AN ASSESSMENT OF THE CRITICAL SUCCESS FACTORS FOR TECHNOLOGICAL CAPABILITY BUILDING AND SUSTAINABLE DEVELOPMENT IN THE MINING SECTOR: A CASE STUDY OF THE PLATINUM MINING INDUSTRY IN ZIMBABWE.

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DECLARATION

This dissertation is submitted in partial fulfilment of the requirements for the Master of Business Administration degree at the Graduate School of Management, University of Zimbabwe.

I voluntarily declare that this dissertation is a result of my own study carried out from August, 2015 to February 2016. I further declare that this dissertation has not been submitted for consideration for any degree candidature other than the Master of business Administration at the University of Zimbabwe.

Student _____ Date _____

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I confirm that the work submitted was carried out by the candidate under my supervision as the appointed supervisor and have approved the dissertation.

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Date_____

Ephraim Makoni

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DEDICATION

To my mother, Diana, and father Sylvester, brother Shepherd for always inspiring me and in God we trust.

ABSTRACT

There is an ever increasing demand to improve capabilities for the mining sector, especially the platinum sector which is faced with declining metal prices threating the viability of operations. To this effect, this study assessed the technological capability development and sustainable development factors affecting the platinum mining sector in Zimbabwe. The study adopted a positivism approach based on quantitative survey in analysing the current levels of technological capabilities development and sustainable development in the platinum mining sector. The study further investigated institutional mechanisms in place to support technological capabilities accumulation and sustainable development. Furthermore, the study sought to establish the critical success factors affecting technological development and sustainable development affecting the platinum mining sector in Zimbabwe.

The study focussed on the three mining operations along the Zimbabwe's Great Dyke. A pilot tested structured questionnaire was used to solicit responses from junior, middle and senior management of the operations who were selected using stratified random sampling.

The study found and concluded that the integration of regulatory framework, management capabilities and capital budgets are critical factors for technological capability development. The unfavourable regulatory framework had a negative impact on technological capability development whilst the other predictors had a positive impact. All explanatory sustainable development factors were found to have no implication on sustainable development except for environmental factors.

Policy recommendations and managerial recommendations were made and possible areas for further research were suggested.

Keywords, Technological capabilities, Sustainable development, Management capabilities, regulatory framework, Capital budget, economic, social and environment.

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List of Abbreviations

CSR	Corporate Social Responsibility
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GRI	Global reporting initiative
ICT	Information Communications Technology
ISSD	International Institute of Sustainable Development
OECD	Organization for Economic Cooperation and Development
R&D	Research and Development
SADC	Southern African Development Community
SD	Sustainable Development
TC	Technological Capability
UNIDO	United Nations International Development Organisation
UNDP	United Nations development programme
USGS	United States Geological Services
WCED	World Commission on Economic Development
WEC	World Economic Commission
WIPO	World Intellectual Property Organisation
ZIMASSET	Zimbabwe Agenda for Sustainable Socio- Economic Transformation

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Introduction

There is a growing interest in assessing the pre-conditions for building organisational technological capabilities and sustainable development in the mining industry. “The managers of organisations must continuously improve their organisational capabilities through having a correct understanding of their organisational technological capabilities, identifying the technological developments in the world and monitoring the efforts of competitors to gain access to new technologies” (Favaregh and Khamseh , 2014) The area of technological capabilities especially for developing countries is of importance to both academics and policy makers as it is reliant on skills, technology , innovation and policies in effect. The mining sector is an extractive industry reliant on technological capabilities development to improve productivity and performance through efficient utilisation of resources. There is an ever increasing demand to improve capabilities for the mining sector, especially the platinum sector which is faced with declining metal prices threating viability of operations. There is growing national demand for the platinum sector to achieve full beneficiation of the products locally, and the subject of technological capability developments becomes relevant to the requirements of the policy makers. There are few studies on technological capability development in developing countries, and are rare on the mining sector and let alone the platinum sector. Thus, the assessment of the factors affecting technological capability accumulation are imperative for the platinum sector which is relatively new on the Zimbabwe mining landscape.

The pressures on mining sector are ever increasing as stakeholder groups have expanded to include other stakeholders with different expectations and demands on the sector. The mining sector is no longer held accountable to environmental issues along for them to operate, as the pressures on sustainability issues now include environmental, social and economic. The demands on the mining sector are dictating movement from mere rhetoric in public reports to tangible responses which seek to address stakeholder expectations, and hopefully earn them the social licence to operate. Given the international focus on sustainability in recent years, there is a dire need for methods and techniques that would facilitate sustainable appraisal and decision-making.

1.2 Background to the Study

The production of platinum and associated metal elements in concentrates and matte in Zimbabwe is currently from three mining operations namely Zimplats, Mimosa and Unki located on the Great Dyke at Ngezi, Zvishavane and Shurugwi respectively. The operations are subsidiaries of Implala Platinum (87% attributable interests in Zimplats), Aquarius Platinum and Anglo American (100% Attributable interests in Unki). Mimosa Mine is a 50:50 Joint venture operation between Impala Platinum and Aquarius Platinum. There are also other platinum mines prospects in the pipeline, with projects at various stages of feasibility studies for platinum production on the Great Dyke at Selous, Darwendale and Shurugwi (Makore and Zano, 2012).

The total annual production of equivalent refined Platinum in concentrate and matte in 2014 from Zimbabwe's mines is estimated at 361,000oz. The production from Zimplats, Mimosa and Unki Mines of equivalent refined platinum ounces were 190,000oz, 110,000oz and 61,000oz respectively (Zimplats (2015), Aquarius Platinum, (2015) Anglo American (2015). The relative contribution of each operation to Zimbabwe's total platinum output is shown below on figure1-1 below.

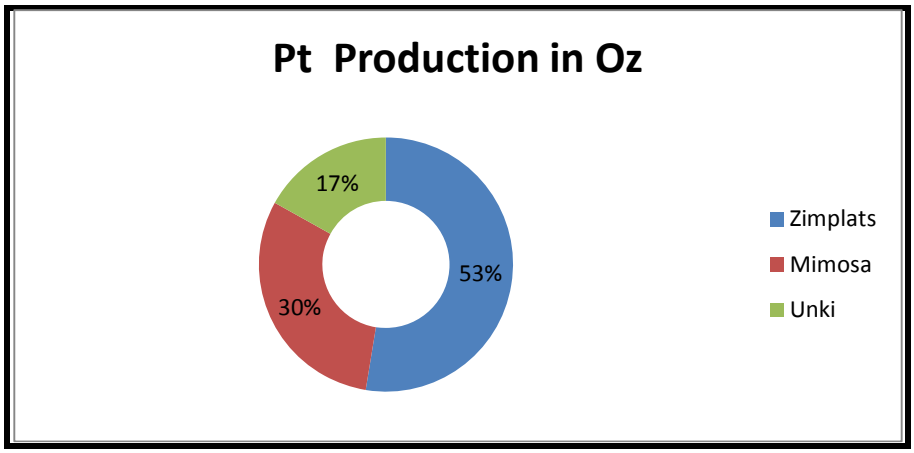


Figure 0-1: Chart showing relative platinum production from current operations in Zimbabwe

Zimplats is the largest producer accounting for 51% of total annual platinum production, derived from three underground mines and open pit mine. In comparison with the world production, Zimbabwe's annual platinum production in 2014 was estimated at 6.8% of the world's total annual platinum production, despite the country having the second largest resources of platinum after South Africa (USGS, 2015), Zimbabwe Investment

Authority, 2015). The optimum platinum production for Zimbabwe has not been fully evaluated, in spite of comparative advantage opportunities that exist for the sector to expand and exploit the resource occurring on the Great Dyke. The production history of Platinum from the current platinum operations on the Great Dyke since 2005 is shown on Figure 1-2. The Great Dyke is a major elongate geological feature which is 550km long and 3-11km wide, with an estimated Platinum resource of 175 million Ounces. The Platinum mining sector is relatively new on the Zimbabwe mining landscape which has previously being dominated by other mineral commodities which include nickel, gold, chrome, asbestos, coal, copper, industrial minerals and diamonds.

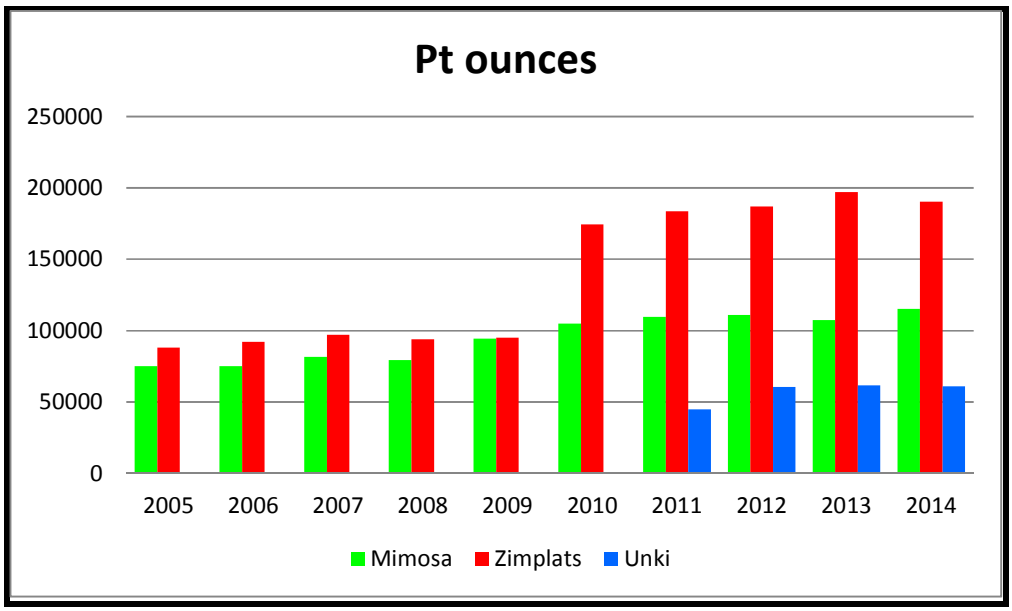


Figure 0-2: Platinum production history since 2005

Mining has been recognized as one of the main anchors of Zimbabwe's economic development under the Zimbabwe Mid Term Plan 2010-15 and the Zimbabwe agenda for socio-economic transformation (ZIMASSET) (Government of Zimbabwe 2010, 2014). The platinum sector fits into the broad vision of economic growth of Zimbabwe, and needs nurturing through enhancement of technological capabilities for improved productivity and sustainable development performance.

1.3 The State of platinum mining in Zimbabwe

The development of the platinum mining sector in Zimbabwe has been slow, despite the discovery of Platinum mineralization on the Great Dyke in 1925 (Prendergast, 1988).

