

The mining sector's response to environmental sustainability

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Abstract

Recent environmental catastrophes such as the Deepwater Horizon oil spill by BP in the Gulf of Mexico and the rising acid mine water in Johannesburg, South Africa, have demonstrated the far reaching environmental, social and financial consequences of unsustainable environmental management practices. Mining is an activity that significantly contributes to South Africa's Gross Domestic Product but has the potential to significantly impact the environment and a diverse set of stakeholders. As a result, it is imperative that mining activities are undertaken in a sustainable manner. This research studied the mining sector's response to environmental sustainability on a company level. The study entailed the use of a mixed methods approach within a strategic framework to enable the researcher to confirm the maturity level of current practices and simultaneously explore the extent to which companies are preparing for the future. The key research findings suggest that South African mining companies have current practices that are relatively developed, with insufficient focus on innovation to meet the future sustainability challenge. Key recommendations to meet the sustainability challenge include industry collaboration, a change in paradigm by companies, integration of suppliers into product stewardship practices and adequately managing the tension between the local empowerment and environmental agenda.

Keywords

South Africa, mining sector, environmental, sustainability, maturity level, practices, strategy.

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.



.....
Heena Bhana

10 November 2010

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1. Introduction to Research Problem

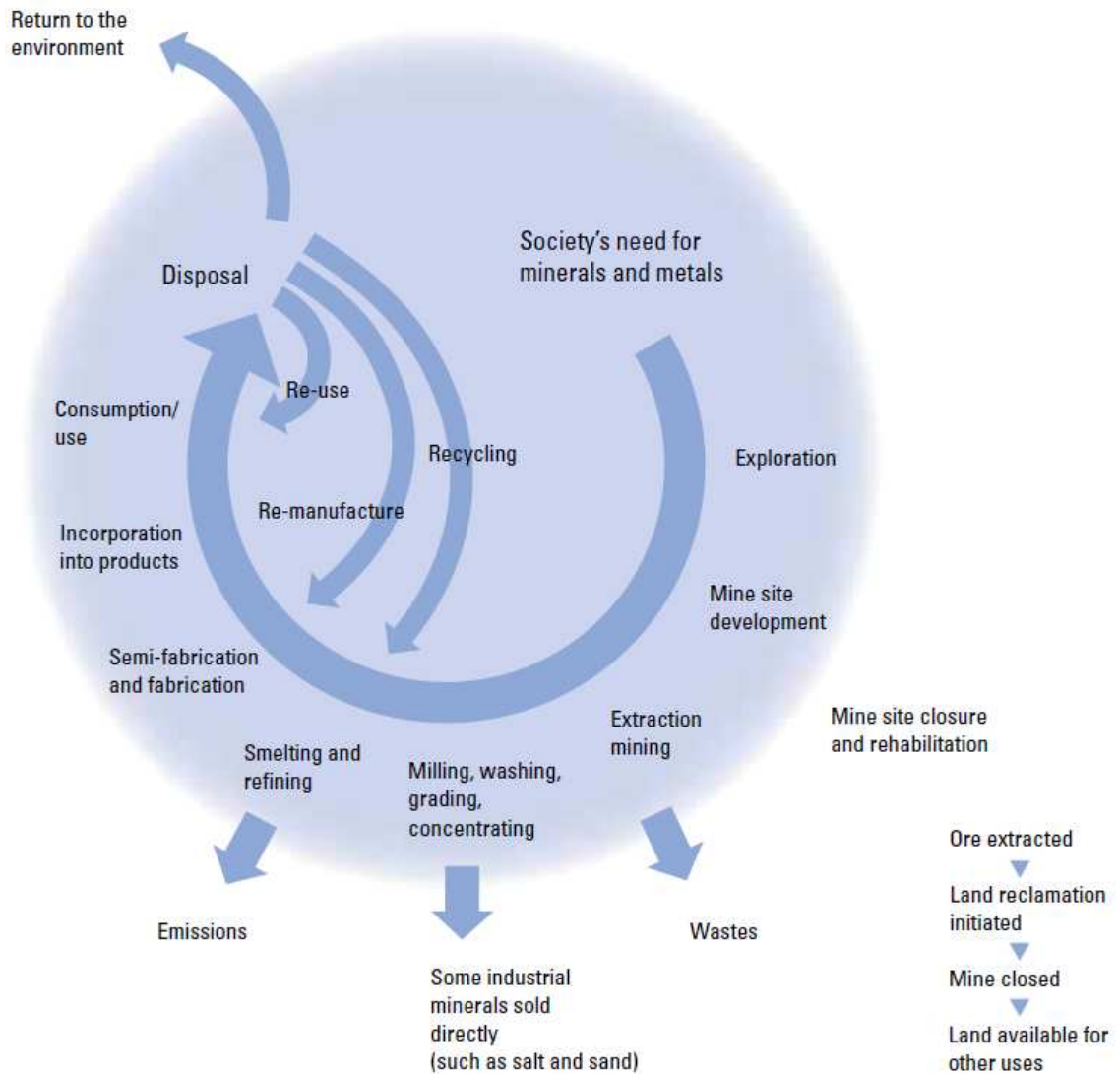
1.1 Introduction to Mining

Mining is a primary economic activity that entails the extraction of commodities from the earth's surface. Bridge (2004) categorises the extracted materials as metals (eg. copper, gold, bauxite, iron, nickel); fuel minerals (eg. oil, shale, coal, uranium); industrial minerals (eg. phosphates, salt, gypsum); and construction materials (eg. stone, sand, gravel). Exploration, mining and mineral processing describe the stages by which the above materials are located, extracted and refined. Figure 1 overleaf depicts this minerals' cycle.

In 2010, the global mining industry generated revenue of approximately \$325 billion (Pricewaterhouse Coopers, 2010), while the South African (SA) mining industry generated revenue of R237 billion in 2009 (Pricewaterhouse Coopers, 2010).

The demand for metals and minerals results in a sector that adds significant economic value to SA's Gross Domestic Product (GDP). In 2009, the SA mining sector accounted for 8.8% of GDP directly, with indirect multiplier effects raising the contribution to approximately 19% of GDP in total (Chamber of Mines, 2010). Mining continues to act as a magnet for investment to SA and in 2009, the mining sector accounted for a third of the market capitalisation of the Johannesburg Securities Exchange (JSE) (Chamber of Mines, 2010).

Figure 1: The Minerals Cycle



Source: Mining, Minerals and Sustainable Development Report (2002)

Other positive economic impacts of the mining industry include GDP growth, direct and indirect export and tax revenues, direct employment, indirect economic spin-offs and a direct contribution to health, education, food, infrastructure and information and communication technology.

1.2 The Negative Impacts of Mining

From Figure 1, is evident that mining is a resource intensive activity. It utilises natural resources and inputs such as the earth's surface, water and energy and converts these inputs into minerals, metals and waste products. Some of the major environmental impacts associated with mining in Africa include acid mine drainage, heavy metals contamination, deforestation, erosion and incomplete reclamation (Hilson, 2001).

Consider the following occurrences:

- 1) The Coal of Africa, an Australian-owned mining company was forced by the Department of Minerals and Energy (DME) to close parts of its Vele mining complex in Limpopo (SA) as a result of not obtaining the appropriate water use licenses (Ryan, 2010). Additionally, the company has encountered a legal challenge from conservationists as a result of the mine's proximity to a world heritage site and it has also been alleged that the company has not developed a mine closure plan (Ryan, 2010).
- 2) The Deepwater Horizon oil spill by BP in the Gulf of Mexico, labelled the worst environmental disaster which lasted for approximately 3 months, releasing approximately 4.9 million barrels of oil into the ocean, irreparably damaging the marine environment, killing 11 people, injuring 7 and resulting in unprecedented financial losses (Tharoor, 2010).
- 3) The rising acid mine water in Johannesburg (SA), which is reportedly 600m below the city's surface, rising rapidly and could spill out into the streets in 18 months time (Sapa, 2010). It has been reported that the situation can have catastrophic consequences for the Johannesburg central business

district if not stopped in time and that this environmental problem is second in SA, only to global warming in terms of its impact, and poses a serious risk to the Witwatersrand as a whole (Sapa, 2010).

The severity of the above occurrences highlight the importance of sustainable mining. Leading companies have recognised the value of sustainability principles (Bartra, 2007) and according to Ericsson and Noras (2005) mining companies large and small are attempting to meet the following objectives:

- 1) To be socially acceptable,
- 2) Environmentally affordable,
- 3) Economically affordable, and
- 4) Apply technologies which serve to achieve the above three objectives.

Listed below are some of the environmental sustainability principles as noted by Hilson and Basu (2003):

- Keep within the earth's carrying capacity,
- Non-exhaustion of natural resources,
- Minimise the depletion of the non-renewable sources,
- The precautionary principle,
- Eco-efficiency, and
- Full costing.

1.3 Research Purpose and Objectives

The above-mentioned principles are amongst the many principles and definitions of sustainable mining. Whilst there is a burgeoning literature that

examines sustainable mining on a national and global level, there is insufficient research and information with respect to mining companies' response to sustainability on a company level (Hilson & Murck, 2000).

Salzmann, Ionescu-somers, & Steger (2005) based on literature review and an analysis on the business case for corporate sustainability identified that there is an insufficient understanding of managers' business logic for adopting corporate sustainability strategies. They attribute this to a lack of descriptive research in these areas. Hamman (2003) further states that majority of companies are yet to develop a coherent response to sustainability.

Based on the status of research and information available, this study focused on the mining sector's response to environmental sustainability on a company level. According to Nag, Hambrink and Chan (2007), strategic management is a field that deals with the major intended and emergent initiatives taken by management on behalf of owners, involving utilization of resources, to enhance the performance of companies in their external environments. The study was conducted within a strategic framework, using a mixed methods approach that enabled the researcher to:

- 1) confirm the strategic practices undertaken by mining companies, and simultaneously
- 2) explore the strategic alignment of practices along the following two dimensions:
 - a) Time, capturing the need for companies to simultaneously fulfil short- and long-term objectives and

- b) Internal and external orientation, encapsulating the need for companies to protect internal skills, competencies and technologies whilst obtaining the new external perspectives to create change and innovation.

1.4 Scope of Research

In 2009, the SA mining industry generated revenue of R237 billion (Pricewaterhouse Coopers, 2010). Furthermore, the SA mining sector accounts for a third of the market capitalisation of the JSE (Chamber of Mines, 2010). Whilst the mining sector has positively contributed to GDP, there are environmental impacts associated with mining activities. The core focus of this study is environmental sustainability and the mining sector's response thereto.

While the researcher acknowledges that environmental sustainability is closely integrated with social and economic sustainability, the study will make references to social and economic sustainability in so far as environmental sustainability practices and concepts are impacted upon.

2. Literature Review

2.1 Introduction

To gain an understanding of environmental sustainability in the context of the SA mining sector, secondary data was analysed. Relevant legislation, books, journal articles and newspaper articles were reviewed. Summarised below are key aspects from the literature reviewed, focussing on the environmental impacts of mining, the significance of sustainable mining, global and national imperatives and the business case for sustainable development.

2.2 The Environmental Impacts of Mining

As an extractive industry, mining has far reaching impacts for the environment, as listed in Table 1 overleaf. Acid mine drainage is cited as one of Africa's major environmental challenges (Hilson, 2001). Sapa (2010) reported that "in Johannesburg, millions of liters of highly acidic mine water is rising up under city and, if left unchecked, could spill out into its streets some 18 months from now". Catastrophic losses (such as the Deepwater Horizon oil spill by BP), rising raw material and energy costs and social upheaval are key drivers of the green capitalism agenda (Wallis, 2010). As a result, it is important to understand the manner in which mining can be undertaken sustainably.

Table 1: The Impact of Mining on the Environment

Environmental Impacts	Pollution Impacts	Occupational/health Impacts
<ul style="list-style-type: none"> • Destruction of natural habitat at the mining site and at waste disposal sites • Destruction of adjacent habitats as a result of emissions and discharges • Destruction of adjacent habitats arising from an influx of settlers • Changes in river regime and ecology due to siltation and flow modifications • Changes in land form • Land degradation due to inadequate rehabilitation after closure • Land instability • Danger from failure of structures and dams • Abandoned equipment, plants and buildings 	<ul style="list-style-type: none"> • Drainage from mining sites, including acid mine drainage and pumped mine water • Sediment runoff from mining sites • Pollution from mining operations in riverbeds • Effluent from mineral processing operations • Sewage effluent from sites • Oil and fuel spills • Soil contamination from treatment residues and chemical spillage • Air emissions from mineral processing operations • Dust emissions from sites in close proximity to living areas and habitats • Releases of methane (from coal mines) 	<ul style="list-style-type: none"> • Handling of chemicals, residues and products • Dust inhalation • Fugitive emissions within the plant • Air emission in confined spaces from transport, blasting and combustion • Exposure to asbestos, cyanide, mercury or other toxic materials used on-site • Exposure to heat, noise and vibration • Physical risks at plants or on-site • Unsanitary living conditions

Source: Hilson (2000)

2.3 Sustainable Mining

Bridge (2004) notes that the mining industry, over the past two decades, has come under tremendous pressure to improve its social, developmental, and environmental performance. As a result, mining companies are increasingly embracing the concept of sustainable mining. However, a key debate evident within the literature reviewed is whether mining is in fact sustainable since resources are finite and non-renewable - giving rise to the question of intergenerational access to these resources. Cowell, Wehrmeyer, Argust and Robertson (1999) noted the two emergent views in the debate as follows:

- 1) The continued extraction of non-renewable resources is a necessary part of sustainable development.
- 2) The extraction of resources must be greatly reduced or even eliminated.

