

# A framework for the measurement and reporting of environmental costs at a platinum mine

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## **ABSTRACT**

**TITLE:** A framework for the measurement and reporting of environmental costs at a platinum mine

**KEYWORDS:** Environmental management accounting; environmental costs; sustainability; Corporate Social Responsibility; triple-bottom-line; platinum mining

*Sustainability is the key to unlocking a future that beholds the opportunities that exists today.*

Environmental issues are an increasing concern for various stakeholders in the mining industry. To address these concerns, managements of mining companies should embrace sustainable mining practices in their daily decision making processes. Internal decision making processes are strongly dependent on the quality of data included in reports used by management. Currently environmental issues are only considered as a separate item which is attached to the annual financial statements. No link is made between the environmental performance of the mine and the economic performance that is achieved.

To achieve greater acknowledgement by management of the importance of controlling environmental costs on a daily basis, environmental costs need to be identifiable in internal management reports, including management accounting reports. Various methods are available with which the value of environmental inputs and outputs can accurately be determined. If these values are correctly integrated into information systems, reporting these environmental costs will be possible, allowing a mining company to consider triple-bottom-line reporting.

The goal of this study is to assist mining companies, specifically platinum mining, in measuring and reporting on environmental costs by setting up a framework. This framework will be formulated by means of conducting a thorough study of the recent and current literature pertaining to the measurement methods of environmental costs upon which a comparison will be drawn between this theory and the actual measurement and reporting of environmental costs by means of case study research. A gap analysis has identified the problems that platinum mines are experiencing, and consequently, the framework created will assist platinum mines in introducing the reporting of environmental costs.

A case study on a platinum mine was done in order to evaluate the current measurement methods and reporting on environmental costs. The collected data was analysed through explanation building and an organisational-level logic model was developed in order to understand the reasons that costs are recorded and reported on by using the method currently applied in the case study principal. This

organisational-level logic model will assist in identifying problems within the current costing method in relation to environmental cost measurement and reporting. The findings identified by the case study were compared to the theory underlying environmental management accounting after which a gap analysis identified the problems that platinum mines experience. Based on the findings of the gap analysis, a framework was developed to assist platinum mines in closing the gap that has been identified.

The framework, if applied within an organisation will assist mining companies in expanding their current reporting on environmental issues to an in-depth review of environmental impacts which can be linked to the achievement of economic performance. This will allow a step forward in triple-bottom-line reporting as the value of environmental costs has been identified as the missing link in current financial reports.

The framework could not be tested as the application of the framework requires a procedural change within the organisation which needs to be approved at top management level. This limitation does, however, open the possibility for a follow up study. Additional reporting on environmental costs will help management in adding value and quality to daily and overall decision making processes. This hypothesis can be tested in possible future studies which involve multiple-case studies and which will extend the framework to include a decision making matrix.

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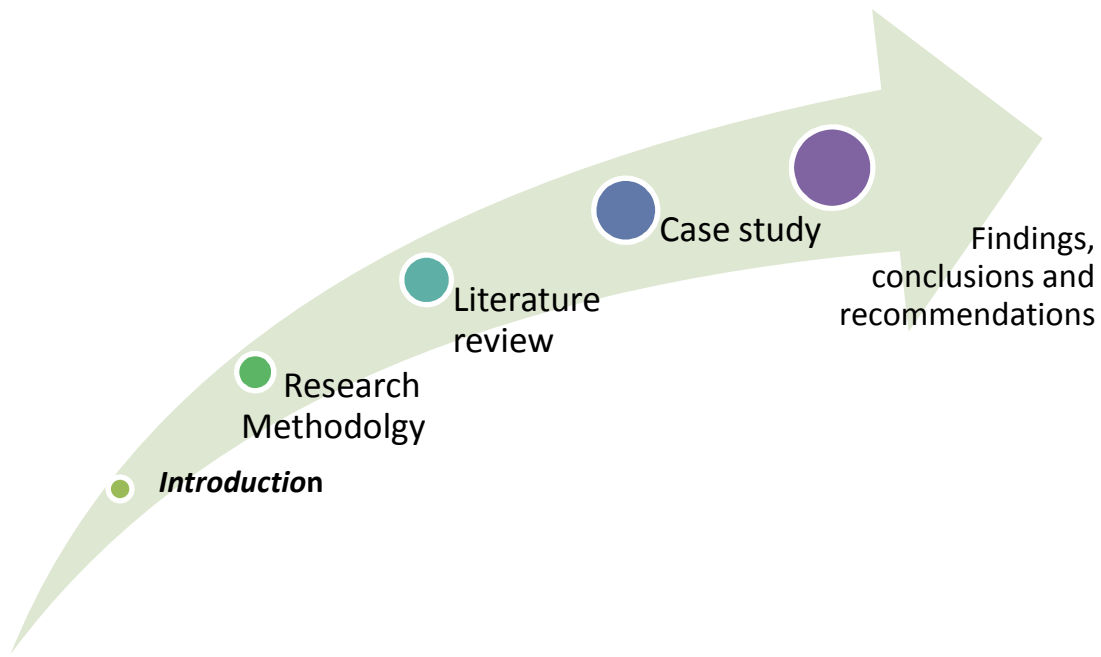
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## **Chapter 1**

### **Introduction**

#### **1.1 Introduction and Problem statement**

This research comprises a case study on the current measurement and reporting of environmental costs at a platinum mine. ‘Going green’ involves more than implementing recycling projects and industries working late at night to disguise toxic fumes released from their towering chimneys. It is becoming increasingly important for shareholders and investors to ensure that the environmental footsteps are left behind upon which future generations can build (Schaltegger & Figge, 2000). For an informed decision to be made on investing activities, a potential shareholder should have data readily available to the public relating to the company’s environmental activities *and costs*. For this reason, the Corporate Social Responsibility (CSR) reports have to include the environmental aspects of the company. This report is published as part of the annual statements (Institute of Directors (KING III), 2009:10) as an integrated report.

Financial and non-financial aspects have an interdependent relationship that indicates to stakeholders that a company has the ability to create and sustain value (Hindley, 2012:4). Integrated reporting entails more than merely stating that a company has considered environmental and social implications of the organisation, and should thus be able to link sustainable performance and economical performance (Institute of Directors (KING III), 2009:108; Montalván & Chang, 2006). This is currently being done through the application of the Sustainability Reporting Framework as developed by the Global Reporting Initiative. The

framework assists stakeholders and possible future investors in assessing the quality of the integrated report published through rating of the content of the report (GRI, 2013). This rating allows investors to compare various companies' performances in relation to CSR through the setting of guidelines for reporting. These guidelines represent internal and external stakeholder accountability and their goals to achieve sustainable development (Du Toit & Buys, 2013).

In order to improve the decision making process of a mining company, environmental information needs to be linked with economic variables (Prinsloo, 2010:112). Currently this is not the case as *environmental cost information* is lacking most of the time (Jasch, 2009:2). The consequence of this is failure to recognise the economic value of natural resources, material and energy efficiency improvements as well as the financial value of good environmental performance (Jasch, 2009:2).

Reporting of these environmental costs as a separate line item will allow management to identify problem areas within the current costing or production system which may, in turn, improve profitability. The triple bottom line reporting (a company's success measures based on economic, social and environmental performance (Gray & Milne, 2002) is widely discussed and criticised as not adding any value to the company or their shareholders (Norman & MacDonald, 2004) while there are enough research has in fact been done to prove the opposite (Raar, 2002; Pava, 2007; Hacking & Guthrie, 2008; Buys, Van Rooyen & Bosman, 2009).

If done correctly in conjunction with a sustainable balanced scorecard (SBSC) (Figge, Hahn, Schaltegger, & Wagner, 2002) and a single-measure organisational sustainability index to integrate the measures in the SBSC, stakeholders will benefit from the additional reporting (Hubbard, 2009). Data envelopment analyses dictate that stakeholders from platinum mining companies are currently benefiting from efficient environmental performance with regards to economic and social gains (Oberholzer & Prinsloo, 2011).

Currently the reporting on environmental aspects mostly concerns the needs of *external* stakeholders. This can be changed in order to assist *internal* management in strategic decision making on complete accounting and reporting of environmental costs, thus adding value to internal decision making processes. Consequently the problem is addressed by the following research question:

*Will a framework for measurement and reporting of environmental costs assist companies in expanding their current environmental disclosures to in-detail reporting of environmental information?*

The central argument of this study is therefore as follows: in order to create a sustainable environment, mining sectors need to ensure that they mine economically, effectively and efficiently – not only considering production costs, but also the reserves being mined – thus ensuring effective and efficient extraction of reef minerals. But this can only be done if all cost aspects are taken into account, including environmental cost information.

And so, the goal of this study is to investigate methods of accounting and reporting of environmental costs at platinum mines in order to ensure a sustainable future from which not only organisations will benefit, but individuals within the organisation as well. This will allow a *framework* to be set for the measurement and reporting of environmental costs.

Hence, this study will extend the literature by identifying gaps in current measurement and reporting of environmental costs, which will allow for further research aimed at developing accounting systems to accommodate the need for detailed environmental accounting applications, thereby adding value to the concept of the triple bottom line.

## **1.2 Background**

### **1.2.1 Relevance of the study**

Mining is considered a major source of income for economies such as South Africa – it ensures employment and encourages transactions between supplier and buyer, thereby stimulating economic growth (Chamber of Mines: South Africa, 2011). In South Africa mines are still owned by the private sector, which ensures growth opportunities and competitive advantages internationally. To preserve this economic source of power, mines in South Africa need to extend their current life spans in order to sustain profitability for a longer period of time. Improved mining practices will contribute to sustainable mining.

Environmental costs include a variety of costs such as disposal costs, investment cost and external costs, and can even include environmental profits (environmental cost savings). These costs are usually not linked to products or processes, but are allocated within the overhead account. This suggests a lack in full recording of environmental costs, causing improvements in efficiency and possible opportunities to prevent costs from being overlooked (Jasch, 2003).

The White Paper on Environmental Management Policy for South Africa (SA, 1998:32), published in the Government Gazette on 15 May 1998, has set out the following goals in relation to environmental costs:

- To ensure that markets reflect the costs of environmental resources and to correct markets where they fail to reflect environmental impacts.
- To develop and maintain a national environmental accounting system to reflect the economic cost of the depletion of environmental resources.
- To investigate systems of cost-benefit analysis and risk assessment for assessing economic, social and environmental costs with a view to improve decision making on environmental and development issues.

In order for the government to reach their goals, industry needs to support the same values and should strive to realise the same goals. Platinum Group Metals (PGM) mining in South Africa possesses over 80 percent of the world's Platinum Group Metals reserves. Mining in total accounts for 20 percent of South Africa's Gross Domestic Product of which the biggest contributors are gold and platinum mining (Projects IQ, 2011). Considering these facts, platinum and gold mines especially need to adhere to these goals as well in order for the government to ensure the full accomplishment of the goals set out above.

King III (Institute of Directors, 2009), the Global Reporting Initiative (GRI, 2013), International Federation of Accountants (IFAC, 2005), International Organisation for Standardisation, Environmental management – ISO14000 (ISO, 2009) and International Organisation for Standardisation, Social responsibility – ISO26000 (ISO, 2010) all encourage companies to adhere to the guidelines set out in their publications.

The Global Reporting Initiative (GRI) guidelines are only recommendations which a company can use to report on environmental issues, but these can improve the quality of reports published (Ambe, 2007:54), thereby addressing the growing need of shareholder information requirements.

Various stock exchanges around the world require that Corporate Social Responsibility reports be included in their financial statements that are published each term, and with the Kyoto Protocol as discussed during COP 17 (United Nations Climate change Conference, 2011) in Durban, companies will have to adhere to stricter application of environmental policies. Thousands of companies are compiling their own Corporate Social Reports using the Global Reporting Initiative's framework (Corporate Register, 2012). However, these reports do take on various forms. The reason for this is two-fold: one being the fact that various and differing industries and sectors have different impacts on the environment and society and therefore need to address these different issues in their reports; and the second being the lack of available standards with which to measure these reports seeing that the GRI is only a guideline (Hindley, 2012). A study done by

Hindley and Buys (2012) concluded that the majority of the South African mining industry only reports on positive non-financial performances, the reason for this being the lack of a clear indication of what is considered to be acceptable reasons for non-disclosures.

### **1.2.2 Literature review**

Shareholders are increasingly demanding reliable environmental disclosures as part of the company's annual reports. For these disclosures to be reliable they need to be obligatory, regulated either by legislation or accounting standards. This will require of current regulators to change their standing on environmental reporting (De Villiers & Van Staden, 2011) and set certain standards to meet compliance – especially the accounting standards.

According to De Villiers and Barnard (2000) mining companies tended to disclose more environmental information in comparison to other industries recorded in the Financial Mail Top 100 industrial companies during 1994 – 1999. It can therefore be concluded that mining companies and their shareholders value the information reported on sustainability issues (Raar, 2002; Hubbard, 2009).

The International Federation of Accountants (IFAC) is an organisation that develops high quality standards and guidance to ensure high quality accounting practices around the world. They promote and enforce internationally recognised standards through supporting independent standard-setting boards which include: International Auditing and Assurance Standards Board, International Accounting Education Standards Board, International Ethics Standards Board for Accountants, and the International Public Sector Accounting Standards Board. As the need for reporting on environmental issues increased, IFAC compiled an international guidance document, Environmental Management Accounting (IFAC, 2005). This document is not a standard with defined requirements, but rather fills the gap currently left between regulatory requirements, standards and pure information that relates to environmental issues.

The IFAC document on Environmental Management Accounting, promotes the reporting of physical and monetary values in regards to environmental aspects. Currently, mostly data relating to rehabilitation costs are reported (as provisions under International Accounting Standards (IAS) 37 regulation). Further investigation will determine where and whether other environmental costs are recorded and reported on in cost terms. The Environmental Management Accounting workbook (Japan MOE, 2002) identifies several methods with which the value of environmental costs can be calculated, where each method mentioned, refer to a different scope in the business

process. This allows for the supposition that more than one method of measurement can be applied throughout the whole business process.

IFAC (2005) set out the following cost categories for environmental management accounting:

- Materials costs of product outputs
  - Includes the purchase cost of natural resources such as water and other materials that are converted into products, by-products and packaging.
- Materials costs of non-product outputs
  - Includes the purchase (and sometimes processing) costs of energy, water and other materials that become non-product outputs (waste and emissions).
- Waste and emission control costs
  - Includes costs for handling, treatment and disposal of waste and emissions.
  - Remediation and compensation costs related to environmental damage.
  - Control related regulatory compliance costs.
- Prevention and other environmental management costs
  - Includes the costs of preventative environmental management activities such as cleaner production projects.
  - Also includes costs for other environmental management activities such as environmental planning and systems, environmental measurement, environmental communication and other relevant activities.
- Research and development costs
  - Includes costs for research and development projects related to environmental issues.
- 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.

Several studies have indicated that the costs of waste disposal make up one to ten percent of the total environmental costs and the purchase cost of the wasted materials comprises 40 to 70 percent of the total environmental costs (depending on the business sector) (Jasch, 2009:12). In mining the ore to waste ratio is very small (Mudd, 2010) which emphasises the importance of keeping waste cost to a minimal possible in the mining sector. Planning, which involves both the environmental department as well as the management accounting department, is of utmost importance in minimising the waste as far as possible at the most cost efficient way.

The Global Reporting Initiative (GRI) promotes the use of sustainable reporting in assisting companies globally to become more sustainable and contribute to sustainable development. They have created Sustainability Reporting Guidelines (GRI, 2013) that is internationally used by companies from various sectors. These Guidelines assist companies to be more transparent in their reporting to shareholders and allow them to take accountability for their actions. The Sustainability Reporting Guidelines include economic, environmental, and social aspects. Companies can use these guidelines as part of their strategic planning and especially when considering sensitive issues such as social and environmental aspects.

The Sustainability Reporting Guidelines (GRI, 2013) have created several performance indicators, of which G4 is the latest version, published in May 2013, which companies can implement in order to assist in compiling their sustainability reports. The environmental dimension of sustainability (which is important for this study) includes a company's impact on living and non-living natural systems, including land, air, water and ecosystems. This category includes inputs (material, energy and water) and outputs (emissions, effluents and waste). It also includes biodiversity, transport and product and service-related impacts, as well as environmental compliance and expenditures. These guidelines, however, only assist companies in reporting on actual usages in environmental aspects, but do not guide companies on how to report on these aspects in *monetary* terms.

According to the United Nations Division of Sustainable Development (UN DSD, 2001) the total corporate environmental costs is made up of the environmental protection costs, the costs of wasted material, and the cost of wasted capital and labour. Waste is therefore defined as production inefficiency (purchase value of non-material output). If these inefficiencies can be minimised, production levels can increase but with lower costs per unit which increases profitability. Environmental costs applicable to the platinum mining sector would include the following:

- Water
  - Drinking water at underground and above ground operations
  - Sewerage on sites
  - Drilling
  - Processing plant
  - Refining plant
- Emissions of sulphur dioxide (SO<sub>2</sub>)
  - Processing plant
  - Refining plant
- Direct and indirect greenhouse gas emissions (including CO<sub>2</sub> and CO<sub>2</sub> equivalents)

- Processing plant
- Refining plant
- Transportation
  - Roadways
  - Railways
- Oxygen
  - Mining
    - Underground ventilation
- Energy
  - Mining
    - Winch controls
    - Drilling
    - Underground lights
    - Air pumps
    - Water pumps
    - Shaft cage control
    - Waste conveyance
    - Administration and service department electricity needs
  - Process plant
  - Refining plant
- Rehabilitation costs
  - Shaft closures
- Waste rock and tailings
  - Management of waste rock and tailings (transport and dumping)
  - Treatment of tailing dams

These environmental cost elements were identified using current Corporate Social Reports (2007 – 2012) (Corporate Register, 2012) as guidelines. During the case study phase of this research further environmental costs may be identified and included.

### **1.2.3 Conceptual scope and context of the study**

The main research question in this study is:

*Will a framework for measurement and reporting of environmental costs assist companies in expanding their current environmental disclosures to in-detail reporting of environmental information?*

To answer this question this study uses the conceptual framework as indicated in Figure 1, pg.9, which will guide and direct the study toward answering the main research question and toward setting up a framework for the measurement and reporting of environmental costs, thereby improving the quality of environmental reporting.

The main research question comprises specified goals which can be articulated and sub-divided in the following questions:

1. Why do environmental costs need to be measured?
2. Which environmental costs need to be measured?
3. Which methods should be used to measure the environmental costs identified?
4. How are these environmental costs accounted for in the financial statements of the company i.e. where these costs should be reported?
5. How can the current measurement and reporting of environmental costs be improved?

The conceptual scope (Figure 1, pg.10) indicates that in order to improve strategic decision making, the need to measure environmental costs must be understood. As soon as the need is established it is important to define what the environmental costs are, and which of these are applicable within the organisation's sector or industry. These costs should then be measured by application of various methods that are available – the organisation needs to decide which method would be the most appropriate measure in consideration of their current costing procedures. Only after these three aspects have been concluded will reporting of environmental costs would be possible. Environmental costs can now be integrated into internal reporting which management can use to improve daily decision making.

This conceptual scope will assist in establishing a framework for the measurement and reporting of environmental costs (Figure 1, pg.10).

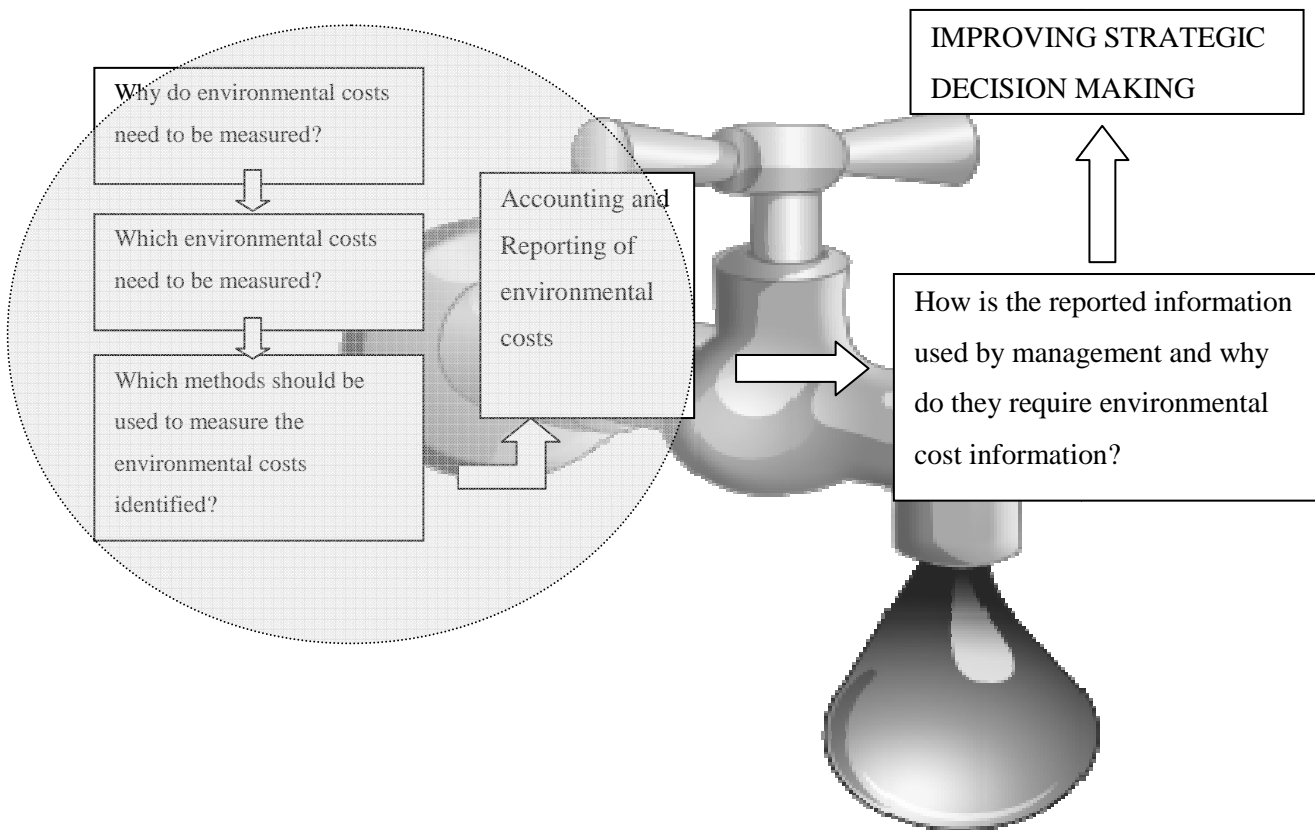


Figure 1 Conceptual scope (own research)

### 1.3 Objectives

The goal of this study is to investigate methods of accounting and reporting of environmental costs at platinum mines so as to ensure a sustainable future from which not only organisations will benefit, but also individuals within the organisation. This will allow a *framework* to be set up for the measurement and reporting of environmental costs. The goal will assist in answering the main research question.

In order to reach this goal certain objectives need to be addressed:

1. The first objective of this study is to identify the current measurement methods and reporting on environmental costs in the platinum mining sector of South Africa. This will answer questions one to four as identified in the conceptual scope of this study (Figure 1).
  - o This objective will be achieved by identifying which environmental costs need to be measured and why, which methods of measurement should be used and where these costs should be reported.

2. The second objective of this study is to identify the possibilities of improving these measurement methods in order to assist in more accurate reporting of environmental costs. This will answer question five of the conceptual scope of this study (Figure 1, pg.10).

This study will identify:

- a. the gaps in current environmental cost measurement and reporting,
- b. how this gap can be filled to improve current reporting, and
- c. the outlines of a framework for the measurement and reporting of environmental costs at a platinum mine.

#### **1.4 Method**

This research follows a case study approach, which covers both *explanatory* (what is environmental costs and which methods can be used to measure these costs) and *exploratory* (which measurement methods and reporting standards are currently in use) methods to enable the establishment of a framework for measurement and reporting of environmental costs (Yin, 2009:9).

In acquiring a deeper understanding of how environmental management accounting is applied in practice and how this application can be improved by further research, a case study was chosen as the most appropriate research method (Yin, 2009:4). A *single case study* in the mining sector will be done as this particular case contains a critical test from an existing theory and is representative of the chosen sector. The reason that the mining sector was chosen for this study is motivated by the research done by Antonites and De Villiers (2003) which indicates that the environmental impact of mining is greater than any other sector. For this reason mining industries need to disclose more environmental information and certain accounting policies force the mining sector to adhere to these disclosures (Antonites & De Villiers, 2003). Platinum mining was chosen to serve the purpose of this study as the case study is easily accessible, information were readily available and full co-operation was given by the case study principal.

By following a case study approach, this research will be able to assist mining companies in setting up a framework for the practical implementation of measurement and reporting of environmental cost. The environmental costs that are applicable to one platinum mine is most likely to be applicable to another, hence the assumption that one case study will be enough to cover all aspects required in this research (Yin, 2009:47).

A case study protocol as used in Yin (2009:79) will be followed in order to maintain integrity of data collected and analysed. This model is a decision making model which will include individuals, social groups and an organisation as part of the case study (Yin, 2009:37–38).

Current research indicates that no uniform framework exists that can be applied in the measurement and reporting of environmental costs (Japan MOE, 2002; Hecht, 1999). Several methods which can assist in the measurement of environmental costs have been identified, but very few are practically viable in real-life scenarios. Not enough research has been done to set a standard for companies in order to quantify the environmental data at hand.

As mentioned, the goal of this study is to investigate methods of accounting and reporting of environmental costs at platinum mines so as to ensure a sustainable future. This will allow for a *framework* to be set for the measurement and reporting of environmental costs. The data collection methods will include the following:

- Documentation (financial reports, management accounting reports and environmental reports)
- Archival records (previous financial statements published)
- Direct observation

The data will be analysed by using the following techniques:

- General strategy
  - Reliance on theoretical propositions
  - Explanation building
  - Organisational-level logic modelling

What makes this study unique and distinguishable from previous studies is the fact that it takes into account how specific environmental costs are measured in practice and *whether* they are measured at all. It will investigate where these costs (if measured) are currently reported on in the financial statements of a company.

This study will emphasise for mining companies and managers the impact of environmental costs and the importance of effective management, all of which can improve profits. The management accounting function within the mines will be extended to include environmental management accounting.

This study will also create possibilities for further research on improving current accounting systems used for mines so that they may accommodate environmental management accounting needs in respect of the accounting and reporting of environmental costs.