Some of the reasons cited for the slow development and mothballing of most platinum projects prior to the 1990s, include geological conditions such as poor ground conditions, marginal grade which could not be offset by cost efficient mining and extraction and higher metal prices than prevailing at the time, high capital costs of establishing the mines, complex mineralogy of the ore which included talc (Prendergast, 1988). Poor geological and ground conditions were attributed to the closure of BHP Hartley mine in 1999, which was Zimbabwe's largest single investment after independence of US$585million. The poor ground conditions in the hanging wall of the platinum reefs of the Great Dyke exacerbated the situation by increasing the dilution of the ores, rendering them low grade for economic extraction. Since then, there have been various internal and external challenges faced by the platinum sector in Zimbabwe. These have been analysed by the researcher using the PESTEL (Political, Economic, Social, Technological, Environmental and Legal) factors scanning technique and the SWOT analysis. The SWOT analysis was used to explore the internal and external environment based on strengths, weaknesses, opportunities and threats.

1.3.1 Political factors influencing Platinum mining sector

Government policies are driving the beneficiation agenda as part of wealth and job creation. The Mid-term fiscal policy and the ZIMASSET agenda are advocating for local beneficiation and ensuring greater local processing of Zimbabwe's natural resources. The Platinum sector is exporting 47% of production in the form of concentrates which are further beneficiated through smelting and refining in South Africa (Zimplats 2015, Aquarius, 2015 and Anglo American, 2015). The expectations of the government who is both the regulator and owner of resource being exploited by the platinum sector are an important facet of technological capability development and sustainable development, and are relevant to this study.

1.3.2 Economic factors influencing the Platinum mining sector

Metal Prices

Globally and locally, the platinum mining sector is facing survival challenges in a global economic environment characterized by slow economic growth. The average world economic growth rate for 2015 has been estimated to be 3.5% and China's economy which was achieving growth rates in excess of 7% is beginning to show signs of slow down (IMF, 2015). The current decline in commodity prices is coinciding with the

economic slowdown in emergent markets and the metal prices are now at their lowest since Global Financial Crisis prices levels. The platinum prices in October 2015 reached their lowest since 2008, of $905/oz. from a six year peak price of $1911/oz in 2011 (Johnson Matthey, 2015 and KITCO, 2015). The 8 year daily platinum price trends, 200 and 60 day moving averages prices are shown below of Figure 1-3.

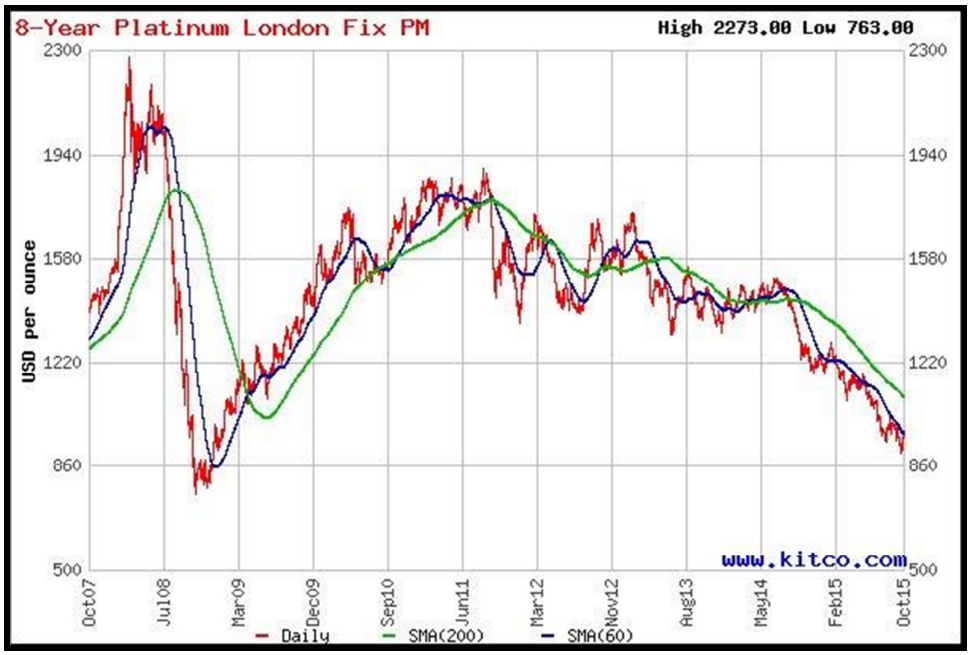


Figure 0-3: An 8 Year Platinum London Fix chart, showing a new cycle of declining Platinum prices which commenced from around the middle of year 2011 to date. (www.kitco.com), accessed on 27 October 2015.

In the face of depressed prices platinum operations are adopting various strategies of survival which include asset restructuring, improving efficiencies and production to sustain revenues under cost leadership strategies. Cost Leadership strategies by mining firms, can be levered on technological and innovative competitiveness. Metal prices have an impact on revenue to be generated from platinum mining and ultimately capital which is required for growth through development of technological capability and sustainable development initiatives which are subject of this study.

Infrastructure

The Platinum sector is operating in an environment of energy constraint, where it has to have continuous power supply agreements with energy providers. Zimbabwe, power

generation is is at 947MW in October 2015 against installed capacity 1910MW which has been affected by depleted water levels at Kariba (ZESA,2015, ZPC, 2015). Expansion of the Platinum sector relies on availability of power for the underground operations, concentrators, smelters and refineries. Reduction in power usage requires efficient plant and machinery which are anchored on technology and innovation management processes that are tools towards building capacity and sustainable competitiveness both at macro and micro-economic levels. Locally, The industrial development policy, the science and technology and innovation policy, and the Nano technology statement recognizes science, technology and innovation as the key drivers to achieving competitiveness and sustainable growth through technological changes (Ministry of industry and Commerce , 2011, Ministry of Science and Technology Development, 2012, Ministry of Economic Planning and Investment Promotion,2011).The ability to acquire foreign technologies, adapt them and improve them, as well as to develop the required infrastructure, is crucial for the success of the mining sector in Zimbabwe. The study of technological capability is necessary as the advancement of technological capability seeks to address some of the challenges associated with infrastructural deficiencies through development and acquisition of innovative processes.

1.3.3 Social factors affecting Platinum Mining Sector

The communities in which the mining companies operate expect their members to be employed by the mining firms, including provision of access roads, health services and educational facilities. The platinum mining sector must respond by engaging the diverse stakeholders and address their sustainability expectations in-order to get the 'social licence' to operate (Azapagic, 2004), Government of South Africa,2012). Thus, sustainability must encompasses how society and business engage to create value along social, environmental and economic dimensions (Garriga &Mele 2004),(Wheeler, Colbert and Freeman, 2003). The area of how the platinum mining operations are addressing the diverse social aspects under sustainable development in order to get community approval necessitates this study.

1.3.4 Technological Factors affecting Platinum Mining Sector

New technology developments which include robotics and mechatronics and diagnostic sensors will impact all areas of the platinum value chain through increased productivity and safety (Government of South Africa, 2012). Therefore, the growth of the sector is largely dependent on foreign direct investment (FDI) through multinationals which bring high technology and R&D leading to growth of local capabilities through spill overs of knowledge (Dash, 2015). The role of innovation and how it can be fostered in technological capability development by operations in the platinum sector needs to be understood.

1.3.5 Legal factors affecting Platinum Mining Sector

The Platinum and the entire mining sector are facing challenges from the government which is now reasserting its control over natural resources. Resource nationalism is also a growing global challenge to the mining sector where numerous countries are taking steps to protect their sovereign assets by imposing new resource taxes and royalties (Government of South Africa, 2012) How the regulatory framework affects technological capability development and sustainable development needs to be contextualised in the Zimbabwean environment. Some of the key regulatory issues are discussed below.

Royalties

The Platinum sector is required to pay royalties of 10% of gross fair market value of the platinum produced, under the Mines and Minerals Act (Chapter, 2105). The royalties are impacting operating costs, which are supposed to be offset by revenues which are being affected by low prevailing low metal prices since 2008.

Platinum Tax

During 2013 the Government of Zimbabwe proposed an export tax on unrefined platinum, with a view to encouraging platinum mining companies to invest in smelting and refining capacity in Zimbabwe. This export tax, at a rate of 15 percent of revenue, was deferred to take effect from 1 January 2015.

Ground Rentals

In 2013, through a statutory instrument, Platinum mining companies are now required to pay $1000/ha of ground they own under their mining leases as ground rentals. This impact negatively on cash operating costs for the operations with large mining leases in excess of 20,000ha.

Environmental Impact Assessment Levy

A levy of 1.5% of total project costs under statutory instrument, SI 7 of 2007 is required for environmental impact assessments (EIA) review by the Environmental Management Agency (EMA) for any new projects. This has an impact on project capital of major projects, but must be traded off with sustainable development benefits which are addressed by EIAs.

The Indigenization and Economic Empowerment

The Indigenization and Economic Empowerment (Chapter 14:33) which was accented into law in 2011 requires foreign entities with a minimum investment of $500,000 to cede 51% of the company ownership to indigenous Zimbabweans. The Platinum sector is at various levels of individual engagements with the government to achieve the indigenisation ownership thresholds. The act has seen the creation of Community Ownership Trusts, where each mining sector in the industry has provided seed money for community development.

The indigenisation and economic empowerment Act, has negative impact on Foreign Direct Investment, which is required for the Platinum Sector to grow through expansion of existing mines and creation of new mines. Mining Ventures are capital intensive and require huge investments against a backdrop of poor liquidity on the Zimbabwean markets. BHP Hartley and Unki Mines required investment capitals of US$585million and US$ 480 Million respectively.

1.3.6 Environmental factors affecting Platinum Mining sector

The extraction and processing of minerals is strongly associated with environmental impacts which, include depletion of non-renewable resources, landscape degradation, and health and safety impacts to workers and communities (Azapagic, 2004). These factors can be expanded to include water pollution, air and noise pollution and land rehabilitation. These factors are subject of sustainable development, being addressed under environmental issues.

1.3.7 Strengths of Platinum Mining Sector

Zimbabwe has abundance resources of Platinum and associated metals and the Great Dyke host the second largest resource of platinum group metals after the Bushveld Complex of South Africa. The total reserves of Platinum in 2014 were estimated to be 7.5Moz (Zimplats, 2014, Aquarius Platinum, 2015 and Anglo American, 2015).

The sector has a high level of technical and production expertise buoyed by control through Multinationals and availability of limited skills from other mining sectors that have being closing through viability challenges such as the chrome and gold sectors. The resource endowment in Zimbabwe is huge and studies of technological capabilities and sustainable development may have long term benefits for the platinum sector which have high lives of mine.

1.3.8 Weaknesses of platinum mining sector

The industry exports metals in the form of concentrates and matte which are not the end state in the production chain of the metals. The levels of R&D in the local platinum industry are insignificant when compared to South Africa and is largely dependent on the holding companies.