Mining is important for SA's economic growth and its fulfillment of Millennium Development Goals (MDGs) such as job creation and poverty alleviation and it is hence imperative to understand the manner in which mining can be undertaken sustainably.

Mining entails the exchange of natural capital for other forms of capital such as financial, manufactured and social and if the net effect of these capital stocks is positive over time, then mining is sustainable (Rajaram, Dutta, & Parameswaran, 2005). This is in contradiction with the Agenda 21 principles (United Nations Conference on Environment & Development, 1992) which advocate the use of non-renewable resources, subject to the following principles:

- 1) The use of non-renewable resources should not exceed the rate at which substitutes are developed,
- 2) The use of renewable resources should not exceed the natural regeneration rates, and
- 3) The output of substances into the environment should not exceed its assimilative or carrying capacity.

Based on acceptance of the above view and in alignment with Elkington's (2001) triple bottom line philosophy, Guerin (2006) asserts that sustainable development in the mining industry means that investments should be profitable, technically appropriate, environmentally sound and socially responsible. He further stated that applying these facets at an operational level equate to:

- Ensuring the preservation of biodiversity,
- Making efficient use of resources,
- Identifying and communicating with all stakeholders and particularly strengthening relationships between mining operations and the communities in which they operate,
- Reducing wastes and emissions,
- Minimizing the footprints of operations,
- Monitoring areas of potential impact, and
- Reducing costs and maximizing returns.

Hilson and Murck (2000) assert that there is ample of opportunity for the mining industry to operate more sustainably. Specifically noted are the following

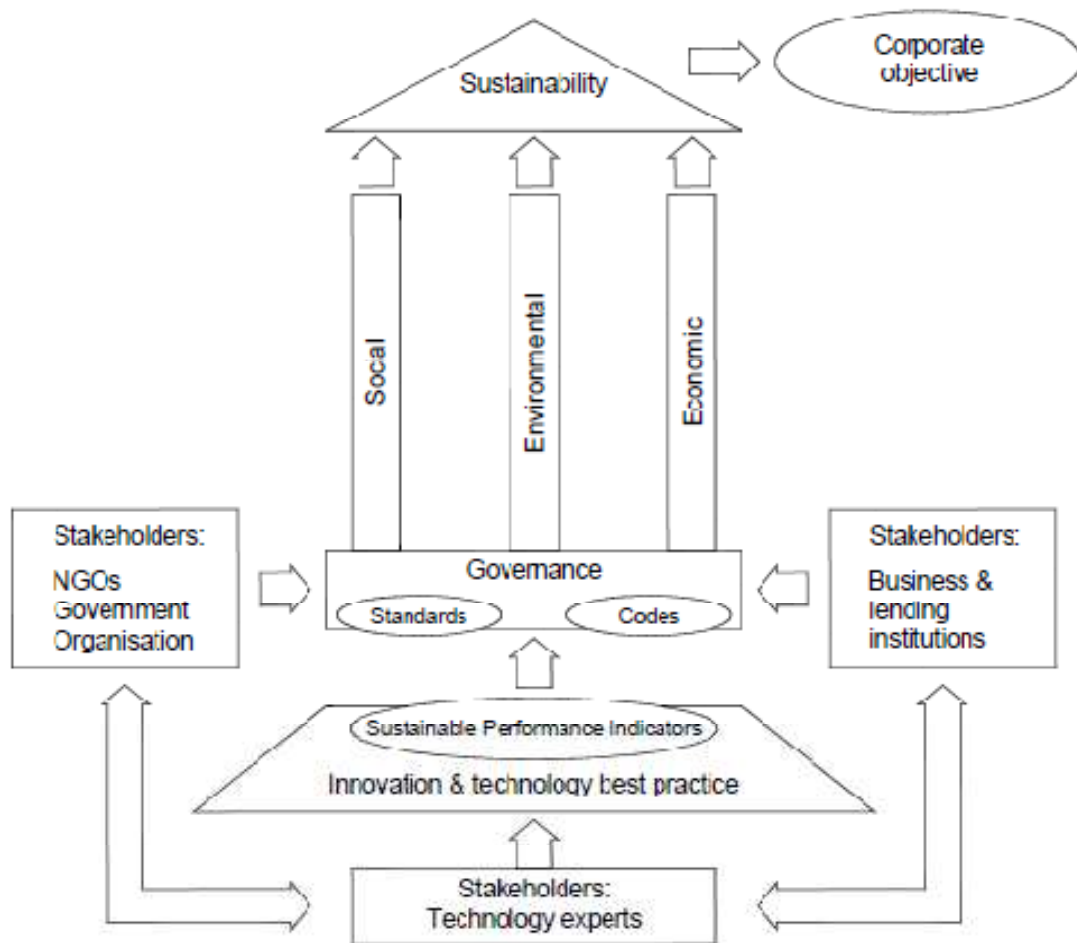
practices that will enable a mine to improve performance in both the environmental and socioeconomic arenas and thus contribute to sustainable development at a mine level:

- Improved planning,
- Implementation of sound environmental management tools and cleaner technologies,
- Extended social responsibility to stakeholder groups,
- The formation of sustainability partnerships, and
- Improved training.

In line with the assertions of Guerin (2006), Hilson and Murck (2000) and Hilson and Basu (2003) concur that sustainable mining should entail the use of resources in as environmentally sound a manner as possible. They further argue that “this requires the adoption of state-of-the-art environmental management practices and low waste technologies. To achieve such innovation and technological improvement, a best practice approach is needed. Such innovation along with efficient technology implementation enables mining projects to produce products more at a lower cost”.

Provided in Figure 2 overleaf is a Framework for Sustainable Development in Mining, as developed by Basu and Kumar (2002).

Figure 2: Framework for Sustainable Development in Mining



Source: Basu and Kumar (2002)

The above framework incorporates the business case for sustainable development and aspects hereof are further discussed below in the context of SA by providing an overview of the above key constituents, as applicable to the mining industry in SA.

2.3.1 Industry Initiatives and Legislation

This section describes general sustainability and industry specific legislative and guideline initiatives pertinent to the mining sector. The description is provided on a global and national basis.

2.3.1.1 The Global Imperative

2.3.1.1.1 The United Nations Conferences

In 1983, the United Nations (UN) convened the World Commission on Environment and Development (WCED) to establish policies relating to sustainable development. Subsequently sustainable development was defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission, 1986). A consequent UN conference in 1992 was the Rio Earth Summit, leading to the adoption of Agenda 21, a blue-print for action to achieve worldwide sustainable development. In 2002, at the World Summit on Sustainable Development (WSSD) held in Johannesburg, addressing poverty was cited as the greatest global challenge. The Johannesburg Plan of Implementation (JPOI) was agreed upon as a negotiated outcome. The JPOI sets out targets for achieving sustainable development, inclusive of the MDGs. In Johannesburg, countries also committed themselves to preparing and implementing national strategies for sustainable development.

2.3.1.1.2 The International Finance Corporation Guidelines

The International Finance Corporation has developed the Environmental, Health and Safety General Guidelines (International Finance Corporation, 2007) which are technical reference documents with general examples of good international practice. These guidelines are designed to be used in conjunction with industry sector guidelines. For the mining sector, the Environmental, Health and Safety Guidelines for Mining (International Finance Corporation, 2007) have been developed. These guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technologies at reasonable costs.

2.3.1.1.3 Mining, Minerals and Sustainable Development Project

In May 2002, the Mining, Minerals and Sustainable Development (MMSD) report was published (International Institute for Environment and Development, 2002). This report provides an in-depth global view of sustainable development within the mining and minerals' sector. Additionally, a MMSD report was also prepared for southern Africa, with the intention of determining how the mining and minerals sector can contribute to this region's transition into sustainable development.

2.3.1.1.4 The International Council on Metals and Mining and Global Reporting Initiative

The International Council on Metals and Mining (ICMM) is a CEO led organisation, established in 2001 to address industry related sustainable

development challenges, with a focus on social and environmental responsibilities (International Council on Mining and Metals, 2010). The ICMM comprises 18 mining and metals companies and 30 regional and national mining associations. Of the 18 member companies, seven are SA based. ICMM members are committed to a Sustainable Development Framework, comprising three elements:

- 1) *Ten principles for sustainable development* (supported by position statements) which member companies are required to implement.
- 2) A requirement for member companies to *publicly report* on economic, environmental and social performance on an annual basis, in accordance with the Global Reporting Initiative (GRI) Sustainability Reporting Framework. The GRI is a network-based organization that has developed a global Sustainability Reporting Framework which promotes a standardised approach to reporting and enables the:
 - benchmarking of organisational performance over time, and
 - Demonstration of organisational commitment to sustainable development.

An important aspect of the framework is sector supplements, developed to focus reporting within industries. ICMM members are committed to reporting in accordance with the Mining and Metals Sector Supplement, developed in collaboration with the MMSD project.

- 3) *Quality assurance*, evidenced through independent and external assurance ensures that member companies are implementing the above two elements, adhering to the 10 ICMM principles and GRI framework for public reporting.

2.3.1.1.5 Non-governmental Organisations (NGOs)

Non-governmental organisations (NGOs) representing the interests of communities and the environmental are also stakeholders within the mining industry. An example thereof is the Bench Marks Foundation (BMF), an international faith-based organisation, with partners in Australia, Hong Kong, Canada, USA, UK and Colombia (Bench Marks Foundation, 2010). This NGO's objectives include the promotion of ethical investments and monitoring of multinational companies to ensure their compliance with sustainable development. The BMF conducts forums, workshops and has published research on the mining sector in relation to sustainability.

2.3.1.2 The South African Imperative

2.3.1.2.1 Legislation

In SA, legislative requirements include acts, bills, standards and regulations. The Constitution of SA is the highest authority of law. The National Environmental Management Act is the overarching and enforceable body of legislation, followed by the Mineral and Petroleum Resources Development Act, in respect of mineral rights, prospecting permits and mining authorizations (Department of Minerals, 2010). The Mining Charter has also been developed and it sets a framework, targets and timetable for affecting the entry of historically disadvantaged individuals into SA's mining industry (Department of Minerals, 2010).

It should be noted that a host of best practice guidelines have also been developed by industry and in some instances are commodity specific.

2.3.1.2.2 National Strategy on Sustainable Development

In response to the JPOI targets, SA in 2008 finalised the development of the National Framework on Sustainable Development (NFSD). This framework proposes a national vision, principles and areas for strategic intervention that will enable and guide the development of the national strategy and action plan (Department of Environmental Affairs, 2010). In May 2010, the draft National Strategy on Sustainability Development (NSSD) and action plan was made available for public comment. Key principles of the NSSD include:

- Responding effectively to climate change,
- Towards a green economy,
- Building sustainable communities,
- Sustaining our ecosystems & using natural resources efficiency, and
- Enhancing governance systems & capacity.

2.3.1.2.3 Sustainable Development through Mining Framework

The Department of Minerals and Energy (DME) has initiated the Sustainable Development through Mining (SDM) programme to develop a sustainable development strategy for the SA mining sector and to work towards reporting sustainable development progress to the United Nations in 2010, in terms of SA's commitments made at the Johannesburg World Summit on Sustainable Development. In a draft report dated August 2009 and titled "Strategic

Framework for implementing Sustainable Development in the South African Minerals Sector: Towards Developing Sustainable Development Policy and Meeting Reporting Commitments”, sustainable development in the mining sector is articulated conceptually. The report documents the SDM programme’s proposed vision and associated key strategic objectives, illustrating the partial and ongoing attainment through projects and outcomes.

2.3.1.2.4 King III Code of Corporate Governance

The King III Code of Governance for South Africa replaced the King II Code as of September 2009 (Institute of Directors in Southern Africa, 2009). One of the essential principles of the King III Code is the view that governance, strategy and sustainability are inseparable. In line with the code’s recommendations, good practice requires that economic, social and environmental issues be included in corporate strategy, management, reporting and assurance throughout the year, in the same way as financial matters are dealt with. The King III Environmental Sustainability Practice Note complements the King III Code and provides the relevant principles as well as an implementation guide (Institute of Directors in Southern Africa, 2009)..

2.3.1.2.5 Socially Responsible Index

The Socially Responsible Index (SRI) was launched in 1994 in response to the King II Code requirements (JSE, 2010). The objective of the index was to:

- Identify organisation’s who successfully engage in sustainability reporting and good governance,

- Provide a tool for the assessment of an organisation's sustainability policies, and
- Enable continuous improvement and consequently alignment with global sustainability standards.

King III supports the notion of sustainability reporting. It advocates that instead of reporting on sustainability in addition to financial reporting, it should be integrated with financial reporting.

2.3.1.2.6 Analysis of Industry and Legislative Initiatives

From the above initiatives, it is evident that government, industry and NGOs are involved in the sustainability debate. Responses by these stakeholders demonstrate their commitment to sustainability. The SA government's policy response relating to sustainability generically and the mining sector specifically entails the NFSD (published in 2008), NSSD (published 2010) and SDM (published in 2009). This response appears to be lagging behind industry initiatives such as the ICMM Sustainable Development Framework. The ICMM was established in 2001 and activities relating to the Sustainability Development Framework are ongoing, such as the ICMM Member Annual Review Report, published in 2009, as part of its quality assurance programme.

2.3.1.3 The Social Licence to Operate

Public relations are cited by Wallis (2010) as one of the green practice responses to sustainability. Within the mining sector, communities within which

mines operate, employees, consumers, investors and social and environmental activists are key stakeholders.

Since mining is location specific, communities within and surrounding those locations could be greatly impacted by mining activities. In SA, there is evidence of mines working in close co-operation with surrounding communities (Hilson, 2001). In addition to hiring local labour for mining operations, mines could add socio-economic value by building infrastructure (such as roads, water and sanitation services), improving healthcare and contributing to skills development.