### **1.5 Overview of the study**

This study consists of five chapters. The layout is as follows:

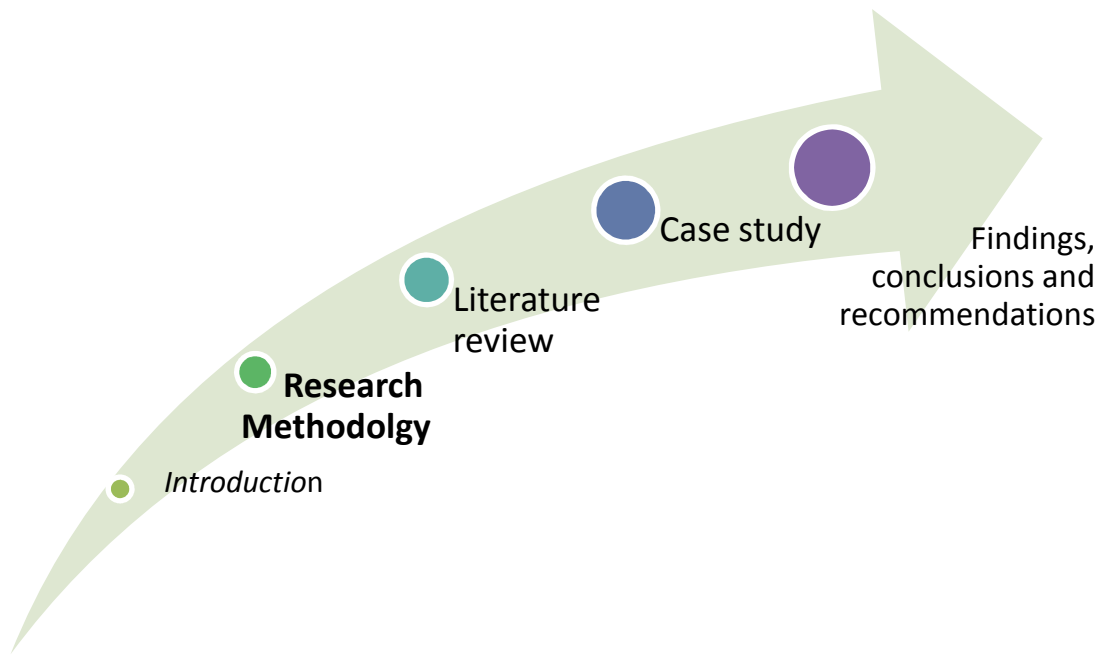
**Chapter 1: Introduction:** The introduction and the background of the study are discussed, which includes previous studies done on environmental management accounting, the problem statement, objectives, and research method

**Chapter 2: Research Methodology:** This chapter focuses on how the case study will be executed, which data will be collected and how the data will be analyzed in order to ensure triangulation of data. The research follows a World 2 point of view as it extends the literature on scientific methods and techniques, thereby setting a framework for the measurement and reporting of environmental costs.

**Chapter 3: Literature review:** This chapter will focus on Environmental Management Accounting and discuss why and what environmental costs need to be measured, the methods applied to measure environmental costs and how these costs are treated in the reporting of financial performance within the mining sector.

**Chapter 4: Case study:** This chapter will discuss the findings of the case study and indicate any gaps, if any, in the current measurement and reporting of environmental cost information, as identified during the case study.

**Chapter 5: Findings, conclusion and recommendation:** This chapter summarizes the findings from the literature study and the case study; arrive to conclusions and the core is setting up a framework for the measurement and reporting of environmental costs at a platinum mine.



## **Chapter 2**

### **Research Methodology**

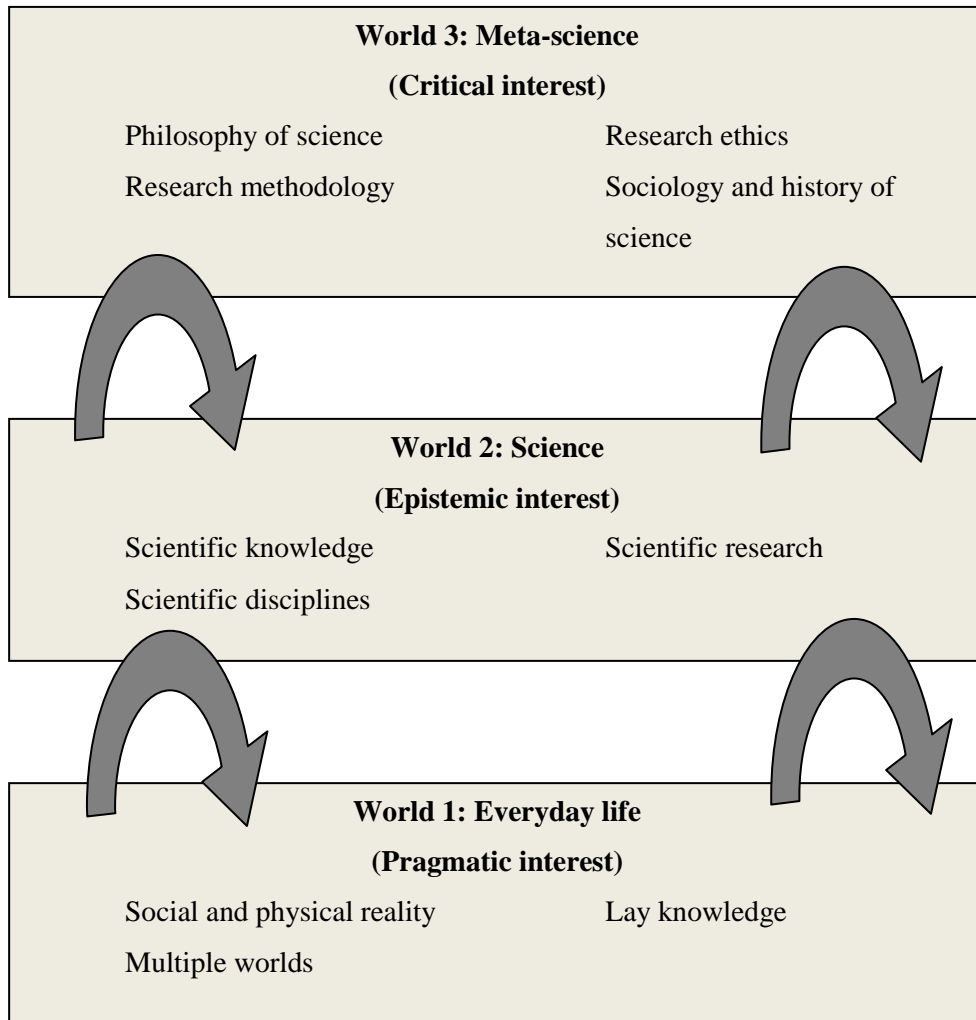
#### **2.1 Introduction**

This chapter will focus on the research methodology required to assist in answering the question of whether a framework for measurement and reporting of environmental costs will assist mining companies in expanding their current environmental disclosures to in-detail reporting of environmental information.

Research types are discussed in section 2.2 and case based research in specific is discussed in section 2.3 A case study was chosen as an appropriate research method, as a deeper understanding is required on how environmental management accounting is applied in practice, and how this application can be improved by further research (Yin, 2009:4). A *single case study* has been done in the mining sector as the case involves critical testing from an existing theory and is representative of the sector chosen. Platinum mining was chosen to serve the purposes of this study as the case study site is easily accessible, information readily available, and full co-operation was granted by the case study principal.

The research design for case studies will be discussed in section 2.4 to facilitate understanding of how a case study should be conducted. A case study protocol was followed so as to ensure that the integrity of the data remains uncorrupted. The various aspects of the protocol will be discussed in

section 2.5, which includes an overview of the case study project, case study questions, data collection methods and methods used for data analysis. Finally, the limitations of the research methods will be explained in 2.6.



**Figure 2 The basic framework of the Three Worlds Research Paradigms (Mouton, 2011:139)**

Research problems can be distinguished within three contexts (Figure 2) namely World 1, World 2 and World 3 view points (Mouton, 2011:138). World 1 refers to ‘every day’ knowledge (known as lay knowledge) and how this knowledge can be applied to solve problems, gain insight and reach consensus in our everyday tasks. World 2 focus on the world of science and scientific research on the selected phenomenon in World 1 and are investigated systematically and rigorously. World 3 is the context of meta-science where reflection is done on the nature of science and scientific research.

A World 2 view was applied in this study as it critically reviews the current scientific knowledge in order to solve the problems identified in the literature by setting up a framework, applying it back into the World 1 view.

## **2.2 Research types**

Research can take on various forms and therefore, to ensure that the correct methods of research are applied in answering specific questions in science, it is important that the following types of research be considered:

### *1. Pure research*

Pure research is done to add value to existing theories and hypotheses which may have practical implications on the current or future time frame (Kumar, 2005). This type of research will contribute to the base of knowledge (Williams, 1998:4).

### *2. Applied research*

Applied research is conducted to solve specific problems, formulate policies or procedures, or to understand phenomena in the field of science (Kumar, 2005). This type of research is applied in order to solve a specific problem (Durrheim, 2006:45).

This research addresses current issues in the measurement and reporting of environmental costs experienced in platinum mining companies, and is therefore considered as applied research.

Upon identifying the type of research, the objectives of the undertaking research should be considered (Kumar, 2005). Objectives of research can be classified as follows:

1. *Correlational research* attempts to prove the existence of interdependence between two or more items.
2. *Exploratory research* attempts to gain knowledge on a topic of which the current literature is unfamiliar, or to explore the possibility of future studies within a certain field not yet studied (Williams, 1998).
3. *Descriptive research* attempts to clarify a certain phenomenon through the investigation of mostly quantitative and statistical data (also referred to as an explanatory studies) (Blumberg, 2008:11).
4. *Explanatory research* attempts to use qualitative findings to help clarify quantitative results (Ivankova, Creswell & Clark, 2011).

This study analyses the data collected on current measurement and reporting of environmental costs and compares the data to underlying theories on environmental management accounting. It can therefore be considered as an explanatory case study. As this case study will also explore the possibilities of expanding the current literature in regards to environmental management accounting, in specific, reporting of environmental costs, it can also be considered to be an exploratory study as well.

Structured or unstructured approaches can be followed in answering research questions (Kumar, 2005). A structured approach refers to quantitative research which means that systematic and objective processes are followed, using numerical data from a selected sample to generalise findings (Maree & Pietersen, 2011). Unstructured approaches are used in qualitative studies, where qualitative studies can be defined as research with a flexible approach relating to the research process, in order to determine the nature of a problem without any quantification of data (Kumar, 2005).

The research design for this study is based on Figure 3, pg.18, and Figure 4, pg.19.

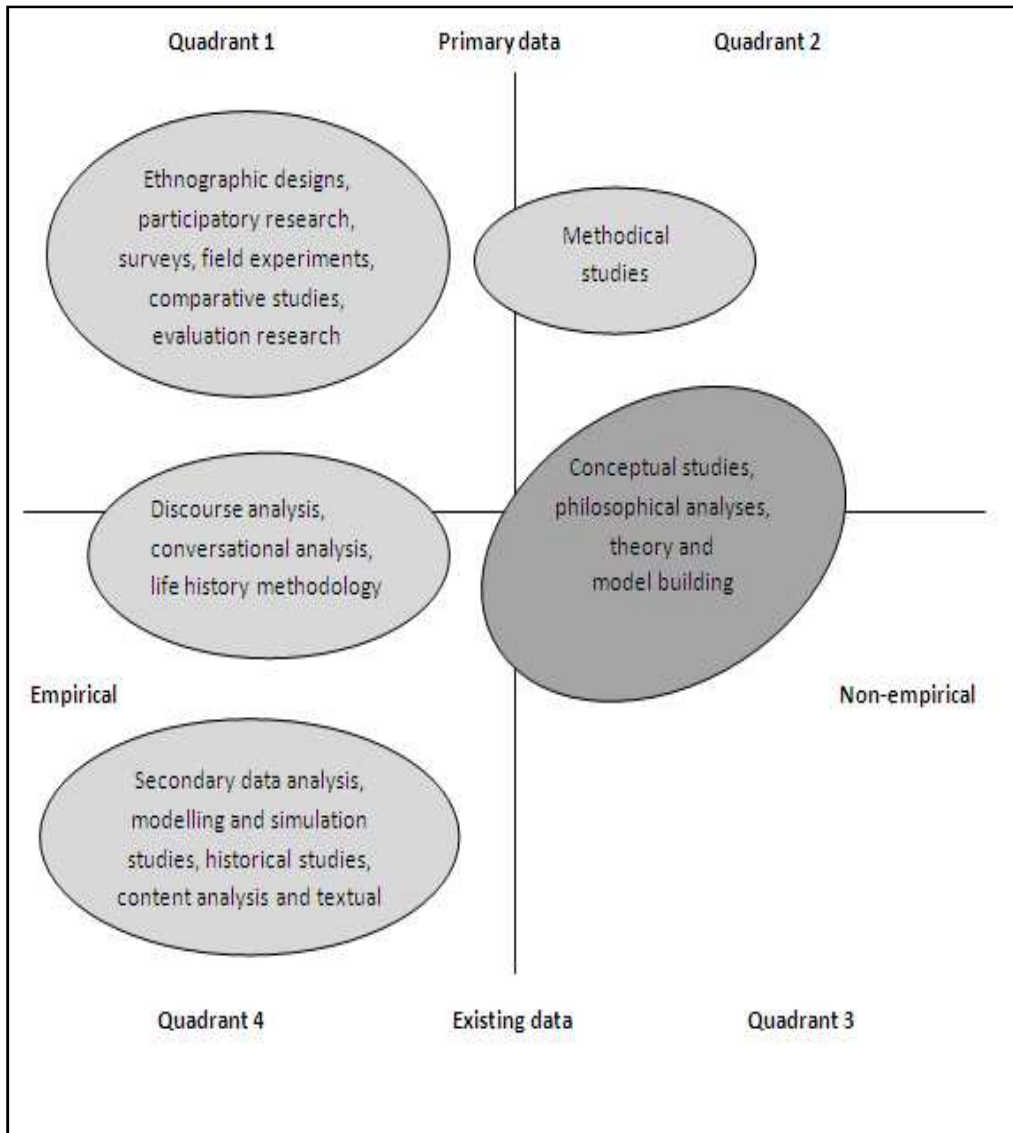
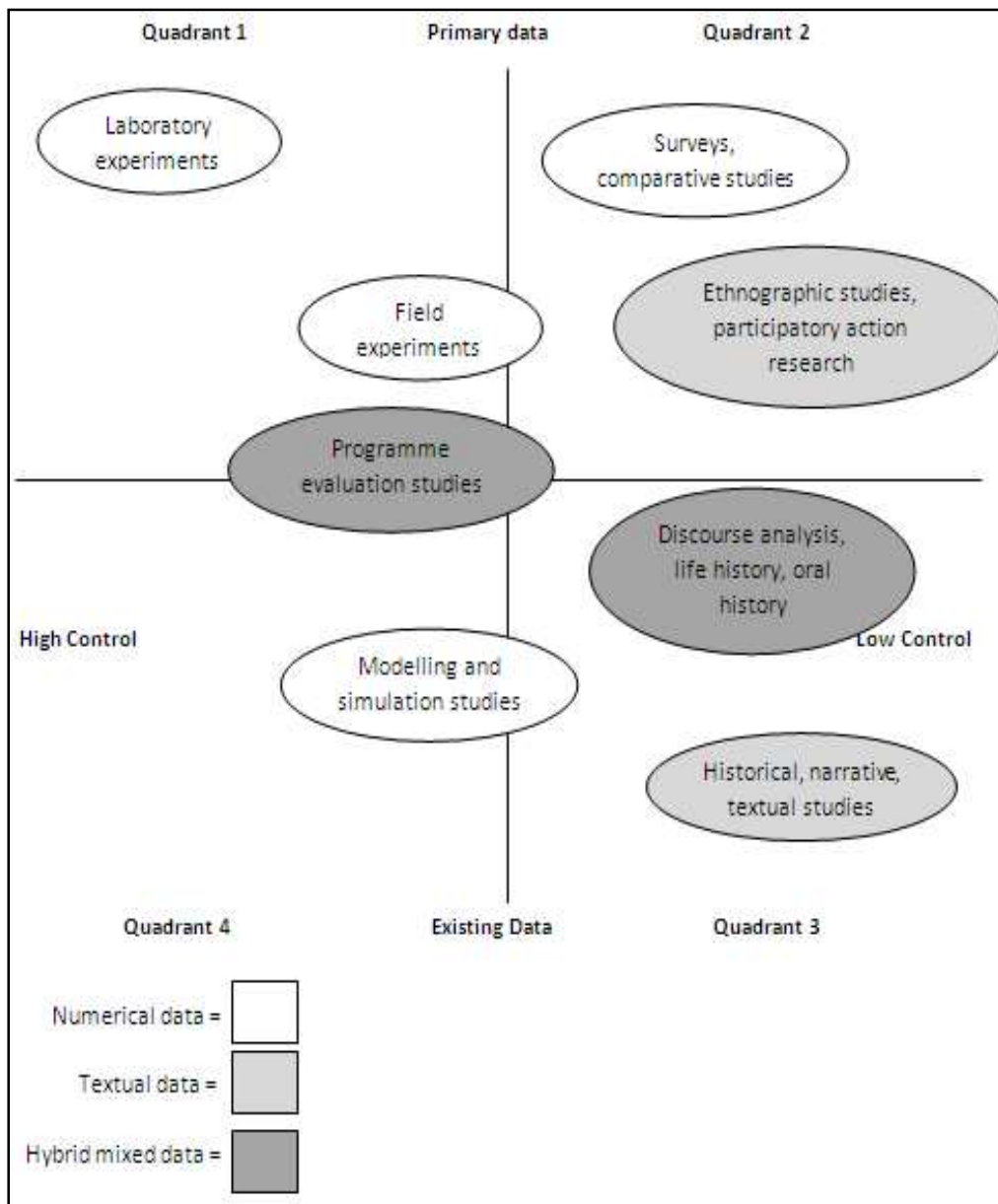


Figure 3 Mapping designs (Level 1) (Mouton, 2011:144)



**Figure 4 Mapping designs (Level 2) (Mouton, 2011:145)**

Figure 3 illustrates the various research designs that are available, and when and where each design is to be used. Empirical studies are based on observed and measured occurrences and draw knowledge from actual experiences rather than from theory or belief. Non-empirical studies on the other hand include philosophical analyses, conceptual analyses, theory building and literature reviews (Mouton, 2011). The data used for analysis in a study can vary from new data (primary data) to existing data (secondary data). This study includes empirical analyses, as the case study will observe a current phenomenon where the findings of the case study will be compared to current literature in order to construct a new framework. Data analysed comprises existing data from the case study principal which will be used to create new data. The study is thus conducted within the fourth quadrant.

Figure 4 is only applicable to empirical studies and involves the dimensions of primary and/or secondary data and the degree of control. This study makes use of both primary and secondary data with moderate control which is numerical and textual in nature.

In using Figure 3 and Figure 4 it has been determined that this study would be classified as evaluation research and would follow a structured approach seeing that data is collected and analysed in order to create a framework that can be applied in practice.

### **2.3 Case based research**

Schramm (1971) observes that the essence of a case study is “that it tries to illuminate a decision or a set of decisions: why they were taken, how they were implemented, and with what result”. Gerring (2007:20) defines a case study as “the intensive study of a single case, where the purpose of that study is – at least in part – to shed light on a larger class of cases (a population)”. In consideration of these two definitions, Yin (2009:18) took the definition of a case study one step further by giving it a twofold technical definition that includes reference to the scope of a case study and the case study enquiry itself. The scope of the case study as an empirical enquiry should “investigate a contemporary phenomenon in depth and within its real-life context when the boundaries between phenomenon and context are not clearly evident” Yin (2009:18). The case study enquiry itself “copes with the technical distinctive situation in which there will be many more variables of interest than data points and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis” (Yin (2009:18). This definition has made it possible to take case study research seriously in a World 2 research view point.

It becomes clear that theoretical ideas on environmental accounting should be studied in light of how it is interpreted in the real world. This poses the questions: does the theory assist companies in measuring and reporting on environmental costs sufficiently? If not, how can the theory be improved? By applying a case based research method, this study will be able to answer these questions.

### **2.4 Research design**

Research design is the logical flow of events that links the empirical data to a study’s initial research questions and ultimately to its conclusions (Yin, 2009:26). A case study has five

components which need to be considered when compiling a research design. These five components are listed and linked to the case study in 2.4.1 to 2.4.5. The remainder of the section discusses theory development, quality of research design and case study design categories.

#### **2.4.1 The study's questions**

A case study is a good research method to use for answering the “how” and “why” questions. These questions must have substance in order to add value to current literature. Before the study's question can be asked, a thorough literature review needs to be conducted in order to narrow down the topic to key issues. By thinking about the loose ends of current studies, potential unasked questions can be the points of departure for new research (Yin, 2009:27).

*The main research question is (Chapter 1, pg.2):*

*Will a framework for measurement and reporting of environmental costs assist companies in expanding their current environmental disclosures to in-detail reporting of environmental information?*

#### **2.4.2 The study propositions**

These are all the aspects within the study which need to be examined. This is an important component of a case study design as it will assist in leading the researcher to the collection and analyses of the correct data. If a study does not have propositions, the researcher will only want to explore the current field of study and the propositions will be replaced by a purpose (Yin, 2009:28).

*This study has five propositions (Chapter 1, pg.9):*

- 1. Why do environmental costs need to be measured?*
- 2. Which environmental costs need to be measured?*
- 3. Which methods should be used to measure the environmental costs identified?*
- 4. How are these environmental costs accounted for in the financial statements of the company?*
- 5. How can the current measurement and reporting of environmental costs be improved?*

#### **2.4.3 The unit of analysis**

Identifying the unit of analysis bears great importance as it directs the study's focus. The unit of analysis can only be identified as soon as a primary research question has been accurately

determined. The unit of analysis can be revisited throughout the study as new information becomes available during data collection (Yin, 2009:29).

*This study will make use of the following units of analysis (Chapter 1, pg.10-11):*

- 1 *Measurement methods of environmental costs*
- 2 *Reporting of environmental costs*

#### **2.4.4 The logic in linking data to the propositions**

Various methods exist which can assist in linking the collected data to the propositions of the study, which include pattern matching, explanation building, time series analyses, logic models and cross-case syntheses (Yin, 2009:33).

*Methods that will be used in this study will include (Chapter 1, pg.12):*

- *Explanation building*
- *Firm or organisational-level logic model*
- *Relying on theoretical propositions (rival explanations).*

#### **2.4.5 Criteria for interpretation of the findings**

When designing the case study possible rival explanations should be considered in order to include these questions into the data collection phase (Yin, 2009:34).

*The rival explanation identified for this case study is:*

*Mining companies will not benefit from additional measurement and reporting of environmental costs.*

#### **2.4.6 Theory development**

The five steps discussed in 2.4.1 – 2.4.5 (pg.21 – 22) will direct the researcher toward constructing a preliminary theory related to the field of study. This component of the case study research is important as it directs data collection and analysis (Yin, 2009:37). Types of theories that can be included in a case study based research method are:

- Implementation theory
- Individual theories
- Group theories

- Organisational theories
- Social theories.

This research includes implementation theory as well as organisational theory, as the current implementation of environmental costing methods is examined within an organisation. Specific procedures are put in place in an organisation, and these needs to accommodate environmental costing – if they do not, procedures should be adjusted before environmental management accounting can be implemented.

#### 2.4.7 Quality of research design

When conducting a case study research, it is of utmost importance to have quality checks in place for every stage of the case study. This will lend credibility to the outcomes and recommendations of the study. The quality of the research design can be tested by using Table 1:

TESTS	CASE STUDY TACTIC	PHASE OF RESEARCH IN WHICH TACTIC OCCURS
<b>Construct validity</b>	Use multiple sources of evidence	Data collection
	Establish chain of events	Data collection
	Have key informants review draft of case study report	Composition
<b>Internal validity</b>	Do pattern matching	Data analysis
	Do explanation building	Data analysis
	Address rival explanations	Data analysis
	Use logic models	Data analysis
<b>External validity</b>	Use theory in single-case studies	Research design
	Use replication in multiple-case studies	Research design
<b>Reliability</b>	Use case study protocol	Data collection
	Develop case study database	Data collection

Table 1 Case study tactics for four design tests (Yin, 2009:41)

#### 2.4.8 Case study design categories

Case study designs can be divided into four categories:

- 1 Single case design – holistic (single unit of analysis)
- 2 Single case design – embedded (multiple units of analysis)
- 3 Multiple case design – holistic (single unit of analysis)
- 4 Multiple case design – embedded (multiple units of analysis)

This research will follow a single case design with an embedded view, as the case study is a representative case with two units of analysis which is the measurement of environmental costs and the reporting of environmental costs.

The research design of a case study is important as it has a direct impact on the quality of the data collected and analysed (Yin, 2009), and great care and time should be spent on this stage of the study.

## **2.5 Case study protocol**

### **2.5.1 Overview of the case study project**

#### *i Background information*

The case study principal currently reports on environmental issues, but environmental cost information is lacking. Calculating this information will add value to reporting on these issues to external stakeholders as well as to internal cost control. This will improve profit margins thereby benefiting internal stakeholders by ensuring a future in the mining sector.

#### *ii Project objectives and auspices*

This project identifies:

- the current measurement methods and reporting of environmental costs in the platinum mining sector of South Africa, and
- the possibilities of improving these measurement methods in order to assist in more accurate reporting of environmental costs.

#### *iii Case study issues*

This study identifies the following issues:

- The case study's environment needs to be defined.
- The costs applicable to that environment need to be identified.
- The measurement methods of those environmental costs need to be investigated.
- The reporting of the environmental costs needs to be confirmed.

iv Field procedures

Access to the case study site was granted telephonically and via email. Meetings were scheduled with the environmental department and the management accounting department. The researcher has experience in working on a mine site as a junior shaft accountant and capital accountant and is therefore well-familiar with the environment of the case study.

v General sources of information

Information required in order to answer the case study question was collected via:

- annual financial reports,
- sustainability reports,
- detailed accounting entries of overhead accounts,
- ore / waste handling and flow,
- process flow chart for platinum mining,
- extraction flow chart for platinum mining, and
- environmental reports.

**2.5.2 Case study questions**

i Specific questions

The propositions for this case study are stated as follows:

1. Why do environmental costs need to be measured?
2. Which environmental costs need to be measured?
3. Which methods should be used to measure the identified environmental costs?
4. How are these environmental costs accounted for in the financial statements of the company?
5. How can the current measurement and reporting of environmental costs be improved?

ii Potential sources for answering each question

The case study environment has been defined by using relevant readings and observations of the environment. The costs applicable to the defined environment have been identified through the investigation of archival records of environmental reports included in Corporate Social Responsibility reports, data from the environmental department as well as the management

accounting department. The measurement methods of the identified environmental costs have been investigated through relevant readings and the current calculation methods used by the case study principal. The reporting of the environmental costs can be verified through the confirmation of current reporting of environmental costs by the case study principal (Financial statements, Corporate Social Responsibility reports, detailed accounting entries of all overhead accounts) and through international mining companies' Corporate Social Responsibility reports and financial statements (for comparison purposes).