The industry has shortage of highly skilled and trained workers in sector whose production is highly mechanised and technology based. There is a need to understand the current levels technological capability within the platinum sector and how the weaknesses can be converted into strengths, hence this study.

1.3.9 Opportunities

The sector can act as a catalyst for growth poles, through developing downstream beneficiation activities, and upstream activities through supporting local supply chains which will enhance or develop local manufacturing capabilities. Most of the capital goods and equipment are imported.

1.3.10 Threats

The cost leadership strategies being embarked by players in the sector to profitability in the face of declining metal prices has seen decreased funding for R&D from holding companies. In-addition, government support for R&D institutions has been impacted negatively by budget constraints (Daily News, 2015). Collective learning will enhance R&D (Lall and Teubal, 1998), therefore the absence of R&D collaboration within the platinum sector will imply that the sector will rely on imported technology raising the costs of technology transfer and reducing their ability to exploit new technological capabilities. New technologies are increasingly being used by mining operations to promote sustainable development by enhancing their environmental and business performance (Dash, 2015).The platinum sector can apply or adapt technologies to enable new activities that lead to economic and environmental benefits.

The availability of power may impact growth and sustainability of the platinum sector.

The discovery of near surface platinum ore bodies as a result of exploration in South Africa and rest of the world may also impact the growth of the sector in Zimbabwe. Open pit operations require low capital for establishment when compared to underground operations above.

The Opportunities and threats discussed above are subject of technological capabilities development and need to be contextualised for the platinum sector to have competitive advantage over other operations.

1.4 Statement of the Problem

As can be seen from the foregoing discussion, there are several issues that may impact both technological capability and sustainable development which need to be assessed in the Zimbabwean context. These problems are:

Problem 1: The macroeconomic environment and regulatory framework impacts on technology driven growth of the platinum sector in terms of them being incentives or disincentives are issues which need study. The analysis above also showed that cash margins for the sector are decreasing and the extent of technology usage to increase productivity through high efficiencies in resource utilisation is an area that needs assessment. How the sector is bringing in technology through FDI is also critical, considering that the entities have foreign ownership. The symbiotic role between economic integration and FDI, has yet to be fully analysed and more so the issue of policy towards FDI (Dash, 2015)

Problem 2:The use of internal resources by the operations in the platinum sector to build the necessary technological capabilities need to be understood, considering that one of the strengths of the Zimbabwean platinum sector is the abundance of the resource to guarantee long life of operations, which is also negated by poor infrastructure and skills.

Problem 3: Social and environmental issues are now considered to be high on the stakeholder agenda with various expectations, which mining operations need to address in-order to get a social licence to operate. These issues of sustainable development are

numerous, and how the new platinum operations are meeting and satisfying the pressures from the communities in which they operate are critical considering the subjectivity nature of some of the demands.

Extensive research on the development of technological capabilities is being carried out not only in emerging countries (Kim, 1997), (Lall, 2000) but also in advanced countries (Miyazaki, 1995). However, little is known about the process of building up technological capability in non-industrialized countries, which include Sub Saharan Africa (Jin, 2005).

A wide of majority of studies on corporate sustainability appeared to focus on multi-industry United States of America samples, leaving vast research area on single industry sectors and geographical areas (Salzmann, Ionescu-sommers and Steger, (2005).Commitment to sustainability impacts on the economic performance of the companies in the long term (Kroher, 2005), Schwarz et al, 2006), Dwakins and Lewis, 2003), Salman *et al*, 2005), Hopkins 2002).

This study therefore seeks to "make an assessment of critical success factors for technological capability building and sustainable development in the Zimbabwean Platinum mining sector"

1.5 Objectives of the Study

The broad objective of the study is to assess the technological capabilities and sustainable development factors that are critical for the platinum industry to remain competitive. The specific objectives are:

- To assess the current levels of technological capability and sustainable development in the platinum mining sector in Zimbabwe
- To establish institutional mechanisms in place to support technological capacity building and sustainable development in the platinum mining sector in Zimbabwe
- To identify critical success factors for the development of technological capability in the platinum mining sector in Zimbabwe
- To identify critical success factors for the sustainable development of platinum mining sector in Zimbabwe

1.5.1 Research Questions

In an effort to address the objectives outlined above, the research will attempt to answer the following questions:

- What are the current levels of technological capability and sustainable development in the platinum mining sector in Zimbabwe
- What are the institutional mechanisms in place to support technological capacity building and sustainable development in the platinum mining sector in Zimbabwe
- What are the critical success factors for the development of technological capability in the platinum mining sector in Zimbabwe
- What are the critical success factors for the sustainable development of platinum mining sector in Zimbabwe

1.5.2 Hypothesis

The researcher has formulated the following hypotheses:

H_1: Internal factors have an impact on technological capability building

H_2: External factors have an impact on technological capability building

H_3: At least one of Social, economic and environment factors integration have an impact on sustainable development

1.6 Justification

Technological capability building and sustainable development are key areas for economic development for developing countries with and without mineral resource endowments. The extraction and processing of metals to finished products against backdrop of exogenous shocks require development of innovative capabilities to remain competitive, locally and internationally through development, importation and adoption of capacitive technologies.

The study will assist the players in the industry to identify industry specific and firm level strategies in managing and developing technological solutions for efficient extraction of mineral value.

Beneficiation is a top priority to the Government of Zimbabwe, and is also one of the main focus areas of SADC, regional block under the industrial development policy. This study will also contribute to the development of the national beneficiation policy in line with the Zimbabwe Agenda for Social and Economic Transformation policy initiative (ZIMASSET), (Government of Zimbabwe, 2014).

Mineral resources are non-renewable and therefore the extraction of the resource to benefit current needs and future needs has to be assessed. The study will seek to find out how much is invested in sustainable development and what are the key sustainable development indicators for the sector which maximise benefits to key stakeholders.

1.7 Limitations of the Study

Time and money constraints prevent studies to be carried out over the entire mining sector, but studies on the platinum sector which has few operations can be used to conclusively generalise findings for the Platinum sector.

The study is encompassing many variables, not all variables will be researched to test their relationship and how they impact technological capability development and sustainable development of the mining operations under study. Data will be gathered from competing operations in the industry and there may be reluctance to reveal sensitive data. Few studies have been carried out locally and the researcher has limited sources for adopting relevant survey questions.

1.8 Scope of the Study

The research focussed on key players within the Platinum mining industry in Zimbabwe, a sector that produces platinum in concentrates and matte. Regional and international benchmarks are based on secondary data which is available in the public domain. The study will focus on the period after 2009, to minimise possible distortions of results due to the hyper-inflationary economic environment prior to the adoption of the multi-currency system which stabilised the economy.

1.9 Dissertation Structure

The structure of the dissertation will be as follows:

1.9.1 Chapter 1

The first chapter introduces the research problem and provides the scope and justification of the study.

1.9.2 Chapter 2

This chapter focuses on literature survey on the technological capacity building factors and on the measurement framework.

1.9.3 Chapter 3

The chapter introduces the research methodology and research design adopted to assess the technological capacities factors and capabilities of the platinum producing mines in Zimbabwe. In addition to that, the chapter covers the underlying research philosophies adopted for the study, data collecting techniques, data

1.9.4 Chapter 4

This chapter contains the research findings and a detailed discussion of the findings.

1.9.5 Chapter 5

The chapter narrates the conclusions and recommendations of the study.

CHAPTER 2: LITERATURE SURVEY AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter focusses on the literature review on the research area of study and commences with defining technological capability building and sustainable development. The researcher explores the widespread factors associated with technological capability building and sustainable development and the theoretical framework underpinning the study. The researcher provides a syntheses of the common factors and their measurement frameworks which are being considered by other researchers. The section concludes with the conceptual framework for the study focussing on specific area which have limited studies.

2.2 Defining Technological Capability Building

Technological capabilities are an intricate collection of skills, technological knowledge and organizational structures required to operate a technology efficiently in order to achieve any process of technological change (Lall, 1992 in Alejandria, 2009). Thus, technological capabilities are about how organisations are able to integrate skills, employee learning, educational competencies, and technology which is embodied in assets used for production such as plant and machinery. The subject of technological capability is about the amalgamation of resources required to achieve technical changes such as right skills, knowledge, experience and organizational systems (Bell and Pavitt, 1993) in Alejandria, 2009) (Aderemi, Oyebisi and Adeniyi, 2009). Bell and Figueiredo (2012) expound further by referring technological capability of the firms as a stock of accumulated knowledge in human resources within organisational systems, technical physical systems, and goods and services. Technological capabilities may differ from one organisation to another and therefore, are firm specific since institutional knowledge is accumulated over time from skills of its human capital.

Dahlman et al (1987), split technological capabilities into three capabilities consisting of production, investment and innovation capabilities, which are supposed to be interacting and are also inseparable. The production capabilities focus area is on production efficiencies and the ability to adapt to the ever changing market conditions. Investment capabilities focus on new productive ventures which include the expansion of existing facilities. Lastly, innovation capabilities centre on new technology which encompass the ability to improve the current technology, or to develop new products and services.

Whitfield and Whitfield (2010) assert that technology is understood to contain 'embodied' and tacit elements. The embodied elements are the physical equipment, organised knowledge and other external inputs and tacit elements are the skills, technical knowledge and organizational coherence required to make technologies function in a firm (Whitfield and Whitfield, 2010). The tacit elements of technology are institutional elements which cannot be simply transferred to a firm and they have to be learnt. Thus, the learning process requires conscious effort on the part of firms, which in this study is linked to management capabilities. Development of technologies are also influenced by the physical environment in which the firms operate and are linked to the regulatory framework. This study encapsulates the notion that technological capability accumulation can be accomplished through the assimilation of tacit and embodied elements associated with technology.

2.3 Defining Sustainable Development and link to Corporate Social Responsibility

There are various definitions of sustainable development (SD) that have been proposed by various researchers. The subject of sustainable development is not new and has been in existence at least since the 1800s, and with initial focus on environmental issues affecting various industries and how ecological balances can be achieved. Towards, the end of the last Century, focus has changed to include broader scopes of equitable distribution of resources and wealth other than environmental issues. Catton (1986) regards sustainable development as an improvement in the quality of life of the population while taking cognisant of the ecosystem's regenerating capacity that is considered as the maximum continuous load on the environment (Catton, 1986). Sorlin (1997, extends further the principle of carrying capacity and maintaining ecological balance as part of sustainable development. However, the World Commission on Environment and Development (WCED), definition in the Brudtland report of 1987: Our Common Future is still widely referred by many researchers of sustainable development on the use of resources. WCED, 1987 defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, ,1987), (Steurer, Langer, Konrad and Martinuzzi, 2005), (Drexhage and Murphy, 2010)

Recent studies are expanding the subject of sustainable development to encompass a tripartite core structure often referred to as the three pillars or triple bottom line which embrace equitable consideration of economic, social, and environmental dimensions (Steurer et al, 2005), (Ebner and Baumgartener, 2006), (Drexhage and Murphy, 2010). However, some researchers have preference for using ecological as a substitute for environmental when referring sustainable development as an effective integration of social, economic and ecological issues(Kemp & Gibson, 2015), Schlurr and Holtz , 1998), Ciegis et al, 2009). Ciegis et al (2009) includes equitable per capita income of future and current generations, biodiversity and close social relationships in the communities in which mining industry operates in the definition of sustainable development. Mudd (2012) recommends that sustainable development concept within a mining environment must include the availability of resources and a productive environment.