From the consumers, activists and investors perspective, it is important to note that as a result of the global GRI Sustainability Reporting Framework and SRI Index, companies in SA are increasingly integrating corporate responsibility into annual reporting procedures (KPMG, 2006). However, based on SA mining case studies, Hamman & Kapelus (2004) argue that there remain gaps between sustainability reporting and activities.

Nelson and Scoble (2006) note that gaining a social license to operate has emerged as a critical success factor for mining companies. They assert that this should be integrated into the mine planning process and propose situational tools to enable this. The Ethical Funds Company (2008) further reinforces the importance of gaining and maintaining the social licence to operate in mining. To maintain a social licence to operate, it is imperative that mining companies build reputation through material actions.

2.3.2 Current Environmental Practices

SA mining practices are generally considered advanced (Rajaram, Dutta & Parameswaran, 2005). The current status of mining varies significantly from continent to continent, but the most advanced practices occur in North America, Australia, Europe and South Africa, while less advanced practices occur in Asia and other parts of Africa. (Rajaram, Dutta, & Parameswaran 2005).

Specific examples that can be cited are those of the Chinese and Mexican mining industries. Li (2007) states that practices adopted by Chinese state mining companies are inferior to international norms. For Chinese companies to operate in other parts of the world and maintain current levels of economic development, mining practices must improve. In contrast, the Mexican mining industry is an example of an industry that has embraced a cultural shift that has enabled the advancement of sustainability practices (Suppen, Carranza, Huerta, & Hernández, 2006). This industry has demonstrated how lifecycle assessments aid not only in mitigating environmental impacts but adopting a more preventative approach in mining.

Hilson and Basu (2003) state that in a study of the Canadian non-ferrous mining sector, Environmental Management Systems (EMSs) and improved data collection were the industry's main responses to addressing the challenge of sustainability.

In a study conducted by Guerin (2006) in the Australian mining sector, the following tools and approaches were identified as being the most commonly used:

- 1) Cleaner production, which entails preventive environmental strategy to increase eco-efficiency, involving the efficiency assessment of products, systems and processes. Applications of this include industrial ecology where the waste from one process (or company) is used as a feedstock for another process (or company). It can also include incorporation of environmental concepts into a product or service at the design stage. Important tools of cleaner production are listed below, with a more detailed description relating to mining and minerals processing attached to Appendix 4:
 - Resource optimization
 - Input substitution
 - Technology modification
 - Good house-keeping
 - On-site recycling
- 2) Life cycle analysis, which involves a qualitative and quantitative approach to identify and calculate the impacts of a product or service from production, through its use and beyond.
- 3) Product stewardship, which identifies the cradle-to-grave responsibility for an organization's product or service.
- 4) Stakeholder engagement, which encompasses the range of individuals/organizations affected, influenced or impacted by businesses and those with potential themselves to influence, impact or affect business. Engagement potentially spans passive and active modes of engagement

including disclosure and transparency by businesses to their stakeholders, and direct involvement, consultation or partnership with stakeholders. Supplier engagement is an example whereby a company works with its major suppliers to assist the company achieve its goals for sustainable development.

Hart and Milstein (2003) further assert that programs in pollution prevention and product stewardship are well institutionalised in large companies.

2.3.3 The Business Imperative

Based on an analysis within the SA mining industry, Hamman (2003) advocates that there is a strong business case for companies to actively support sustainable development (as depicted in Figure 2). In a literature review and research analysis on the business case for corporate sustainability, Salzmann, Ionescu-somers & Steger (2005) reviewed theoretical frameworks, descriptive studies and tools and as a result identified that there is an insufficient understanding of managers' business logic for adopting corporate sustainability strategies. Elements identified pertain to how business cases are built, how effective they are and what barriers they face.

It is evident that the linkages between environmental sustainability and business strategy may not always be clearly understood. Porter and van der Linde (1995) and Hart (1997) state that the green debate has been framed incorrectly in terms of risk reduction and cost-cutting. Furthermore, policy makers, business

leaders and environmentalists have focussed on the static impacts of environmental regulation and ignored the more important offsetting productivity benefits gained from innovation.

Hart (1997) further states that greening is rarely linked to strategy while Bridge (2004) advocates that the mining industry is increasingly recognising the environment as a as a core strategic issue. Porter and Kramer (2006) identify the link between competitive advantage and sustainability and argue that as a result of sustainability approaches being disconnected from business strategy, companies are unable to see the opportunity in applying sustainability. The Sustainable Value Framework, developed by Hart and Milstein (2003), links the challenge of sustainability to the creation of shareholder value. The framework is also based on two dimensions which are usually the source of tension for companies – time and internal-external orientation. The Sustainable Value Framework integrates the various themes arising in this literature review and is therefore used in this study as a diagnostic tool. The framework is discussed further in Chapter 4.

2.3.4 Innovation and Change

Petrie (2007) advocates that sustainability cannot be achieved through business as usual models of mineral extraction - there is a fundamental need for re-orientation. This is further emphasised by Griffiths (2003) who argues that to simultaneously achieve human and ecological sustainability, transformational change through innovation is required. The importance for innovation and

technological improvement in the mining industry is also emphasised by Hilson and Basu (2003).

The above highlights the importance of innovation and Johne (1999) argues that three types of innovation contribute to business development: product innovation, process innovation and market innovation. For the mining industry which produces commodities, innovation is more likely to happen through technological, market and process innovation.

Hart (2005) asserts that relatively few firms have begun to explore the opportunity associated with new markets and developing disruptive technological capabilities. He argues that most companies are focussed on incremental as opposed to radical change.

2.4 Summary of Literature Review

The literature review commenced with a review of the environmental impacts associated with mining activities, followed by a discussion and definition on sustainable mining (depicted in Figure 2). Current responses to environmental sustainability by various stakeholders including government, the mining industry and NGOs were reviewed. Government's response appears to be lagging behind that of the mining industry.

In relation to other stakeholders, such as communities, evidence suggests that that SA mining companies are increasingly recognising the importance of gaining and maintaining the social licence to operate and responding

proactively to members of the communities in which they operate. Also linked to this social licence to operate is performance reporting and SA companies are recognised as increasingly integrating sustainability reporting into annual reporting.

In relation to current preventative practices, it appears that SA is adopting various practices, however, the maturity of such practices on a company level has not been documented.

An important theme arising from the literature is the fact that the business case for sustainability is not sufficiently understood. As a result of the disconnect between business strategy and sustainability, the true value of opportunity within sustainability and society are often overlooked.

The final theme emerging from the literature review is that business as usual methods will not meet the current sustainability challenge and innovation is cited as an important factor for the change required.

The themes arising from the literature review were used to formulate the research questions, as discussed Chapter 3.

3. Research Questions

Based on the themes arising from the literature review in Chapter 2, the following research questions have been identified:

- 1) What is the level of maturity of current internally and externally oriented environmental sustainability practices?***

- 2) Is there alignment between current internally and externally oriented environmental sustainability practices?***

- 3) Is change being adopted incrementally or radically?***

- 4) To what extent are environmental sustainability practices integrated into business practices?***

4. Research Methodology

4.1 Introduction

This chapter describes the research methodology adopted for this study. It details the research approach, methodology, population and sampling techniques selected. It also provides an overview of the data collection and analysis methods, concluding with the research limitation factors and associated mitigating responses.

4.2 Research Method

This study is primarily descriptive in nature as its major purpose is to describe the characteristics of a population (Zikmund, 2003). This descriptive study describes the response to environmental sustainability of SA mining companies, based on some previous understanding of the nature of the research problem (Zikmund, 2003), as described in Chapter 2 of this report.

The research method employed for this study is a mixed method approach, which integrates quantitative and qualitative approaches. Quantitative research is often confirmatory in nature and driven by the theory and current state of knowledge about the phenomenon under study while qualitative research is often exploratory in nature and aims to generate information about unknown aspects of a phenomenon (Teddile & Tashakkori, 2009). According to Creswell, Plano, Gutmann, & Hanson (2003), mixed methods involve the collection or analysis of both qualitative and quantitative data in a single study in which data

are collected concurrently or sequentially and involve the integration of data at one or more stages in the process of research. A major advantage of mixed methods research is that it enables the researcher to simultaneously ask confirmatory and exploratory questions in the same study (Teddile & Tashakkori, 2009).

4.3 Unit of Analysis

The unit of analysis for the study was the company responses.

4.4 Population and Sampling

A population is comprised of any complete group that shares similar characteristics (Zikmund 2003). The population of relevance for this study included mining companies operating in SA.

To obtain a sample of the population, a purposive sampling technique (Gray, 2009) was used, based on the JSE listed mining companies. Whilst 56 mining companies are listed on the JSE, 7 companies account for 85% of the market capitalisation of mining companies (Profile Media, 2010). Furthermore, it should be noted that mining companies comprise a third of market capitalisation of all JSE listed companies. The sample was selected based on companies ranked highest in terms of market capitalisation of mining companies, with a minimum criterion of including 85% of the market capitalisation of mining companies and consequently 28% of the all JSE listed companies.

The resulting sample comprised the seven mining companies, as listed below:

- 1) Anglo American,
- 2) BHP Billiton,
- 3) Anglo Gold Ashanti Limited,
- 4) Anglo Platinum Limited,
- 5) Impala Platinum Holdings Limited,
- 6) Goldfields Limited, and
- 7) Exxaro Resources Limited.

4.5 Data Collection

Data were gathered through semi-structured personal interviews, enabling the gathering of data through face-to-face contact with individuals (Zikmund, 2003). According to Teddile and Tashakkori (2009), interviews provide ample opportunity for interviewers to ask for explanations to vague answers or to provide clarification if a question is unclear. Furthermore, face-to-face interviews rendered flexibility to the interview process by allowing the exploration of themes identified within a defined context (Kvale, 1996).

For each company identified within the sample, the Environmental or Sustainability Manager was interviewed, depending on the selected company's organisational structure. The afore-mentioned individuals are responsible for sustainability and associated issues within the company and:

- Have first hand knowledge of current practices and future plans regarding environmental sustainability,
- Understand environmental strategy in the context of corporate strategy,

- Have first hand knowledge of the implementation of environmental sustainability practices.

To reduce interviewee bias (Zikmund, 2003), data was triangulated using the companies' published Sustainable Development Reports. All interviews were recorded using audio-recording technology. The advantage of the audio recording is that it offered a permanent record, one that is fairly complete in terms of the speech that occurs, and can be checked by other researchers (Denscombe, 2007).

4.5.1 Interview Guide Development

The semi-structured interviews were conducted using an interview guide, attached as Appendix A. This guide was developed by taking into consideration the literature review in Chapter 2 and the emergent research questions articulated in Chapter 3. Described below is the rationale behind the content and structure of the interview guide.

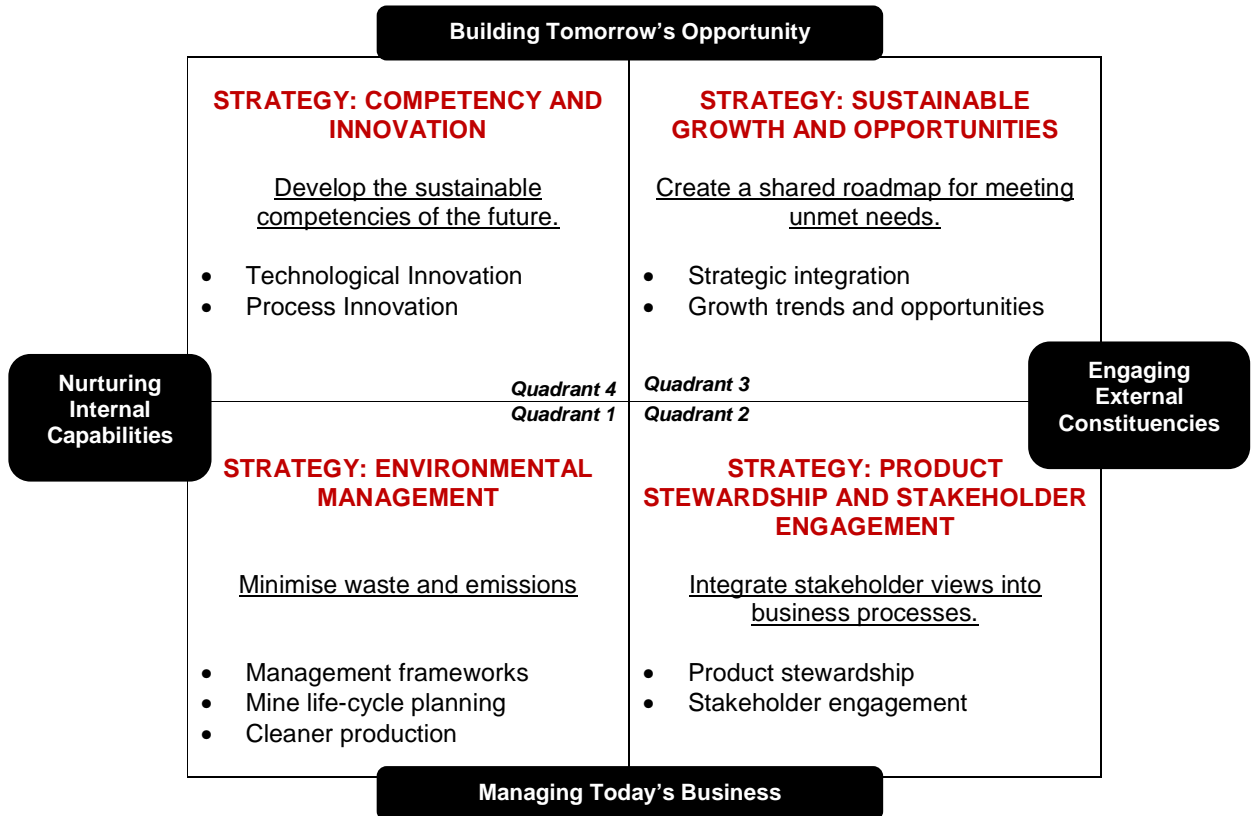
According to Nag, Hambrink and Chan (2007), strategic management is a field that deals with the major intended and emergent initiatives taken by management on behalf of owners, involving utilization of resources, to enhance the performance of companies in their external environments. Hart and Milstein's (2003) Sustainable Value Framework is essentially a strategic framework that enabled the researcher to utilise a mixed methods approach to:

- 3) *confirm* the strategic practices undertaken by mining companies based on current knowledge, and simultaneously
- 4) *explore* the strategic alignment of practices along the following two dimensions:
 - c) time (present and future), capturing the need for companies to simultaneously fulfil short- and long-term objectives.
 - d) Internal and external orientation, encapsulating the need for companies to protect internal skills, competencies and technologies whilst obtaining the new external perspectives to create change and innovate.