### **2.5.3 Data collection methods**

Data was collected via physical collection of data at the case study site, e-mails from the case study principal, accessing reports from [www.corporateregister.com](http://www.corporateregister.com), as well as The McGregor BFA database where financial and integrated reports for various platinum mines were downloaded. This is necessary for a cross-case analysis on the reporting of environmental costs at a platinum mine which will assist in the gap analysis.

### **2.5.4 Data analysis methods**

As this case study is of an explanatory nature, the data will be analysed using *explanation building*. This involves identifying casual links between reality and theory relating to the measuring and reporting of environmental costs. These links or lack thereof will assist in directing future research and will allow for a deeper understanding of the topic (Yin, 2009:141).

The process is as follows (Yin, 2009:143):

1. Making an initial theoretical statement about how environmental costs should be measured.
2. Comparing the initial findings of the case study against such a statement.
3. Revising the statement.
4. Comparing other details of the case against the revision.

A firm or organisational-level logic model will be used to understand the allocation of expense items to certain cost elements.

## **2.6 Limitations of the research method**

Case based research has received a lot of criticism in terms of not being a desirable method for research in the field of science (Kennedy, 1976). This is due to the fact that the case study requires

intensive en extensive planning and validity checks so as to ensure that the outcome of the research can be viewed as a true reflection of a desired outcome. The responsibility lies in the researcher in proving that these checks have been done correctly and that the data which was collected has been treated objectively and fairly (Yin, 2009:14). Case studies are also frequently faulted in terms of not being able to articulate into generalised scientific application. It should, however, be remembered that case studies test theoretical propositions and not the representations of a sample. A good counter argument would be that of Lipset, Trow and Coleman (1956), who state that a single case study is not done to “particularize”, but rather to “generalize”.

Case studies are also criticised for being too time consuming and that the result of all this research only leads to an enormous amount of unreadable data. This bias is only based on case studies done in the past and can be rectified if the researcher takes extreme care in the setup of an appropriate database for data collected and writes the case study in such a way as to avoid lengthy, narrative discussions (Yin 2009:15).

Most criticism of case studies can be dismissed; however, it remains clear that case studies are difficult to compile and great care should thus be taken when conducting case study research (Yin, 2009:16).

## **2.7 Summary**

This chapter discussed the research design and methodology required for achieving the two objectives of the study (pg.10-11).

As discussed, this study is a World 2 type study with an empirical approach to research where secondary, numerical and textual data with medium control will be used. This study will include applied, explanatory and exploratory research. In light of the fact that these dimensions indicate an evaluation research design (Mouton, 2011:161) it has been decided that a case based research design be followed.

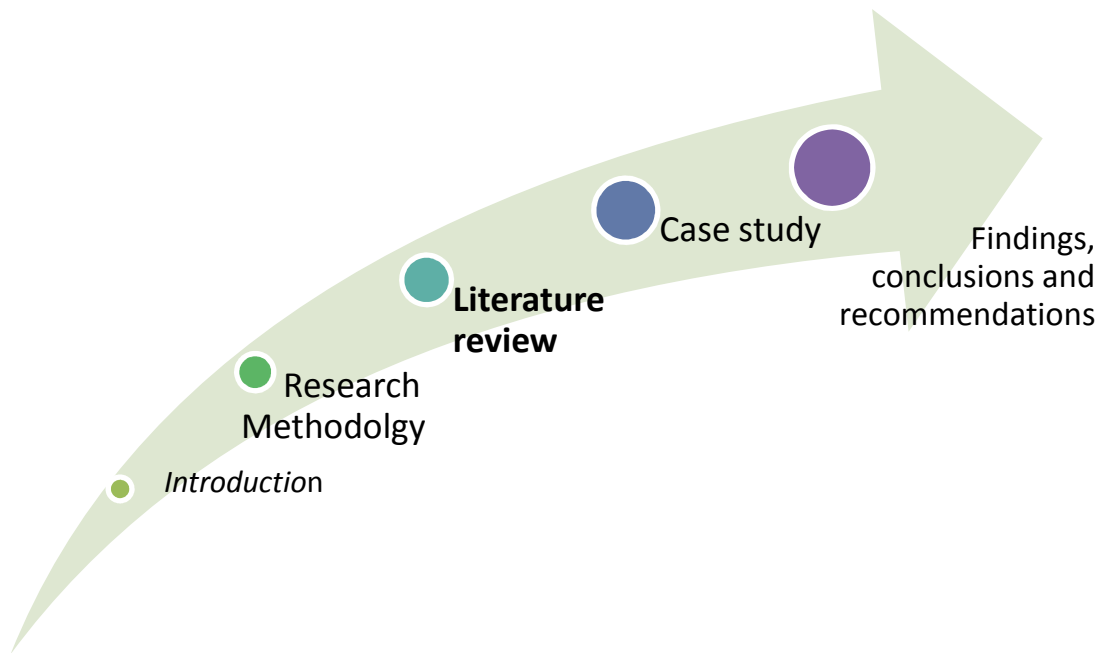
The case study was designed with the use of a case study protocol so as to ensure internal and external validity of the study. The case study protocol identified possible issues that can be encountered during the case study pertaining to the definition of the case study’s environment; the costs applicable to the environment defined need to be identifiable, various measurement methods of the identified environmental costs need to be investigated, and the reporting of these costs needs to be confirmed.

Access to the relevant information was granted by the case study principal and a confidentiality agreement signed between the researcher and the case study principal. Data was collected via email, internet, and a site visit which was analysed using three methods, explanation building, the building of an organisational-level logic model and rival explanations, in order to understand the allocation of expense items to certain cost elements.

The limitation of this research method lies therein that the validity of the research can be easily violated if thorough planning and checks have not been in place from the start of the research. This limitation can be overcome through validity checks that are put in place, the objective, and fair treatment of data by the researcher. *It should be remembered that a case study is a test of theoretical propositions and not a representation of a sample.*

Chapter 3 will discuss the underlying literature on environmental accounting which will be used to answer questions one to four in regards of the first objective, i.e.:

1. Why do environmental costs need to be measured?
2. Which environmental costs need to be measured?
3. Which methods should be used to measure the environmental costs identified?
4. How are these environmental costs accounted for in the financial statements of the company, i.e. where these costs should be reported?



## **Chapter 3**

### **Literature review**

#### **3.1 Introduction**

The aim this chapter is to reach the first objective of this study, which lies in answering the first four research questions. The questions of which environmental costs need to be measured and why, which methods of measurement to be used and where these costs should be reported, are answered through a critical review of the literature and previous underlying research in environmental management accounting.

The importance of measuring environmental costs (i.e. management accounting) in the modern company profile will be discussed in section 3.2. The origin of Environmental management accounting, including its definition, will be discussed in section 3.3 along with environmental costs (cost categories) to be measured. Section 3.4.1 will involve a discussion on the measurement methods available for measuring environmental costs and comprises material flow cost accounting, activity based costing, life cycle costing and a combination of methods that includes resource accounting. These categories and methods are defined; discussed and critically reviewed in order to derive which environmental costs are applicable to the platinum mining sector, as well as which method will be the most appropriate method to use in the extraction industry. Section 3.4.2 focuses on the reporting of environmental costs in the financial statements.

### **3.2 The importance of environmental management accounting**

In order to answer question one it is important to note that environmental issues are an increasing concern for internal and external stakeholders in the mining industry (Frick, 2002; IFAC, 2005; Jenkins & Yakovleva, 2005; Alewine & Stone, 2010). Environmental management accounting adds value to the internal management process with a specific focus on the environment. External reporting of environmental management accounting information is becoming more prevalent as shareholders and other stakeholders of companies increasingly require these types of information (IFAC, 2005:23). It is important, in particular for mining companies, to adopt strategies in order to provide evidence of good mining practices especially during these times where mining has had such negative impacts on landscapes and communities around the world (Pettersen, 2008).

The main focus areas of environmental management accounting can be categorised as follows (refer to Figure 5, pg.31):

- Compliance
- Eco-efficiency
- Strategic position

Several environmental guidelines and policies exist with which companies are encouraged to comply with. This compliance is not compulsory or mandatory, but is considered necessary in achieving good corporate governance (Institute of Directors, 2009; Jasch & Savage, 2008). Through compliance and good corporate governance, a company can be more eco-efficient as the effects of environmental impacts are made known to management. Hence, inefficiencies within the company can be identified and addressed (IFAC, 2005:24; Jasch & Savage, 2008). In reducing inefficiency a company can improve its long-term strategic position by continuously evaluating and assessing their compliance and eco-efficiency standing. This will require that a company addresses environmental issues at a higher level within.

By making use of data envelope analysis (DEA) in a study, Buys, Oberholzer and Prinsloo (2011) have proven that platinum mines in South Africa are not achieving economies of scale in relation to reporting on environmental impacts pertaining to the Global Reporting Initiative guidelines. This study emphasises the importance for mining companies, especially platinum mines, to focus on increasing their economies of scale through improved environmental management by applying environmental management accounting principles.

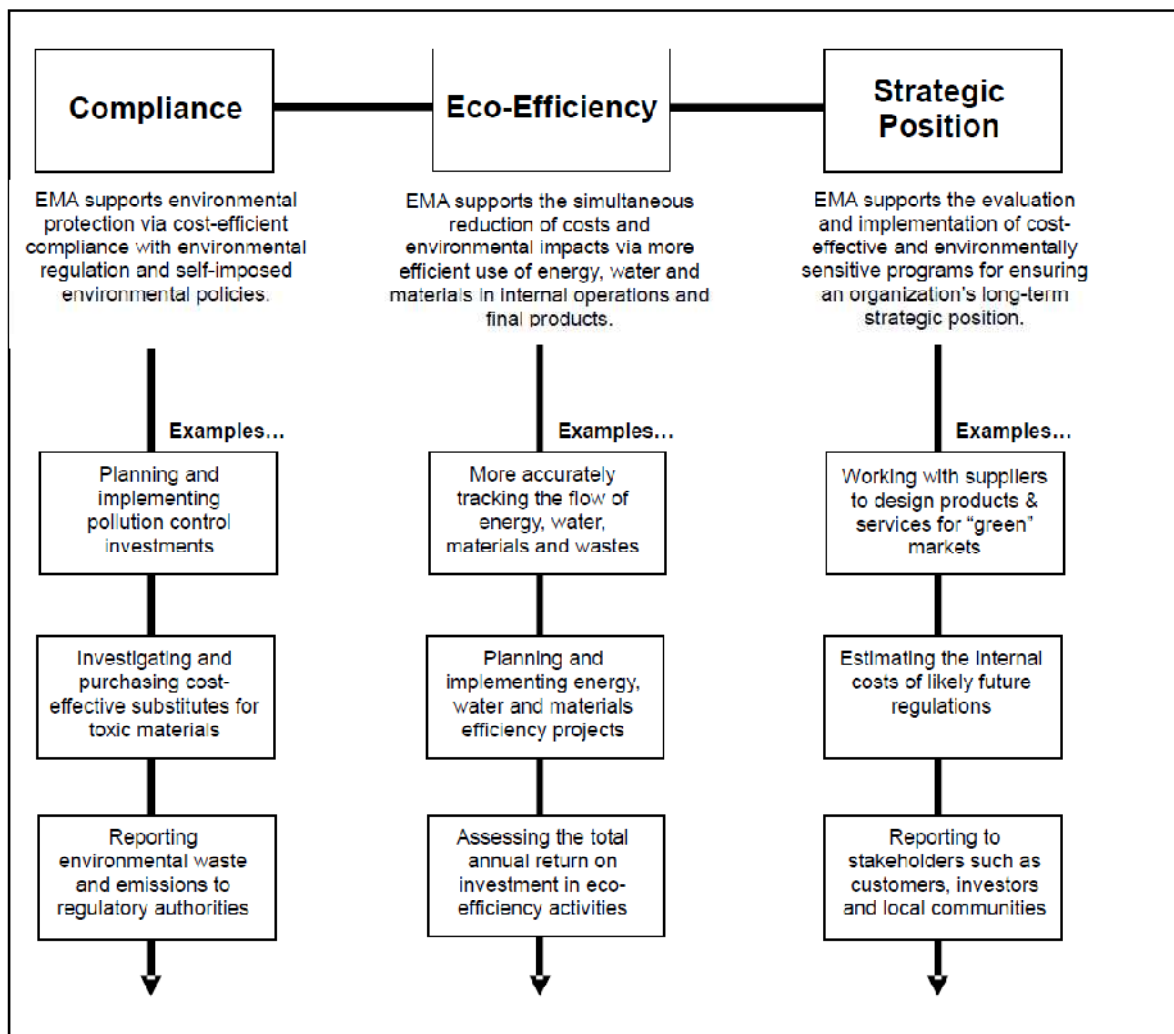


Figure 5 Uses and Benefits of environmental management accounting (IFAC, 2005:24)

Platinum group metals are being used in a wide range of environment-related technologies such as catalysts for chemical process facilities, catalytic converters for exhaust control in transport, electronic components, hydrogen fuel cells, a variety of speciality medical uses, etc. The demand for these metals can only be expected to increase in future as rising pressures to meet environmental challenges are placed on companies (Glaister & Mudd, 2010). The extraction of natural resources from the earth's core has currently instigated several debates on how mineral extraction can be sustainable. In considering only the environmental impacts, the mining industry can ensure environmental protection against natural resource exploitation and rehabilitate land to allow further use for following generations (Jenkins & Yakovleva, 2005).

Mining companies can achieve this by considering their environmental costs and including them in their internal decision making processes. External reporting on these costs will direct investment and shareholder attention to the impact that these costs have on their returns, thereby forcing mining companies to manage environmental issues in such a way as to ensure sustainable development. If platinum mining does not comply with sustainable mining principles, South

Africa's economy will be negatively affected in a large sense. Environmental issues need to be first priority in planning and control of mining companies in order to sustain development in this sector.

Increasing regulation with regards to environmental management is pressuring mining companies to include environmental information in their annual reports (Institute of Directors, 2009; IFAC, 2005; ISO, 2009; ISO, 2010; GRI, 2013) Figure 6 indicates the existing interrelationship between environmental management accounting, Corporate Sustainable Development, GRI, and the various standards related to social health and safety, the environment and sustainability.

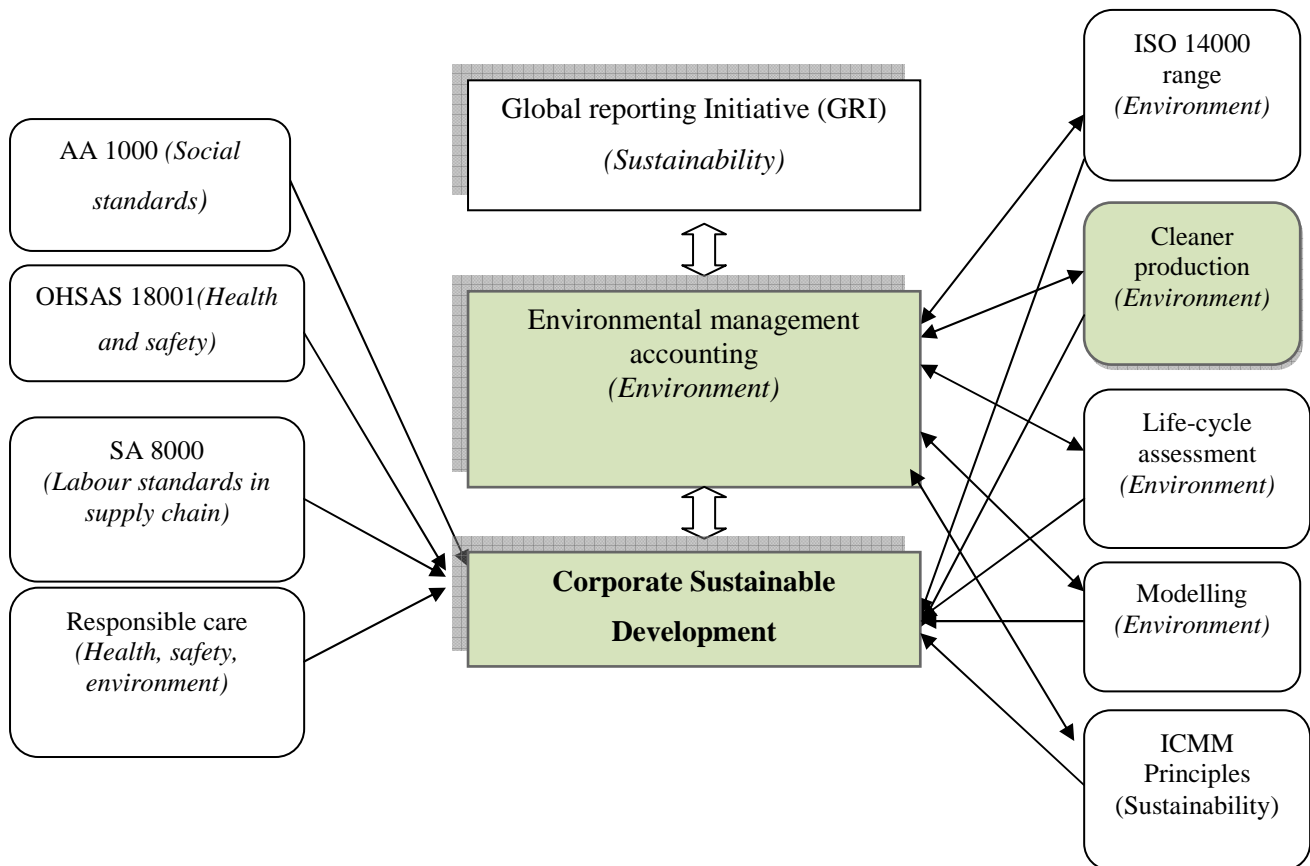


Figure 6 Sustainability inter-relationships (Möhr-Swart, Coetzee & Blignaut, 2008)

Corporate sustainable development has various standards and guidelines which direct and enforce compliance pertaining to social and environmental aspects. Adhering to these standards will ensure that a company develops a sustainable environment. However, in order to adhere to these standards and guidelines a company should have certain measures and tools in place. These measures and tools are defined in environmental management accounting. To assist companies in achieving sustainable development, the Global Reporting Initiative has published reporting guidelines including the measurement of environmental aspects amongst others.

Previous studies indicate that it does pay to be green in the long term (Bragdon & Marlin, 1972; Porter & Van der Linde, 1995; Bhat, 1999; Griffin & Mahon, 1997; Pava & Krausz, 1996; Salama, 2003; Schaltegger & Figge, 1997; Schaltegger & Synnestvedt, 2002), although a lot of criticism tends to indicate the opposite (Telle, 2006:195; Norman & MacDonald, 2004). If annual reports of mining companies can indicate the financial impacts of environmental costs and cost savings due to increased environmental management, companies worldwide would increasingly pay more attention to the current impacts of their production on the environment.

Roger Baxter, Head of Economics and Strategy of the South African Chamber of Mines, cannot overemphasise the importance of mining for the South African economy. Statistics reveal that mining contributes 19 percent to South Africa's GDP, 50 percent to its exports, provides job opportunities to 1 300 000 people, and makes up 17.2 percent of the total corporate tax inflow. These statistics alone prove that South Africa needs to look after its mining reserves in order to maintain a healthy growth factor in the future (McKay, 2013, Miningm<sup>x</sup>, 2013).

South Africa provides 70 percent of the global platinum demand, and 21 percent of South Africa's mineral revenues comes from this sector alone (Esterhuizen, 2013). Platinum mining companies need to consider all aspects of cost control in order to remain part of the global mining supply chain as costs of mining are increasing and platinum market prices are decreasing.

According to Chris Griffith, CEO of Anglo Platinum, input costs are increasing at a higher rate than inflation due to *structural changes* in the platinum industry (Miningm<sup>x</sup>, 2013). To remain profitable, South Africa's platinum mining sector needs to consider an extensive view on its current mining practices and how this can be 'cleaned up' to ensure sustainable growth in the sector (Nahman, Wise & de Lange, 2009).

The answer to question one is that traditional accounting practices do not support decision making functions sufficiently in the environmental department due to inadequate information. Environmental management accounting fills this gap by allowing management to access more information on environmental costs and quantities, previously hidden by conventional accounting systems.

Environmental liabilities in the mining environment are increasing and industries in this specific sector are becoming more aware of these. It is currently difficult for most companies to link environmental liabilities to financial effects, the major reason for this being a lack in clear understanding on how to measure these liabilities and how to incorporate them into their financial reporting (De Beer & Friend, 2006).

Using a qualitative matrix evaluation or a streamlined life cycle analysis, including life cycle costing and total cost analysis will assist in addressing the uncertainties mentioned above (De Beer & Friend, 2006).

### **3.3 The origin of environmental management accounting**

This section will attempt to answer question two through defining environmental costs and the origin of environmental management accounting. Environmental management accounting can be defined as the identification, collection, analysis and use of physical information (use, flows and destinies of energy, water and materials) and monetary information (environment-related costs, earnings and savings) for internal decision making (UNSD, 2001; IFAC, 2005:19) (See Figure 7). This is important to note as this section will attempt to add to the answer of question one and answer question two.

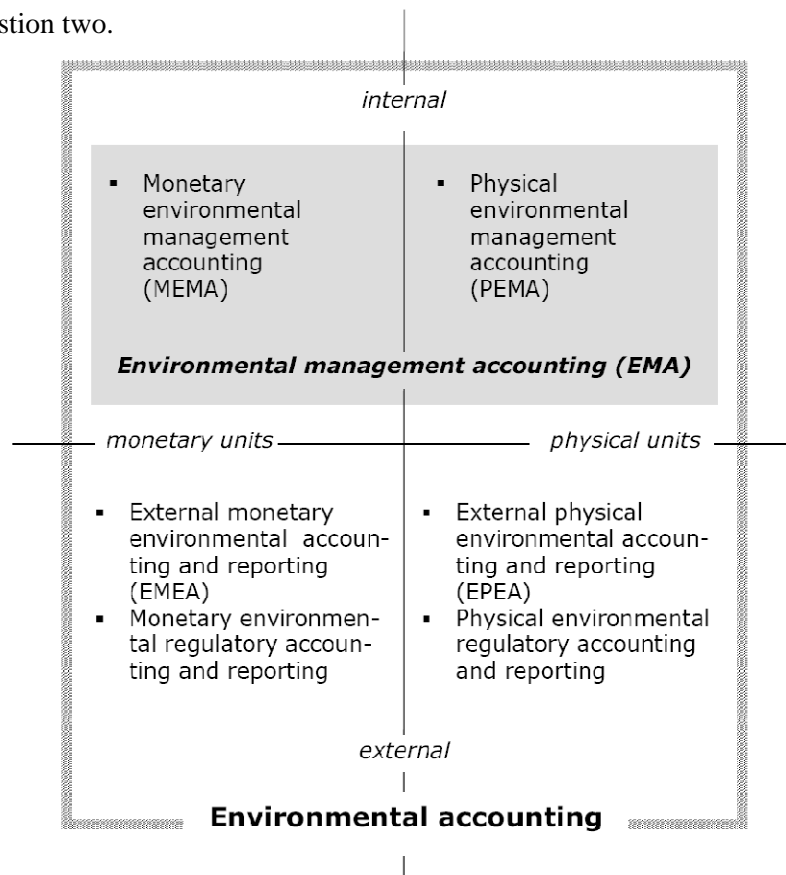


Figure 7 Environmental Accounting systems (Burritt, Hahn & Schaltegger, 2002)

*Internal information* is information that is used by management for internal decision making. These reports are not published and are not available to the public due to the confidential information that they may hold regarding the business processes of a company. These reports need

to include all aspects of the company in order to ensure that management makes informed decisions on a daily basis. *External information* is information that is published and available to the public. These reports usually need to answer the questions of stakeholders pertaining to various topics such as economical performance as well as their social and environmental performance amongst others. Physical information regarding environmental accounting refers to the flow of energy, water, materials and wastes.

*Management accounting* assists in answering the needs of management with regards to internal information primarily, and should include monetary and as well as non-monetary information to support internal decision making (Jasch & Savage, 2008). Consequently, *environmental management accounting* includes internal costs that have direct and indirect impacts on the environment (Schaltegger & Wagner, 2005). *Financial accounting* addresses the needs of external stakeholders through the reporting of standardised financial information (Jasch & Savage, 2008), while *environmental accounting* includes environmental costs in these external reports. Environmental accounting is dependant on environmental management accounting for the measurement and recording of environmental costs.

*Physical environmental information* keeps record of all physical inputs and outputs that relate to material and energy flows (UNDSD, 2001; IFAC, 2005). Keeping record of physical information is of utmost importance as it can be used to determine inefficiencies within the company's business processes. *Monetary environmental information* on the other hand consists of all the costs and earnings relating to the environment (UNDSD, 2001; IFAC, 2005).

Environmental management accounting embodies and merges two of the three pillars of sustainable development, namely economics and the environment, and describes how they affect a company's internal decision making processes (Herzig, Viere, Burritt & Schaltegger, 2006). Sustainability accounting was developed to assist companies in collecting, analysing and communicating corporate sustainability information. This information is an important component in assisting management's efforts to address corporate sustainability challenges (Schaltegger, Bennett & Burritt, 2006). The challenges it attempts to address relate to the three dimensions of sustainability and their interrelationship, namely ecological-environmental, social and economic. The interrelationship in the sustainability triangle is clearly illustrated in Figure 8, pg.36.

Effectiveness in the sustainability triangle refers to the goal of management when attempting to improve a single dimension of the triangle. Effectiveness can be measured in absolute values (Schaltegger *et al*, 2006) whereas efficiency on the other hand describes the relationship between these dimensions and is measured by using ratios (Schaltegger *et al*, 2006). This research will

focus on the ecological angle and how eco-efficiency can be improved within sustainability accounting.

