energy, water and other materials that are converted into products, by-products and packaging)	1	2	3	4	5
16.2	<b>Cost of non-product outputs</b> (the purchasing cost of energy, water and other materials that become non-product output)	1	2	3	4	5
16.3	<b>Waste and emission control costs</b> (handling, treatment and disposal costs of waste and emissions; remediation and compensation costs related to environmental damage; and any control-related regulatory compliance)	1	2	3	4	5

	costs)					
16.4	<b>Prevention and other environmental management costs</b> (the cost of preventive environmental management activities)	1	2	3	4	5

**Annexure B: Correlation coefficient**

**Spearman's Rank Correlation Coefficient:**

		Cronbach's Alpha	Q8Factor	Q9Factor	Q10Factor	Q11Factor	Q13Factor	Q14Factor	Q15Factor	Q16Factor
Spearman's rho	Q8Factor	0.68	1							
	Q9Factor	0.82	.310**	1						
	Q10Factor	0.78	.396**	.644**	1					
	Q11Factor	0.78	.247*	.639**	.757**	1				
	Q13Factor	0.88	.184	.371**	.452**	.427**	1			
	Q14Factor	0.88	.221	.286*	.369**	.400**	.514**	1		
	Q15Factor	0.90	.213	.402**	.612**	.417**	.364**	.180	1	
	Q16Factor	0.85	.112	.342**	.506**	.447**	.600**	.421**	.582**	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

## Annexure C: Letter from language editor

October 20, 2014



TO WHOM IT MAY CONCERN

### Re: Letter of confirmation of language editing

The dissertation "Evaluating the awareness of environmental management accounting in the South African chemical industry" by Eduard Kotzee (23990368) was language, technically and typographically edited. The sources and referencing technique applied was checked to comply with the specific Harvard technique as per North-West University prescriptions. Final corrections as suggested remain the responsibility of the student.

**Antoinette Bisschoff**

Officially approved language editor of the NWU since 1998  
Member of SA Translators Institute (no. 100181)