Bearing in mind the above-mentioned intent, Hart and Milstein's (2003) Sustainable Value Framework was adapted by the researcher for the mining sector, as depicted in Figure 3 overleaf. The framework incorporates key current practices identified by Guerin (2006) who conducted an analyses of sustainable development initiatives in the Australian mining sector. Hart and Milstein's (2003) assertions, where applicable to the mining sector were also incorporated into the framework, in addition to other emergent themes from the literature review such as innovation and integration of environmental strategy into corporate strategy.

The interview guide was structured based on the four quadrants of the Sustainable Value Framework provided in Figure 3 overleaf. A further description of the four quadrants is provided in Appendix 5.

Figure 3: Sustainable Value Framework



Source: Hart and Milstein (2003), adapted

For each of the four quadrants, the maturity level of the practices were observed, based on feedback from interviewees and an assessment of the companies' Sustainable Development Reports. The maturity levels were captured using the following criteria:

- 1) Non-existent – no strategies or practices in place,
- 2) Emerging – strategies or practices in their development stage,
- 3) Developed – strategies or practices that are already developed, but not fully institutionalised, and

- 4) Institutionalised – developed strategies or practices that are incorporated into a structured and well-established system.

In accordance with the mixed method approach, the interview guide contained a combination of open-ended items (with probes) that generate rich narrative data and closed-ended items that have predetermined response categories (Teddile & Tashakkori, 2009) Additionally, questions were designed to flow, structured around identified themes, enabling a structured response to the research questions listed in Chapter 3.

4.6 Data Analysis

Mixed method data analysis involves processes whereby quantitative and qualitative data analysis strategies are combined, connected or integrated in research studies (Teddile & Tashakkori, 2009).

For the closed-ended questions, data were categorised (where applicable), based on the following scales:

- 1) Constant sum scale – a measure of attitudes in which interviewees were asked to divide a constant sum among response alternatives to indicate the relative importance of attributes (Zikmund, 2003).
- 2) Rating scale – a measurement scale that requires the interviewees to estimate the magnitude of a characteristic or quality that an object possesses (Zikmund, 2003).

The results from the above analyses were combined to determine a representative score for each company within the four identified quadrants (detailed in Chapter 3).

Content analysis was performed on the above-mentioned results and responses obtained from open-ended questions as it facilitated the objective, systematic and quantitative description of the collected data (Zikmund, 2003). A thematic analysis was also performed, enabling the application of the similarity and contrast principles (Teddile & Tashakkori, 2009) allowing the researcher to compare and contrast qualitative and quantitative data collected.

4.7 Research Methodology Limitations

Summarised below are the identified limitations arising from the adopted research methodology, accompanied by mitigating factors employed:

- 1) Researcher bias resulting from the researcher's personal perceptions and assumptions (Zikmund, 2003). This was mitigated by preparing an interview guide which guided the interview. The companies' published Sustainable Development Reports were also used to confirm data collected from the semi-structured interviews.
- 2) Researcher error resulting from the failure of the researcher to correctly record responses (Zikmund, 2003). Audio-recording technology was used to ensure that responses to open-ended questions were recorded verbatim.
- 3) Response bias resulting from respondents answering questions in a manner that consciously or unconsciously misrepresents the truth. Data triangulation

(Teddile & Tashakkori, 2009) was used by reviewing the companies' published Sustainable Development Reports.

5. Results

5.1 Introduction

This chapter presents the results obtained from the data collected during the semi-structured interviews. The chapter commences with a description of the research sample, followed by the results for each of the four quadrants of the Sustainable Value Framework Analysis, and is concluded with the aggregated results of the Sustainable Value Framework Analysis.

5.2 Research Sample

Provided in Table 2 below is a summary of the sample as selected during the research planning stage, together with the actual sample in accordance with the semi-structured interviews conducted.

Table 2: Research Sample

	Planned Sample	Actual Sample	Response Rate
Number of Mining Companies	7	6	86%
Proportion of Market Capitalisation of Mining Companies	85%	78%	91%
Proportion of Market Capitalisation of all JSE Listed Companies	28%	26%	91%

Six of the seven companies comprising the sample were interviewed, constituting a company response rate of 86%. Based on market capitalisation, the response rate was 91%. It should also be noted that the companies

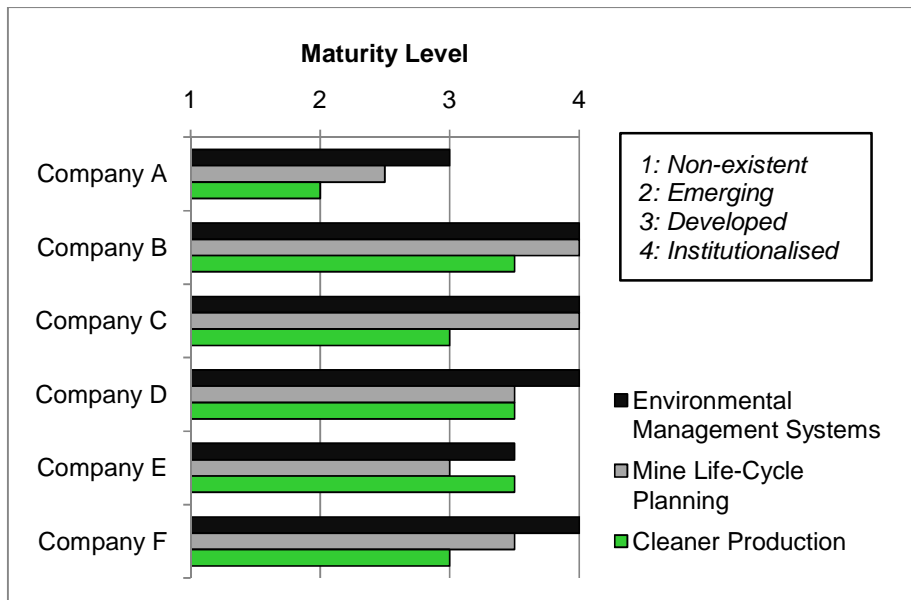
interviewed account for 78% of the market capitalisation of mining companies on the JSE and 26% of all JSE listed companies.

To maintain confidentiality of the identity of the individuals interviewed and the companies they represent, the results are presented as coded and in manner that does not render individuals or companies identifiable.

5.3 Environmental Management Practices (Quadrant 1)

Provided in Figure 4 below are the maturity level results for quadrant 1, followed by a discussion per company for environmental management systems, mine life-cycle planning and cleaner production. This discussion has been included to provide further insight into current adopted practices.

Figure 4: Quadrant 1 Maturity Level - Environmental Management



5.3.1 Environmental Management Systems

Company A

Company A's operations are certified in terms of the ISO 14001 EMS standard. A key underlying principle of the EMS is continuous improvement and the objective is to incorporate environmental considerations into how the company operates and should be intrinsic. However, the interviewee stated that "it works better in some operations than in others and is easy to talk about". Challenges linked to the EMS are not related to the system itself, but the implementation thereof.

The interviewee further stated that environmental management is not sufficiently entrenched into the mining project life-cycle and its associated disciplines. The interviewee acknowledged the importance of integrating environmental management into appropriate aspects of the company's operations.

Company B

Approximately 95% of company B's sites are certified in terms of the ISO 14001 EMS standard. The interviewee indicated that the implementation of the EMS is fairly institutionalised and this is achieved through a "company-wide consistent understanding and consistent implementation of environmental policy and standards".

Company C

Approximately 86% of the company's sites are ISO 14001 certified. The interviewee indicated that the ISO requirements are baseline in nature and company endeavours to perform beyond compliance. The EMS is fairly institutionalised and the interviewee stated that there are dedicated resources for this purpose at an operational level.

Company D

All the company's operations implement an ISO 14001 EMS. When the EMS was developed, a decision was made at the outset to develop an EMS that truly works for the company as opposed to an EMS that is merely certifiable. The company has opted to make its standards impeccable in an effort to maintain its social licence to operate.

Company E

All of the company's sites have an EMS that is ISO 14001 certified. The interviewee indicated that these systems are fairly developed but not yet entrenched uniformly across the entire organisation. The result is that the company is at times reactive to issues.

Company F

All except one of this company's operations have ISO 14001 certified EMSs. The interviewee confirmed that the EMS is institutionalised and is embedded in the company's day-to-day operations.

5.3.2 Life Cycle Planning

Company A

The development, operation and management of mining operations are currently a focus area for the company. The interviewee stated that “the company is also trying to incorporate the principle of designing for closure with the end in mind”. This is particularly significant since many environmental impacts are built into a mine’s design from the onset and it is difficult to change during later stages of the project. The interviewee also stated that environmental management is not sufficiently entrenched into its project cycle.

Company B

This company, over the last seven years, has developed a strong focus on mine life-cycle planning, taking a holistic view from mine exploration to closure. Planning is done in accordance with a set of predefined criteria, in line with the company’s sustainability practices and values. Mine closure plans are self-assessed and third party assessed.

Company C

This company has practiced mine life-cycle assessments for the last five years. The interviewee indicated that over time, it has become more sensitive to designing for sustainability. Designs for all new mines are such that there are zero emissions and no impact on water, land and air.

Company D

The company has been conducting mine life-cycle planning for approximately ten years. The interviewee indicated that mine closure plans are detailed, with similar level of detail for costing. Mine closure plans are updated on an annual basis and are also verified through external assurance.

Company E

The company has integrated sustainable design principles into all aspects of its business, from mine exploration to closure. All operations have closure plans. All new projects undergo intensive reviews and audits based on the aforementioned principles.

Company F

This company integrates sustainable development into mine life-cycle planning. An integral part of its planning is closure planning. All sites are required to have closure plans.

5.3.3 Cleaner Production

The interviewed companies are involved in a diverse range of commodities that entail varying extraction and processing techniques. An assessment has been made on the degree of the focus of the companies on the cleaner production tools discussed in Chapter 2, as categorized by Guerin (2006). This assessment was made by obtaining feedback from the interviewees and

evaluating the companies' Sustainable Development Reports. Provided in Table 3 below are the results of the assessment.

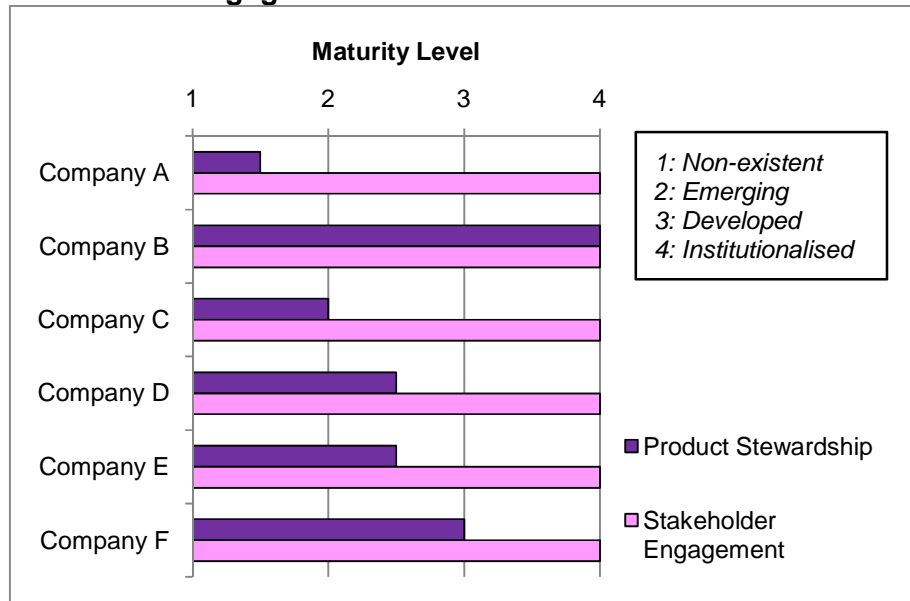
Table 3: Cleaner Production Tool Focus

Company	Resource Optimisation	Input Substitution	Technology Modification	On-site Recycling	Good House-keeping
A	Strong	Low	Moderate	Low	Strong
B	Strong	Strong	Strong	Low	Strong
C	Strong	Low	Moderate	Low	Strong
D	Strong	Moderate	Moderate	Strong	Strong
E	Strong	Moderate	Strong	Low	Strong
F	Strong	Low	Moderate	Low	Strong

5.4 Product Stewardship and Stakeholder Engagement (Quadrant 2)

Provided in Figure 5 overleaf are the maturity level results for quadrant 2, followed by a discussion on product stewardship and stakeholder engagement. This discussion has been included to provide insight into current adopted practices.