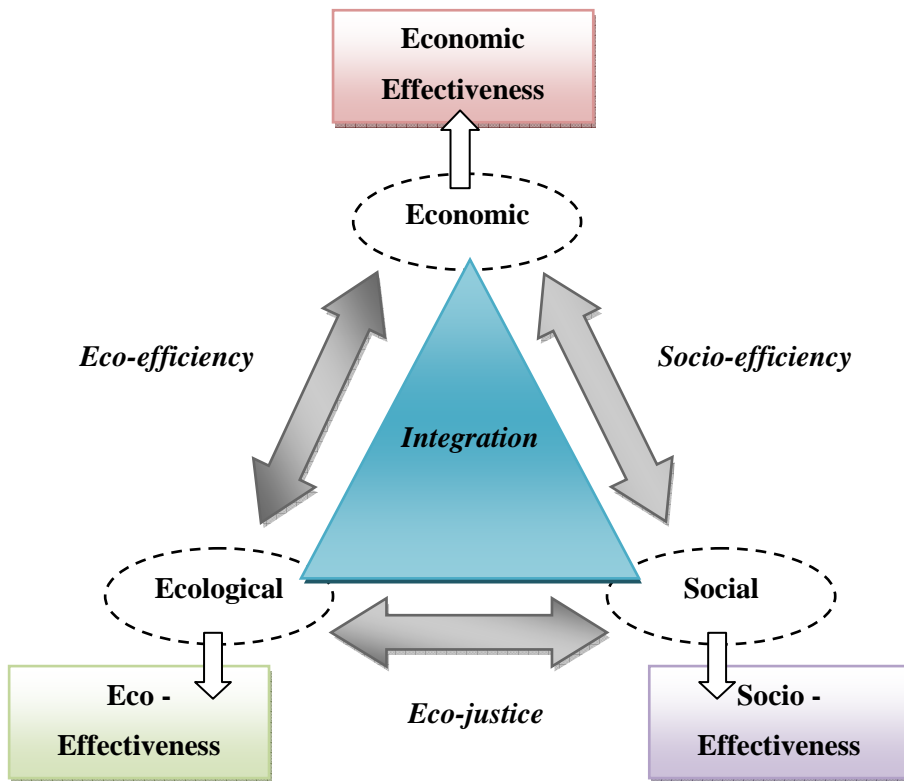


Figure 8 Sustainability triangle (Schaltegger *et al.*, 2006)

The ecological challenge involves increasing ecological effectiveness of activities, or otherwise stated how the impact of business activities on the environment are reduced (Schaltegger *et al.*, 2006). These attempts to measure the impacts on the environment, lead to the introduction of physical environmental management accounting (Figure 7, pg.34).

Physical environmental management accounting (see Figure 7, pg.34) tracks the physical flow of inputs and outputs during the production process. Accounting departments need to work very narrowly with other departments (environmental departments, production departments and other operational departments) so as to accurately determine the physical input and output units that are required to apply physical environmental accounting practices (IFAC, 2005:30). Flow cost accounting is used to assist in the detailed accounting of the physical flow of material through every stage of the business process. Once this data has been collected, it can be used to assist in the generation of environmental performance indicators. In turn, environmental performance indicators assist companies in assessing and reporting the material related aspects of its environmental performance (IFAC, 2005:32).

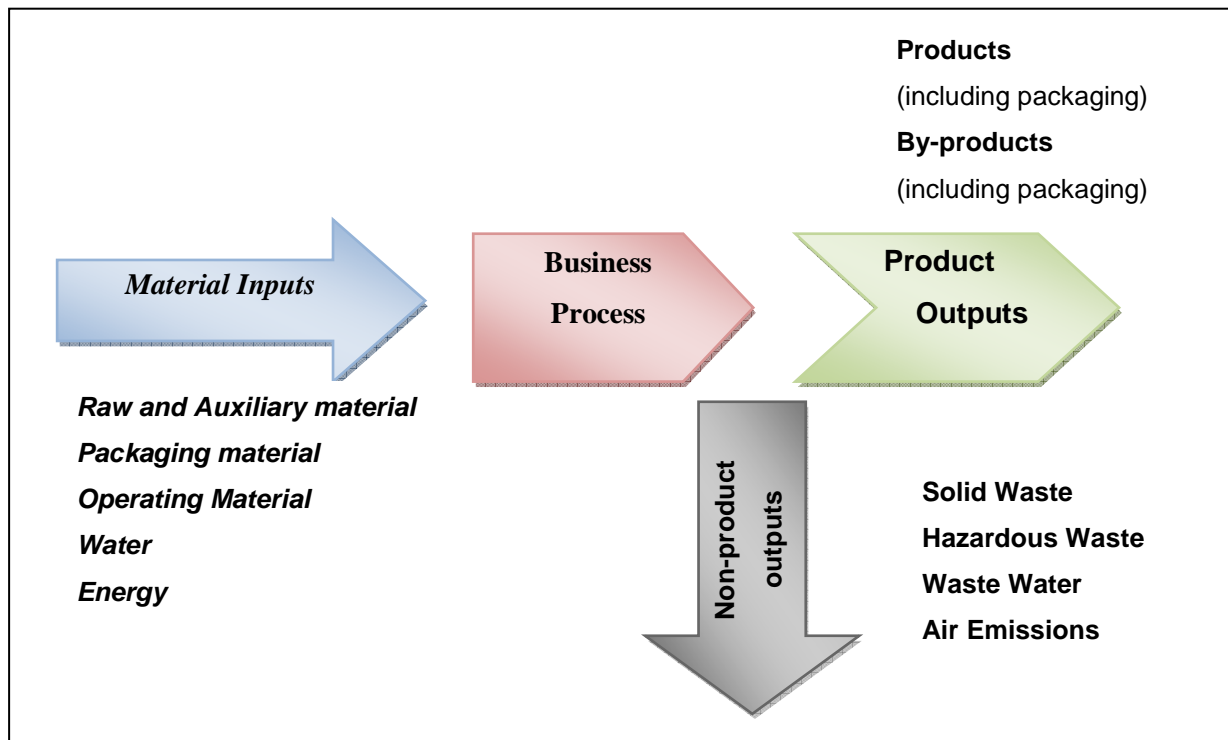


Figure 9 Environmental management accounting: Input - Output types adapted from IFAC, 2005:33

Figure 9 refers to the input-output types applicable in environmental management accounting. The inputs and outputs indicated in Figure 9 comply with the ISO 14031 environmental performance indicators for operational systems. These categories can be adjusted to suit the mining sector (IFAC, 2005:33) and will assist in answering question two.

According to IFAC (2005), input and output categories are:

*i* Material inputs

- *Raw and auxiliary material* inputs are inputs that form part of the product output. Raw materials are major product components whereas auxiliary material refers to the minor product components.
- *Packaging material* refers to the inputs for use in the despatching of the product outputs.
- *Operating material* refers to the inputs that become part of the non-product outputs
- *Water* includes all the water used from all sources (rainwater, groundwater, surface water from rivers and lakes).
- *Energy* refers to all energy sources including gas, coal, electricity, fuel oil, district heating and cooling, biomass, solar, wind and water.

*ii* Product outputs

- *Products (including packaging material)* refer to physical products that will be delivered to customers.

- *By-products* refer to the minor products that were produced during the production of the main product resulting in additional revenue flows to the company.

iii Non-product outputs

- *Solid waste* is the non-hazardous waste in solid form (waste paper, plastic, food waste, scrap products, etc.)
- *Hazardous waste* includes any form of flammable, infectious, toxic or carcinogenic waste material.
- *Waste water* refers to contaminated water as a result of the production process.
- *Air emissions* can be defined as the contamination of the air streams and includes the following: nitrogen oxides, sulphur dioxide, carbon monoxide, particulate matter consumed and volatile organic compounds, metal particulates, radiation, noise and heat.

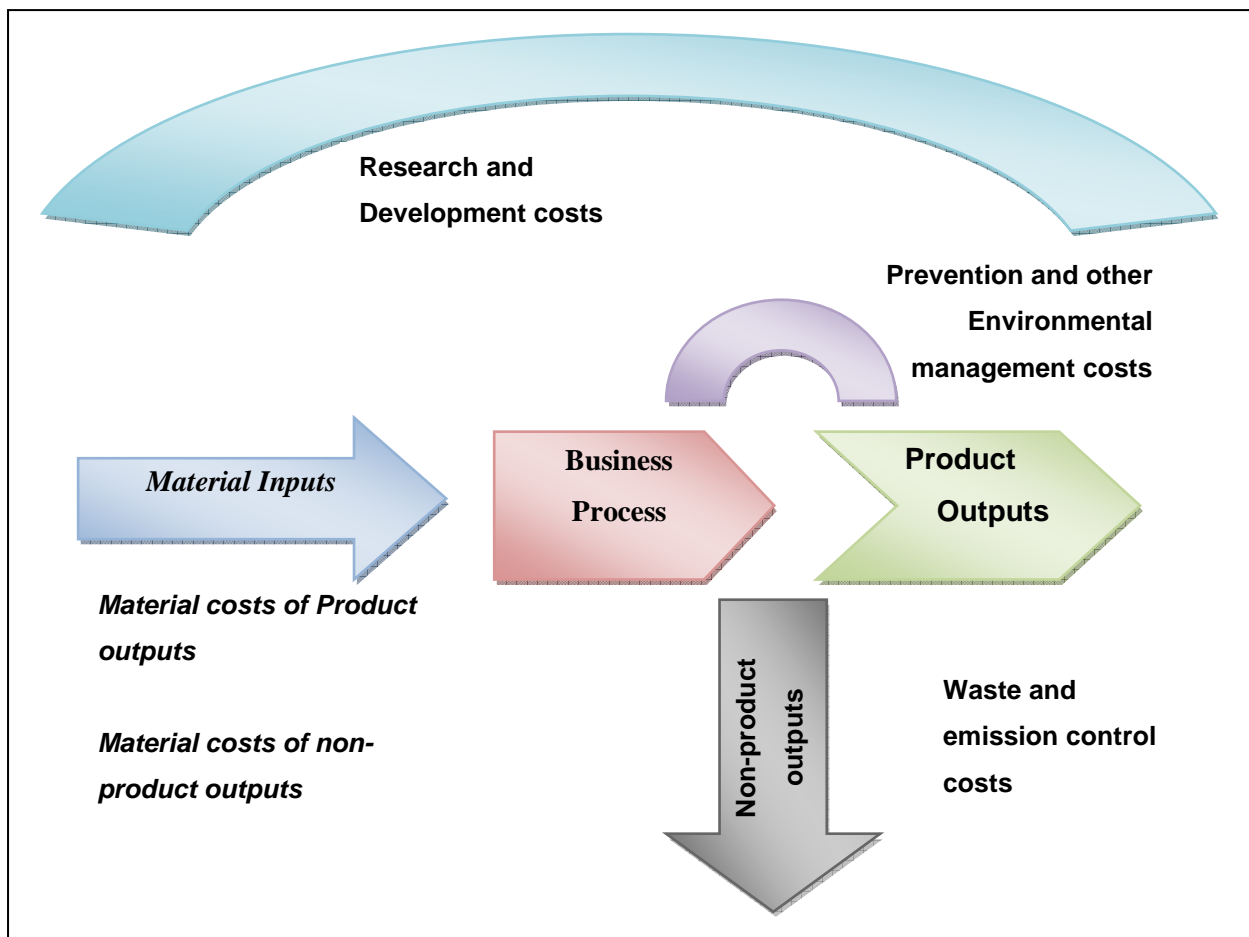


Figure 10 Cost categories for environmental management accounting (own research)

Eco-efficiency (Figure 8, pg. 36) is the link between monetary and physical environmental management accounting (IFAC, 2005:41). Monetary environmental management accounting attributes a monetary value to the physical units measured in physical environmental management

accounting. These values can assist companies in measuring their economic performance (profitability) in relation to their environmental performance. Various cost categories should be considered when monetary environmental management accounting is applied (Figure 10, pg.38).

Cost categories that should be included in environmental management accounting and answers question two, are (Jasch, 2001:23):

- Waste and emission treatment which should include the following elements:
  - Depreciation for related equipment
  - Maintenance and operating materials and services
  - Related personnel
  - Fees, taxes, charges
  - Fines and penalties
  - Insurance for environmental liabilities
  - Provisions for clean-up costs, remediation.
- Prevention and environmental management, which includes:
  - external services for environmental management activities,
  - personnel for general environmental management activities,
  - research and development,
  - extra expenditure for cleaner technologies, and
  - other environmental management costs.
- Material purchase value of non-product output refers to:
  - raw materials,
  - packaging,
  - auxiliary materials,
  - operating materials,
  - energy, and
  - water.
- Environmental revenues, which entails:
  - subsidies
  - awards received for the successful implementation of preventative and corrective procedures in regards to environmental impacts.

IFAC (2005:55) incorporated the following costs categories into their definition of environmental costs:

- Materials costs of product outputs:
  - Raw and auxiliary materials

- Packaging materials
- Water.
- Research and development costs.

Some of these cost categories are difficult to apply to the mining sector, as this sector involves the extraction and refining of minerals and not necessarily the production of goods. The case study will assist in compiling cost categories specifically for the platinum mining sector

### **3.4 Methods of applying environmental management accounting in theory**

This section will focus on answering questions one to four of the first objective of this study which aims to identify the current measurement methods and reporting of environmental costs in the platinum mining sector of South Africa. The literature on the calculation of environmental cost information lacks a *clear* framework that can be applied by mining companies to assist them in the calculation of the total environmental costs which they incur. To address this issue the Global Reporting Initiative (GRI, 2013) has compiled a Mining and Metals sector supplement which will assist mining companies in compiling their Corporate Social Responsibility reports with a lot more ease as it provides Mining and Metals sector-specific commentary. However, it should once again be emphasised that it only assists in what physical units of environmental issues should be reported on.

The Mining and Metals sector supplement (GRI, 2013) was compiled to assist mining and metal companies with reporting issues specific to their sector. These additional guidelines assist companies within this sector to identify important aspects to include in their CSR reporting through sector specific management approaches, sector specific indicators, additional data points to the G4 indicators as well as additional guidance to the G4 indicators (GRI, 2013).

For the purpose of this study only the additional environmental indicators will be discussed. These additional indicators include the following (GRI, 2013):

- Biodiversity
  - Mining companies own or hold licences over large areas of land. Extraction sites, infrastructure and other mining activities may disturb proportions of this land holding. The impact of this disturbance to habitats and biodiversities should be assessed more accurately against the land disturbed as well as the amount of land returned to beneficial use.

- Mining operations needs to manage these disruptions to habitats and biodiversity. They should report on the number and percentage of total sites identified as requiring biodiversity management plans according to stated criteria and the number and percentage of those sites with plans in place.
- Effluents and waste
  - The mining sector deals with large quantities of material due to its extractive nature. Total amounts of overburden, rock, tailings and sludges and their associated risks should be reported in order to indicate the company's ability to manage risks and mitigate any potential consequences.

Currently, most CSR reports only report on the physical information in their external reports; very few companies can provide monetary information on environmental issues (Jasch, 2009:2). To expand on the current benefits in the physical information published, companies need to compare these units to monetary values in order to realise the impact of environmental control on their organisation (internal) as well as the impact on shareholder value (external) (Burrirt *et al*, 2002; Prinsloo, 2010:112). Environmental management accounting considers environmental and economic interrelationships by indicating the organisation's impact on the environment and the effects of the environment on the organisation (Burrirt, 2005). To be able to report on this interrelationship, a comprehensive framework for environmental accounting has been constructed to represent key aspects in the link between environmental management accounting and environmental risk management. Each element in the matrix (Table 2, pg.42) represents the tools that environmental management accounting lends to management.

		Environmental Management Accounting							
		Monetary Environmental Management Accounting				Physical Environmental Management Accounting			
		Short term focus		Long term focus		Short term focus		Long term focus	
		Risk	Return	Risk	Return	Risk	Return	Risk	Return
Past/Present Orientated	Routinely generated information	1. Environmental cost accounting (e.g. variable costing, absorption costing, activity based costing)		2. Environmentally induced capital expenditure and revenues		9. Material and energy flow accounting (short term impacts on the environment such as product, site, division and company levels)		10. Environmental (or natural) capital impact accounting	
	Ad hoc information	3. Ex post assessment of relevant environmental costing decisions		4. Environmental life cycle (and target) costing		11. Ex post assessment of short term environmental impacts (e.g. of a site or product)		12. Life cycle inventories Post investment assessment of physical environmental invest appraisal	
Future Orientated	Routinely generated information	5. Monetary environmental operational budgeting (flows)  Monetary environmental capital budgeting (stocks)		6. Environmental long term financial planning		13. Physical environmental budgeting (flows and stocks) (e.g. material and energy flow activity based budgeting)		14. Long term physical environmental planning	
	Ad hoc information	7. Relevant environmental costing (e.g. special orders, product mix with capacity constraints)		8. Monetary environmental project investment appraisal  Environmental life cycle budgeting and target pricing		15. Relevant environmental impacts (e.g. given short run constraints on activities)		16. Physical environmental investment appraisal  Life cycle analysis of specific project	

**Table 2 Environmental management accounting comprehensive framework (Burritt, 2005)**

The following calculation methods for environmental management accounting have been identified by previous research and will form the base for this research.

### **3.4.1 Calculation methods of environmental costs**

This section will answer question three, i.e. how environmental costs should be measured within a company. Environmental costs can be categorised into two categories: costs applicable to environmental protection and costs applicable to material and energy flows, all of which can be reduced by spending on environmental protection costs. From this viewpoint environmental costs can be defined as all costs directly and indirectly related to material and energy use and their

results on the environment (Schaltegger & Wagner, 2005). In Table 3a and Table 3b (pg.44) an overview of current environmental costing methods are indicated:

	Costs of environmental protection		Costs of material and energy flows	
	<i>Past/Present costs</i>	<i>Future costs</i>	<i>Past/Present costs</i>	<i>Future costs</i>
<b>Stand alone calculations</b>	Emission reduction cost(*VDI, 1979; *UstatG, 1974)	Environmental budgeting (*Wagner and Janzen, 1991)		
<b>Full cost accounting</b>	Full costs of environmental reduction (*Fleischman & Paudke, 1977; *Stölzle, 1990; *Haasis, 1992; *Wicke, 1992, CICA, 1997)  <i>Environmental life cycle costing (Klöppfer &amp; Ciroth, 2011; Durucan, Korre&amp; Munoz-Melendez, 2006)</i>	Consideration of the costs of environmental risks (*Neumann-Szyszka, 1994; Harding, 1998)  <i>Environmental life cycle costing for expected future risks and additional costs (Klöppfer &amp; Ciroth, 2011; Durucan, et. al., 2006)</i>	Costs of remaining material (*Fischer & Blasius, 1995; *BMU & UBA, 1996)  <i>Environmental life cycle costing for material and energy flows(Swarr et. al., 2011)</i>	<i>Environmental life cycle costing for expected material and energy flows (Swarr et. al., 2011)</i>
<b>Direct costing</b>	Environmentally orientated direct costing (*Roth, 1992; *Kloock, 1990, 1993, 1995)  Multi-stage direct costing (*Schreiner, 1988)	Costing of future environmental costs (*Freese & Kloock, 1989; *Roth, 1992; *Kloock, 1993, 1995)		

\* These documents are only available in German, the source mentioned these references and they were included here for completeness and to indicate the time frame of research on the methods used to measure environmental cost.

Table 3a Overview of current environmental costing methods updated by the researcher (Schaltegger & Wagner, 2005)

	Costs of environmental protection		Costs of material and energy flows	
	<i>Past/Present costs</i>	<i>Future costs</i>	<i>Past/Present costs</i>	<i>Future costs</i>
<b>Process costing</b>	Activity based costing (Ditz et al. 1995; Heller & Shields, 1995)  Environmentally orientated process costing (*Herbst, 2001; *Seidel & Herbst, 2001; *Letmathe, 1998)	Activity based budgeting (Borjesson, 1997)	Material and energy flow-orientated costing ( <i>Material flow cost accounting or Flow cost accounting</i> ) (Fichter et al. 1997; *Kunert, 1995; *Spengler et al. 1998; *Fischer & Blasius, 1995, <b>Jasch, 2009</b> )  Material and energy flow-orientated activity based costing (Schaltegger et al. 1996; Schaltegger & Müller, 1998; <b>Möhr-Swart, Coetzee &amp; Blignaut, 2008</b> )	Material and energy flow-orientated activity based budgeting (Schaltegger & Burritt, 2000)
<b>Target costing</b>		Environmentally orientated target costing (*Seidel & Herbst, 2001; *Herbst, 2001)		

\* These documents are only available in German, the source mentioned these references and they were included here for completeness and to indicate the time frame of research on the methods used to measure environmental cost.

**Table 3b Overview of current environmental costing methods updated by the researcher (Schaltegger & Wagner, 2005)**

However, environmental costs can be viewed differently depending on a company's view of what the term environment entails. A definition of what environmental costs are and what should be considered as environmental costs should be examined so as to ensure that all possible environmental costs are considered. Burritt (2005) classifies environmental costs using five different costing facets. Each of these facets will identify environmental costs depending on the facet applied:

1. Conventional cost accounting – using job and process costing as well as direct and indirect costing methods.
2. Measurability – some environmental impacts cannot be measured due to a lack of standardised units of measurement for certain natural resources.
3. Quality – refers to prevention costs, appraisal costs, internal failure costs and external failure costs applicable to a product.
4. Life cycle and activity – life cycle analysis that includes research and development costs, design costs, production etcetera. Activity assists in identifying activity cost drivers.
5. Target audience – this address the needs of various stakeholders (internal and external).

Various different measurement methods can be applied, depending on how a company classifies environmental costs.

Measuring environmental costs became a focus point in research during the early 1970's. Stand alone calculations were done in an attempt to control environmental impacts. However, this method was re-active in nature and did not take into account integrated technologies or environmental protection costs (Schaltegger & Wagner, 2005). It became apparent that a more structured approach to costing environmental impacts needed to be developed. At that stage current management accounting methods were taken one step further, to include an environmental aspect.

The four management accounting methods are thus:

- i. Life cycle costing
- ii. Activity based costing
- iii. Material flow cost accounting
- iv. Combination of methods, including resource accounting.

*i Life Cycle Costing*

Full cost accounting, also referred to as life cycle costing and total cost assessment (White, Savage & Shapiro, 1996; Norris, 2001; Shapiro, 2001; Hunkeler & Rebitzer, 2001; Hunkeler, Lichtenwort & Rebitzer, 2007) is a method for estimating and accumulating costs for a product over its entire life cycle. This is done to ensure that the profits made during the manufacturing phase of the life cycle will cover expenses occurred during the pre- and post manufacturing phases (Drury, 2012:543). Considering the fact that mining is not a manufacturing industry, the definition needs to be a taken step further: life cycle costing needs to be considered alongside life cycle assessment,

where life cycle analysis involves the assessment of the overall impact of products, production systems as well as human activity on the environment (Curran, 2013).

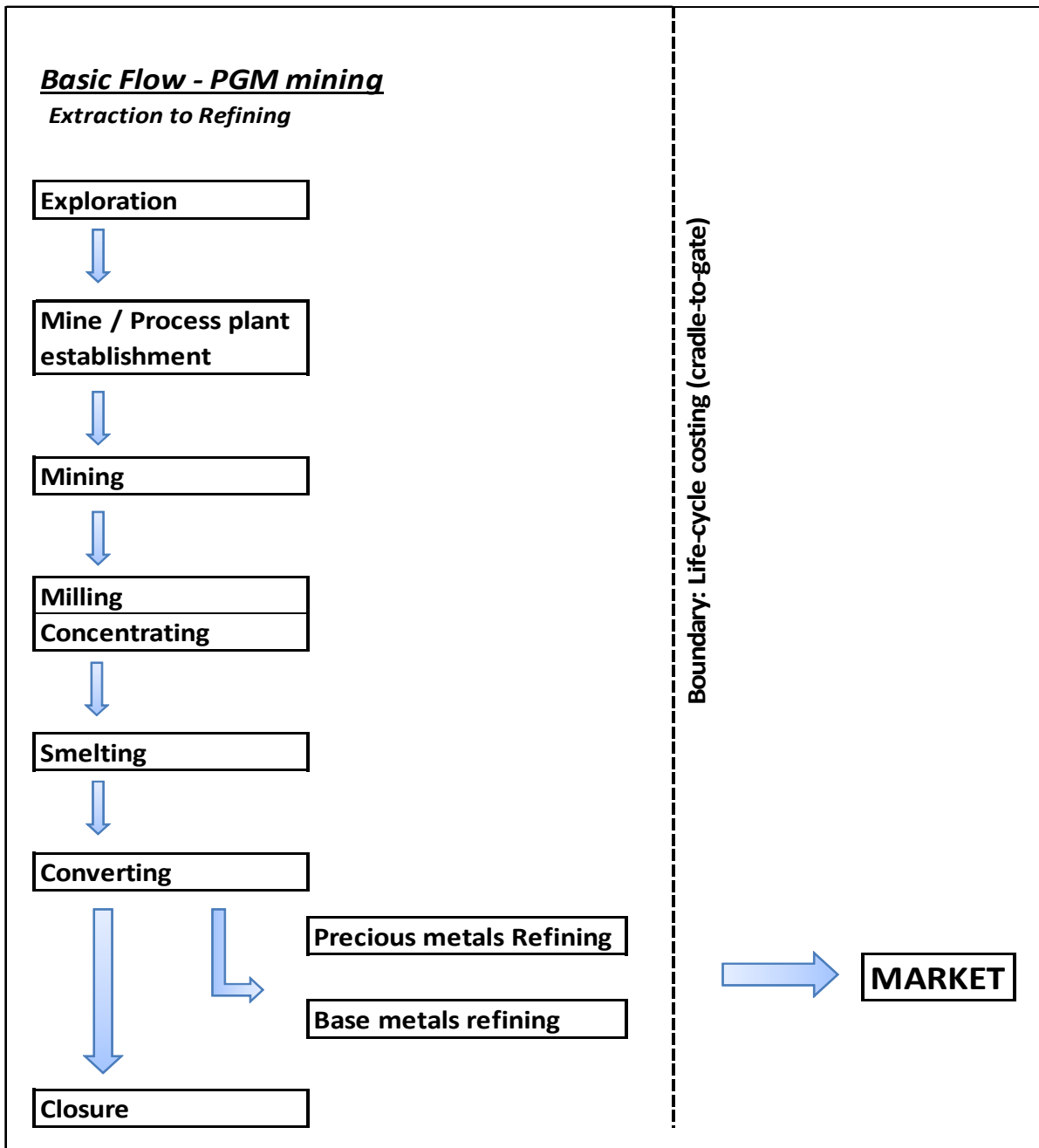
Life cycle analysis is currently done in the mining industry to assist mining companies in assessing their environmental and economic performance (Durucan, Korre & Munoz-Melendez, 2006). Due to the nature and quality of the data required to complete a life cycle analysis, data is not publicly available as it is considered to be confidential information of companies. This tends to result in over simplified reports for mining processes. In order to address this shortcoming, a mining life cycle model (LICYMIN) has been developed using Oracle 9i Enterprise Edition. This model relies on site specific data and provides traceable as well as realistic allocations of environmental impacts (Durucan *et al*, 2006).

Environmental life cycle costing is fully compatible with life cycle analysis (Klöpffer & Ciroth, 2011) thereby allowing environmental impacts in the life cycle of mining to be valued in monetary terms. A study done by Caddy (2011) on the potential benefits of life cycle analysis for the platinum mining industry has indicated that a platinum life cycle analysis should include a financial component for each of the various processes respectively, allowing platinum mining companies to derive true benefits from such an analysis.