Some researchers have attempted to link sustainable development and Corporate Social responsibility. Corporate social responsibility (CSR) is a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis (Juscious ,2007). CSR is a social strand of the sustainable development concept which is mainly built on a sound stakeholder approach and CSR focusses mainly on the corporate engagement (Ebner, 2008). CSR focus on the institution and this study takes that view and will regard CSR as part of the social pillar of sustainable development.

2.4 Factors influencing technological capabilities

Technological capabilities studies are being carried out both at national and firm level. Researches although limited, are being carried for both developing and developed countries at national level, and at industry sector or firm level.

Amongst the studies on firm level, there is a wide consensus that technological capabilities building are influenced by both internal and external factors to the firm. (Aderemi et al, 2009)

Whitfield & Whitfield (2010) proposes that technological capability development is determined by five broad factors which include the incentive structure facing firms

(macroeconomic environment and policies),availability of the right quantity and quality of skills, availability of technological information and support services (Research skills, standards and quality systems, outsourcing research and collaboration of research), capital and government technology policies. Shamsuddin,Wahab and Hazana (2012) and Madanmohan et al (2003) are advocates of R&D investment, planning and control, technical personnel, training programs, market orientation, government support, national technology infrastructure and mode of transfer, collaboration amongst firms, general education, formal education, work experience, internal efforts to assimilate products, external technical experience and age of the firm as factors influencing technology capability of the firm.

Aderemi et al (2009) is of the view that technology capability development is firm specific and is a result to responses to external and internal incentives and in interaction with other economic agents, both private and public and local and foreign. In summary, Aderemi et al (2009) propose that the technological capabilities of a firm will be influenced government policies toward education which impacts the availability and supply of technical personnel, internal firm efforts to promote learning like on-the-job training and R&D activity and the availability of external micro-level learning support mechanisms to the firm.

This researcher in this study considers technological capability building factors under external and internal broad subdivisions. The conceptual framework discussed later below will follow this line of approach. The internal and external factors of technological capability building encapsulate the independent variables of this study

2.4.1 Internal Factors of technological capability building

The internal factors are resources within control of the firm required to effect and manage technological change. These are R&D policies, training and human resource development, capital budgets, market orientation, management capabilities and employees' skills and work experience. Management capabilities include bundles of knowledge accumulated in organizational routines, procedures, instructions, documentation, management techniques and processes.

2.4.2 External Factors of technological capability building

The researcher proposes industrial policies and regulatory framework (Government policies), knowledge (skills from labour market), availability of technical information and

support (Patenting and licensing) and competition within industry as external factors impacting technological capability building.

2.5 Sustainability issues and indicators for the mining sector

Sustainability reporting has previously being focussed only on standard financial indicators to track their business effectiveness, and now in response to demands from various stakeholders sustainability reports are emerging as a new trend in corporate reporting, which is now integrating social, environmental and economic issues into one report (Vintró ,2010). However, there are many sustainable performance indicators and different reporting requirements depending on listing requirements, which make comparisons between firms and sectors difficult. Organisations such as International Institute of Sustainable Development (IISD), Global Reporting Initiative (GRI) and OCED are attempting to standardise the reporting frameworks. Azapagic (2004), is widely cited by various researchers for developing a framework for sustainable development in the mining industry, proposes several indicators to be reported under the three pillars. The common sustainable development factors by Azapagic (2004), Krajnc & Glaviˇ (2005), Chayaviwattanawong, Prapaspongsa and Kaoudom (2014), and the Global Reporting Initiative, (GRI) are summarised in the table 2.1 below under the three pillars.

Table 0-1: Summary of economic, environmental and social indicators by various researchers and organisations on sustainable development towards a common measurement framework.

Economic	Social	Environmental
Contribution to GDP	Safety and Health	Air Quality (Emissions)
Operating Profit	Grievance mechanisms to handle impacts to society	Effluent & Waste
Investment Capital Expenditure	Creation of Employment and Local worker recruitment	Resource Usage (Water and Energy)
	Diversity and Equal opportunities	Land Management
	Employee education and training	Biodiversity

The GRI protocol is now the most common sustainability reporting tool used by mining companies (Mudd, 2012). However, the researcher concurs, but in this study selects a much smaller of sustainable development indicators integrating views from other

researchers in the field of sustainable development which are applicable to Zimbabwe. The excluded indictors will constitute dummy variables. Sustainable development goals should be tangible with mining activities and operations being friendly to the ecosystem and communities. Moreover, many activities in mining industry consume a lot of energy and water resources. Therefore, the plan to minimize the environmental impacts and water and energy consumption should be considered. Chayaviwattanawong et al (2014). To this effect, the independent variables of sustainable development to be considered in study are tabulated in table 2 below under economic (3 variables), environmental (5 variables) and social issue (4 Issues).

Table 0-2 : Summary of Economic, Environmental and Social indicators to be assessed in this study.

Economic	**Environmental**	**Social**
Operating Profit	Resource Depletion and Renewal	Health and Safety Programs
R&D costs	Emissions Management	Community stakeholder engagement programs
Capital	Energy Usage	Employee education and development
	Water Usage	Employment Policies
	Land Use Management and rehabilitation	

2.6 Measurement framework and metrics on sustainable development

The preceding sections on sustainable development have shown that the area of sustainable development is broad with several issues and indicators, therefore there is no commonly accepted way of measuring it. Thus, sustainable development reporting by mining companies has been based on voluntary reporting which is sometimes criticised as biased and rhetoric as not much will be happening on the ground. Some of the existing metrics of sustainability include Dow Jones Sustainability Index (DJSI), Global 100 index, FTSE4 Good-index, Carbon Disclosure Leadership index and World's Most Ethical Companies.

Sustainable development metrics should be universal and common so that comparisons can be made, and not dependent on listing on stock markets. Hence alignment is critical and initiatives by the GRI and IISD are important, as they bring convergence on sustainability reporting. The measurement metrics are compiled in table 3 after literature studies.

Table 0-3:summary of sustainable development indicators measurable metrics , adapted from Azapagic, 2004, GRI, (IChemE n.d.), Mudd, 2012

Operating Profit	GRI uses earnings before interest and tax (EBIT). This will provide a measure of earnings which are measured in monetary units per year.
Research and Development Costs	This metric refers to costs spend on research and development These are costs measured as a percentage of sales.
Capital	Total value of capital employed, including plants, infrastructure, working capital and is measured by monetary units. The level of company commitment to socially responsible investing, and is measured as a percentage. Return of capital employed, and is measure of how well a company has employed its capital and is measured as percentage increase (decrease) in capital employed
Resource Depletion and Renewal	Rate of depletion of permitted reserve is also indicating how long a company can rely on the existing reserves, rate of renewal of reserves. This is measured as a % per year
Emissions Management	Emissions of gases, dust and particulates and are measured as Kg or tonnes per year.
Energy Usage	Primary and secondary energy used.

	Measured in MJ per year. Primary energy include natural gas, diesel, LPG, Petrol and other fuels. Secondary energy (electricity and heat) These are measured as a percentage of renewable energy and non-renewable energy used relative total energy.
Water Usage	Total water used for production of mineral resources, Percentage of water recycled and reused relative to the total water used or drawn from source (underground and surface). This is measured inm^3 per year.
Land Use Management and rehabilitation	Total land currently occupied and reserved for the future extraction and production activities. Ha per year. Environmental sensitivity of the current and future developments, number and description For rehabilitation the measure is rate of land restoration (restored per year /total) $(m^2/y)/m^2$
Health and Safety Programs	Health and safety of the employees. Measured in terms of number of accidents and injuries. Lost time injuries rates, Fatalities rate. Incident or accident free days, shifts.
Community stakeholder engagement programs	The approach to caring for local communities and ,level of stakeholder involvement, This is measured by number of stakeholder meetings per unit value added /$, Indirect community benefit per unit value

	added $/$ Number of complaints per unit value added /$ Number of legal actions per unit value added /$
Employee education and development	Creation of employment and stability of jobs, level of commitment to human capital investment to address employment education and skills development. This is measured as a % of new appointments/number of direct employees and training expense as percentage of payroll expense.
Employment Policies	The level of commitment to non-discrimination and to providing equal opportunities. The metrics also measures benefits as percentage of payroll expense , Employee turnover % which is measured as (resigned+redundant/number employed) % Promotion rate (number of promotions/number employed

2.7 Measurement framework technological capability and sustainable development

In any organisations there is a need to measure performance for decision making processes. (Neely et al. n.d.) is of the view that a performance management system is a balanced and dynamic system that facilitates support for decision masking processes by congregating, elaborating and analysing relevant information. Kaplan, concurs to this view when addressing performance management systems as framework for, among

others, personnel evaluation, resource allocation, control purposes, learning and continuous improvement.

2.7.1 Measurement framework technological capability

There are several methods, frameworks, and models on assessing technological Capability. Shamsuddin et al (2012) gives a synopsis of the some of the main measurement frameworks which include, benchmarking process, indirect measures (proxies) and direct measures, technological capability indexes. These measurement frameworks are summarised in the table below and discussed in the proceeding sections.

Table 0-4: Summary of technological capability measurement frameworks and methods

Measurement Framework	Method
Bench marking process	Panda and Ramanthan , (1996)
Indirect measures	Archa (2000)
Direct Measures	Panda and Ramanthan (1996),Prencipe, (2000) and Lin (1997)
Technological Capability indexes	Archibugi, Coco (2004) and Haq (1985)

Adapted from Shamsuddin et al (2012)

2.7.2 Breadth and Depth of Largest Firms

Prencipe (2000) proposes a direct method to measure the breadth and depth dimensions of knowledge bases by analysing patents for largest firms in the biotechnology sector. Breadth refers to the range of knowledge types that are used in the technology field. Depth refers to the extent to which a few knowledge types are exploited in depth. The method discriminates knowledge bases through production of scatter plots in the breadth and depth space. Limited empirical studies show characteristic knowledge bases to strongly influence innovative performance and organizational structures. Technology fields do exhibit differences in terms of their knowledge bases. This study will not apply this method owing to limited number of players in the platinum sector and similarities in production and concentrating processes.