Figure 5: Quadrant 2 Maturity Level - Product Stewardship and Stakeholder Engagement



5.4.1 Stakeholder Engagement

Based on the responses from all the interviewees and the companies' Sustainable Development Reports, it should be noted that all companies' acknowledged that the social licence to operate within communities and governments is critically important in mining and agreed that it is necessary to build reputation and legitimacy through effectively engaging with a broad range of stakeholders on environmental issues amongst others.

The companies' engage with a variety of stakeholders such as:

- Various levels of government, including local, regional and national,
- Communities within which mines operate,
- Non-governmental organisations and community-based organisations,
- Industry and commodity specific associations, and

- Investors and shareholders.

Of all of the companies interviewed, majority of the companies' stakeholder engagement processes are institutionalised. Additionally, the following observations were made by majority of the interviewees:

- Challenges associated with stakeholder engagement include high economic expectations of mining companies by communities.
- Investors are becoming increasingly interested in environmental sustainability, particularly in light of the catastrophic Deepwater Horizon oil spill by BP in the Gulf of Mexico (Tharoor, 2010). An interviewee stated that "there is a small but growing group of investors who have mandates focussed on environmental and social integrity".

It should be noted that all of the interviewed companies are constituents of the 2009 SRI Index (JSE, 2010), attached as Appendix 3. The objective of the index is to identify companies who successfully engage in sustainability reporting and good governance and integrate triple bottom line principles and good governance into its business activities.

Furthermore, it should be noted that 4 of the 6 companies interviewed are ICMM members, and 5 of the 6 interviewed companies subscribe to the ICMM principles. Provided in Table 4 overleaf is the 2009 ICMM Member Performance.

Table 4: 2009 ICMM Member Performance

Company	ICMM Member	Policy Alignment with Principles	Assurance of Policy Alignment with Principles	G3 Application Level	Use of MMSS	Assurance of G3 Application Level
A	yes	yes	no	A+	yes	yes
B	yes	yes	no	A+	yes	yes
C	no	N/A				
D	yes	yes	yes	B+	no	yes
E	no	N/A				
F	yes	yes	yes	A+	yes	yes

Source: ICMM Member Performance Table – Annual Review 2009

5.4.2 Product Stewardship

Company A

The interviewee indicated that the company’s life-cycle analysis practices are not sufficiently developed but does “look downstream into the value chain”. In assuming further responsibility for its product, the company has not demonstrated its willingness. Currently, procurement from and interaction with suppliers is driven by cost and performance integrity, without an environmental focus. The interviewee stated that “green procurement work is generally premature and not very rigorous”. The interviewee further conveyed that “we will start to go there as those requirements materialise and they are materialising in some parts of the business, but there hasn’t been a strategic focus to get there ahead of the curve”.

Company B

Company B proactively engages with its suppliers and seeks to work with suppliers that share its ethos on sustainable development. The company’s dedicated supply chain resources are well versed on the topic of green

procurement. All suppliers are required to conduct self-assessments and selected major suppliers are audited to ensure compliance with the company's sustainability principles and standards. The company works closely with suppliers and has found that through sharing best practice, it is able to continuously learn and improve.

The company notes that within a developing economy like SA, not all local businesses have the capacity to comply with its standards. As a result, it has embarked on capacity building programs with these businesses.

Company C

Company C's procurement objectives are currently highly focused on the empowerment of local and historically disadvantaged suppliers.

The company indicated that it conducts life-cycle analyses and new mines will be designed such that there are zero emissions and no impact on the water, air and land. Hence, it will be important that the company engages in green procurement and procures goods and services from suppliers who comply with its green agenda. The interviewee noted that it is currently looking at ways to procure from suppliers who are ethical and responsible.

Company D

The interviewee stated that life-cycle analyses are conducted on high-risk items only, such as cyanide. The company also does spot checks on suppliers who provide high-risk items only.

In preparing its EMS for the ISO 14001 certification, the company underwent the process of preparing detailed material safety data sheets. Whilst the company's green procurement initiatives are not well developed, its intent is to build on the positive work done to date to promote green procurement policies within the supply chain.

The interviewee also noted that within the SA context, there are often tensions in the supply chain between the local empowerment objectives and the green agenda.

Company E

Company E has not conducted many life-cycle analyses on various products within the supply chain, but based on the ones completed, the interviewee indicated that these tend to be expensive, time consuming and not always providing the company with results that can benefit the business. The interviewee further stated that certain life-cycle analyses should be conducted at an industry level.

Green procurement within the company's supply chain is relatively new on its agenda, for approximately two years now. A crude assessment has been done on all the company's suppliers and the first set of audits have recently commenced.

The interviewee noted that as a large organisation, tension sometimes exist between centralised and localised procurement. It was suggested by the interviewee that these internal tensions need to be addressed and managed.

Company F

The company focuses on life-cycle assessments and strives to produce products that are environmentally friendly and have a minimal impact on society.

There is also a strong focus on managing environmental risks (amongst others) relating to suppliers. The company conducts an evaluation of all suppliers prior to procurement. Regular audits are also conducted for environmental compliance.

5.5 Sustainable Growth and Opportunities (Quadrant 3)

Provided in Figure 6 below are the maturity level results for quadrant 3, as inferred from the companies' Sustainable Development Reports and interviewees' responses during the interviews, as summarised in Table 5 overleaf. This is followed by a discussion per company, to provide insight into current strategic intent and practices.

Figure 6: Quadrant 3 Maturity Level - Sustainable Growth and Opportunities

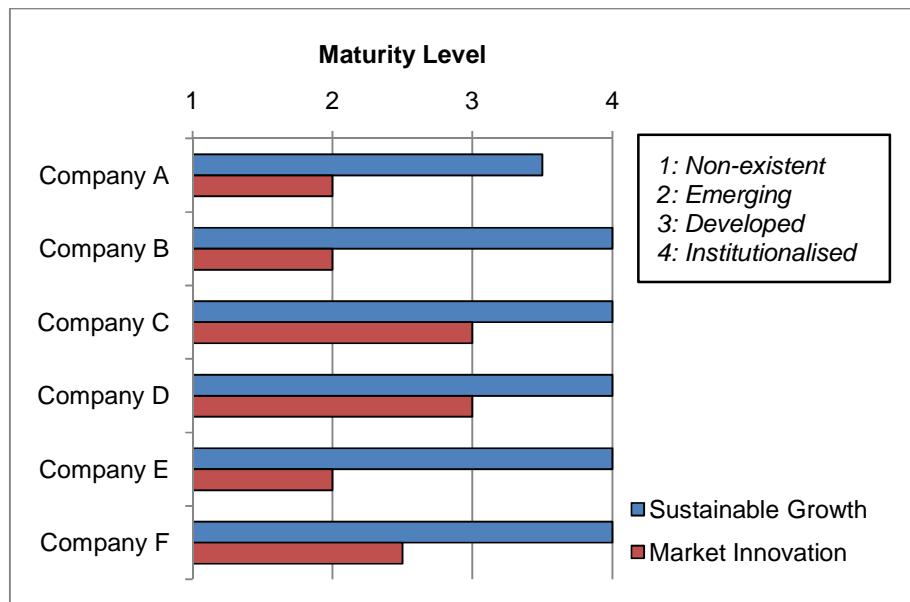


Table 5: Strategic Growth and Intent

Question	Company					
	A	B	C	D	E	F
1) To what extent is the company's environmental sustainability strategy and principles integrated into its corporate strategy?	Extremely	Extremely	Extremely	Extremely	Extremely	Extremely
2) To what extent is the company conducting current operations sustainably?	Somewhat	Extremely	Extremely	Extremely	Extremely	Extremely
3) To what extent does the company's vision direct it to solve environmental problems?	Somewhat	Somewhat	Somewhat	Somewhat	Somewhat	Somewhat
4) To what extent does the company innovatively use waste streams to generate revenue?	Somewhat	Somewhat	Somewhat	Extremely	Somewhat	Somewhat
5) To what extent has the company explored business opportunities in markets other than its traditional focus areas?	Not at all	Somewhat	Extremely	Extremely	Somewhat	Somewhat

Company A

The company's strategic approach to environmental management is predominantly reactive. The reactive strategy is underpinned by compliance with government and socially imposed requirements. The interviewee stated that the reactive approach is the starting point and a baseline but also indicated that the company is adopting a proactive approach, focussed over and above compliance.

The interviewee also stated that "good environmental practice can lower risks but will most likely increase costs". Whilst acknowledging that environmental sustainability is critical to both the sustainability of the business and its long-term cost structure, the interviewee stated that "there is a trade-off between meaningfully reducing the environmental footprint and a significant capital investment".

The interviewees' emphasized that environmental sustainability within the company is viewed as integrated with the economic and social pillars of sustainable development. It was stated by the interviewee that the "social licence to mine has a very strong environmental and communal piece and mostly the two are related". This integrated approach is fairly recent and is also documented in the company's Sustainable Development Report. Whilst the intent of integration is apparent, it appears that implementing this integration has been challenging.

The interviewee cited that the “legacy of past mining cultures often makes it difficult for companies to change”, however a change in leadership at this company has mobilised current change management practices with respect to environmental sustainability.

Company B

Company B acknowledges that it has a large environmental footprint and states that it will endeavour to do zero net harm through all of its activities and wherever possible, offset its footprint by adding value to the environment. The interviewee stated that in terms of the five capitals model, company B’s vision is “to be a net adder of capital environmentally over the life-time of our operations and beyond”.

When asked whether it is possible to minimise risks and reduce costs by applying good environmental management practices, the interviewee stated good practice upfront minimises the long-term costs overall and that it is important to take a long-term view of costs. Additionally, the interview noted that to address the sustainability challenge at hand, “people need to be more innovative and think outside the box”.

Company B has recently launched programs to ensure the integration of social and environmental policy into its business processes. The interviewee stated that the success of integration has been as a result of a ‘pull-push strategy’. Initially, practices are made obligatory (push) and with time, the practices become institutionalised and embedded (pull) within the company.

Company C

The interviewee stated that sustainable development is about a business understanding the impact it makes and managing those impacts in a progressive manner - the goal is essentially to minimise negative impacts, enhance the positive ones and find and exploit opportunities along the way.

Company C is moving from a reactive and risk-based approach to relatively proactive one. The company has strongly integrated sustainability into its strategy and focuses on value creation for all stakeholders. The integration has been operationalised within the company by leadership creating awareness and through an existing re-engineering process that the company is undergoing. This process has enabled the company to integrate environmental sustainability into the company whilst simultaneously integrating other changes.

The interviewee also noted that this company has a dual short- and long-term focus. By focussing on long-term business opportunities without compromising current business, the company is able to reposition itself for the future.

The interviewee also stated that minimising environmental risks does not reduce but increases costs, which must be factored into the cost of doing business.

Company D

The interviewee stated that the company has progressively integrated environmental sustainability into the social and economic pillars of sustainable

development. According to the interviewee, “sustainable development is about managing risks, doing so responsibly and capitalising on any opportunities that may arise”.

The interviewee also acknowledged that the mining industry by nature has been reactive in its response to environmental sustainability. Company D advocates that it is not merely reactive but fairly proactive, way ahead of compliance. The interviewee further stated that within the company, every single person is responsible for environmental sustainability and that the ultimate Sustainable Development Manager for the company is the CEO. Historically, environmental managers were isolated from other disciplines, however, environmental sustainability is increasingly becoming embedded within the company.

The interviewee also indicated that it is possible to minimise risks and reduce costs by applying good environmental practice, such as use of waste streams to generate revenue.

Company E

Company E defines environmental sustainability within the broader context of economic and social sustainability and governance. The company's approach is legal compliance as a minimum, with environmental management systems that enable continuous improvement. The interviewee also indicated that the environmental agenda is relatively new and in some respects, the company remains reactive to certain issues and is not fully proactive. The company manages risks but also explores opportunities linked to sustainability.

The interviewee noted that the environmental role is increasingly becoming integrated into the company. The role of Environmental Manager has changed from being purely operational to focus compliance monitoring and consultative. Disciplines are taking relatively more responsibility for environmental sustainability.

An observation made by the interviewee was the fact that new graduates, as a result of their education, have a greater focus environmental sustainability and its integration into the tasks they undertake.

Company F

The interviewee confirmed that the company views sustainability from an integrated environmental, economic and social perspective. The business strategy is well integrated with the sustainability agenda. The company advocates that profitability is linked to value creation and non-financial benefits such as societal upliftment and environmental protection.

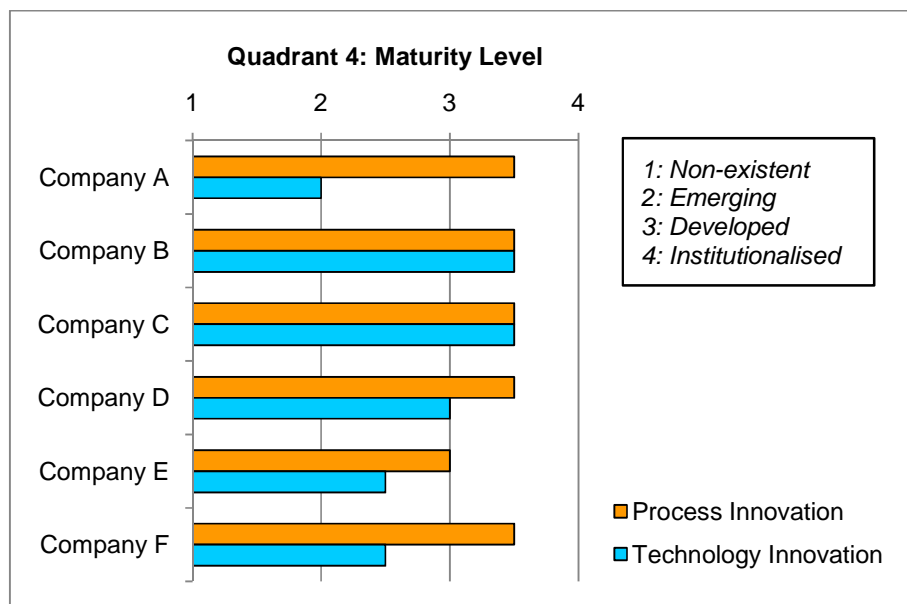
The interviewee indicated that it is possible to mitigate risks and lower costs in the long-term through good environmental practice.