Da Silva and Amaral (2009) state that most environmental concerns can be linked to economic aspects – financial benefits are achieved in reducing material and energy consumption. To measure this financial benefit, the total environmental cost of mining should be recognised. When conducting environmental life cycle costing, mining companies should comply with the Society of Environmental Toxicology and Chemistry's (SETAC) code of practice. This document includes a framework which assists in system boundary identification (Swarr, Hunkeler, Klöpffer, Pesonen, Ciroth, Brent & Pagan, 2011).

Platinum has numerous uses, and therefore completing a full life cycle costing analysis from cradle-to-grave would be time consuming adding minimal value to the internal decision making of mining companies. An alternative approach would be a cradle-to-gate measurement, where the life cycle ends when the final product leaves the production site. For this reason, a cradle-to-gate approach is a preferred and the most suitable method when considering life cycle analysis and life cycle costing data for platinum mining. This will include all production, processing and waste handling activities (Durucan *et al*, 2006).

Costs that should be included in a cradle-to-gate approach includes all costs up to the point where platinum or other platinum group metals are sold into the market (Figure 11, pg.47)



**Figure 11 Boundary for life-cycle costing (cradle-to-gate): platinum mining (own research)**

When consolidating life cycle analysis and life cycle costing data the following need to be considered (Swarr *et. al*, 2011):

- Consistent system boundary definition and application in both life cycle analysis and life cycle costing.
- Possibilities of double counting of physical and monetary values in life cycle costing should be avoided by internalising the costs to indicate only real monetary flows.

Epstein (1996) defines full environmental cost accounting as the inclusion of “current costs for past sins”, “current costs for current sins” and the “future costs for current sins” in the product cost calculation. The biggest problem that companies face with regards to environmental management is deciding which costs to include in their product costs. The three elements in Epstein’s definition need to be considered individually as companies view the treatment of these costs differently (Epstein, 1996).

Current costs for past sins are the costs involved in cleaning up and rehabilitating areas that are affected and disturbed by pollution. Companies do not want to include these as part of product costs as these costs can be substantial and including them as part of product costs can affect the profitability of products which is why they consider them as indirect costs instead. Another problem faced by companies when including these costs under product costs is that managers find it difficult to control costs when performance appraisals are being done, and they feel that they cannot be penalised for someone else’s mistakes from decades ago. Management accounting makes provision for the treatment of these costs as follows:

1. charging pollution clean-up costs or rehabilitation costs directly against the shareholders equity,
2. including these costs as part of the product cost (considering full life cycle costing), or
3. capitalising these costs as an asset (the expenditure provides future value in terms of product development or goodwill).

Current cost for current sins refers to current environmental impacts of a product or service. Including these costs as part of product costs is acceptable for companies, but adequate allocation of these costs are lacking as they are not recorded as environmental costs within the accounting systems.

Future costs for current sins make provision for the effects that current production or services will have on the environment in the future. Mining companies in particular have to make provisions for these costs in their financial statements as part of their liabilities (IAS 37) so as to ensure that there will be adequate funds available to rehabilitate the area after the life of mine has been reached.

In light of the issues mentioned above, Epstein (1996) has concluded that most companies do not carefully identify, track or understand the causes of environmental costs. To address these issues companies have started applying life cycle analyses to better their understanding of the impact that every stage of the production process has on the environment. In turn this will allow companies to better recognise and control environmental costs in the future in the application of life cycle costing.

Full cost reporting systems include all the future or actual costs and benefits including environmental and social externalities (Bebbington, Gray, Hibbit & Kirk, 2001). These externalities are measured by using methods which have been developed by environmental economists to estimate their non-market values. Herbohn (2005) conducted an experiment which involved taking these measures of externalities and including them in a full cost environmental reporting system. The experiment failed as a result of the lack of a clear understanding of the reduction of intrinsic environmental values to financial terms. The reason for this is that the environmental economic valuation method's role within the accounting and reporting framework is not clear enough.

The case study principal is using SAP accounting software which makes provision for energy and environmental resource management. However, this however only includes energy consumption and emission data. The case study will provide information on how the case study principal is conducting life cycle analysis and how this can be linked to life cycle costing and a company's accounting system.

#### *ii Activity based costing*

Activity based costing is a cost accumulation system that makes use of activities and cost drivers to assign costs to products or services (Drury, 2012:253; Banker, Bardhan & Chen, 2008), thereby assisting companies in identifying production costs associated with each activity within the production process. This method was developed as an alternative to traditional costing methods which no longer accurately addressed the growing need for companies to allocate overhead costs to products and services. The application of activity based costing in companies improved their decision making processes by granting a better understanding on how resources are used within the company (Raz & Elnathan, 1999). Refer to Figure 12 (pg.50) for the process of cost allocation in activity based costing.

Implementing activity based costing requires skills and knowledge as well as capital (Raiborn & Kinney, 2009). However, mining companies do have access to the necessary skills, knowledge and accounting systems which will allow for various costing structures. Therefore, implementing activity based costing at platinum mines (if it not implemented yet) should be possible without encountering too many obstacles.

Using activity based costing holds several benefits when measuring environmental costs. Managements gain better understanding of why costs arise, thus enabling them to implement

appropriate management approaches such as activity based management (Kaplan & Bruns, 1987; Innes & Mitchell, 1997; Banker *et. al.*, 2008; Blocher, Stout, Cokins & Chen, 2008). Understanding cost behaviour and the reasons that they occur assists management in identifying areas within the company that needs improvement, whether it is product design, pricing decisions or market segments that need to be developed. Furthermore, this will assist management to improve their strategic decision making in the long run (Innes & Mitchell, 1997; Banker *et. al.*, 2008; Blocher *et al*, 2008). Additionally, activity based costing also reveals where value is added and where value is destroyed within a company (Jasch, 2009:114)

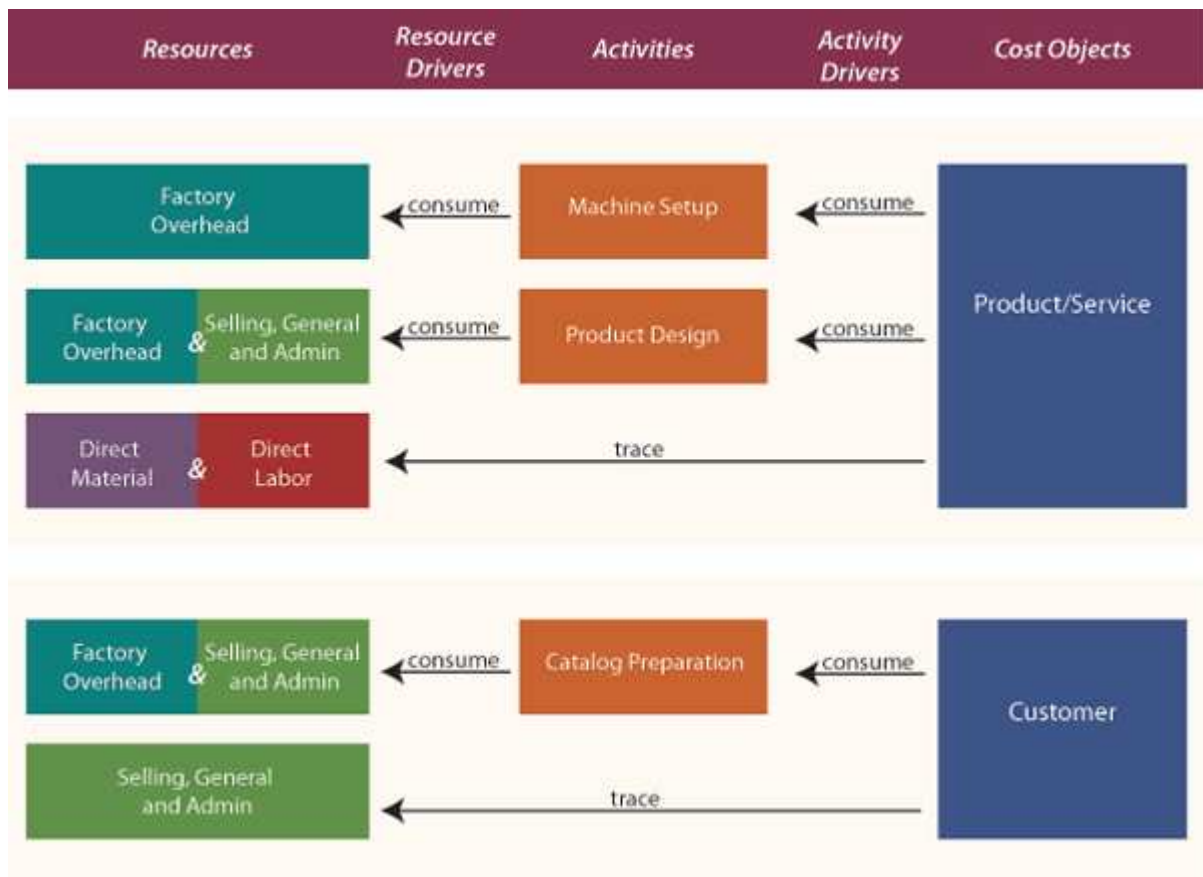


Figure 12 Activity based costing process flow (Principles of Accounting)

The following key cost drivers in the mining industry have a cumulative effect on input costs (Möhr-Swart *et al*, 2008):

- Raw material costs (explosives, timber, clothing)
- Indirect taxes, unemployment insurance funds, skills development funding
- Waste water discharge charge system
- Costs related to meeting the requirements of the Mining Charter and the application of social plans
- Electricity and water cost increases

- Impact of the stronger Rand
- Wage negotiation outcomes
- Potential costs for healthcare funding.

Jasch (2009:116) found that the following allocation keys are applicable to environment related issues:

- Volume of emissions or waste treated
- Relative costs of treating different kinds of waste or emissions
- Direct costs of material inputs, treatments or projects.

When considering sustainable development and environmental costs, the most important factors will be water and energy (Möhr-Swart *et al*, 2008). Several cost elements exist within water and energy consumption which should be considered when measuring environmental costs. These elements are:

a Water

- Normal costs
  - Based on water prices as set by the Department of Water Affairs and Forestry (DWAF)
- Taxes, permits and indirect costs
  - Water use authorisation costs
  - Cost of application, time and effort, uncertainty
  - Waste discharge charge system costs
    - Charges that provides disincentives or deterrents to the discharge of waste
    - Charges to cover the quantifiable costs of administratively implemented measures for mitigation of waste discharge related impacts
    - Predetermined management costs.
- Possible future costs
  - Trading of water use authorisation
  - Water conservation and demand management costs.

b Energy

The Energy Efficiency Strategy of the Republic of South Africa expects the usage of electricity in the mining industry to reduce by 15 percent by 2015. This is achievable if mining companies can manage to pay attention to their environmental costs.

An example of how overhead cost allocation can have an impact on the production costs of products can be seen in Table 4 and Table 5 (pg.53).

<b>Example</b>					
	<b>Product A</b>	<b>Product B</b>	<b>Overhead</b>	<b>Product A</b>	<b>Product B</b>
<b>Material</b>	Direct costs	Direct costs		70	70
<b>Direct labour hours</b>	Direct costs	Direct costs		30	30
<b>Overhead</b>	<b>Distribution by percentage product turnover</b>				
Depreciation			50		
Rent			10		
Energy			5		
Communication			10		
Administration			25		
Waste and emission treatment			10		
<b>Total overhead</b>			<b>110</b>	<b>55</b>	<b>55</b>
<b>Total product costs</b>				<b>155</b>	<b>155</b>

**Table 4 Environmental costs hidden in overhead accounts (Jasch, 2009:114)**

<b>Example</b>					
	<b>Product A</b>	<b>Product B</b>	<b>Overhead</b>	<b>Product A</b>	<b>Product B</b>
<b>Material</b>	Direct costs	Direct costs		70	70
<b>Direct labour hours</b>	Direct costs	Direct costs		30	30
<b>Energy</b>	<b>Attribution to cost centres and products by actual process flows and equipment involved</b>		1	1	3
<b>Waste and emission treatment</b>			1	3	6
<b>Depreciation</b>			7	13	30
<b>Overhead</b>	<b>Distribution by percentage product turnover</b>				
Rent			10		
Communication			10		
Administration			25		
<b>Total overhead</b>			<b>54</b>	<b>27</b>	<b>27</b>
<b>Total product costs</b>				<b>144</b>	<b>166</b>

**Table 5 Environmental costs attributed to cost centres and products (Jasch, 2009:115)**

This data indicates that the total product costs add up to 310 in both cases, but in Table 4 (pg.52) when using a traditional method of including environmental costs in the company's overhead account the total product cost for product A and B are equal, whereas in Table 5 the environmental costs are indicated separately and applied to product A and B. By reporting and allocating these environmental costs separately has altered the product costs of product A and B – product A was over costed when the environmental costs were included in the overhead account and product B under costed. This can have a direct impact on product profitability.

In using the activity based costing method; environmental analysis can be done after each stage of the mining process. In doing so, mining companies can identify which stages of their processes have the biggest impact on the environment as well as their cost structure. This problem area can then be managed to ensure more efficient and sustainable mining.

### *iii Material Flow Cost Accounting*

Jasch (2009:116) defines material flow cost accounting as “a tool for measuring the flows and stocks of materials for a company, production process or product in both physical and monetary units. It is based on an input-output analysis of material flows, but applies a different cost allocation procedure”. According to Strobel (2002) flow cost accounting can be considered as the quantification of factors within the material flow system.

Managing material flows will assist in increasing efficiency of inputs, leading to cost reductions, also having a positive impact on the environment (Strobel, 2002). A considerable percentage of production costs consist of material costs and a large share of these costs comes from material losses within a production system (waste) (UN DSD, 2001; Gale, 2006; Strobel & Redmann, 2002). Naturally, waste does not create value within in a company and where it was previously only measured in physical terms material flow cost accounting now measures waste in monetary terms as well (Onishi, Kokubu & Nakajima, 2008). This assists companies in identifying hidden waste material costs in order to increase production efficiencies and reduce the environmental impacts of the company (Onishi *et al*, 2008; USEPA, 2000). As material flow cost accounting links environmental impacts with cost implications, it is likely to assist in improving in the quality of internal decision making (Onishi *et al*, 2008; USEPA, 2000).

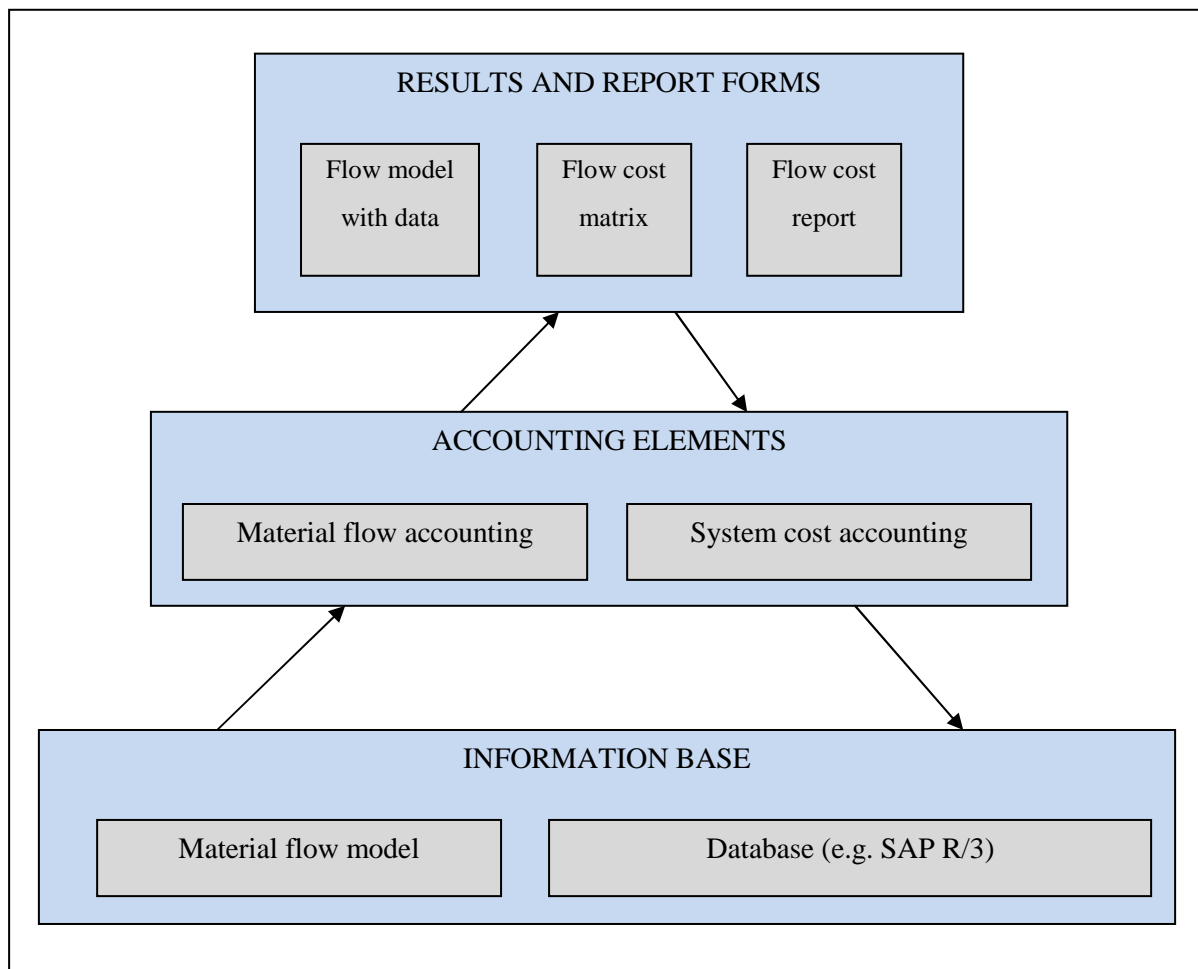
However, material flow cost accounting only assists in calculating the costs of product and non-product (waste) output, and does not calculate the *total environmental costs* (waste and emission treatments, prevention and environmental management costs) incurred by an organisation, whether process or product (Jasch, 2009:116). The implication is that other methods will need to be applied in conjunction with material flow cost accounting in order to measure the total costs of all environmental impacts.

The cost categories in material flow cost accounting are classified as follows (Strobel & Redmann, 2002; Jasch, 2009:119):

- Material costs
  - Physical quantities of materials involved in the production processes and inventories are linked with material purchase prices
  - Costs are separated according to product and non-product output
- System costs
  - The production process uses inputs to produce outputs
  - All costs associated with the handling of material are included (personnel costs, depreciation of machinery)
- Disposal/delivery costs
  - These costs are the costs associated with the finished product and non-product output leaving the organisation

When applying material flow cost accounting, several components need to work together in conjunction with one another: an information base, accounting elements and results (Figure 13, pg.55). The information base includes a material flow model which maps the structure of the

material flow system, and a defined database such as SAP R/3. The data base should include material flows, inventories and other relevant system data. The accounting elements are material flow accounting and system cost accounting, where material flow accounting assists in materials flow quantity assessment, materials flow valuation and material flow costing. On the other hand, system cost accounting is based on materials flow accounting and includes definitions, allocations and apportionments of system costs. This information needs to be communicated to management in order to enable them to make informed decisions: this is done through the reporting of results calculated within the accounting elements (Strobel & Redmann, 2002).



**Figure 13 The components of material flow cost accounting (Strobel & Redmann, 2002)**

However, several shortcomings in this method should be taken in consideration:

- This method makes provision for production companies where inputs are converted into outputs during the production phase.
- Mining is not a production system. It extracts ores which needs to go through a process of smelting and refining until the Platinum Group Metals are purified and sold into the market.

This method can be used if it is adjusted to suit the mining sector's extraction processes

Waste from materials will lead to overspending on weekly budgets and in the worst case scenario not reaching their mining targets. Analysing the reasons for increase in wasted materials can be useful in environmental analysis as it will assist mine shafts in identifying problem areas which may include either insufficient planning or unforeseen underground conditions.

#### *iv Combination of methods*

Several studies indicate that in order to measure environmental costs more accurately a combination of methods should be applied (Kreuze & Newell, 1994; Orbach & Liedtke, 2002; Busch & Liedtke, 2006; Jasch, 2009:114). This will not only assist in the application of environmental management accounting, but will also have additional benefits with regards to environmental performance management. Using activity based costing over and above the life cycle of a product can improve productivity and efficiency, leading to higher net margins (Kreuze & Newell, 1994). Material flows are traced within a company and allocated to back to the cost centre that is responsible for the environmental impact. This will improve environmental performance and ultimately profitability (Jasch, 2009:114). It all comes down to one fact: resources need to be managed efficiently in order to improve productivity and profit margins – using resource efficiency accounting in conjunction with various costing data throughout the company in order to improve the efficiency with which resources are applied.

#### Resource efficiency accounting

Resource efficiency accounting collects and interprets data pertaining to the life-cycle wide material and energy inputs and identifies corresponding costs within a company (Orbach & Liedtke, 2002). This is done by making use of the company's existing cost accounting system. By focussing on cost misallocation, potential cost reductions are identified (Busch & Liedtke, 2006). Resource efficiency may not allocate monetary values to environmental impacts, but hidden costs will be revealed.

Consequently, this method takes material and energy inputs into consideration from an environmental point of view, which are firstly structured, then classified and assigned to single production processes or final products (Liedtke, Rohn, Kuhndt & Nickel, 1998). The problem is that the assumption that fewer inputs lead to improved cost and overall ecological impact is not always valid (Busch & Liedtke, 2006). Financially, fewer inputs would lead to lower costs, but the ecological impact might not have been reduced. A company needs to take both aspects into consideration when making strategic decisions.

The main advantage of this method is that simple impact assessments can be created, generating comparable and manageable results which are illustrated by a resource efficiency portfolio (Figure 14).

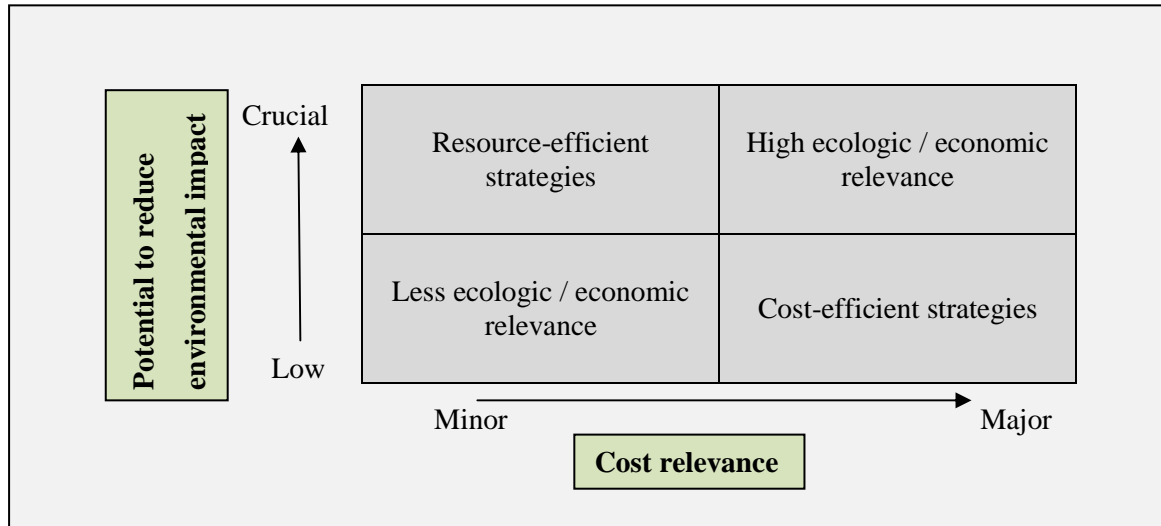


Figure 14 Resource efficiency portfolio analysis (Busch et. al., 2004).

This portfolio simultaneously takes the life-cycle wide environmental data and its corresponding costs data into account. Management decisions can then be aligned with sustainable growth development. The objective of this portfolio analysis is to provide a decision making base for various production processes or products. The Y-axis refers to the material-input orientated, ecological data, and the X-axis refers to the material and energy input cost data (Busch & Liedtke, 2006). For this process to be implemented successfully, deriving information from an input and output analysis in conjunction with material flow accounting is necessary.

The answer to question three is that either one of these methods, or a combination of these methods, can be used in order to measure environmental costs. It will all depend on what the current measurement method of the company is and how they can adjust their current accounting methods to include environmental cost categories.

### 3.4.2 Reporting of environmental costs

This section focuses on answering question four which forms part of the first objective, i.e. how are environmental costs accounted for in the financial statements of the company? Environmental costs can be identified and measured as discussed in section 2.4.1, but what should companies do with these costs after measuring them? Examining International Federation of Reporting Standards (IFRS) from an environmental perspective indicates that the conceptual framework and a few

standards provide grounds for measuring and monitoring environmental assets, liabilities and expenditures. The following standards and interpretations relate to environmental and resource accounting and was researched in a study by Negash (2009), which looked at the relationship between IFRS and environmental accounting in Table 6:

IFRS/IAS number	Title and/ or description	Relevant paragraph(s). Paragraph numbers in parenthesis	Remarks
Framework	Framework for preparation & presentation of financial statements	Accountability (14), relevance (26), materiality (29 &30), substance (35), neutrality (36), prudence (37), completeness (38), liabilities & obligation (60), capital maintenance (81), probability (85), measurement reliability (86), recognition of liabilities (91)	Statement to the effect that sustainability is within the bounds of the conceptual framework of IASB and FASB
IAS 41;	Agriculture		Sector's sensitivity to the environment. See ISO classification and Wiseman's disclosure scores.
IFRS 6;	Exploration & evaluation of mineral resources;	Paragraph (11): requirement for provision and contingencies	Refer to statistics about emissions; production of pollutants; toxic waste disposal systems, ground water pollution & land degradation; depletion, industrial accidents; environmental impact studies.
IFRIC 3 (withdrawn)	Emission rights and allowances	Several paragraphs deal with whether government allocated rights; and the accounting treatment at the start of emission, and the setting aside of provisions.	Kyoto Agreement, Copenhagen Summit; Agreement versus treaty; efficiency of national and global allocation systems, speculation and transferability of emission rights; whether climate change has o boundaries; markets for trading emission and similar rights and their derivatives; sovereign rights; global shared databases (REA).