2.7.3 Technology capability indexes

The WEF Technology Index

The WEF Technology Index includes three main categories of technology which are innovative capacity, ICT diffusion and technology transfer. The innovative capacity considers patents, tertiary institutions enrolment. Internet, telephone, PCs constitute the ICT diffusion. Technology transfer is made up of primary exports. This study considers this method to be ideal for countries and will not be used.

The UNDP Technology Achievement Index

Desai et al (2002) propose the Technology Achievement index (UNDP, 2001). The researchers consider technology achievement to be based on two indicators in a study of 84 countries in creating the synthetic index. These are creation of technology based on patents, receipts of royalty and license fees and diffusion of technologies based on internet hosts and medium and high technology exports, telephone mainlines and electricity consumption and human skills. The UNDP technology achievement index is referring to countries, but some factors such as human skills, patents and technology exports can be used in the measurement framework for this study.

The Technological Capabilities Index (ArCo)

Archibugi & Coco (2004) propose a Technological Capabilities Index (ArCo) which considers three aspects of technology based on a study of 162 countries. These technological aspects are innovative activity (patents and scientific publications), technology infrastructure (ICT and electricity consumption and human capital (tertiary technical enrolment and literacy rate). The ArCo index aspects of tertiary enrolment and literacy rate, and scientific publications are relevant to this study as they can be associated with knowledge.

Industrial Development Scoreboard UNIDO

UNIDO (2002) proposes four categories namely: technological effort (patents and R&D), competitive industrial performance (manufactured value added (MVA), manufactured exports, technology imports (FDI, foreign royalties payments, and capital goods) and skills and infrastructure (tertiary technical enrolment and telephone mainlines). Most of

the categories used by UNIDO for technological capability measurement framework, such as patents and R&D, FDI, capital good and skills are relevant to this study

Science and Technology Capacity Index

Wagner et al (2004) considers eight (8) indicators which are combined and split into three categories namely: enabling factors (GDP and tertiary science enrolment), resources (R&D expenditure, number of institutions, scientists and engineers and embedded knowledge (patents, science & technology publications). The measurement framework, can be cascaded downwards to firm level and most of the factors are applicable and can be used in this study.

World Bank Institute, Knowledge Assessment Methodology

The World Bank supplies the largest database on development indicators which include indicators of technological capabilities. Overall, the programme contains 76 variables, of which 20 relate to the innovation system, 16 to education and training, and 13 to information infrastructures.

2.7.4 Panda and Ramanathan Model 1996

In this Panda and Ramathan model, the organization capability in developing value added equals the organization's technological capability. The model is based on the proposition that technological capability is equal to organizational capability in developing value added. The model identifies the technological gap after comparing the technological capability with an ideal mode. This benchmarking method is not considered in this study.

2.7.5 Measuring Metrics of Technological Capability Variables

The various measurement frameworks summarised above are important to this current study of technological capabilities as they help to portray the various variables for assessing technological capabilities, which assists in the formulation of conceptual framework. The frameworks have convergence on internal and external knowledge, skills, capital, institutions, infrastructure and innovation capability.

From the aforementioned section where the various measuring frameworks on technological capabilities were scrutinised, the researcher proposes the following measurement at sector level and firm level for each variable under study. Since there are several factors outlined in the section below, the researcher will only assess four that are likely to have a significant impact on technological capability development.

Industrial policies and regulatory frameworks.

The measurement framework will focus on fiscal regime and number of legislations in place for the sector. The fiscal regime will be measured by royalties and taxes in place for the mining sector.

Skills and Training from Labour market

The role of science and technology including formal education in technological capability building is critical. The assessment will focus on number of technology support institutions which include tertiary institutions such as universities, polytechnics and other specialists' institutions and overall the knowledge in the platinum sector.

Availability of technical information

In any technology transfers, the role intellectual property transfers, such as patenting and licencing is valuable in technological capability building. The role of industry consultants and standards association groups will also be assessed. The presence and absence of these groups will be measured.

Competition within industry

The number of players within the sector and market structure needs assessment. The platinum sector in Zimbabwe has few players mainly determined by resource ownership. This variable will not be assessed.

Research and Development

The frameworks discussed in the section above on R&D were focussed mainly on registering patents as a direct measure of the variable. The number of patents and R&D expenditure are still the most practical quantitative measure of technology capability, even though some inventions are not protected by patents, (Matinde, 2014).

Management Capabilities

Management capabilities refer to the skills, knowledge and aptitude of managers of relevance to the management role. The inputs into management capabilities are education and qualifications, ongoing formal and informal training, development and experience and management rules and other environmental factors (Tamkin et al. n.d.)

Capital Budgets

The import of capital goods, equipment and machinery is a measure of this variable. Capital budgets in the mining sector are an investment in technological capability building. This requires assessment in the Zimbabwean context.

Own Employees

Qualifications and skills and years of experience are indirect measures of technological capability building. The internal skills is important for also driving institutional technological capability as discussed at the beginning of this chapter.

Internal Training

On the job training is still regarded as one of the inputs into technological capability building. Training budgets and relevance of training are the measurable parameters.

2.8 Theoretical Frameworks of Technological Capabilities and Sustainable Development

2.8.1 Economic Theory on technological capability development

The subject of technological capabilities is at the forefront of theories of economic growth which focus on technology and human capital as engines of growth (Romer, 1986), (Stokey ,1988) and Young, (1991) in Aderemi et al (2009). Recent literature on technological capability suggest that long run economic growth as seen in emergent markets in Asia, reflects sustained increases in firm productivity which stem from

continuous accumulation of technological capabilities (Biggs et al in Aderemi et al ,2009).

The accumulation of technological and innovative capabilities is key factor for developing countries to achieve world leading positions in different sectors of the economy either by catching up with the technological frontier or by engaging in development of new technological trajectories. Therefore, technological capability building is increasingly regarded as a driver for economic growth (Yeh and Chang, 2003). UNIDO (2004) regards technological capability as vital to national economic performance due to introduction of stronger intellectual property rights, regulatory harmonisation and standardisation or sound macroeconomic policies.

2.8.2 Resource Based View on building technological capabilities.

Technological capabilities if they have to accomplish sustained competitive advantage have to be firm specific as alluded at the beginning of this chapter. Research is showing that the internal resources of a firm rather than external environment is possibly the primary source of performance differences amongst firms (Akio, 2005). This perspective is aligned to the resource based view or theory. The resource based view (RBV) regards the prominence of resources and capabilities as the building sources of sustained competitive advantage for firms (Barney & Wright ,2011). The RBV approach brings a more systematic approach to firm level analysis by emphasising the importance of firm's resources and capabilities as sources of competitive advantage. The RBV is about how a firm deploys its capabilities and resources to achieve superior performance which will be obtained by firms that align their organisational structures with the resources and capabilities (He et al. 2012).The RBV approach is relevant in the accumulation of technological capabilities in the mining sector as each firm uses its internal resources capital, skills and knowledge, experience and innovation capability to develop its technological capabilities to its advantage. If the technological capabilities cannot be matched by competitors then sustained competitive advantage is assumed to be achieved. However, the study will not investigate the extent of competition within the platinum sector in Zimbabwe as it will likely to have a negative impact when conducting the research as the subject area is sensitive and the need to keep information confidential.

2.8.3 Sustainable Development Theoretical framework

The concept of sustainable development has evolved over a long period of time, with initial focus on using resources in a responsible way by allowing for a balance between environmental and economic issues. Social and economic issues were initially addressed as far as they were linked to environmental issues, until they were regarded as pillars of sustainable development (Steurer, 2001) in Steurer and Langer,(2005). Steurer and Langer (2005) stress that the time has since passed when interests and activities of all but the most obvious stakeholder groups could be conveniently overlooked. This indicates the growing power of some stakeholder groups on influencing decision making in organisations and the need to respond appropriately to social, economic and environmental pressures in order to mitigate negative impact such as alienation of company from society, reputational damage, increased costs and threats of losing licence to operate (Hill, 2001) in Steurer and Langer 2005), (Di et al, 2012). Mutti et al (2012) argue that stakeholder theory posits that firms are responsible for delivery benefits to all their stakeholders rather than only to shareholders and customers. To this effect the stakeholder approach is relevant to the discussions on sustainability issues affecting the mining sector. This focus on easing stakeholder pressures fits into the stakeholder theory from a sustainable development perspective. Stakeholder perspective focus on certain stakeholder groups through exploration of their characteristics of power or status, urgency and legitimacy (Mitchell et al, 1998)

Stakeholder theory from a sustainable development perspective is considered to involve corporate and stakeholder perspective (Steurer and Langer ,2005). This approach focuses on stakeholders who are affected by corporate policies and practices, and the approach is to integrate groups with a stake in the firm into managerial decision making and how to balance the competing demands of various stakeholders. The relationship between business and society has to be cemented based on ethical requirements of doing the right thing.

The corporate perspective deals with how corporations interact with stakeholders in order to secure critical resources and is often utilised as the instrumental approach. The instrumental theories view corporations only as instruments for wealth creation and their social activities are only means to achieve economic results (Garriga ,2004). Therefore, the focus of the corporations is on financial performance and sustainable competitive advantage through long term achievement of social objectives

2.8.4 Resource based view application to sustainable development

Gariga, (2004), applied the resource based view of the firm and dynamic capabilities as ways for firms to have superior performance over competitors. This is achieved through the interplay of human, organisational and physical resources over time meeting the four criteria of valuable, rare and imitable and organisational ability to deploy resources and meet social objectives and sustain competitive advantage.

Hart (1995) further presented the RBV which included the aspects of dynamic capabilities and link with external environment. Hart (1995) argues that most important drivers for new resources and capabilities development will be constraints and challenges posed by the natural biophysical environment (Gariga, 2004). This link to the environment is compatible to the study of sustainable development.

2.8.5 Economic theory perspectives to sustainable development

Mikeseli (1994) adopts the general rule advocated by most economists that the present generation bequeath to future generations a natural resource base with a capital value at least equal to that which it inherited. This implies that in the mining sector mineral resources which are being depleted by mining must be replenished through exploration, optimal extraction and savings, and substitution of products to maintain natural capital for future generation, hence sustainability.

2.9 Research gaps from literature review

The development of technological capabilities has attracted extensive attention both from the theoretical and empirical viewpoint, but extensive research on the development of technological capabilities is being carried out not only in emerging countries (Kim, 1997, Lall, 2000) but also in advanced countries (Miyazaki, 1995). This research in emerging countries is based on the development experiences of newly industrializing economies (Kim, 1997, 1999), (Lee, 2001). Little is known about the process of building up technological capability in non-industrialized countries, which include Sub Saharan Africa (Jin, 2005).