The interviewee stated that leadership supports the environmental agenda and that environmental activities are becoming increasingly embedded into the company.

5.6 Competency and Innovation (Quadrant 4)

Provided in Figure 7 below are the maturity level results for quadrant 4, followed by a discussion per company, which has been included to provide further insight into the companies strategic intent and practices.

Figure 7: Quadrant 4 Maturity Level – Competency and Innovation



Company A

The interviewee confirmed that to achieve the company’s predefined environmental targets, radical technological change is needed. It was further noted that radical technological change is limited by current competency and current cultures of mining practice.

The interviewee conceded that the company is weak on conducting research and development and that insufficient spend in this regard is a definite

shortcoming. Research and development is however done around project specific challenges and is outsourced by the company's technical disciplines.

The interviewee further stated that that there are challenges inherent in achieving technological innovation such as:

- the trade-off between mechanisation and job creation in emerging economies such as SA, where relatively large sections of the population are unemployed and unskilled.
- the trade-off between investing in research and development as opposed to other activities in which the company may have a competitive advantage.
- the cost implications since research and development approaches require time to incubate, develop and be proven. This often is challenging in a production environment where employees are hard-pressed to meet short-term objectives and budgets.

The interviewee also confirmed that the current focus on innovation is on process as opposed to technology. The company is in the process of implementing a new business process framework, from which major process improvements are expected.

Company B

Company B has a research and development group as part of its technical core, which focuses on all aspects across the entire business. The research and development group interacts with the company's supply chain department, suppliers and potential suppliers and are charged with constantly looking for

innovative technologies which can enable resource optimisation and input substitution, both in the short- and medium- to long-term. The approach adopted is as follows:

- Short-term: the research and development department works with the supply chain to carefully evaluate if there are alternative ways to do what they are currently doing. The company's view is that suppliers are continuously innovating to maintain their competitive advantage and this provides the supply chain with additional solutions.
- Medium to long-term: the company partners and collaborates with educational, research and development and commodity specific institutions to conduct research on an industry level.

The company has launched an internal programme to ensure that environmental sustainability policies, standards and procedures are embedded within the company. The interviewee also stated that the company's current planning horizon includes the mine of 2030, which is highly mechanised.

Company C

Company C has a research and development department based at its head office which has a short-term focus and works across all business units. Steering committees have been set up, comprising individuals from various business units with different skills. The objective of these committees is to evaluate ways of working smarter and minimising impacts on the environment. Whilst the above-mentioned research and development department has a short-term focus, the company also has a growth department, which focuses on new

opportunities and technologies. This department's philosophy is to be open to new ideas and it uses a funnel approach to filter innovative ideas.

The company is in the process of undergoing an overarching re-engineering process. This process has provided the company with the opportunity to integrate environmental sustainability policies and standards into the company by ensuring that roles, responsibilities and structures can be clearly defined.

Company D

The company has a decentralised research and development model, with Sustainable Development experts at a regional level. Information sharing occurs through steering committees. The current technological focus is water, energy, robotics and mechanisation. Separate funds are allocated to research and development and selected individuals are tasked with sourcing the best available technologies and developing the associated business cases.

When asked about the role of incremental and radical change, the interviewee conveyed that certain process related changes (such as the development of the ISO certified EMS and behavioural and attitude changes) tend to have a much bigger impact over the long-term than short-term radical and technological changes. The interviewee expressed that the company's planning processes are not cast in stone and the company is adaptable and open to change and new ideas.

Company E

The company has a research and development department which focuses on resource optimisation and efficiencies in the short-term. The interviewee described a few examples where efficiencies were gained as a result of technological innovation. One of the examples included the patenting of unique technology, researched and developed by the company itself.

The company also partners with educational, research and development and commodity specific institutions to conduct research on an industry level.

The interviewee confirmed that the company has implemented a combination of process and technological innovation.

Company F

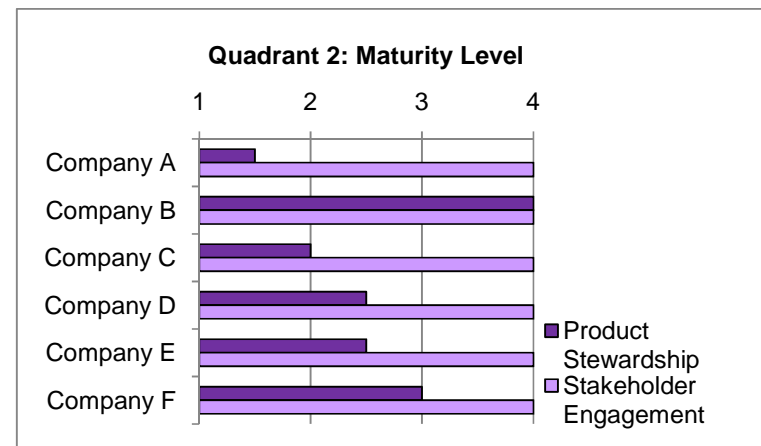
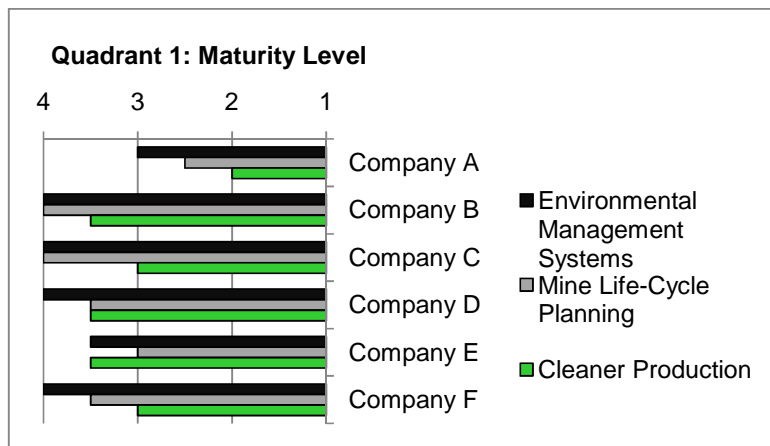
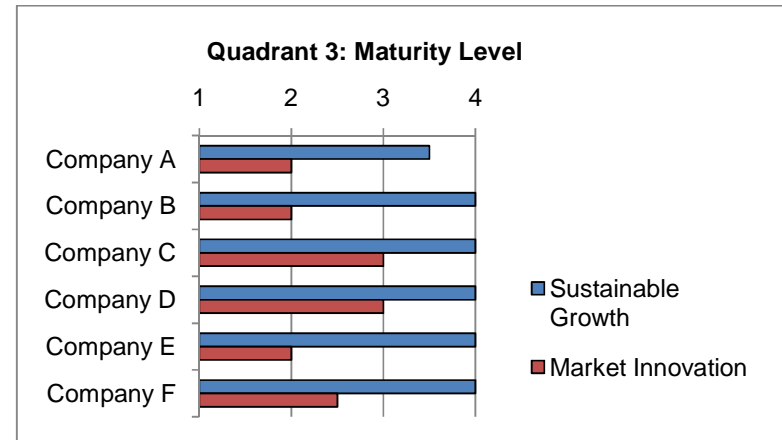
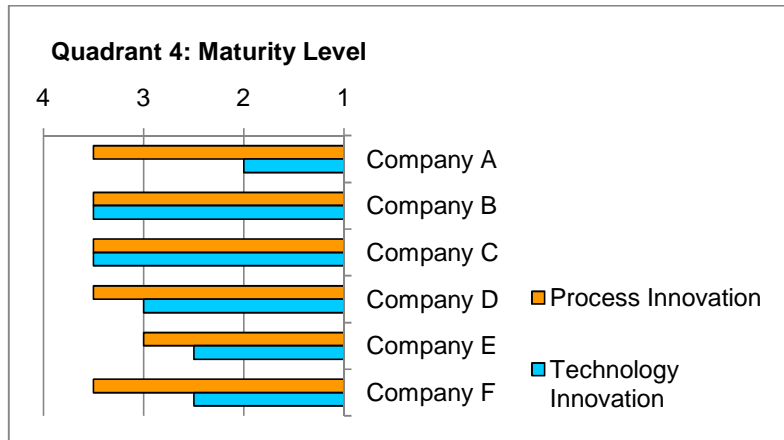
Company F does not have a research and development unit within its SA operations. It does however partner with educational, research and commodity specific institutions to conduct research on its behalf.

The interviewee also indicated that the company is open to adopting new proven technologies into its operations. The interviewee does not see radical change as a challenge for the company since it has an embedded change management and engineering processes.

5.7 Sustainable Value Framework Analysis

Based on the maturity level data collected for each of the four quadrants of the Sustainable Value Framework as described in Chapter 4, the results have been aggregated and are illustrated in Figure 8 overleaf, followed by a summary of the results.

Figure 8: Sustainable Value Framework Analysis



A. Quadrant 1: Environmental Management

- 100% of the companies interviewed have formal environmental management frameworks in the form of EMSs.
- Majority of the afore-mentioned EMSs are certified in terms of the ISO 14001 standard.
- Two thirds of the companies have an EMS that is institutionalised and embedded within the organisation, while the remaining third have a developed EMS that is currently being incorporated into the companies' culture.
- 83% of the companies have mine life-cycle planning practices that are relatively developed.
- 83% of the companies are employing cleaner production tools that are at a relatively developed stage.
- Resource optimisation and good-house-keeping tools are relatively more prominently applied than technology modification, input substitution and on-site recycling.

B. Quadrant 2: Product Stewardship and Stakeholder Engagement

- 100% of the companies have stakeholder engagement practices that are well developed and institutionalised.
- Two third of the companies are in the process of developing practices related to life-cycle assessments green procurement of goods and services.

C. Quadrant 3: Sustainable Growth and Innovation

- 100% of the companies have integrated environmental strategy into corporate strategy.
- 33% of the companies are currently focussing on market innovation
- 67% of the companies are in the process of developing processes linked to market innovation.

D. Quadrant 4: Competency and Innovation

- 100% of the companies have practices in place for process innovation and are developing the competencies required in this regard.
- 67% of the companies are relatively focussed on technological innovation and developing the associated competences.
- 50% of the companies have a current focus that implies that process innovation is more important than technological innovation.

6. Discussion of Results

This chapter provides an analysis of the results presented in Chapter 5, within the context of the literature review in Chapter 2. The chapter is structured in alignment with the research questions posed in Chapter 3.

6.1 Current Environmental Sustainability Practices

Research Question 1: What is the level of maturity of current internally and externally oriented environmental sustainability practices?

6.1.1 Internally Oriented

Management Systems

It has been noted by Hilson & Nayee (2002) that an EMS, a component of an overall management system that includes organisational procedures, environmental responsibilities and processes, can assist a mining company to comply with environmental regulations, identify technical and economic benefits and ensure that corporate environmental policies are adopted and followed.

100% of the companies interviewed have formal management frameworks in the form of EMSs. Majority of these EMSs are certified in terms of the ISO 14001 standard. Furthermore, two thirds of the companies have an EMS that is institutionalised and embedded within the organisation, while the remaining third have a developed EMS that is currently being incorporated into the companies' culture.

The above-mentioned facts demonstrate the companies' commitment to environmental management. The formalised management system is documented and defines the roles and responsibilities of all individuals within the companies and enables continuous improvement. This is of particular significance within large multinational companies, such as those interviewed, especially since mining operations and corporate head offices tend to be geographically separated by large distances. Additionally, for the companies' to maintain their ISO certification, they need to ensure that they update the EMS in accordance with the best practice.

The above findings are also in accordance with Hilson & Nayee's (2002) findings that a number of multinational mining companies (the companies with economical and technological flexibility) have implemented comprehensive EMSs at sites.

Mine life-cycle assessments

Life cycle assessment is noted by McLellan, Corder, Giurco, and Green (2009) as a tool for designing for sustainability. Using this tool enables the inventory and analysis of inputs and outputs of each phase of the life of a process. Based on the interviews, 83% of the companies have mine life-cycle planning practices that are relatively developed. Only one of the companies is currently developing this practice.

The afore-mentioned results confirm that the companies acknowledge the importance of systems thinking and view their operations holistically. This is of

particular significance considering the industry's legacy of insufficient planning, evident in the acid mine drainage challenge that Johannesburg is faced with (Sapa, 2010). All of the companies interviewed acknowledged the importance of planning for mine closure and ensuring that sufficient financial provision is made in this regard.

Cleaner Production

Hilson (2003) based on in-depth research stated that cleaner production is a preventative environmental management approach and a process that embraces waste minimisation and pollution prevention and combines environmental and business concerns.

The results in Chapter 5 indicate that 83% of the companies are employing cleaner production tools that are at a relatively developed stage. One of the companies is in the process of developing these tools.

As documented in Chapter 2, Guerin (2006) categorised the cleaner production tools as: resource optimization, input substitution, technology modification, good house-keeping, and on-site recycling. Whilst the interviewed companies are involved in a diverse range of commodities that entail varying extraction and processing techniques, an assessment was made in Chapter 5 of the focus of the companies on the above-mentioned cleaner production tools. From these results, it is apparent that resource optimisation and good-house-keeping tools are relatively more prominently applied than technology modification, input substitution and on-site recycling.