IAS 20	Government Grants	Initial acquisitions of emission rights & allowances recorded as assets whose valuations are subject to impairment tests.	Government grants could be influenced by the politics of the day. Government can over/under supply the rights certificates; endemic corruptions in the public sector might frustrate the system.
IFRIC 5; IFRIC 21	Decommissioning, restoration & environmental rehabilitation funds; <b>Changes in existing decommissioning, restoration and similar liabilities</b>	Purpose of fund (1), voluntary & required contribution to the fund (2), geographically dispersed sites (2), independent trustees, accounting for interest in the fund (7), obligations to make additional contributions (10), contingent liability (10), reimbursement rights (BC 12)	Disclosure of the size of the fund; arms length of the trustees; plans for additional contributions; responsibility for past degradations; adequacy of the fund.
IFRS 8	Operating segments	Core principle (1), nature of an operating segment (5), aggregation criteria (12), quantitative thresholds (13), disclosure (20), profit/loss/ assets and liabilities (23), measurement (25), geographical information (33)	For a global company whether its branches and subsidiaries are operating in environmentally sensitive sectors; and whether the segment meets the quantitative threshold, or whether it is required to prepare consolidated financial statements, and whether its segments meet international standards.
IAS 27, IFRS 3, IAS 28 and <b>IAS 31, SIC 12 IFRS 10 and IFRS 11</b>	Consolidation, investments in mergers and acquisitions, interests in joint ventures and associates; <b>Consolidated financial statements; Joint arrangements</b>	Several paragraphs relate to ownership, risk, reward, and significant influence.	Group & consolidated statements are prepared for listed legal entities. Listed and unlisted companies might be sued for violating environmental standards in countries where their segments operate/operated in the past. This in turn might trigger an unbundling wave.
IAS 37	Provisions, contingent liabilities & contingent assets	Several paragraphs that require charging current earnings for setting aside normal provisions and contingent liabilities.	Absence and inadequacy of provisions suggests earnings inflation which in turn affects intrinsic (fundamental) values of equities.

IAS 8	Accounting policies, changes in accounting estimates and errors	Accounting policies (10), retrospective application (22), warranty obligations (32 & 33), errors (41), prior period errors (49), impracticability of retrospective adjustments (51, 52 & 53)	The extent to which past earnings require restatement, and how this is going to be shown in past, present and future financial statements (retrospective & prospective adjustments).
IAS 1	Presentation of financial statements	Material omissions (7); purpose of financial statements (9), fair presentation (15), rectification of accounting policies (18), going concern (25), provisions (54), estimation uncertainty (125)	Minimum set of information that must be included in the comprehensive financial statements of environmentally sensitive companies.
IFRS 1	value (16), compound financial instruments (23), parents, subsidiaries, joint ventures & associates (24), changes in decommissioning, restoration and similar liabilities (25E), non IFRS comparative information (36), reconciliations (39) value (16), compound financial instruments (23), parents, subsidiaries, joint ventures & associates (24), changes in decommissioning, restoration and similar liabilities (25E), non IFRS comparative information (36), reconciliations (39)	Accounting policy (97), fair	Fair value of environment related assets, liabilities and provisions.
IFRS 7, IAS 37 & IAS 39, IFRS 9, IAS 38	Financial instruments disclosure, presentation and recognition and measurement, intangibles & impairment		Disclosure of past and present environment related risk(s); qualitative and quantitative description of the effective and non effective hedging strategy; fair value of carbon derivatives and other environment related assets and liabilities.

**Table 6 Summary of Accounting standards that relate to environmental issues (Negash, 2009:16-18) (adjusted – to included latest information)**

Table 6 (pg.60) indicates that the International Accounting Standards Board (IASB) already has a base on which environmental costs can be reported on at a corporate level. Negash (2009) concluded her study by proposing a separate statement on Environmental Assets and Liabilities (Table 7).

<b>Statement of Environmental Assets and Liabilities*</b> <b>As of December 31, 20XX</b>	
<b>Financial information:-</b>	<b>Comparative year</b>
<b>Environmental assets:-</b>	
Cash in trust funds	
Investments in trust funds at fair value	
Emission rights held	
Emission rights held for sale (at fair value)	
Insurance & similar products held against environmental risks	
Contributions to voluntary & mandatory schemes	
Inventory of natural & biological assets & depletions	
Investments in air & water quality	
Capitalized research & development	
Capitalized net site preparation & restoration costs	
<b>Environmental Liabilities and uncertain liabilities (provisions or contra asset accounts)</b>	
Present value of decommissioning, restoration & rehabilitation	
Legal and constructive liabilities arising from past events	
Deferred income from government allocations of emission rights	
<b>Uncertain liabilities (Provisions or contra asset accounts)</b>	
Provision for decommissioning, restoration & rehabilitation (current)	
Provision for decommissioning, restoration & rehabilitation of (past)	
Provision for contingent liabilities from past events	
<b>Net adjustments to retained earnings for past errors &amp; material omissions</b>	
<b>Net surplus (deficit) for current year+</b>	
<b>Estimate of net environmental assets (liabilities)</b>	

\* The statement can be accompanied by the disclosure of minimum non-financial information such as actual and ISO permissible standards of emission, production and disposals of waste, depletion and replacement of natural resources (forestry), major capital projects that lead to deterioration of air and water quality and habitat, and urbanisation.

+ Net surplus (deficit) is achieved after consideration of recurrent income and expenditure such as interest and dividend incomes from environment related investments, tax rebates and dues, recurrent expenditure on environmental protection, current charges for normal provisions for decommissioning and rehabilitation, past errors and omissions, current contribution to independent environmental rehabilitation funds and tax gains and losses arising from hedge activities on environment related products, and more.

**Table 7 Possible Environmental Assets and Liabilities statement proposed by Negash (2009)**

The proposed statement for Environmental Assets and Liabilities was constructed with the use of IFRS, however, it still does not allow for any day-to-day reporting of costs applicable to the environment. These costs have a large impact on a company's profit margins (Castro & Chousa, 2006; Dunk, 2002) and should be included as part of the Statement of Comprehensive Income.

The Global Reporting Initiative only serves as a *guideline* for companies on reporting on physical units (GRI, 2013), but not on reporting of environmental costs. However, IFAC (2005) encourages

companies to report on the physical units of environmental impacts, as well as the monetary values of these impacts, but is also only a guidance document. Companies therefore have the choice of whether they want to implement the IFAC guidelines or not. Implementing these monetary guidelines is often viewed by management as a task that will not add any value to their decision making, and that it will need a large amount of capital and expertise in order to implement successfully.

Environmental reporting awards a sense of visibility to a company's environmental activities and impacts (Milne & Gray, 2007). On the other hand, the danger of corporate environmental reporting lies therein that some companies will want to use this type of reporting as a method of constructing a new image for stakeholders and prospective investors (Hopwood, 2009). In doing so a company creates a new face while shielding internal activities from the rest of the business world (Hopwood, 2009), resulting in a positivistic type of reporting that neglects looking at negative environmental impacts.

Bartelmus (2007) notes that the System for integrated Environmental and Economic Accounting (SEEA) which has been revised in 2003 only elaborates on physical and hybrid environmental-economic accounting and detail valuation methods for natural resources. Monetary valuation of environmental impacts on the other hand is rejected (United Nations, 2003). Consequently, the System for integrated Environmental and Economic Accounting (SEEA) does not fully meet its objective of assessing sustainable development (Bartelmus, 2007). Physical accounting only allows warning signals to be sent with regards to sustainability, but it does not attempt to measure ecological sustainability (United Nations, 2003; Bartelmus, 2007). The environment needs to be given a voice through the language of business, which entails accounting information (Reyes, 2002).

Reyes (2002) distinguishes environmental reporting in three contexts of which each has a different approach to reporting of environmental costs:

- Environmental accounting in the context of financial accounting
  - This context includes information regarding the cost impacts of environmental performance (liabilities, contingencies, impairment of assets and intangibles) which are reported in the financial statements (external reporting).
- Environmental accounting in the context of management accounting
  - This context entails the use of environmental cost and savings in order to improve internal decision making (internal reporting).
- Environmental accounting in the context of auditing

- This context involves the assessment of a company's adherence to IFRS and other GAAP issues in relation to environmental matters that can affect the financial statements (external reporting).

A study done by Castro and Chousa (2006) concluded that many companies report on environmental issues, but that very few include information on the financial impacts of their sustainability performance. This is a great hurdle in the process of integrating the management of sustainability into the decision making of a company and its investors (Castro & Chousa, 2006). The study further indicates that there is value in analysing a company's environmental and social performance in relation to its financial performance. In using SustainAbility (2001) and Rappaport's model (1986) for shareholder added value, Castro and Chousa (2006) found it evident that the link between environmental management and the company's ability to create value has the ability to measure sustainability using financial ratios.

Various guidelines (IFAC, 2005; Institute of Directors, 2009; ISO, 2009; ISO, 2010; GRI, 2013) and regulations (country-specific due to the difference in jurisdiction areas) focus their attention on environmental impact reporting, but only guide the users on physical or non-financial reporting of data (Herzig & Schaltegger, 2006). Therefore, a link should be drawn between environmental reporting and financial reporting. In order to achieve this, a strategy-focused design for sustainability performance management requires an overall change in the traditional accounting systems applied in order to accommodate environmental issues and their financial impacts (Herzig & Schaltegger; Burrit, 2005). From the literature it is evident that many additional measures need to be taken before full reporting of environmental impacts (physical *and monetary*) will be possible, and that more standardised accounting and reporting procedures are needed (Ditz & Ranganathan, 1997; Bennett & James, 1998; GRI, 2013).

Environmental accounting and reporting is necessary in order to answer requirements of a company with regards to environmental dangers, corporate responsibility, relationship between the industry and the environment, measuring of the impact on the environment and the disclosure and reporting of the impacts. This can be explained through the theoretical model constructed by Jones (2010) in Figure 15 (pg.64).

In the sixth premise current accounting are considered to be inadequate – there are currently a wealth of academic research on how to improve accounting systems through the inclusion of environmental aspects, however very little studies have been done on the success of implementing environmental accounting, environmental management accounting in specific. The main reason for this is the fact that conventional accounting is based on a capitalist view – and modern capitalist

accounting has a limited world view where companies only aim to achieve as much profit from their activities as possible even at the expense of the environment (Maunder & Burritt, 1991). This is a very dangerous view point for the mining industry as this industry need to create a sustainable environment to ensure that future generations can use the land and that the biodiversity of the area is protected.

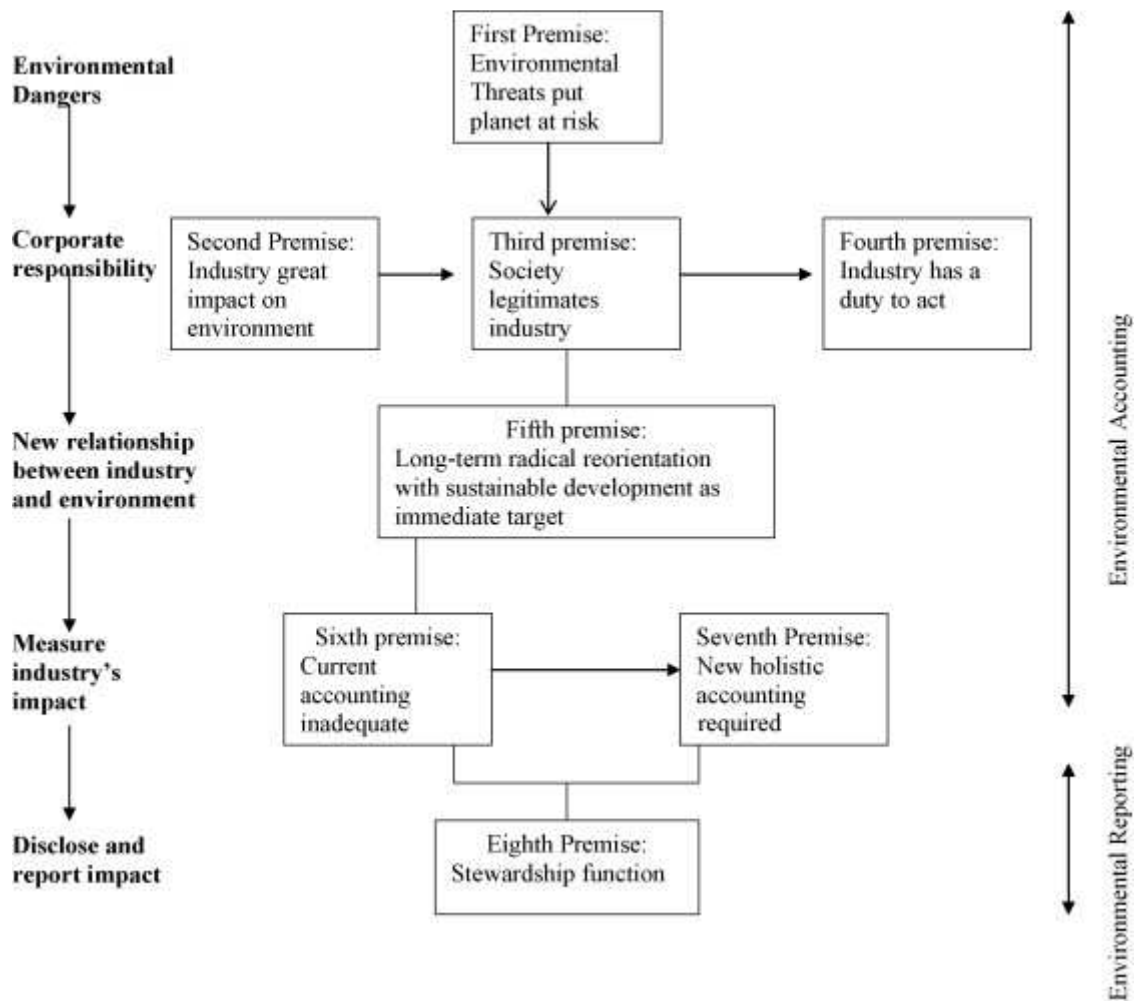


Figure 15 A theoretical model for environmental accounting and reporting (Jones, 2010)

The answer to question four is that environmental costs should be reported on in a company, whether it is in their corporate sustainability reports or whether it is part of their annual financial statements as a separate statement. It is important for companies to be able to measure their economic performance in relation to their environmental impacts.

### **3.5 Summary**

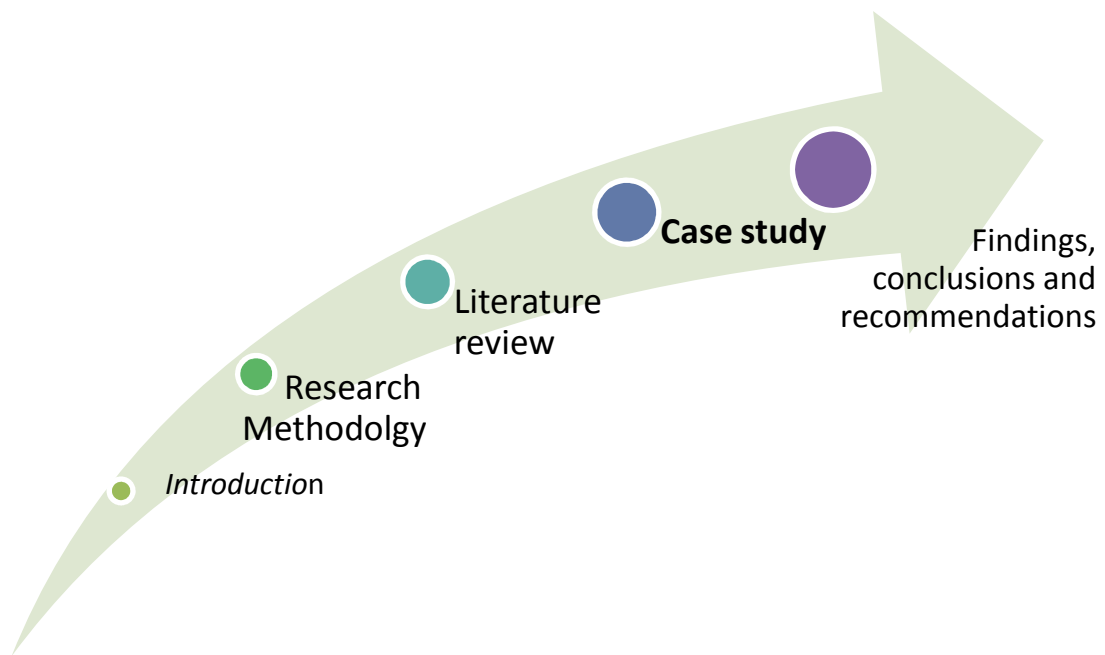
The aim of this chapter was to reach the first objective of this study, i.e. answering the first four research questions. The question of which environmental costs need to be measured and why was answered in section 3.3, which methods of measurement should be used was discussed in section 3.4.1 and where these costs should be reported on in section 3.4.2 was answered through a critical review of the literature and previous research underlying environmental management accounting. This chapter assisted providing overarching answers to questions one to four of the first objective. These answers will need to be tested specifically for the platinum mining sector.

Environmental management accounting originated from conventional management accounting, addressing the need to link eco-logical performance with economic performance through improving eco-efficiency. Pressures from various stakeholders and guidelines forced companies to include the environmental matters in their performance appraisals. The first question, i.e. why should environmental costs be measured, was clearly answered in the discussion about the major impact of mining activities on the environment. In order to develop a sustainable future, mining companies need to consider environmental costs as part of their decision making. Question 2, i.e. which environmental costs should be measured, was answered by means of the literature and IFAC (2005) guidelines, and should include the following categories: waste and emission treatment costs, prevention and environmental management costs, material purchase value of non-product output, environmental revenues, materials costs of product output and research and development costs.

This chapter has concluded that three methods (question three) for measuring environmental costs are to be considered in the modern organisation, namely life cycle costing (or full cost accounting); activity based costing and material flow cost accounting. Life cycle costing needs to be done with the assistance of a life cycle analysis and should include all aspects of a product's life cycle and not only the production phase. The life cycle analysis identifies environmental issues to which values are attached. Activity based costing assists companies in identifying which activities have direct and indirect impacts on the environment. Companies need to allow for an environmental cost element in order to record costs correctly in the accounting system. Material flow cost accounting is the input-output analysis of a production process. However, because this method takes only waste into account, it should be used in conjunction with activity based costing in order to ensure that all the possible environmental costs have been identified and accounted for. These methods can be combined by a company in order to answer their needs pertaining to reporting and current accounting systems already in place. Resource efficiency accounting assists companies in identifying hidden costs currently trapped within their reporting formats. Finally, this literature

review has assisted in answering the fourth question of the first objective, of which the methods discussed will assist mining companies in identifying and calculating the value of their environmental spending, while assisting this research in setting up a framework for measuring and reporting environmental costs at a platinum mine.

The theoretical review is a critical step in this research as the method of research is a case study analysis which needs to compare the theory of environmental management accounting and the application of environmental management accounting in practise. Where Chapter 3 answered the first four research questions from the literature, Chapter 4 will build upon it and compare the literature underlying environmental accounting to the practical application of environmental accounting in order to provide further (case study specific) answers to question one to four of the first objective of this study.



## **Chapter 4**

### **Case study**

#### **4.1 Introduction**

Chapter 2 discussed the research methodology of case studies and Chapter 3 discussed the literature underlying environmental management accounting and answered the first four research questions (pg.9) from a literature perspective. Chapter 4 will apply the research design drafted in Chapter 2 and analyse the data that has been collected. Data was collected from various sources to ensure triangulation of data, and various quality checks were put in place to ensure validity of data and explanation building, organisational-level logic models and rival explanations are tested to ensure that all possible outcomes are covered in the case study.

The goal of this study is to investigate methods of accounting and reporting of environmental costs at platinum mines to ensure a sustainable future – from which not only organisations will benefit, but individuals within the organisation as well. This will allow a *framework* to be set for the measurement and reporting of environmental costs. Consequently, this goal will assist in answering the main research question:

*Will a framework for measurement and reporting of environmental costs assist companies in expanding their current environmental disclosures to in-detail reporting of environmental information?*

In pursuance of the goal the main research question can be sub-divided into the following questions (refer to pg.9). These five questions will establish which data needs to be collected from the various sources used in this study, whereby answering each question will reciprocally answer the main research question. This chapter focuses on answering questions 1 to 4, which in turn focus on reaching the first objective of this study, which is to identify the current measurement methods and reporting of environmental costs in the platinum mining sector of South Africa. Question 5 will be answered in Chapter 5, which focuses on reaching the second objective of this study, which is to identify the possibilities of improving these measurement methods in order to assist in more accurate reporting of environmental costs by developing a framework for the measurement and reporting of environmental costs at a platinum mine.

The literature review in Chapter 3 identified and produced the first four questions relating to the first objective of this study of which the answers were generalised. This chapter will direct attention to the platinum mining industry through the case study, of which the answers will be more specifically directed toward the platinum mining industry.

Section 4.2 will provide a summary regarding which data should be collected from various sources in order to answer questions one to five, whereas section 4.3 will contain the minutes of the informal meetings held with the environmental and management accounting departments. Section 4.4 will summarise the actual data that has been collected, which will then be analysed in section 4.5. The data analysis will be done in using explanation building in section 4.5.1, organisational-level logic model in section 4.5.2 and testing the theory against the rival explanation in section 4.5.3. A cross-case analysis will be conducted in section 4.6 on the reporting of environmental costs in various platinum mines by using their most recent published integrated reports (the McGregor BFA data base will be used to collect this data). The cross-case analysis assists in verifying whether other platinum mines are currently reporting on environmental costs and in generalising the findings of the case study. Quality checks in place will be discussed in section 4.7, and the case study findings, based on the data analysis, will be discussed in section 4.8.

#### **4.2 Data that needs to be collected from the case study principal**

Collecting data from the case study principal on the current measurement and reporting of environmental costs will assist in identifying gaps within the current theoretical framework for the application of environmental management accounting and will allow mining companies to realise the benefits of reporting on these costs. The following is a summary of the data that to be collected from the case study principal:

- **Detailed accounting entries of overhead accounts**
  - Purpose of data:
    - To identify any environmental costs allocated to these accounts.
- **Extraction flow chart**
  - Purpose of data:
    - To understand the process before extraction of ores and waste can commence.
    - Will assist in identifying all the environmental costs associated with these flows.
    - To identify activities to assist in calculation of activity based costing.
- **Ore and waste handling flow chart**
  - Purpose of data:
    - To understand the material flow in platinum mining.
    - This will assist in:
      - Identifying additional environmental costs
      - Setting up a framework to calculate future environmental costs
      - Identifying activities to assist in calculation of activity based costing
      - Quantising input-output data for material flow cost accounting
- **Platinum mining flow chart (summary of the above)**
  - Purpose of data:
    - To assist in calculating the life cycle costing (cradle-to-gate) as well as activity based costing of platinum mining.
    - To identify the input-output quantities that will assist in applying material flow cost accounting.
    - This will add value to the framework as well as Sustainability Reporting.
- **Environmental reports**
  - Purpose of data:
    - To understand the environment of platinum mining and to provide a framework that will assist in the management of environmental issues at a platinum mine.
- **Life Cycle Assessments**
  - Purpose of data:
    - To assist in life cycle costing (cradle-to-gate).
- **Procedures in regards to Shaft Closures and Rehabilitation of mine site**
  - Purpose of data:

- To assist in environmental cost identification.
- **IAS 37 applications and notes**
  - Purpose of data:
    - To understand the current reporting in the interpretation of possible liabilities and provisions relating to environmental issues.

#### **4.3 Minutes of meetings held with the case study principal**

Three scheduled informal meetings were held with the case study principal on 11 October 2013 on site. These meetings were scheduled in order to obtain the views of the different departments on environmental costs and how they perceive the role of these costs within a platinum mine. The outcome of these meetings will assist in answering question two, three and four. As these meetings were informal, no agenda was set up. The following departments were involved:

- Environmental department
- Management accounting department

##### Management accounting department (11:20 – 11:35)

- This meeting was held with the mineral process management accountant
- The outcome of the meeting was as follows:
  - The case study principal currently reports on environmental costs – in total for the company as well as per shaft. Confirmation was given that these reports can be provided to verify which environmental costs are included. Central management accounting agreed to assist after which an informal meeting was scheduled at 13:00 for further discussion.

##### Environmental department (12:00 – 12:45)

- This meeting was held with three environmental specialists on site including the head of department.
- The outcome of the meeting was as follows:
  - Life cycle assessments are not currently done by the case study principal. They are busy researching the possibility of introducing it in the near future, but the attendees at the meeting were not entirely convinced that this will work at this specific mining company. The reason that they believe this will not work is that there are not enough people employed to assist with the workload of such a task. The implication thereof is that this exceedingly complicates the calculation of cradle-to-gate life cycle costing. Head office should be contacted to confirm

when and whether life-cycle assessments will be done on the mine. Contact was given to confirm this fact after the meeting. (Head office was contacted after the meetings held, refer to pg.73).

- Activities involved in environmental cost flows will be identifiable and will be used to allocate costs, making activity based costing methods easy to introduce.
- Their current accounting system does not provide for an environmental cost element when entering cost data into the system, making it particularly difficult to identify environmental costs in the accounting system, and consequently, these costs ‘disappear’ in overhead accounts. This is easily rectifiable by simply having the accounting system administrator add a cost element to their current accounting system. Training is required so as to ensure that the correct costs are allocated to this element.
- Budgets are currently done with a line item that refers to environmental costs, but actual data pulled from the accounting system does not have a line item with which to compare actual versus budgeted figures.
- Input-output quantities that can be used to calculate environmental costs using material flow cost accounting are not readily available. According to the environmental department, identifying this will be a difficult and time consuming task.
- Documents containing their current detailed reporting on environmental costs were received via email on 15 October 2013.

Management accounting department (13:00 – 14:00)

- This meeting was held with a senior management accountant of the case study principal.
- The outcome of the meeting was as follow:
  - The attitude towards additional line item reporting was not positive. The senior management accountant pertains that it will only be extra work with no real benefits, but that he would like to see the outcome of such an exercise.
  - They apply responsibility accounting, which makes it more difficult to identify environmental costs in their accounting system as there are no responsible people to account for these costs.
  - According to the management accounting department there is enough data readily available on input-output quantities to complete a material flow cost accounting analysis. Upon asking why the environmental department does not have access to this information, the answer given was that they should be able to access this information on the system.

- It was agreed that, upon the signing of the confidentiality agreement, financial data regarding standard costs and detailed accounting entries would be sent via email. A confidentiality report was signed and sent to the case's study principal on 14 October 2013.

Head Office Confirmation of Life Cycle Analysis:

- It was confirmed with the contact at head office that the Life Cycle Analysis study will only be completed in December 2013 after which they will apply for approval for implementation. A date could not be confirmed.

#### **4.4 Data collected**

This section will summarise the data that has been collected from the case study principal as well as data collected from other sources in order to ensure a triangulation of data in the attempt to answer question one to four. Due to the classified nature of the information provided and the confidentiality agreement signed, the data collected from the case study principal cannot be reproduced.

In light of this matter, a summary of the data collected from the case study principal is provided:

- **Detailed accounting entries of overhead accounts**
  - *This will assist in answering question two.*
- **Process flow chart**
  - *This will assist in answering question two and three.*

The only flow charts available was the ore extraction flow chart (Figure 16, pg 73) and the basic platinum flow chart (not included as it was too general) which only indicates basic flows of platinum mining and refining.
  - More information involving this process is needed in order to identify proper flow of materials (input-output flows) – the case study principal was not able to assist in providing this information.