Despite a large volume of research undertaken on technological capability , there is scarcity of research on impact on overall performance (Kuen, 2003) and Shamsuddin et

al, 2012). Arguably, if firms do not know the impact of technological capabilities on performance, it is very difficult for them to align technological capabilities with their corporate and functional objectives. Thus, an assessment of technological capability is essential. Furthermore, the assessment output provides the effectiveness of using resources, ability to effectively import technology, enable products and processes to be changed in order to suit local conditions and in the case of exports and external conditions (Fransman, 1984).

A review of the multidisciplinary literature on sustainable development (SD) reveals a lack of a comprehensive theoretical framework for understanding sustainable development and its complexities (Jabareen, 2006).Measuring sustainable development on different scales is lacking and attempts should be made to measure sustainable development on other scales than that of countries. Unece et al (2013) suggest the possibility of applying the indicator set at company level, by harmonising sustainable development issues.

Tulder and Kolk (2010), state that the lack of research on sustainable development in Sub Saharan Africa is troubling and that there is relatively little on the ground to show sustainable development. The two researchers propose that there is greater need for sustainable development in Sub Saharan Africa due to greater poverty, environmental degradation and institutional governance issues. The geographical imbalances on studies of sustainable development warrant research in Zimbabwe, and in particular the platinum sector which is relatively new on the mining landscape.

Mudd (2012), acknowledges controversy surrounding the concept of mining sustainability and proposes that the controversy would probably diminish if the science of assessing and reporting mining sustainability were sufficiently developed. Hence, there is a lot of rhetoric being associated with sustainability reporting and a general need to move from rhetoric and policy and agree on how to assess mining sustainability, even within similar contexts and unit of analysis. Some of the assessment and reporting frameworks follow a predominately retrospective siloed approach to assessing mining sustainability, while overlooking trade-offs and synergies among sustainability dimensions in particular no reference to scarcity of mineral resources and the effective legacy of mineral operations across geographical scales (Fonseca et al, 2013).

Whilst sustainability includes social, economic and environmental aspects, some researchesare focussed on one aspect only which is mainly environmental. Wagenhals and Kuhn (2012) note that little research has been done on the actual effectiveness of indicators toward company goals which is fundamental for improving sustainable performance (Mudd 2012).

2.10 Conceptual frameworks for technological capability building and sustainable development in the mining sector:

Aderemi et al (2009) proposed conceptual framework on how organisations can development technological capabilities to achieve sustained competitive advantage when studying ICT technologies. Figure 2-1 proposes a conceptual framework for development of technological capability adopted for this study (Aderemi et al ,2009)

Sustainable development framework for sustained performance involves integration of economic , social and environmental factors Figure 2-2. Proposes a conceptual framework for sustainable development in the mining sector adopted for this study.

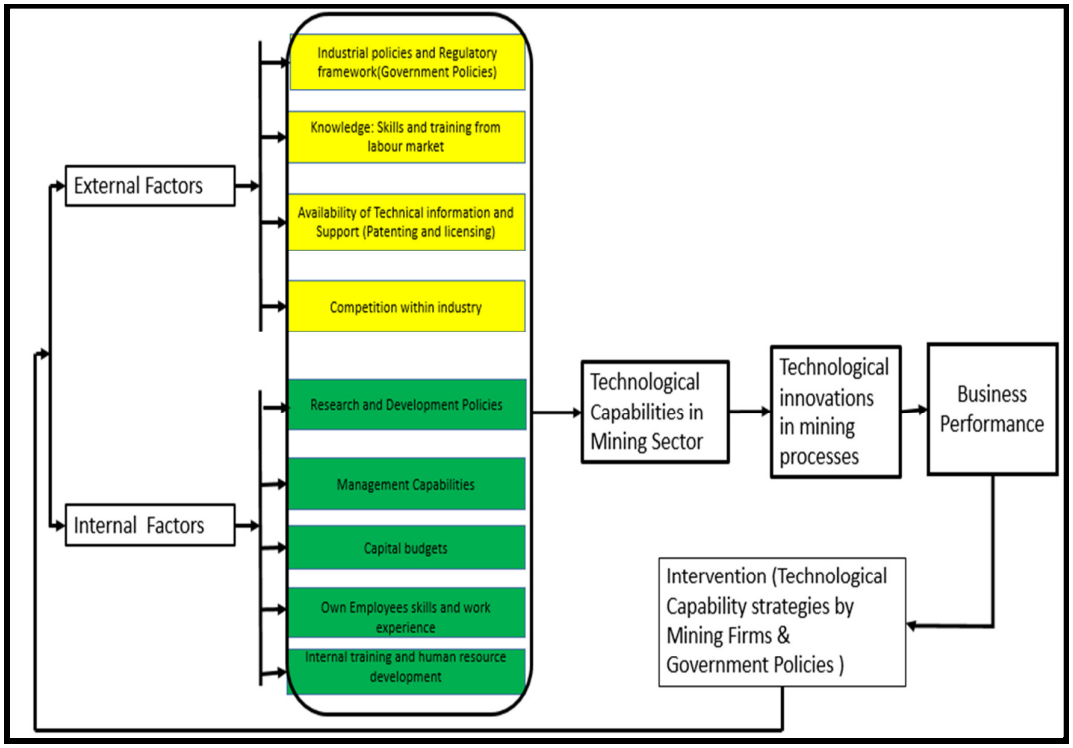


Figure 0-1:Conceptual framework for technological capability building used to develop the conceptual framewrok for this this study.

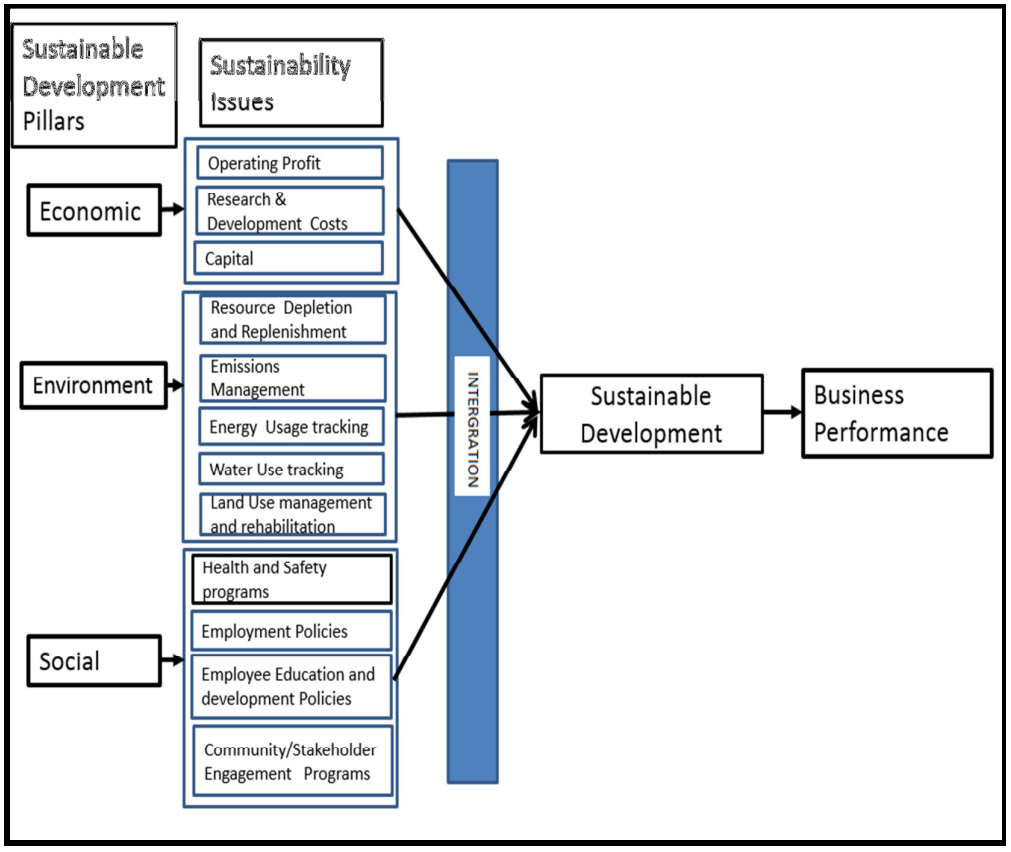


Figure 0-2:Sustainable development framework adopted for this study.

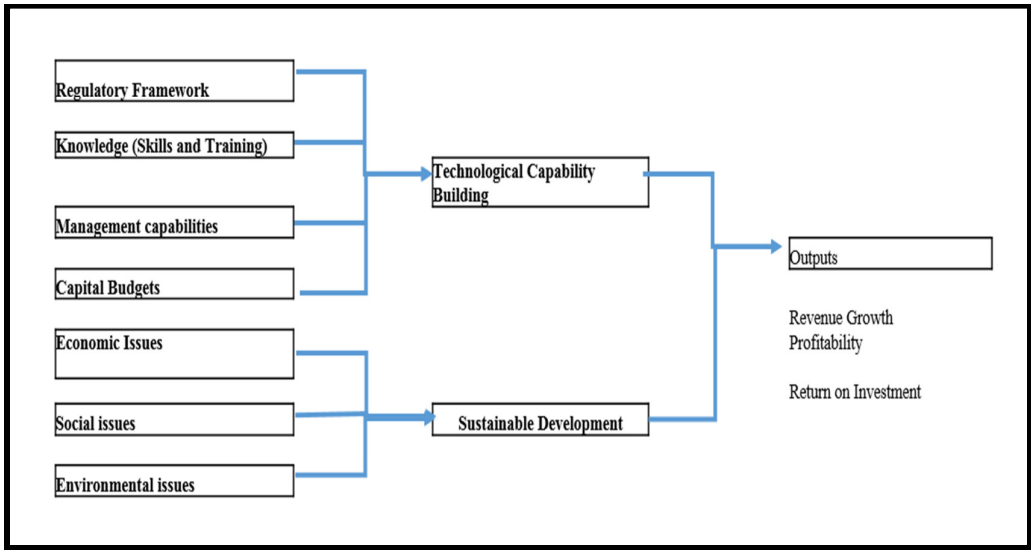


Figure 0-3 Conceptual framework for technological capability development and sustainable development adopted for this study. Adapted from Aderemi et al (2009) and GRI.

2.11 Chapter Summary

Technological capability is a construct of skills, technological knowledge and organizational structures required to operate a technology efficiently and achieve any technological process change, which may result in superior performance either derived from new products or production efficiencies. Technological capabilities are firm specific and their development is dependent on various factors which are both internal and external to the firm. The internal factors influencing the technological capabilities development are R&D policies, management capabilities, capital budgets, employees and internal training. Industrial policies and regulatory framework, skills and training from labour market, availability of technical information and support and competition within the industry constitute some of the external factors that are attributable to technological capability development. These variables constitute the independent variable to be assessed in this study.