In a study conducted by Guerin (2006) in the Australian mining sector, technology modification and on-site recycling were cited as the most common applications of cleaner production tools. Ghose (2009) articulates that there has been an overriding sense of urgency for the mining industry to adopt a new technology future where the focus is on system attributes of clean, continuous and smart technology. Bridge (2004) further emphasises the importance of technology by stating that technological innovation is central to advancing eco-efficiency. To ensure that it meets stated environmental targets it is imperative that mining companies operating in SA increase the use of technology modification as a cleaner production tool.

Only one of the interviewed companies has a strong focus on on-site recycling and demonstrated numerous examples of how revenue can be generated as a result of innovatively using waste streams from its operations. It is equally imperative that SA companies adopt this cleaner production tool.

6.1.2 Externally Oriented

Stakeholder Engagement

From the results in Chapter 5, it is evident that 100% of the companies have stakeholder engagement practices that are well developed and institutionalised. This can be attributed to the fact that companies recognise that the social licence to operate within communities and governments is critically important in mining. All companies interviewed agreed that it is necessary to build reputation

and legitimacy through effectively engaging with a broad range of stakeholders on environmental issues amongst others.

Company A provided examples of how historically, its inability to effectively engage with stakeholders prevented it from operating. As a result, it has through experience learnt the importance of getting this right. Company B's interviewee stated that "if you think it is expensive doing it this way the first time, you have no idea how expensive it is getting it wrong".

To build reputation and legitimacy, companies have allocated the resources and created the platforms to effectively engage with government, communities and NGOs.

An observation made during the interviews was the fact that communities within developing markets tend to have high economic expectations of mining companies. Hamann (2003) observed that the unique challenges and opportunities present in SA may create some tension between the local context and international demands regarding corporate social responsibility and competitiveness. As a result, SA mining companies must find innovative solutions to manage the tensions between local challenges and international demands.

Another observation made during the interviews is the fact that investors are becoming increasingly interested in environmental sustainability and that there is a small but growing group of investors who have mandates focussed on

environmental and social integrity. This feedback is positive since a major source of tension in the sustainability debate is between the long-term sustainability agenda and the short-term agenda of meeting financial objectives.

Product Stewardship

Whilst companies have the platforms to effectively engage with stakeholders, one of the stakeholder groups not meaningfully engaged is suppliers. Only 50% of the companies recognise the importance of conducting life-cycle assessments on commodities and processes and procuring goods and services based on environmental criteria. It appears that green procurement practices are only emerging and this agenda is relatively new. Additionally, in SA, there appear to be procurement tensions between the local empowerment agenda and the environmental agenda. The tension between the sustainability and local development agenda must be carefully managed by companies through innovative solutions and supplier development programmes such as those implemented by Company B.

For the externally oriented practices, it is apparent that stakeholder engagement processes are fairly developed. However, the response is skewed to meaningfully engaging with stakeholders (such as government, communities and NGOs) who are more inclined to impact companies' social licence to operate. Based on a study in the Australian mining sector, Guerin (2006) noted that there are barriers to the current way in which suppliers are engaged by mining operations and that these barriers need to be overcome before the benefits linked to value chain sustainability are realised. This applies to SA

companies as well and it is impertative that companies begin to understand the barriers and address them to reap the benefits inherent in the supply chain.

6.2 Current Practice Alignment

Research Question 2: Is there alignment between current internally and externally oriented environmental sustainability practices?

According to Bridge (2004), full legal compliance with state environmental regulations is a necessary but increasingly insufficient means of satisfying society's expectations on environmental issues. This has been confirmed by the companies' relatively developed and institutionalised stakeholder engagement practices (Quadrant 2 results). The maturity level of EMSs' and the use of cleaner production tools (Quadrant 1 results) demonstrate that the companies' have frameworks and tools to in place to build reputation and legitimacy in an effort to maintain their social licence to operate.

Whilst mine life-cycle planning practices are relatively developed, product stewardship practices, particularly in relation to life-cycle analyses and meaningfully incorporating suppliers, are only emerging. Hence, it is evident that the companies' are biased to dealing more proactively with the stakeholders that impact the companies' social licence to operate such as governments and communities. It is hence imperative that companies in future ensure that suppliers are more meaningfully engaged.

Additionally, the data in Table 4 indicates that two thirds of the interviewed companies are ICMM members that have attained an assurance of the G3 application level. This suggests that companies are increasingly improving their reporting procedures.

Based on the companies' interaction with the above-mentioned stakeholders, it is apparent that companies are increasingly becoming accountable to society. This accountability appears to be supported by concrete actions in the form of environmental management frameworks and cleaner production tools. However, there is a need for companies to advance practices related to life-cycle assessments and green procurement.

6.3 Incremental and Radical Change

Research Question 3: Is change being adopted incrementally or radically?

Central to sustainable development is the balance between change and stability (Guerin, 2006). An observation made by Wallis (2010) was that the basic instruments for responding to ecological crisis are technology and markets. Johnes (1999) asserts that innovation is likely to occur either through market, process or product innovation. For the mining sector which produces commodities, the change required is related to technological and market innovation, as represented by the upper quadrants of the Sustainable Value Framework (Figure 8). Provided below is an analysis of the mining sector's response to innovation in technology and markets, followed by a discussion on incremental and radical change.

6.3.1 Technological Innovation

According to Hart and Milstein (2003) bold strategies in clean technology continue to be less common among large established companies than are activities in pollution prevention or product stewardship. This is confirmed by the results in 6.1.1 which suggest that the use of technology modification as a cleaner production tool should be prioritised.

Only 50% of the companies interviewed demonstrated relatively developed practices regarding technological innovation and are adequately developing the competencies for technological change. The remainder of the companies have practices that are emerging and the individuals interviewed from these companies acknowledged the importance of innovation and change. Hence, the failure of these companies to increase the rate of development of technology may render them uncompetitive as Hart (2005) confirms that future economic growth will be driven by those firms that are able to develop disruptive technologies.

Based on the results, maturity of technological innovation can be linked to research and development approaches. Of particular significance is the approach adopted by 50% of the companies whose maturity level is relatively developed. Each of these companies have a dual focus on research and development, focussing on the short- and long-term. A key sustainability debate encompasses the tension between the short- and long-term and these companies have demonstrated that by allocating resources appropriately, these tensions can be effectively managed, to attain the positive results.

6.3.2 Market Innovation

Research and consulting experience in the United States suggest that few firms seem to recognise, let alone exploit the full range of sustainable business opportunities available (Hart, 2005). For the SA mining sector, the research results indicate that only one third of the companies have identified and pursued business opportunities outside its traditional markets and understand the importance of market innovation. The remaining two thirds fail to recognise the opportunity inherent in sustainable business practices and its linkage with alternative markets. This provides evidence that companies do not have the foresight and creative vision for the market innovation required.

6.3.3 Incremental and Radical Change

The environmental performance of a mining enterprise is more closely linked to its innovative capacity than to the regulatory regime under which it operates Bridge (2004). The maturity level of technological and process innovation indicate that companies are currently developing practices that are relatively more focussed on process innovation as opposed to technological innovation. Furthermore, only one third of the companies have developed practices that encompass market innovation. Hence, it is apparent that companies' innovation focus on technology and markets is relatively less than of process innovation. This confirms Hart's (2005) view that relatively few firms have begun to explore seriously the opportunity associated with the upper half of the Sustainable Value Framework, the portion focussed on new capabilities and markets.

Hence, it is evident that companies are not sufficiently innovating markets or technology to achieve its own environmental targets. The current rate of change is incremental and not sufficiently radical and accelerated to address the urgency of the current sustainability challenge, as asserted by Hilson and Basu (2003). It is imperative that companies and industry explore ways to accelerate the pace of change initiatives.

6.4 Integration of Environmental Sustainability

Research Question 4: To what extent are environmental sustainability practices integrated into business practices?

While Hart (1997) states that greening is rarely linked to strategy, Bridge (2004) advocates that the mining industry is increasingly recognising the environment as a core strategic issue. This is evident from the results in section 0 which convey that all companies have integrated environmental sustainability strategy and principles into its corporate strategy. The extent to which this integration is embedded within companies does however vary, evident from the varying maturity level for practices within the Sustainable Value Framework Analysis.

In describing the integration of environmental sustainability into the companies, most of the interviewees highlighted the importance of leadership and structured processes. This is in accordance with Guerin's (2006) study that at an operational level, there needs to be clear commitment from senior management to make the case for change to a more sustainable operation. Such commitment is needed if effective operation-wide engagement and

participation is sought for a sustainable development initiative. This sentiment was corroborated by most of the interviewed companies who indicated that leadership has played an instrumental role in integrating environmental sustainability into company processes.

7. Conclusion

7.1 Introduction

Mining is an important economic activity within the SA context and adds significant economic value to SA's GDP. However, mining activities have the potential to significantly impact the environment and a diverse set of stakeholders. As a result, it is imperative that mining activities are undertaken in a sustainable manner.

Whilst there is a burgeoning literature that examines sustainable mining on a national and global level, there is insufficient research and information with respect to mining companies' response to sustainability on a company level (Hilson and Murck, 2000). As a result, this study focussed on the mining sector's response to environmental sustainability on a company level.

The study was conducted within a strategic framework, using a mixed methods approach that enabled the researcher to:

- 1) Confirm the strategic practices undertaken by mining companies, and simultaneously
- 2) Explore the strategic alignment of practices along the following two dimensions:
 - a) Time, capturing the need for companies to simultaneously fulfil short- and long-term objectives, and

- b) Internal and external orientation, encapsulating the need for companies to protect internal skills, competencies and technologies whilst obtaining the new external perspectives to create change and innovation.

Summarised below are the main findings of the research, followed by the opportunities for future research and the final research conclusions and recommendations.

7.2 Main Findings

- 1) The research study confirms Harts and Milstein's (2003) view that programs in pollution prevention and product stewardship are well developed in large companies. Summarised below are the key findings in relation to current practices adopted:
 - a) All of the companies have formal environmental management frameworks in the form of EMSs, majority of which are certified in terms of the ISO 14001 standard. These formal systems demonstrate the companies' commitment to environmental management. This is of particular significance within large multinational companies, such as those interviewed, especially since mining operations and corporate head offices tend to be geographically separated by large distances.
 - b) Majority of the companies have in place mine life-cycle planning practices that are relatively developed and all of the companies acknowledged the importance of planning for mine closure and ensuring that sufficient financial provision is made in this regard. This indicates

that the companies acknowledge the importance of systems thinking and view their internal operations holistically.

- c) Majority of the companies are employing cleaner production tools and practices. The results indicate that resource optimisation and good-house-keeping tools are more prominently applied than technology modification, input substitution and on-site recycling.
 - d) All of the companies have stakeholder management practices that are institutionalised and well-established within the companies.
 - e) Product stewardship practices are relatively less developed. It appears that green procurement practices and life-cycle analyses in relation to suppliers are only emerging and this agenda is relatively new.
- 2) Companies are essentially becoming increasingly accountable to society. This can be attributed to the fact that companies recognise that the social licence to operate within communities and governments is critically important in mining. All companies interviewed agreed that it is necessary to build reputation and legitimacy through effectively engaging with a broad range of stakeholders on environmental issues amongst others. Two observations made by interviewees' in relation to stakeholders are that:
- a) Communities within developing markets tend to have high economic expectations of mining companies, and
 - b) Tensions exist in procurement between the local empowerment agenda and the environmental agenda.

- 3) Majority of the companies demonstrate that their current practices focus on process innovation as opposed to market and technology innovation. Hence, it is evident that companies are not sufficiently innovating markets or technologies to achieve their own environmental targets. The current rate of change is incremental and not sufficiently radical and accelerated to address the urgency of the current sustainability challenge. This confirms Hart's (2005) view that relatively few firms have begun to explore seriously the opportunity associated with the upper half of the Sustainable Value Framework, the portion focussed on new capabilities and markets. There is also evidence to suggest that companies do not have the foresight and creative vision for the market innovation required.

- 4) All companies have integrated environmental sustainability strategy and principles into its corporate strategy. The extent to which this integration is embedded within companies does however vary. In describing the integration of environmental sustainability into the companies, most of the interviewees highlighted the importance of leadership vision and structured processes.

7.3 Opportunities for Further Research

Based on the research findings and literature review, opportunities for future research have been identified and are summarised below:

- 1) Hilson and Nayer (2002) assert that it is challenging for junior mining companies (smaller exploration and mineral companies) to implement

leading-edge environmental practices due to a lack of financial and human resources. Whilst the JSE listed mining companies have relatively developed environmental practices, it is likely that junior companies are lagging in their response. It is therefore recommended that a study is conducted to include a broader scope of mining companies, to ascertain the response to environmental sustainability of a larger spectrum of mining companies.

- 2) Mining entails the extraction and processing of a diverse range of commodities such as platinum, copper, gold, coal, iron etc. It is recommended that commodity specific research is undertaken to ascertain the varying environmental response in this regard.
- 3) Guerin (2006) emphasises the need for an integrated response by mining companies to the environmental, social and economic impacts on their operations. It is therefore recommended this study is extended to include the economic and social components of sustainable development.
- 4) Feedback obtained from company interviewees indicate that investors are becoming increasingly interested in environmental sustainability and that there is a small but growing group of investors who have mandates focussed on environmental and social integrity. A study is recommended to ascertain the extent to which investors are incorporating the environmental and social agenda into their mandates.