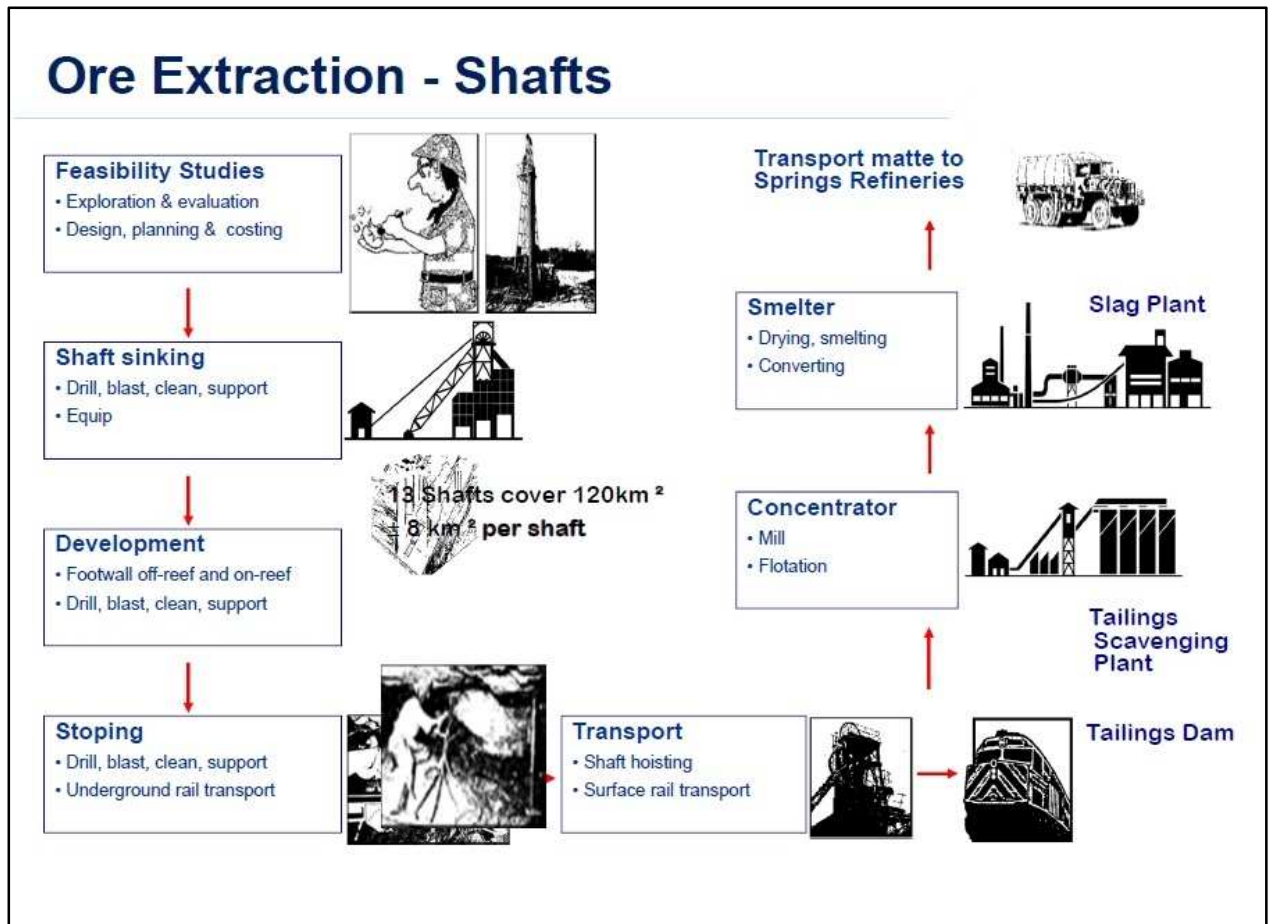


Figure 16 Ore extraction process flow chart (case study principal)

- **Environmental reports**
  - Closure costing report for 2013 was provided
    - *This will assist in answering question two*
  - KING III – principles applied in 2013
    - *This will assist in answering question one*
  - Environmental policy statement 2013
    - *This will assist in answering question one and three*
  - Mineral resource and mineral reserve statement 2013
    - *This will assist in answering question two and three*
  - Sustainable development report 2013
    - *This will assist in answering question one to four*
- **Life cycle assessments**
  - Not available (in progress)
- **Procedures pertaining shaft closures and rehabilitation of mine sites**
  - Included in the Closure Costing report 2013

- **IAS 37 applications and notes**
  - *This will assist in answering question four*
  - Notes to the consolidated financial statements published in 2013

The data collected above is used in the data analysis in section 4.5 below.

## **4.5 Data analysis**

Three methods of data analysis will be used in this study so as to ensure that all possible outcomes have been taken into account when the case study is concluded. The first method used is explanation building (Yin, 2009), the second, an organisational-level logic model and the third, testing the theory against a rival explanation (Yin, 2009).

### **4.5.1 Explanation building**

- i Theoretical statement on how environmental costs should be measured and reported on:*

Environmental costs should be measured using one of three methods or a combination of methods that include activity based costing, material flow cost accounting and life cycle costing (cradle-to-gate). Environmental costs should be reported on in a separate line item with an explanatory note in the financial statements of a mining company.

- ii Initial findings of the measurement methods and reporting of environmental costs by the case study principal:*

In the published **consolidated financial statements** the following items appear as a separate line relating to environmental costs:

- Rehabilitation provision, calculated by using estimates.

No other costs related to environment-related costs were identified in the consolidated financial statements.

The case study principal reports on *monetary units* of the following items under “Environmental” in their **sustainable development report** of 2013:

- Land management
  - Rehabilitation liabilities/current costs
  - Rehabilitation provisions.

The case study principal reports on *physical units* of the following items under Environmental in their **sustainable development report** of 2013 (Table 8):

Production data	Material consumption	Land management	Waste management
Ore milled	Diesel	Disturbed areas rehabilitated	Non-mineral/non-hazardous waste
Tailings disposed on dam	Petrol		Non-mineral/hazardous waste
Dump slag treated	Coal		Accumulated tailings
Furnace and converter slag generated and treated	Industrial burning oil		Accumulated waste rock (on surface)
Total slag treated			
Platinum produced			

Energy	Water	Emissions
Energy consumed	Total water withdrawn	Total direct CO <sub>2</sub>
Energy intensity	Total water consumed	Total indirect CO <sub>2</sub>
	Total water recycled	Total direct SO <sub>2</sub>
	Water intensity	

**Table 8 Physical units reported on by the case study principal (own research)**

In the **detailed accounting records** of the overhead accounts no costs were indicated as environmental costs. The following costs however could be classified as completely or partially environmental costs:

- Total fuels and gases (accounted for in the fuel account, which is considered as variable overhead costs)
  - Oils Greases Gasses
  - Diesel
  - Petrol
  - Industrial Burning Oil
  - Coal

- ISO accreditation (accounted for in the other overhead account, considered to be a fixed overhead cost)
- Water (accounted for in the utilities account, considered as variable overhead costs)
- Electricity (accounted for in the electricity account at a fixed rate, considered as variable overhead costs)
- Off Reef Development costs (accounted for in the off-reef account, considered as capital development costs)
  - Off Reef Development Material (considered as indirect material costs)
  - Off Reef Development Utilities (considered as overhead costs)
- Chemicals (accounted for in the other account for the concentrator, considered as variable overhead costs)

The case study principal does not make use of life cycle analysis in their environmental department which makes the measurement of life cycle costing difficult. They are currently in the process of developing life cycle analysis procedures that should be applied in the near future.

The **closure costing report** for 2013 only includes costs that refer to the closure of the specific sites, which includes rehabilitation costs, removal of structures and waste. This is calculated by using standard costs and a bill of quantities drafted by the environmental department and a consulting firm.

### *iii Revised statement*

Environmental costs measured using activity based costing, material flow cost accounting or life cycle costing (cradle-to-gate), should be reported on a separate line item and explanatory note in the financial statements to ensure a clear understanding of the environmental impacts certain internal decisions have. This will enforce triple-bottom-line reporting, thereby adding value to environmental disclosures.

### *iv Findings based on the revised statement*

The case study principal does not report on environmental costs as a separate line item, the main reason being that they apply responsibility accounting and that, at this stage, there are no people responsible on site to take this activity one step further.

A clear definition of what should be included under environmental costs is lacking between departments. Various departments perceive environmental costs differently which creates a problem when costs are captured in the accounting system.

Physical data is available for environmental inputs and outputs, but there is no link between this data and monetary values. This makes MFCA possible; however, the theoretical application of this method needs to be adjusted to suit the extraction industry.

In conjunction with responsibility accounting, the case study principal uses an activity based costing approach for their costing methods. Hence, including an environmental element as one of the cost drivers would be possible.

#### 4.5.2 Firm or organisational-level logic model

The following organisational-level logic model (Figure 17) has been derived from the collected data for the accounting of environmental costs at a platinum mine:

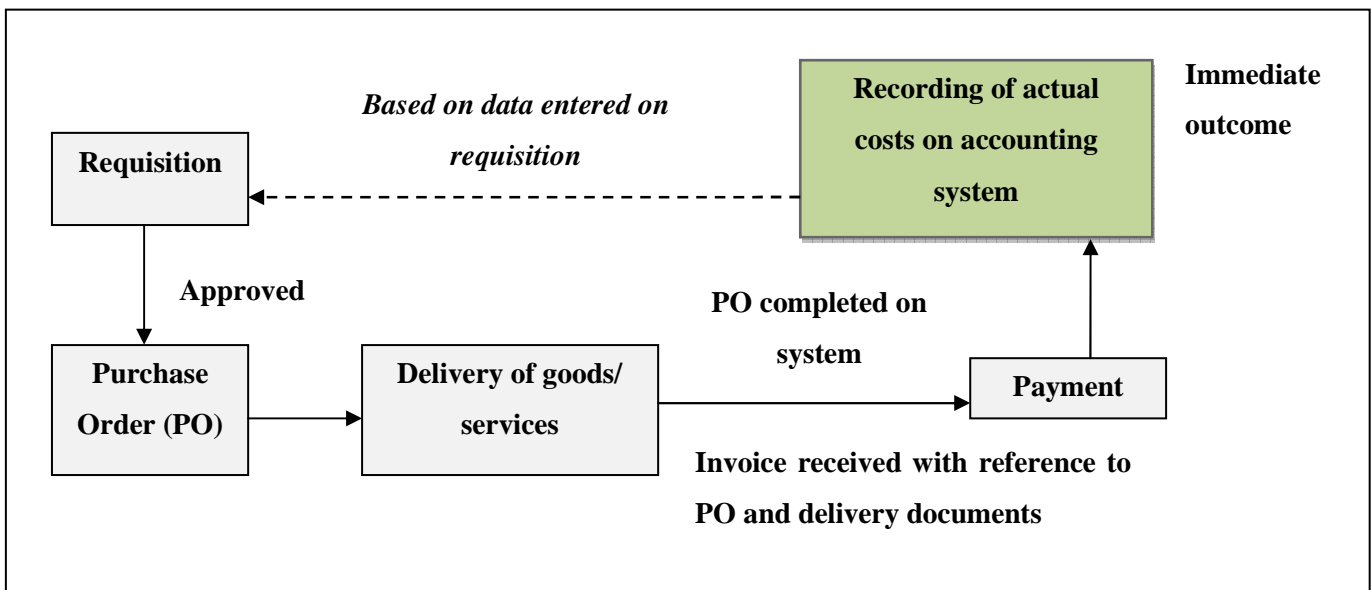


Figure 17 Document flow of cost recording in an organisation (own research)

The data entered in the first step of the accounting system has a large impact on the final reporting of the costs incurred as seen on the flow of cost recording. The logic behind such cost allocation concerning the case study principal can be seen in Figure 18 (pg.78).

Each department has various activities, each having a responsibility linked to it. Goods are required for each activity within the department and for each activity there are several cost

elements which may be valid. The person responsible for each activity decides which cost element should be linked to each expense item that falls under their responsibility. The possibility does exist for certain expenses to be linked to incorrect cost elements. In the case of environmental costs it is essential that environmental costs be clearly defined in order to avoid incorrect cost allocation. During the visit to the case study site it was clear that various departments had different understandings of what environmental costs entail.

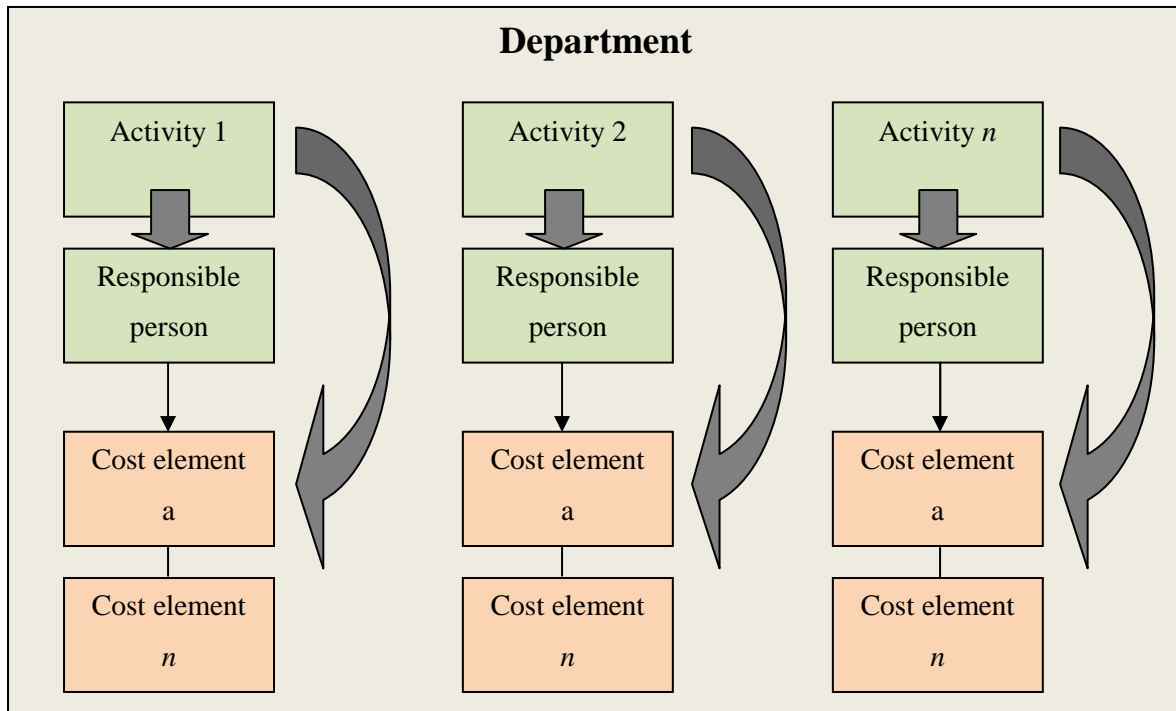


Figure 18 Organisational-level logic model for cost allocation (own research)

#### 4.5.3 Testing the theory against the rival explanation

Several studies have concluded that companies will not benefit from controlling environmental costs and reporting on a triple-bottom-line (Raar, 2002; Telle, 2006:195; Pava, 2007; Hacking & Guthrie, 2008). This opens the question of whether it really would benefit a mining company to spend time and effort on introducing a framework to measure and report on environmental costs.

The data collected from the case study indicate that mining companies measure a large percentage of possible environmental costs with their current accounting systems. The problem is that the mining companies do not refer to these costs as environmental costs. Input-output data is not linked to monetary values and the lack of in-detail process flow diagrams available to the environmental and management accounting departments does not allow these departments to conduct in-detail reporting on environmental costs.

#### **4.6 Reporting of environmental costs – cross-case analysis**

The purpose of the cross-case analysis done in Table 9 (pg.80) is to assist in generalising the findings on the case study principal and articulating them to theory. The external reports (financial statements, notes to the financial statements and sustainability reports) were reviewed so as to confirm whether other platinum mines do report on environmental costs. The three other platinum mines chosen, are platinum mines listed on the Johannesburg Stock Exchange and are considered to be the largest providers of platinum in South Africa.

The financial statements from these three other platinum mines were downloaded from the McGregor BFA database in order to establish whether reporting of environmental costs within the financial statements are available or lacking. The only environmental cost that was identifiable in the financial statements of all four platinum mines was the rehabilitation provision. The only apparent reason for this is that IAS 37 requires this. Only one platinum mine reported on treatment costs recovered.

The Corporate Social Responsibility reports of the platinum mines were downloaded from [www.corporateregister.com](http://www.corporateregister.com) which verified that the platinum mines did not report on environmental costs in these reports: the only monetary values found in these reports were from the case study principal itself. The other platinum mines only reported on physical units.

This cross-case analysis confirms that platinum mines do not report on environmental costs as a separate line item within their annual integrated financial statements.

<i>Identifiable in Financial Statements as monetary values</i>	<i>Case study principal</i>	<i>Platinum mine 2</i>	<i>Platinum mine 3</i>	<i>Platinum mine 4</i>
<b><u>Corporate social responsibility</u></b>				
<i>IFAC - Guidance document on ENVIRONMENTAL MANAGEMENT ACCOUNTING</i>				
<u>Monetary Information</u>				
Cost Categories:				
Materials Cost of product outputs				
Material Cost of non-product outputs				
Processing costs of non-product output				
<i>Energy and water (only material and processing costs applicable in the mining sector)</i>	<i>½ CSR Report</i>	x	x	x
Waste and emission control costs	x	x	✓ treatment cost recovered	x
Prevention and other management costs	x	x	x	x
Research and development costs	x	x	x	x
Environmental revenues	x	x	x	x
<b><u>International Accounting Standards</u></b>				
<i>IAS 37 - Provisions for Liabilities</i>				
Rehabilitation	✓	✓	✓	✓

**Table 9 Comparisons between platinum mines on the current reporting of environmental costs in their annual financial statements.**

#### **4.7 Data quality check**

The quality check table discussed in Chapter 2 (Table 1, pg.23) is used in Table 10 (pg.81) to ensure that all the validity tests have been done and that the research is viable. Chapter 4 was reviewed by the case study principal to ensure that the data was interpreted correctly and that the logic model derived is applicable to the organisation. Multiple sources of evidence and a chain of events were established with which to construct validity. Pattern matching was not done during this case study, but in order to create internal validity, explanation building and logic models have been used. External validity was ensured by a review of the literature underlying environmental

management accounting. In using a case study protocol and a database along with all the data collected data, reliability of the study's findings is ensured.

TESTS	CASE STUDY TACTIC	DONE
<b>Construct validity</b>	Use multiple sources of evidence	✓
	Establish chain of events	✓
	Have key informants review draft case study report	✓
<b>Internal validity</b>	Do pattern matching	x
	Do explanation building	✓
	Address rival explanations	✓
	Use logic models	✓
<b>External validity</b>	Use theory in single-case studies	✓
	Use replication in multiple-case studies	N/A
<b>Reliability</b>	Use case study protocol	✓
	Develop case study database	✓

Table 10 Data quality of case study check (application of Table 1 (pg.23) based on the research done by Yin (2009:41))

## 4.8 Findings

The goal of this study was to investigate methods of accounting and reporting of environmental costs at platinum mines to ensure a sustainable future from which not only organisations will benefit, but individuals within the organisation as well. This will allow a *framework* to be set for the measurement and reporting of environmental costs. The goal will assist in answering the main research question. Question one will be answered in section 4.8.1, question two in section 4.8.2, question three in section 4.8.3 and question four in section 4.8.4. The case study and literature review concluded with the following findings:

### 4.8.1 The importance of measuring environmental costs at a platinum mine

This section will answer question one by identifying the importance for platinum mines to measure environmental costs. Measuring environmental costs assists management in identifying problem areas concerning environmental management as well as cost management. The benefits of improved environmental cost measuring and how it links with revenue and costs within a company can be seen in Table 11 (pg.82).

<u>Value drivers</u> Benefits	Value drivers / benefits	Increased revenue	Cost reduction and efficiency improvement
<b>Financial</b>	Earnings from the sale of materials for re-use and recycling. Financial subsidies, awards. Lower level of environmental fees, taxes, charges. Provision/insurance for damages. Lower level of human workforce costs	Sales	Substitution costs of marketing Cost reduction  Hidden cost savings Cost reduction
<b>Process</b>	Effective resource utilisation. Environmental research and development. More rational decision making Environmental management system	Contribution to Sales  New product	Cost reduction Reduced costs or new processes, savings  Contribution to efficiency improvement Cost reduction
<b>Other</b>	Better working conditions Risk reduction Green image Better reputation Good relationship with authorities Good relationship with competitors Better public trust and confidence	Output efficiency Sales    Sales	Reduced turnover Cost increase, but contingent cost reduction  Reduced costs of operation Lower incidental expenses

**Table 11 Value drivers and environmental benefits and measurement (adjusted) (source: Van & Gartner, 2011)**

This question is answered through the literature, but is applicable to the case study as well. Platinum mines are currently experiencing a very difficult task to remain profitable considering the increase in input-costs of production, especially labour. Through focussing on cost elements that can assist in costs savings and improve the company's environmental performance, would assist in adding value to the company's perceived value by shareholders and their bottom line at the end of the day.

#### **4.8.2 The scope of environmental costs**

This section will answer question two by identifying what environmental costs categories should be included on a platinum mine when environmental costs are measured. Environmental costs can be defined as the costs applicable to all direct and indirect impacts on the environment. Several studies were done previously done to identify cost categories that should be included in the application of environmental management accounting. The following cost categories were identified through literature and were adjusted in order to indicate which are applicable to the platinum mining sector in specific. The data analysis done on the detail accounting entries (pg.75–76) as well as the physical unit reporting of environmental impacts in the sustainability report (pg.75) found that theses cost categories are applicable to the platinum mining sector [*Jasch, (2001:23) and IFAC (2005:55) was used as a base and own research was included to determine the cost categories applicable specifically for the platinum mining sector*]:

- Waste and emission treatment costs
  - Chemicals used in processing and refining stages
  - Depreciation of related equipment
  - Maintenance of equipment
  - Personnel costs
  - Fees, taxes, charges
  - Fines and penalties
  - Insurance for environmental liabilities
  - Provisions for clean-up costs
- Prevention and environmental management
  - External services relating to environmental management (contractors)
  - Personnel within the environmental management department
  - Additional expenditure for new technologies in extraction, processing and refining which will ensure ‘cleaner’ mining.
- Material purchase value of non-product output
  - Energy
  - Water
- Environmental revenues
  - Subsidies, and awards received for the implementation of preventative and corrective procedures concerning environmental impacts
- Material costs of product output
  - Energy
  - Water
- Research and development costs
  - New shaft or mine feasibility studies
  - Biodiversity
- Rehabilitation provisions (this is of utmost importance in mining in creating a sustainable environment for future generations and thus, these provisions need to be indicated separately)

#### **4.8.3 Methods of measuring environmental costs**

This section will answer question three of this study by identifying the most accurate methods to measure environmental costs at a platinum mine. Various methods are available for the measurement of environmental costs. Life cycle costing (cradle-to-gate), activity based costing, and material flow cost accounting is considered to be the most popular methods used by

companies. The reason for this is that companies already make use of these cost accounting methods within their accounting systems and hence, only small adjustments would be necessary to accommodate an additional cost item that links to environmental aspects. Combination of methods are not used as commonly due to the fact that it requires a lot more administration and reconciliations – an additional burden on most companies already limited by time constraints.

However, material flow cost accounting needs to be adjusted for the extraction industry as it theoretically applies only to production companies. Using the environmental management accounting principles and the process flow of platinum mining, Table 12 (pg.85) has been constructed in Excel for application within the platinum mining sector.

Material flow cost accounting for the calculation of environmental costs needs to be used in conjunction with other methods, as this method alone does not take into account all the environmental cost categories which are required for a full cost calculation of environmental impacts.

Life cycle costing (cradle-to-gate) is the most accurate method as it takes into account every stage of the platinum mining cycle and is based on the life cycle analysis done by the mine. The advantages of doing a life cycle analysis along with life cycle costing (cradle-to-gate) are numerous. However, this method is difficult to apply if input-output quantities for every stage within the life cycle are not available and a life cycle analysis is not being done.

Activity based costing is easy to apply as most ERP systems are built around the same principle applied in this method. This method will assist management in identifying which activities have the greatest impact on the environment. These activities can be managed accordingly with increased environmental performance as well as a decrease in costs thereby increasing profitability. If this method is considered for the measurement of environmental costs, certain changes will have to be made in responsibility centres as additional cost centres might be created through the inclusion of environmental aspects.

This study has also found that environmental costs are currently measured by platinum mines, but that most of these costs are absorbed into the utility and overhead accounts and are not classified as environmental costs in nature.



#### **4.8.4 Reporting of environmental costs**

This section will discuss the findings on where environmental costs are reported on in platinum mining companies' integrated reports. This study has found that platinum mining companies report only on rehabilitation costs in their integrated reports published annually, only because they are required to do so by accounting standard, IAS 37, requirements. Environmental aspects are included in the integrated reports as the Global Reporting Initiative and KING III strongly advise companies to apply corporate social responsibility, but only physical quantities are reported on. The main reason for this lies in the fact that platinum mines currently do not account for environmental cost as a separate cost element within their accounting systems, making the reporting of these costs extremely difficult.