Sustainable development is now widely regarded to constitute economic, social and environmental or ecologic issues referred to as the triple bottom line or the three pillars. The three main indicators of sustainable development indicate the change of focus of sustainable development from environmental issues which previously dominated studies in the mining sector to include economic and social issues as the stakeholder groups have expanded and each group has its own pressures and expectations on the sector. Sustainability is only achieved if all three indicators are integrated, where there is overlap of the three sustainable development pillars. Sustainable development indicators are numerous which make the studies complex as comparisons use different measurement frameworks based on applicability to the sector and country. The stakeholder theory from a corporate and stakeholder perspective underpins the studies on sustainable development. The economic theories on development to some extent are relevant as sustainable development is all about equitable distribution of wealth between current and future generations.

The sustainability indicators constituting the conceptual framework of this study are operating profit, R&D costs and capital as independent variables for the economic indicators, resource depletion and renewal, emissions management, energy and water usage, land use management and rehabilitation as independent variables of environmental or ecologic indicators. Health and safety programs, community stakeholder engagement programs, employee education and development and employee policies are proposed as independent variables for social indicators.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides the details on the method used in carrying the research including sources of data that were used. It also outlines the research design, data collection methods and procedures, target research population, sampling methods and size, research instruments and design. In this research, primary data was used.

3.2 Research Assumptions

Assumptions in research are made to form basis of researcher decision on some of the issues during the research process. They assist users of research to make their decisions on the reliability and authenticity of the research.

- The researcher assumed that responses from managers in the platinum mining sector super cede that of other employees due to their wealth of knowledge and experience.

3.3 Research Design

A research design specifies the methods and procedures for collecting and analysing the collected information. It is therefore a blueprint that plans the action for the research project (Zikmund, 2003). The research design focuses on data gathering techniques to be employed, sampling method to be adopted, and management of time and cost constraints. In this study, quantitative research was used. The method uses deductive reasoning were the researcher forms a hypothesis, collects data in an investigation of the problem, uses the data from the investigation after analysis and conclusion is made. The method involves collection of quantitative information that can be tabulated along a continuum in numerical form. The method uses visual aids such as graphs and charts to assist in understanding the data distribution. Most quantitative research fall into two categories; studies that describe events and studies that are aimed at inferring causal relationships such as those in this study.

3.3.1 Research Philosophy

Saunders, Lewis and Thornhill (2009) identify four research philosophies which are namely: positivism, realism, interpretivism and pragmatism. In this study, the researcher adopted the positivism research philosophy. According to Fisher (2010), positivism holds that an accurate and value free knowledge of things is possible and that the intention of positivism is to create general laws that can be used to predict behaviour, in terms of probability at least, if not in absolute terms. It holds out the possibility that human beings, their actions and institutions can be studied as objectively as the natural world. Remenyi et al (1998) as cited in Saunders, Lewis and Thornhill (2009) concurs with this definition of positivism by stating that a positivist will prefer "working with an observable social reality and that the end result of such research can be law like generalizations similar to those produced by the physical and natural scientists". The researcher adopted the positivism approach as the data collected required highly structured methodology and statistical analysis as supported by Saunders et al (2009).

3.4 Research Approach

Saunder et al (2009) establish that there are two basic types of research approaches, namely deduction and induction. Collis and Hussey (2003) state that the deductive approach essentially involves the testing of a theoretical proposition through the employment of a research strategy designed specifically for the purpose of its testing. Induction involves the collection and analysis of data with a view to developing an understanding of the relationships that may exist between phenomena. In the inductive approach therefore, theory development follows from data collection and analysis (Saunders et al, (2009).

For the purposes of this research, the study used the deductive approach to develop an understanding of the technology capability and sustainable development of the platinum mining sector in Zimbabwe. This is so since the study started with the theory, then formulated hypothesis and the data was collected to test the hypothesis.

3.5 Research Strategy.

Survey strategy was adopted by the researcher to gather data for the research. A survey can be defined as a research technique in which information is gathered from a sample of people by use of a questionnaire or interviews (Saunders et al, 2009). A questionnaire was

designed and information was obtained from the three managerial groups in the platinum mining sector in Zimbabwe, based on their grades using stratified random sampling.

Closed questions were used to gather information in the questionnaire because they are easy to analyse.

3.6 Target Population and Sampling

3.6.1 Target Population

Population is the full universe of people or things from which the sample is selected (Greener, 2008). The population determines the sampling process to be used including the whole research methodology as noted by Saunders et al (2009). For the purposes of this research, the population is represented by all platinum mining managers in the platinum sector in Zimbabwe. These mines are Zimplats, Unki and Mimosa Mine. The target group comprises junior, middle and senior management within the three operations.

Table 0-1: Target Population

Mining Company	Junior Managers	Middle Managers	Senior Managers	Target Population (Junior, Middle and Senior Management)
Zimplats	33	31	17	81
Unki	25	27	12	64
Mimosa	31	29	15	75
Total	**89**	**87**	**44**	**220**

In this study the researcher targeted to collect data from junior, middle and senior management and the target population is 220.

3.7 Sampling

Saunders et al (2009) defines sampling as, "the process by which a researcher selects a sample of participants for a study from the population of interest". The rationale behind

sampling is that by selecting a representative subgroup of the population, the researcher may draw conclusions about the entire population. Sampling, will also among other advantages cut costs, reduce labour requirements and gathers vital information quickly.

In this study the researcher used the stratified random sampling technique. Stratified random sampling is a modification of random sampling where you divide the population into two or more relevant and significant strata based on one or a number of attributes (Saunders et al, 2009). The effect is to divide the sampling frame into a number of subsets. A random sample (simple or systematic) is then drawn from each strata. This sampling method is normally applied where the population is regarded as being heterogeneous with respect to the random variable under study. The division of the population into strata therefore is meant to ensure the sample to be chosen will be representative of the various strata making up the population.

In this study the population was divided into senior, middle and junior management for each population. Each management group formed a strata as they represented different levels of experience and knowledge. The number to be sampled from each strata was based on proportions. The researcher then applied simple random technique to pick respondents of this study based on the number determined by proportions from these population categories (strata).

3.8 Sample size

Saunders et al (2009) says significance of the test statistic is influenced by the sample size. A large sample size improves the reliability of the results. The researcher selected a sample of 100 managers using stratified simple random sampling.

3.9 Data Sources and Collection

Primary data which is data captured at the point or data collected for a specific project was used in this research. It is data generated for the first time and for a specified problem at hand. In this research primary data was obtained from questionnaires distributed to the Zimplats, Mimosa, and Unki Mines. The advantage of primary data

which the researcher experienced was that it is directly relevant to a specific problem and offers greater control of data accuracy to the researcher.

3.9.1 Research Instrument

There is a great variety of research instruments that can be used for primary data collection (Fisher, (2010). These methods include questionnaires, interviews, focus group discussions and direct observation, and experimentation methods.

For the purposes of this research questionnaires were used. This method was considered appropriate because each person (respondent) is asked to respond to the same set of questions thereby providing an efficient way of collecting responses from a large sample prior to analysis (Saunders et al, 2009). This research instrument was also chosen because of the following additional considerations:

- Geographic Flexibility – questionnaires can reach a geographically dispersed sample simultaneously and at relatively low cost because the interviewer presence is not required.
- Respondent Convenience – questionnaires can be filled in whenever the intended respondent has time, meaning that there is a better chance that respondents will take time to think about their replies. This also allows respondent time to check facts that they may not recall without checking.
- Cost – the questionnaire is relatively cheap compared to personal and telephone interviews.

3.9.2 Data Collection

A structured questionnaire was used to collected primary data. An introductory letter was attached to the questionnaire to provide the respondent with some explanations of the purpose. Respondents were given 7 working days to complete and respond. All questions in the questionnaire were closed questions for ease of administration. A Likert scale was used with a rating of 1 to 5 as shown on Table below.

Table 0-2: Lickert Scale of the questionnaire

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

3.9.3 Pre-Testing Questionnaire

The questionnaire was pretested to 10 co-workers to ensure that it does not have ambiguous questions and that it meets minimum standards. Ten (10) co-workers were used for convenience and easy of accessibility considerations. Pretesting also has an advantage of ensuring reliability of questions (Saunder et al 2009). However, the 10 co-workers were not used in the actual survey.

3.9.4 Ethics

Saunders et al (2009 defined ethics as the appropriateness of the researchers behaviour in relation to the rights of individuals and organisations who became the subject of the study. In this research privacy of participants was guaranteed as well as consent of participants was sought. All guidelines to conduct a research study were followed. Objectives of the research were clearly explained to participants and information collected was used solely for academic purposes.

3.10 Data Analysis

To assess the technological capability factors and sustainable development factors of platinum mining operations in Zimbabwe, two dependent variable that are Technological Capability and Sustainable Development were used. For technological capability, internal factors (Management capability, Budgetary Framework) and external factors (Regulatory framework and Skills and Training) were explanatory variables. On Sustainable Development, Social, Economic and Environmental factors were explanatory variables. Correlation tests were done as well as reliability tests, significance tests and regression analysis on the data collected.

3.10.1 Model Specification

A simple linear regression model of the form below was used.

$Y_i=\beta X_i +\mu_i$

Where:

i denotes the cross section dimension,

Y_i is the dependent variable which is either Technological Capability or Sustainable Development.

X_i is a column vector of explanatory variables which are Management Capability, Capital Budget, Knowledge (Skills and Training) and Regulatory Framework for Technological Capability and Environmental, Social and Economic factors for Sustainable Development.

β is a vector of regression parameters,

μ_i denote the disturbance terms which are assumed to be uncorrelated with any variable.

The general to specific approach was used eliminating all insignificant variables to come up with the final model. The approach has an advantage of having all necessary variables included within the model.

3.10.2 Validity and Reliability

Saunders et al (2009) state that "reliability refers to the extent to which your data collection techniques and analysis procedures yield consistent results". For the purposes of this research, the questions of research validity and reliability were addressed through the design of a robust questionnaire. Data reliability was tested using SPSS to calculate the Cronbach's Alpha Value and then ascertain the level of data reliability.

3.11 Limitations of the Study

The research could not be conducted in other platinum mining jurisidictions such as South Africa, Russia and Canada due to time and financial constraints. The findings therefore, may not be generalized to the global mining sector.

3.12 Chapter Summary

This chapter has discussed the research design used in the study and proffered the reasons for choosing the design. The chapter also reviewed concepts and literature concerning the population of the study, sampling techniques, research methods and instruments, pre-testing, data quality, control, presentation and analysis, and how the research was carried out and its limitations. The next chapter discusses the results of the study.

CHAPTER 4: RESEARCH FINDINGS, ANALYSIS AND DISCUSSIONS

4.1 Introduction

This chapter presents results of the research and the concomitant discussion of the findings which are linked to the literature review from chapter two. The analysis was derived from primary data which was collected using structured questionnaire to the management of mining and engineering services companies in the platinum sector. The chapter starts by analysing demographic characteristics and response rate of the sample chosen. The detailed descriptive analysis of data collected for each and every research objective followed. Correlation analysis, reliability tests, regression and hypothesis testing were performed in line with the research objectives.