7.4 Conclusions and Recommendations

7.4.1 Conclusions

From the study findings, it is clear that SA mining companies have current environmental practices that are relatively developed. The institutionalisation of environmental management frameworks demonstrate the companies' commitment to environmental sustainability while the mine life-cycle practices demonstrate that companies' have developed a holistic view of the mining project cycle. Various cleaner production tools are applied, however, it is apparent that the use of technology is not sufficiently prominent.

Furthermore, the companies acknowledge the importance of gaining and maintaining a social licence to operate and are endeavouring to ensure that stakeholder management practices are supported by material practices and actions.

In relation to future practices, it has emerged that companies are currently insufficiently focussed on market and technological innovation. The rate of change of current practices is incremental and not sufficiently radical to ensure that the current sustainability challenge is met.

7.4.2 Recommendations

Based on the research findings and conclusion, the key challenges faced by the SA mining sector entail:

- Managing the tension between current and future practices,
- Managing the tension between the local empowerment agenda and the environmental agenda, and
- Integrating suppliers into life-cycle assessments.

To address these challenges, provided below are key recommendations for the SA mining sector.

7.4.2.1 Industry Collaboration

To ensure that it meets stated environmental targets it is imperative that mining companies operating in SA increase the use of technology modification as a cleaner production tool. Most of the companies interviewed emphasised that its research and development is at times conducted in partnership with educational, research and development and commodity specific institutions, at an industry level. Porter (2008) advocates that a country's competitiveness depends on the capacity of its industry to innovate and upgrade. He further states that the close proximity of firms and associated institutions in the form of geographic clusters encourages competitiveness. This is evidenced from the Economic Commission for Africa (2004) findings which describe the advantages arising from the gold mining geographic cluster (operations of various mining companies) in the Witwatersrand.

Going forward, the mining sector should ensure that it leverages the benefits inherent in industry collaboration, taking advantage of economies of scale to accelerate the rate of technological innovation and change. The success of the

companies and industry will lie in its ability to balance competition and collaboration and accelerate the pace of change.

7.4.2.2 Long- and Short-term Philosophy

Some of the interviewed companies have demonstrated that a dual focus on current and future research and development practices has ensured that the resources have been appropriately allocated. This demonstrates that the long- and short-term tensions can be effectively managed, to attain the positive results. Additionally, some of the interviewed companies expressed that they are currently conducting medium- to long-term planning, part of which is getting an understanding of what the mine of 2030 will involve.

An observation made by some of the interviewees was that investors are becoming increasingly interested in environmental sustainability. This feedback is positive since a major source of tension in the sustainability debate is between the long-term sustainability agenda and the short-term agenda of meeting financial objectives. However, the degree of interest and extent of integration into financial practices remains to be seen.

7.4.2.3 Change in Paradigm

Wallis (2010) asserts that relatively few companies, on a world scale, would consciously choose business as usual over species survival. However, he argues that majority of companies are caught up in structures, many of them internalised, that impede our efforts to build a new paradigm. During the study, companies cited the important role that leadership played in integrating

environmental sustainability into the companies' structures. This demonstrates that companies' leadership understand the urgency of the sustainability challenge and are committed to implementing change. This is encouraging as it suggests willingness by leadership to adopt a new paradigm. However, success will be as a result of execution and not intent. Ultimately, it is the leadership of companies that can create an enabling environment for a culture change to occur to enable the change in paradigm required to meet the current sustainability challenge.

7.4.2.4 Supplier Integration

Guerin (2006) noted that within the Australian mining sector, there are barriers to the current way in which suppliers are engaged by mining operations and that these barriers need to be overcome before the benefits linked to value chain sustainability are realised. This applies to SA companies as well and it is imperative that companies begin to understand the barriers and address them to reap the benefits inherent in the supply chain.

7.4.2.5 SA Local Context Challenges

Hamann (2003) observed that the unique challenges and opportunities present in SA may create some tension between the local context and international demands regarding corporate social responsibility and competitiveness. As a result, SA mining companies must find innovative solutions to manage the tensions between local challenges and international demands. The tension between the sustainability and local development agenda must be carefully

managed by companies through innovative solutions and supplier development programmes.

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Appendix 1: Informed Consent Letter

As part of the MBA 2009/10 degree at the Gordon Institute of Business Science (GIBS), I am conducting research on the response to environmental sustainability by mining companies operating in South Africa who have been commended for successfully addressing corporate sustainability. The method selected for data collection is personal interviews with identified individuals. You are one of the individuals identified for an interview and your contribution to this research will be valuable. The interview should take approximately one hour.

The data collected as part of the interview will be recorded and analysed. Particulars relating to your company name will not be disclosed. Furthermore, please note that your participation is voluntary and you can withdraw at anytime without penalty. If you have any queries or concerns, please feel free to contact either my supervisor or I (contact details below).

Researcher: Heena Bhana

Supervisor: Donald Gibson

E-mail: bhanah@velavke.co.za

E-mail: gibsond@gibs.co.za

Tel No: 084 685 7984

Tel No: 082 782 9455

Signature of participant¹: _____

Date: _____

Signature of researcher: _____

Date: _____

¹ Signature hereto confirms voluntary participation in this research study.

Appendix 2: Interview Guide

A. ENVIRONMENTAL MANAGEMENT

- 1) What is the mine's understanding of environmental sustainability?

- 2) What are the most significant environmental impacts of the mine's activities?

- 3) Can the mine lower costs and risks by implementing appropriate environmental management practices?

- 4) What is the mine's approach to environmental management?

- 5) Environmental Management Approach Maturity

Item	Level of Maturity*	Comments
1) Environmental Management Systems		
2) Life Cycle Analysis		
3) Cleaner Production		
	Focus (low, moderate, high)	
i. Resource optimisation		
ii. Input substitution		
iii. Technology modification		
iv. Good house-keeping		
v. On site recycling		

***Levels of maturity:**

1. non-existent
2. emerging
3. developed
4. institutionalised

6) What are the most significant benefits and costs linked to these practices?

7) What are the most significant operational challenges related to these practices?

B. PRODUCT STEWARDSHIP AND STAKEHOLDER ENGAGEMENT

8) Does the mine extend its responsibilities in terms of the value chain? Does the mine include as part of its responsibility the costs and benefits linked to raw material access, production processes and disposal of spent products? If so, how is this done?

9) Who are the key stakeholders that the mine engages with and how is this done?

10) Product Stewardship and Stakeholder Engagement Maturity

Item	Level of Maturity*	Comments
1) Product stewardship		
2) Stakeholder engagement		
3) Other		

***Levels of maturity:**

1. non-existent
2. emerging
3. developed
4. institutionalised

11) What are the three most significant benefits and costs linked to these practices?

12) What are the most significant operational challenges related to these practices?

C. SUSTAINABLE GROWTH AND OPPORTUNITIES

13) What are the current trends and opportunities linked to environmental sustainability in the mining sector?

14) How and where does the mine plan to grow?

a) By offering new products to existing customers?
b) Tapping into previously unserved markets?
c) Other?

15) What is the mine's environmental sustainability vision?

16) How does this link to the corporate vision?

17) Does the mine's corporate vision direct it toward the solution of environmental problems?

18) Based on the discussion regarding a sustainability vision, to what extent has the mine incorporated its future growth prospects with environmental sustainability? Select the most appropriate option below with an X.

1.	non-existent	
2.	emerging	
3.	developed	
4.	institutionalised	

D. COMPETENCY AND INNOVATION

19) Is the sustainability of the mine's products limited by its existing competency base?

--

20) What skills, competencies and technologies must be developed to enable the mine to innovate and reposition itself for future growth?

a) Skills
b) Technologies
c) Competencies
d) Other

21) What initiatives are in place to support the above?

--

22) Is there potential to realize major improvements through new disruptive technology? Is it possible to creatively destroy current capabilities in favour of innovations for tomorrow? If so, what are the challenges that must be overcome?

--

23) What are the tools and practices that the mine could employ to reposition it and innovate?

--

24) What is the level of maturity of these practices? Select the most appropriate option below with an X.

1.	non-existent	
2.	emerging	
3.	developed	
4.	institutionalised	

Appendix 3: SRI Index Constituents (2009)

2009 SRI Index Constituents (in alphabetical order)

30 November 2009

Absa Group Limited	Massmart Holdings Limited
AdvTech Limited	Medi-Clinic Corporation
AECI	Merafe Resources Limited
African Bank Investment Limited	Metropolitan Holdings
African Oxygen Limited	Mondi Limited and Mondi plc
African Rainbow Minerals Limited	MTN Group Limited
Allied Electronics Corporation Limited	Murray & Roberts
Allied Technologies Limited	Nampak Limited
Anglo American	Nedbank Group Limited
Anglo Platinum Limited	Netcare Limited
AngloGold Ashanti Limited	New Clicks Holdings Limited
Arcelor Mittal South Africa	Northam Platinum Limited
Aveng Group Limited	Oceana Group Limited
Barloworld Limited	Old Mutual plc
BHP Billiton	Palabora Mining Company Limited
The Bidvest Group Limited	Pick 'n Pay Stores Limited
Discovery Holdings	Pretoria Portland Cement Company Limited
DRDGOLD Limited	Rainbow Chicken Limited
Exxaro Resources Limited	Remgro Limited
FirstRand Limited	RMB Holdings
Foschini Group	SAB Miller plc
Gold Fields Limited	Sanlam Limited
Group Five	Santam Limited
Growthpoint Properties Limited	Sappi Limited
Harmony Gold Mining Company Limited	Sasol
Highveld Steel and Vanadium Corporation Limited	Standard Bank Group Limited
Illovo Sugar Limited	Steinhoff International Holdings Limited
Impala Platinum Holdings Limited	Sun International Limited
Investec Bank Limited and Investec Bank plc	Telkom SA Limited
JSE Limited	Tongaat Hulett
Kumba Iron Ore	Truworths International
Liberty	Vodacom Group Limited
Liberty International plc	Woolworths Holdings
Lonmin plc	

Appendix 4: Cleaner Production Applications

Cleaner Production Element	Application	
	Mining	Minerals Processing
Resource Use Optimisation	<ul style="list-style-type: none"> Improved separation of overburden and other wastes to produce higher purity ore 	<ul style="list-style-type: none"> Sequential leaching to recover multiple minerals/metals from ore Conversion of process wastes and emissions into useful by-products Residue processing into geochemically stable forms for safe storage
Input Substitution	<ul style="list-style-type: none"> Review fluids selection across customer's fixed and mobile plant, e.g. to identify opportunities for use of biodegradable lubricants and hydraulic oils 	<ul style="list-style-type: none"> Use of environmentally-friendly reagents and process auxiliaries
Technology Modification	<ul style="list-style-type: none"> Efficient mine design to minimise minerals movement during operation and for closure In-pit milling and separation Design of mine refuelling facilities to enable lowest cost and safe supply of fuel to mobile plant 	<ul style="list-style-type: none"> Alternative metallurgical processes (e.g. biotechnological) Use of energy efficient fixed and mobile plant Application of fuel efficient furnaces and boilers Better monitoring and control of leaching and recovery processes, to increase overall recoveries
Good House-keeping	<ul style="list-style-type: none"> Monitoring and benchmarking of haulage fleet fuel efficiency Staff training and awareness Spill and leak prevention e.g. the management of petroleum hydrocarbons Implement a maintenance strategy to enhance reliability of plant 	<ul style="list-style-type: none"> Staff training and awareness Spill and leak prevention e.g. hydraulic oil, compressed air, water, chemicals Non-process waste segregation Lubricant cleanliness assessments and management programmes that can reduce plant failures
On Site Recycling	<ul style="list-style-type: none"> Composting of green wastes to produce heat/steam generation Re-use of overburden/waste rock in progressive rehabilitation of mine site 	<ul style="list-style-type: none"> Recovery and reprocessing of un-reacted ore from processing waste Counter-current use of water for washing operations

Appendix 5: Hart and Milstein's (2003) Quadrant Summary

Quadrant 1: Environmental Management

This quadrant focuses on aspects of performance that are near-term and internal in nature: cost and risk reduction. Quarterly earnings growth and reduction in exposure to liabilities and other potential losses are important drivers for wealth creation. Clearly, unless the firm can operate efficiently and reduce its risk commensurate with returns, shareholder value will be eroded.

Items considered include:

- 1) Environmental management systems
- 2) Life-cycle analysis
- 3) Cleaner production
 - a) Resource Optimisation
 - b) Input Substitution
 - c) Technology Modification
 - d) Good House-keeping
 - e) On-site recycling

Quadrant 2: Product Stewardship and Stakeholder Engagement

This quadrant focuses on dimensions of performance that are internal in nature but includes salient stakeholders external to the firm such as suppliers and customers in the immediate value chain, as well as regulators, communities, NGOs and the media. Unless it respects these stakeholders' interests, the firm's right to operate might be called into question. But if it uses creativity to include

their interests, the firm can differentiate itself, enhance its reputation, and establish the legitimacy it needs to preserve and increase shareholder value.

- 1) Product Stewardship
- 2) Stakeholder Engagement

Quadrant 3: Sustainable Growth and Opportunities

This quadrant focuses on identifying the needs that will define the growth markets of the future. Growth requires the firm to either offer new products to existing customers or tap into previously unserved markets. A convincing articulation of where and how the firm plans to grow in the future is critical to the generation of shareholder value. The growth trajectory therefore will provide guidance and direction for new technology and product development.

Quadrant 4: Competencies and Innovation

The firm must not only perform efficiently in today's business, but it should also be constantly mindful of generating products and services of the future. This means developing or acquiring the skills, competencies and technologies that reposition the firm for future growth. Without such a focus on innovation, it will be difficult for the firm to create the new product and service flow to ensure that it propellers well into the future. The creation of shareholder value thus depends upon the firm's ability to creatively destroy its current capabilities in favour of the innovations of tomorrow.