#### **4.8.5 Recommendations**

This chapter has concluded that it is important to measure and report on environmental costs in the mining industry so as to create a sustainable environment. It was found that platinum mines currently measure most of the environmental cost categories, but that these costs are absorbed into the utilities and overhead accounts. These costs need to be identifiable in order to assist management in improving environmental impact assessments and measuring the value of these impacts. If the impacts can be measured in monetary terms they will direct internal decision making and add value to the decision making process through the identification of areas that need to be improved. The study recommends that a framework be constructed to assist mining companies in measuring and reporting on environmental costs

### **4.9 Summary**

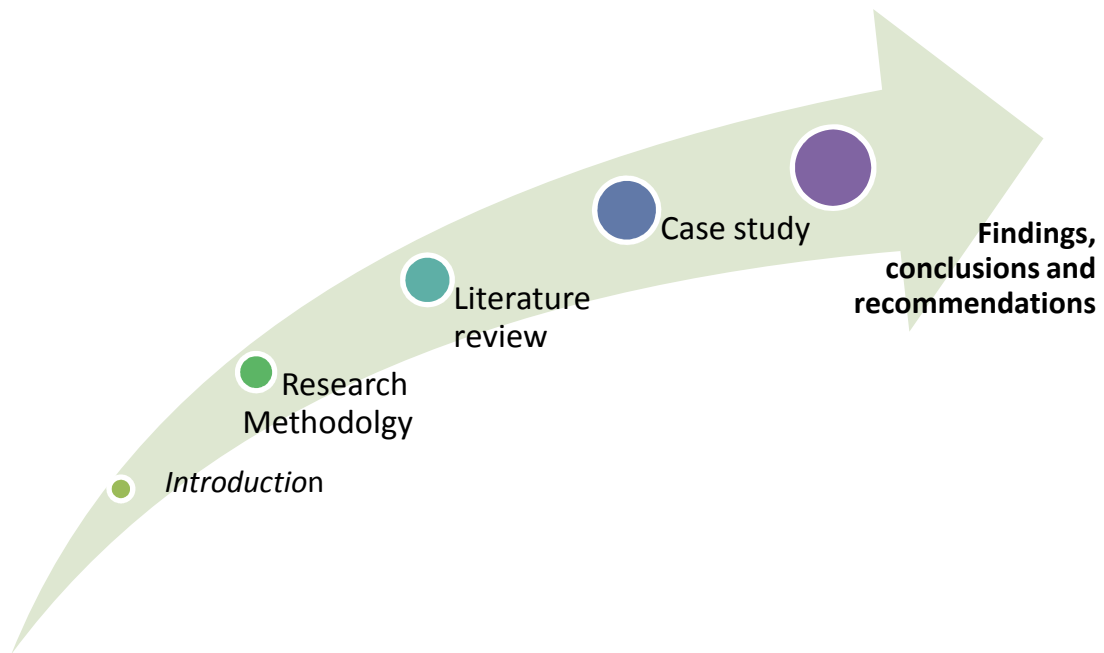
Successful case study research is dependent on a sound research design, which in turn will ensure that the integrity of the outcome is guaranteed and viewed as a valid research attempt. Chapter 4 involved the collected data analysis according to the research plan designed in Chapter 2.

Various sources of data were collected in an attempt to answer the main research question of this study by means of answering questions one to four of the first objective. Chapter 5 will use the answers for these questions to answer question five, which relates to the second objective of this study.

The analysis of the collected data was done by way of explanation building, organisation-level logic model building, and testing the findings against a rival theory. Explanation building has

found that platinum mines do measure most of their environmental costs, but do not report on these costs as a separate line item. The majority of these costs were absorbed into the overhead accounts. Platinum mines do not yet recognise the benefits that lie in reporting on environmental costs as a separate line item and striving toward triple-bottom-line reporting. The organisational-level logic model has assisted in identifying the reasons that cost allocation is done in the current fashion and what has to be done in order to change the cost allocation process. Testing the findings against a rival theory has proven that reporting on environmental costs on a separate line item will add value to internal decision making.

Chapter 5 will conclude the case study research with findings based on the data analysis done in Chapter 4 in the form of a framework that will assist in the measurement and reporting of environmental costs at a platinum mine, thereby answering the second objective of this study.



## **Chapter 5**

### **Findings, conclusions and recommendations**

#### **5.1 Introduction**

This chapter will answer the second objective of this study through identifying the possibilities to improve current measurement methods for environmental costs applied by platinum mines, with a view to assist them in more accurate reporting of these costs. The theory underlying environmental management accounting has been reviewed, and the methodology presented and applied in the previous chapters. This chapter will conclude the research by setting up a framework for the measurement and reporting of environmental costs at a platinum mine in order to answer the main research question of this study:

*Will a framework for measurement and reporting of environmental costs assist companies in expanding their current environmental disclosures to in-detail reporting of environmental information?*

This chapter will briefly revisit the literature in section 5.2 and discuss the findings in section 5.3. The practical implications of the findings are discussed in section 5.4, leading up to a gap analysis in formulating recommendations which will assist in setting up a framework for the measurement and reporting of environmental costs. This chapter also addresses the limitations of the study with

recommendations for future research. Finally, this chapter will conclude with the total contribution made to the current base of knowledge of environmental management accounting.

## **5.2 Summary of literature review**

The literature describes various methods for measuring environmental costs, but lacks a clear framework that can assist mining companies in identifying, measuring and reporting on environmental costs.

The importance of environmental management accounting is emphasised by the growing focus on sustainable development. Environmental management accounting entails the identification, collection, analysis and use of physical and monetary information for internal decision making (IFAC, 2005:19), which embodies and merges two of the three pillars of sustainable development namely economics and the environment. It also assists companies in collecting, analysing and communicating corporate sustainable information required by management in order to address issues regarding sustainability (Schaltegger *et al*, 2006).

These issues encompass the following three interrelating divisions: ecological, social and economic dimensions. This interrelationship is referred to as eco-efficiency (Schaltegger *et al*, 2006). The ecological dimension refers to a company's attempts to reduce negative impacts of their activities on the environment, and forms the main focus point of this study. Before a company can attempt to minimise these impacts, it needs to improve its environmental management (eco-effectiveness), which will have positive effects on the economic division of the company, such as improved profit margins through cost reductions.

The need to measure a company's eco-effectiveness and eco-efficiencies lead to the introduction of physical environmental management accounting which tracks the physical flows of inputs and outputs within a company (IFAC, 2005:30). This input-output data can be used in the calculation of environmental costs through activity based costing (Möhr-Swart *et al*, 2008; Jasch, 2001), material flow cost accounting (Jasch, 2009) or life cycle costing (Klöpffer & Ciroth, 2011; Caddy, 2011; Da Silva & Amaral, 2009; Swarr *et al*, 2011; Durucan *et al*, 2006). These three methods have been identified by previous studies as being the most accurate and effective ways of measuring environmental costs. Cost categories that should be included in environmental costs according to IFAC (2005:55) and Jasch (2001:23) are *waste and emission treatment costs, prevention and environmental management costs, material purchase value of non-product output, material purchase value of product-output, and research and development costs*, hence monetary management accounting.

Activity based costing, when used to measure environmental costs will grant management to have a better understanding of why particular costs occur. This will allow management to identify areas that require improvement within the company. Internal strategic decision making will focus on these areas which have been identified (Innes & Mitchell, 1997; Banker *et al*, 2008; Blocher *et al*, 2008).

Material flow cost accounting is a tool used by management to measure the flows and stocks of material within a company in both physical and monetary units (Jasch, 2009:116). Managing these material and stock flows will increase efficiency of inputs, thereby leading to cost reductions and reduced negative impacts on the environment (Strobel, 2002). One of the major elements that material flow cost accounting attempts to minimise is the amount of waste that largely results from material losses within the production process (UNSD, 2001; Gale, 2006; Strobel & Redmann, 2002). As this method links environmental impacts with cost implications, the quality of internal decision making will improve (Onishi *et al*, 2008; USEPA, 2000). However, although material flow cost accounting focuses on product and non-product waste calculations, it does not take into account total environmental costs. It is therefore implied that this method needs to be used in conjunction with other methods in order to calculate the total cost of environmental impacts of the company's activities.

Life cycle costing (cradle-to-gate) is a method used to estimate and accumulate costs for a product over its life cycle leading up to the point when the final product leaves the company. As platinum has various uses and buyers, it would be a time consuming and costly task for a company to include life cycle costing for the entire life cycle (cradle-to-grave), and with few benefits (Durrucan *et al*, 2006). In a mining company, life cycle costing should occur alongside life cycle analysis, which measures the environmental impacts of products, production systems and humans (Curran, 2013). This in turn will allow companies to value their environmental impacts in monetary terms. Furthermore, it is important that environmental concerns be linked to economic aspects (Da Silva & Amaral, 2009) as this will direct management decisions toward improving sustainability development within the mining sector.

Each of these measurement methods should be integrated into the current costing methods applied in the company to facilitate reporting of environmental costs. In comparing these three methods (Table 13, pg.91) it was found that life cycle costing is the most effective method for measuring environmental costs, but that it requires that a life cycle analysis to be conducted. Neglecting to do so would result in a time consuming exercise, as all the required information will then have to be gathered and analysed. Material flow cost accounting is in principle more appropriate for the manufacturing industry, seeing that mining is extractive in nature instead of productive. The

implication is that material flow cost accounting requires adjustments and tailoring to suit the extraction industry before it can be applied. Another limitation to this method is that it only measures the value of product and non-product output (waste). In order to measure total environmental costs, material flow cost accounting will need to be used in conjunction with another method – activity based costing can measure the total cost of environmental impacts accurately, allowing mining companies to adopt this method without having to face too many system constraints as the expertise and capital are readily available. The drawback, however, is that the company’s current cost accounting methodology needs to be adjusted if they are not currently using activity based costing.

	Life cycle costing (cradle-to-gate)	Material flow cost accounting	Activity based costing
Total environmental cost calculated	✓	✗	✓
Data can be used for internal decision making	✓	✓	✓
Method can be used alongside current costing method	✓	✓	✗

**Table 13 Comparison of environmental cost measuring methods (own research)**

All things considered, the best option for platinum mines would be to adopt life cycle costing with a life cycle analysis, as this will assist in more efficient environmental management as well as management of environmental costs, thus improving eco-efficiency.

Hence, this study has indicated that activity based costing or life cycle costing (cradle-to-gate) can be used, or a combination of methods, to effectively measure environmental costs as long as it includes all environmental cost categories. If material flow cost accounting is to be used, it needs to be used in combination with either life cycle costing (cradle-to-gate) or activity based costing

The literature describes various methods to measure environmental costs but a clear framework to assist mining companies to identify, measure and report on environmental costs are lacking from the current literature.

### **5.3 Summary of findings from the literature and the case study**

The literature emphasised the importance of measuring environmental costs and answered question one by identifying that traditional accounting practices do not support decision making functions in the environmental department sufficiently. This is mainly due to a lack of adequate information available to them. Environmental management accounting fills this gap by allowing management to access more information about environmental costs and quantities, previously hidden by conventional accounting systems. During the process of this study it was observed that environmental liabilities increase in the mining environment and industries in this sector specifically are becoming more aware of this. It is specifically important for mining companies to measure environmental costs as various pressure groups and stakeholders require mines to take responsibility for their actions.

Question two was answered through the use of literature and refined through the case study. The literature indicated that there are several cost categories that should be included in the measurement of total environmental costs which included: Waste and emission treatment costs; prevention and environmental management costs; material purchase value of non-product output; environmental revenues; material costs of product output; research and development costs and rehabilitation provisions (this is extremely important in mining in order to create a sustainable environment for future generations and thus needs to be indicated separately).

Question three was answered in detail in the literature review by discussing various methods which can be used to measure environmental costs. It was found that the best methods would be either life cycle costing (cradle-to-gate) or activity based costing. If material flow cost accounting wants to be used, it should be used in combination with other methods, as this method does not take into account all the possible environmental costs. Through the case study it was found that most of the environmental cost where measured by the platinum mine using their current accounting system, but that is not classified as environmental costs. Through the classification of environmental costs management will be able to identify current problems with regards to environmental management and cost management through the revealing of hidden costs within overhead accounts. Various departments within mining companies may view environmental costs differently due to different interpretations of the environment and environmental impacts. It is important for mining companies to define their environment as well as environmental costs to ensure correct measurement and recording of these costs.

Literature indicated when answering question four that environmental costs should be reported on in the financial statements of a company through the application of various accounting standards,

but that these standards does not necessarily focus on the environment in specific. The only environmental costs that are currently included in the financial statements are rehabilitation costs. All other environmental disclosures however are not compulsory, but rather encouraged by corporate governance and shareholder requirements. The Global Reporting Initiative awards ratings based on disclosures with regards to their standards, but only physical disclosures are included. Mining companies tend to only report on items that can improve their Global Reporting Initiative ratings to ensure a healthy investor relationship and encourage possible future investment opportunities.

Mining companies need to be made aware of the benefits of triple-bottom-line reporting and linking economic performance to environmental performance. By doing so, mining companies can create a sustainable development environment.

The answer to question five with regards to the second objective will be answered through the framework drafted in section 5.5.2.

#### **5.4 Summary of findings and conclusion**

The literature review and the case study have indicated that the case study principal and the other three platinum mines currently do report on various environmental issues in alignment with the Global Reporting Initiative guidelines, and that they do measure environmental costs within their current accounting systems. However, the problem is that the environmental costs measured are still hidden in the overhead accounts. In order to improve their reporting on eco-efficiency, platinum mines need to distinguish their environmental costs from their overhead accounts.

#### **5.5 Practical implication of findings and conclusion**

Based on the findings of the case study, a gap analysis will be done to assist in identifying the problem areas for which a framework will be required, i.e. the first objective (question one to four), from literature and the case study will be used to set up a framework which will assist management to successfully implement the effective and efficient measurement and reporting of environmental costs, thereby answering the second objective of this study (question five). Figure 19 (pg. 94) indicates the development process of creating the framework for measurement and reporting of environmental costs at a platinum mine.

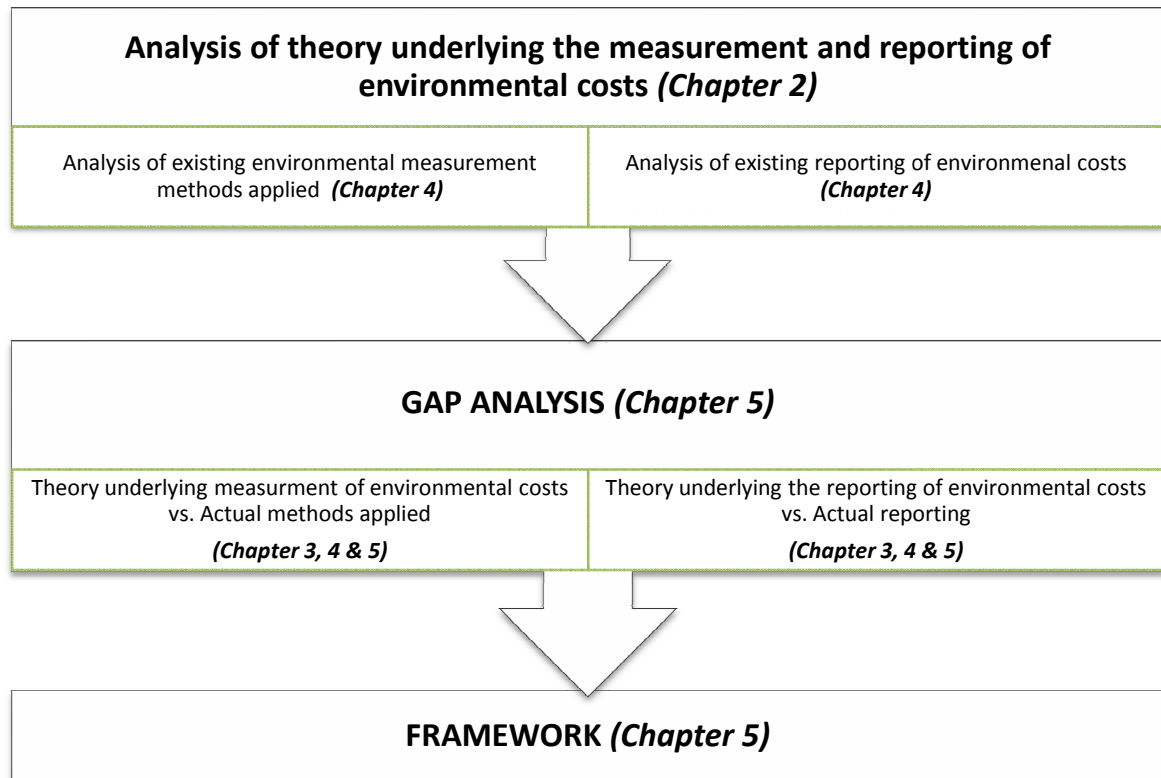


Figure 19 Development process of the framework for measuring and reporting of environmental costs (own research)

### 5.5.1 Gap analysis

The gap analysis was done whilst answering the first objective of this study (Chapter 4) which was to identify the current measurement methods and reporting of environmental costs in the platinum mining sector of South Africa. This objective needed to be met before the second objective. In order to reach the second objective of this study, which is to identify the possibilities of improving the current measurement methods for environmental costs applied by platinum mines so as to assist in more accurate reporting of these costs, an extended gap analysis will be done.

Table 14 (pg.95) summarises the ideal measuring and reporting of environmental costs at a platinum mine and includes all the cost categories identified in the findings of the study (Jasch, 2001; IFAC, 2005; own research) (refer to pg.83). Table 15 (pg.96) summarises the current measurement and reporting of environmental costs at a platinum mine (from case study findings on pg. 81–86 and Table 9, pg.80) which were identified by means of a case study as well as a cross-case analysis. The variance between the ideal and current situations will be considered as the gap experienced in the mining sector. Further investigation is required to determine exactly how the gap can be filled, which is summarised in Table 16 (pg.97).

**Ideal measuring and reporting of environmental costs in the platinum mining sector :**

	Measured	Identifiable in Financial Statements
<b><u>Corporate social responsibility</u></b>		
<i>IFAC - Guidance document on environmental management accounting</i>		
<u>Monetary Information</u>		
Cost Categories:		
<i>Energy and water only material and processing costs applicable in the mining sector</i>	✓	✓
Waste and emission control costs	✓	✓
Prevention and other management costs	✓	✓
Research and development costs	✓	✓
Environmental revenues	✓	✓
<b><u>International Accounting Standards</u></b>		
IAS 37 - Provisions for Liabilities		
Rehabilitation	✓	✓

Table 14 Ideal measuring and reporting of environmental costs in the platinum mining sector (own research).

**Current measuring and reporting of Environmental costs in the platinum mining sector:**

	Measured	Identifiable in Financial Statements
<b><u>Corporate social responsibility</u></b>		
<i>IFAC - Guidance document on environmental management accounting</i>		
<i>Monetary Information</i>		
Cost Categories:		
<i>Energy and water (only material and processing costs applicable in the mining sector)</i>	✓	½ (CSR report)
Waste and emission control costs	✓	✗
Prevention and other management costs	✓	✗
Research and development costs	✓	✗
Environmental revenues	✓	✗
<b><u>International Accounting Standards</u></b>		
<i>IAS 37 - Provisions for Liabilities</i>		
Rehabilitation	✓	✓

Table 15 Current measuring and reporting of environmental costs in the platinum mining sector (own research).

	Corporate Social Responsibility		Accounting standards
External requirements for the measurement and reporting of environmental costs	ISO		IFRS
	GRI		
	IFAC		
	KINGIII		
		Physical units	
Components	Environmental		

**KEY:**

Compliant
Semi-Compliant
Non-Compliant

**Table 16 GAP analysis of the measurement and reporting of environmental cost at platinum mines (own research)**

Table 16 was constructed with the use of data collected from the case study principal and integrated reports published from various other platinum mines. These integrated reports were reviewed in order to establish the degree of compliance on average pertaining to various reporting guidelines, including the ISO, GRI, IFAC, KING III and IFRS. The average platinum mine complied with most of these guidelines and adhered to the accounting standards (IFRS), but when IFAC's guidelines are considered they are only semi-compliant. The reason for this lies in the fact that they follow the Global Reporting Initiative's guidelines which only require the reporting of the physical units regarding environmental impacts. IFAC on the other hand require monetary information as well (IFAC, 2005). It was found that only a few companies include this requirement in their published integrated reports.

Table 16 has indicated that platinum mines need to improve their reporting of monetary units within their corporate social responsibility reporting. Some of the major contributors to the lack of reporting on environmental costs by the case study principal are:

- a lack of a complete life cycle analysis (pg.70–72)
- a lack of a companywide definition of environmental costs (pg.71–76)
- environmental department is only responsible for closure costing calculations and no contribution to costing other environmental impacts is being made by this department (pg.71–76), and
- a lack in understanding of which information is available (input-output quantities) between departments, a lack of clear understanding of how the reporting systems work and how this information can be used to assist in measuring and reporting of environmental costs.(pg.70–72)

These contributing factors will be accounted for when creating a framework for assisting platinum mines in closing the gap which has identified in the reporting of environmental costs.

### **5.5.2 Framework**

Sustainability reporting includes the integration of all three angles of the sustainability triangle (see Figure 8, pg.36) (Herzig & Schaltegger, 2006), hence the term ‘integrated reporting’. Current published integrated reports are additive in nature regarding their social and ecological impacts, therefore, methods need to be identified for the integration of these angles into financial reports. Companies are searching for reporting and communication formats which are ideal for their own purposes; consequently, reporting contents and formats change from year to year (Herzig & Schaltegger, 2006). It is important that these formats be standardised by sector or industry if comparability between companies is to be constructed.

This study has concluded (Table 13, pg.91) that activity based costing or life cycle costing (cradle-to-gate) can be used, or a combination of methods can be used to measure environmental costs as long as they include all environmental cost categories. If material flow cost accounting is to be applied, it needs to be used in conjunction with either life cycle costing (cradle-to-gate) or activity based costing. Various other factors may also influence the decision to measure and report on environmental costs. Data quality from the management accounting department and environmental department will affect the accuracy of the measuring method applied – if the data quality is not up to standard, changes within the departments’ information systems will be required in order to improve the data quality and hence the accuracy of the measurement of environmental costs. This factor is important to consider as it will affect the reporting possibilities regarding environmental costs.

The following framework (Figure 20, pg.99; and Table 17, pg.100) has been developed to assist mining companies, specifically platinum mines, in identifying which factors to measure and report on within environmental costs:

			Management Accounting Department		
			Data quality		
			Poor	Average	Good
Environmental Department	Data Quality	Poor	Major changes required	Major changes required	Moderate changes required
		Average	Major changes required	Moderate changes required	Minor changes required
		Good	Moderate changes required	Minor changes required	Minor changes required

Figure 20 Framework for the measurement and reporting of environmental costs at a platinum mine (own research)

	<b>Management Accounting Department</b>		
<b>Data quality/System</b>	<b>Poor</b>	<b>Average</b>	<b>Good</b>
<b>Changes required</b>	<i>Information systems need to be upgraded to improve the quality of data and to ensure accuracy of data input. The system should accommodate environmental costs according to the costing method that best suits the company. Costing methods that should be considered include: activity based costing, material flow cost accounting and life cycle costing. Environmental costs need to be defined in accordance with the company profile.</i>	<i>Current information system should be audited to ensure that all the requirements for internal reporting are met. Costing methods should be aligned to the company profile to ensure improved usability of data. Environmental aspects should be considered when costing methods are reviewed. Environmental costs need to be defined in accordance with the company profile.</i>	<i>Minor adjustments are necessary to the accounting system in order to include environmental cost allocation under the required cost fields.</i>
	<b>Environmental Department</b>		
<b>Data quality/System</b>	<b>Poor</b>	<b>Average</b>	<b>Good</b>
<b>Changes required</b>	<i>A database with standard as well as actual physical unit quantities of environmental aspects should be designed. Detailed process flow charts should be drafted. This can be used to measure inputs and assess the effects of the outputs on the environment. Expected rehabilitation of mining areas needs to be costed and provisions should be made for this in the accounting records. Closure costing should be done. Life cycle analyses should be introduced. The environment should be defined.</i>	<i>Detailed information with regards to processes should be entered to ensure that the quality of data is improved. Life cycle analysis assessments should be completed and used as a base to measure environmental impacts of all mining processes. The definition of the environment should be reviewed.</i>	<i>Minor adjustments will be needed to synchronize the environmental department and management accounting department data so as to ensure accurate measuring and reporting of environmental costs.</i>

**Table 17 Changes required in the management accounting department and the environmental department (own research)**

Once the changes are made, environmental costs should be measured by using one of the following methods:

- Activity based costing

- Activity based costing requires the identification of activities which relates to environmental aspects of the company. This will include activities that have a direct and indirect impact on the environment.
- Cost drivers will include water, energy sources and chemicals.
- Life cycle costing
  - Life cycle costing requires that a detailed life cycle analysis to be done by the environmental department. Costs should be linked to each element of the life cycle analysis in order to derive life cycle costing (cradle-to-gate)
- Material flow cost accounting in combination with either activity based costing or life cycle costing (cradle-to-gate)
  - Detailed information with regards to input-output quantities for every process is needed.
  - Materials input refer to water, energy, air (underground supply) and chemicals in the extraction sector.
  - Output quantities refer to product output, waste water, chemicals and emissions
  - After these quantities have been measured, costs should be allocated to these quantities by means of market values (water, energy, oxygen and chemicals), costs to direct and control oxygen underground and costs to minimise emissions.

If the environmental costs are successfully measured it will be possible to include these costs as a separate line item in internal management reports and external financial reports

### **5.5.3 Limitations of study**

This study *could not test the framework* as it has to be accepted by the management of the case study principal as part of their costing procedures first. Various changes need to be made in both the management accounting department and the environmental department, which goes beyond the accessibility of this study. The case study principal agreed into a follow-up study which may include the application of the framework as well as the implementation of an Environmental Management Accounting function within the Management Accounting Department which allows for future research possibilities.

The following recommendations for future studies should be considered:

- Testing the framework in a follow up case study as an additional article to this research.

- An in-depth study can be done on the implications of triple-bottom-line reporting in platinum mines on the quality of internal decision making. This study will require a qualitative approach and should include multiple case studies.

#### **5.5.4 Value of the study**

This research has extended the current literature by identifying the gap experienced in sustainable reporting. These findings can assist in further research on the application of triple-bottom-line reporting, linking social, economic and environmental performance.

#### **5.6 Final recommendation and conclusion**

Waste is the direct result of economic inefficiency and extreme changes within the accounting field are required to achieve sustainability through eco-efficiency. Through the introduction of an environmental management accounting system it will be possible to identify and report on two types of information, physical information and monetary information with regards to environmental aspects. This will assist management in addressing inefficiencies. If management focus their attention on environmental performance, more opportunities will be created to increase profitability through the application of environmental management accounting systems.

Environmental costs are currently being measured by platinum mines, but they are not classified as environmental costs and are absorbed into the overhead or utility accounts. Because of this, reporting of environment costs are lacking in the integrated statements of platinum mines. A gap analysis on the reporting of environmental impacts concluded this as well – monetary units of measures in regards to environmental impacts are lacking within the integrated reports published by platinum mines (see Table 16, pg. 97). This gap needs to be filled in order to improve the current reporting of environmental costs at a platinum mine. This study concluded with a framework in order to attempt to close the gap identified, that will assist mining companies to measure and report on environmental costs – in such a way that they can improve their environmental and economic performance.

The central argument in Chapter 1 was that if management is able to identify environmental costs within internal management reports as well as external integrated reports, internal decision making of the company will improve. This will have a direct impact on the profitability of the company and ensure that the company are operating in an eco-efficient manner, thus developing a

sustainable environment. This argument was a strong argument that was confirmed from the literature review findings in Chapter 3 as well as the case study findings in Chapter 4.

The main purpose of this study was to answer one question, whether a framework of measurement and reporting of environmental costs will allow companies to expand their current environmental disclosures to in-detail reporting of environmental information. *Can this be done?* The framework created in this chapter will be able to assist companies to identify the changes required within their management accounting and environmental departments in order to allow for the correct identification, measurement and allocation of environmental costs. If this can be done within the accounting system, it will be an easy task to extract costs that relates to environmental impacts through the touch of a button.

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