4.2 Sample Analysis

This study on technological capabilities and sustainable development factors that are critical for the platinum industry to remain competitive was conducted on a sample of 100 managers of the 3 platinum mining companies which were selected using stratified random sampling as shown on table 3.1. The population was divided into senior, middle and junior management for each population. Each management group formed a strata. The number to be sampled from each strata was based on proportions. The researcher then applied simple random technique to pick respondents of this study based on the number determined by proportions.

4.3 Response Rate

The researcher selected 100 managers from the three platinum companies using stratified random sampling to ensure representation of all managerial levels in the platinum mining industry. As such, 100 questionnaires were sent and 62 were returned resulting in a response rate of 62%. According Johnson and Wislar (2012), a response rate of 60% and above is good for any research, therefore, the 62% is a very good result.

Table 0-1: The response rates from questionnaires

Job Title Class	Sample Population Of Respondents	Actual Response Feedback	% Overall Response Rate
Junior management	40	16	39%
Middle management	40	27	68%
Senior management	20	19	95%
Overall Response	**100**	**62**	**62%**

There was a response rate of 39% from junior management, 68% for middle management and 95% from senior management. The researcher managed to collect the 62 questionnaires from the targeted sample this represents a response rate of 62 % which warrant the validity of the research findings as stipulated by Johnson and Wislar (2012).

4.4 Descriptive Analysis

4.4.1 Demographic Analysis of Respondents

The following charts and tables show demographic information of respondents.

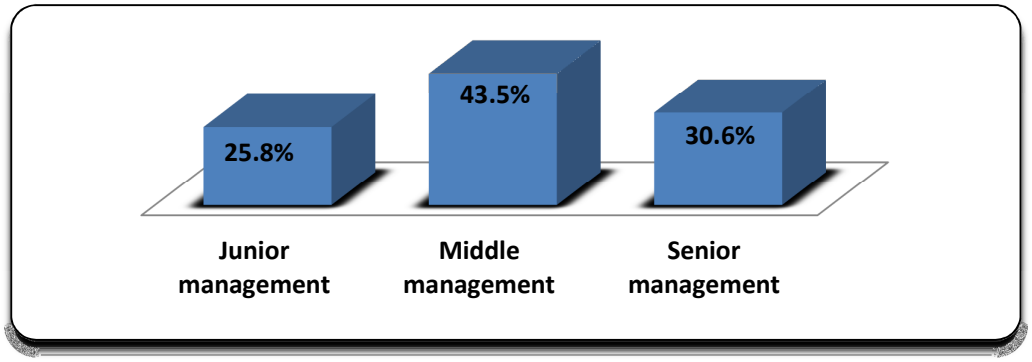


Figure 0-1 Position of the respondents with respect to management levels in the Platinum sector as a percentage of total responses

The figure 4-1 above shows that 25.8% of the respondents that participated in the study are junior management and 43.5% are middle management. Moreover 30.6% stated they are senior management. This demonstrates that the majority of respondent managers in the platinum mining sector are middle managers.

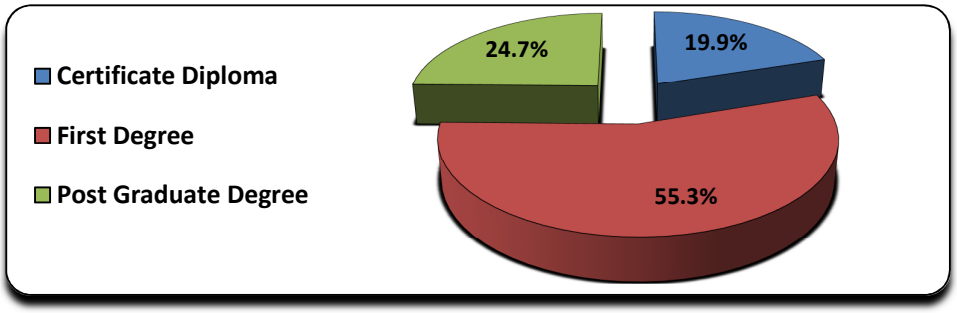


Figure 0-2: Educational qualifications of respondents as a percentage of total responses.

The qualifications of the research participants are presented in the figure 4-2 above with 24.7% indicating that they are qualified to the level of post graduate degree and 19.9% said they are educated to the level of certificate diploma. The majority of the survey participants, 55.3%, are qualified to the level of first degree. Findings above show that the staff is fairly well educated to give adequate responses for the validity of the research and achievement of the research objectives.

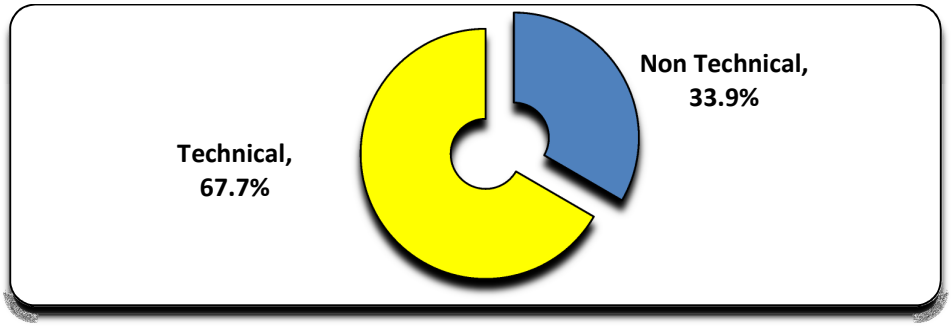


Figure 0-3: Profession of respondents as a percentage of total responses

The figure 4-3 above shows that 67.7% and 33.9% of the study participants are technical and non-technical respectively. This shows that the majority respondents are technical with a fair percentage being non-technical. This gives respondents the ability to give valid responses as respondents with technical background are assumed to have acquired an array of skills, technical knowledge and organisational structures required for understanding technological capabilities development.

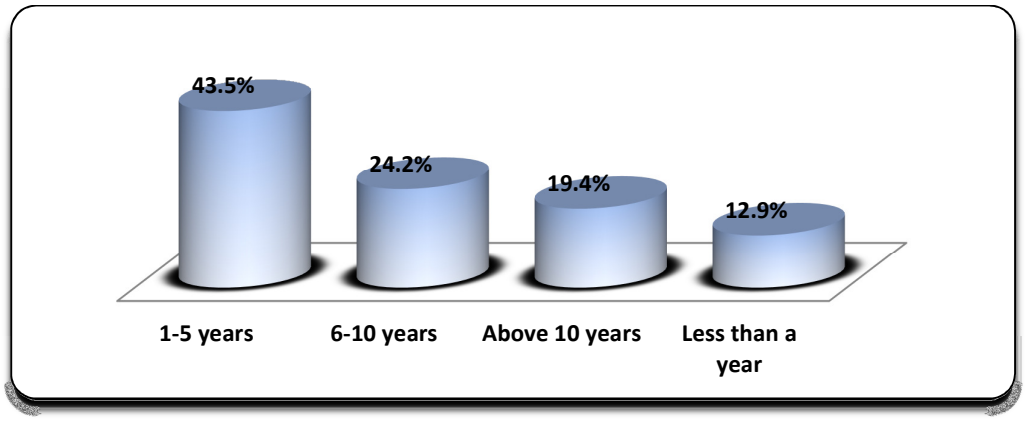


Figure 0-4 Duration of respondent at the organisations sampled

The figure 4-4 above shows that 43.5% of the research participants have 1-5 years' experience working in the respective organisations, 24.2% s have 6-10 years while 19.4% have more than 10 years working experience. Moreover 12.9% said they have less than a year working at the organisation. Respondents have spent considerable time working in their respective organisations and it is implied that they have enough experience to give valid responses on technological capability and sustainable development.

4.5 Reliability Tests

Zikmund (2003) broadly defines reliability as the degree to which measures are free from error and therefore yield consistent results. Saunders et al (2009) concur with this definition when they state that "reliability refers to the extent to which your data collection techniques and analysis procedures yield consistent results". SPSS was used to test the reliability of all research variables in the questionnaire by calculating the Cronbach's Alpha values. In order to raise Cronbach's Alpha, no item was deleted as there was no significant change in values after the deletion.

Table 0-2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.823	.839	60

The table 4-2 above shows the overall reliability of all the variables in the research with a Cronbach Alpha of 0.823. A Cronbach Alpha range of 0.7 to 0.95 is acceptable in research as indicated by Takakol and Dennick (2011). As such, the data is reliable overall.

4.6 Normality Test

Table 0-3: Normality test results – Technological Capability

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Regulatory	.330	62	.000	.714	62	.000
Knowledge	.323	62	.000	.740	62	.000
Management	.287	62	.000	.794	62	.000
Capital	.261	62	.000	.855	62	.000

a. Lilliefors Significance Correction

The Kolmogorov-Smirnov test for normality which is applicable to this study whose results are presented in table 4-3 above show p values to be less than 0.05 implying that the data is not normally distributed and non-parametric tests should be applied. According to Pallant (2005), when significant values are less than 0.05 the data is not evenly distributed.

Table 0-4: Normality test results – Sustainable Development

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Economic	.279	62	.000	.769	62	.000
Social	.303	62	.000	.732	62	.000
Environment	.319	62	.000	.713	62	.000

a. Lilliefors Significance Correction

The Kolmogorov-Smirnov test for normality is a small sample normality test which is applicable to this study whose results are presented in table 4-4 above show p values to be less than 0.05 implying that the data is unevenly distributed and non-parametric tests should be applied.

4.5.1 Correlation analysis results

The aim of the research is assess the relationship between variables. As noted by Pallant (2005), when data is not normally distributed, it is advised to use non parametric statistical tests. As such Spearman's Rank Correlation Coefficient was used to determine direction and significance of relationships between independent and dependent variables. However, all independent variables have weak insignificant relationship with the dependent variable as shown on the table below.

Table 0-5: Correlation analysis of technological capability development factors

Correlations

			Technological Capability	Capital	Regulatory	Management	Knowledge
Spearman's rho	Technological Capability	Correlation Coefficient	1.000	-.080	-.070	.213	.055
		Sig. (2-tailed)	.	.535	.586	.097	.668
		N	62	62	62	62	62
	Capital	Correlation Coefficient	-.080	1.000	.243	.275*	.211
		Sig. (2-tailed)	.535	.	.057	.030	.099
		N	62	62	62	62	62
	Regulatory	Correlation Coefficient	-.070	.243	1.000	.517**	.633**
		Sig. (2-tailed)	.586	.057	.	.000	.000
		N	62	62	62	62	62
	Management	Correlation Coefficient	.213	.275*	.517**	1.000	.524**
		Sig. (2-tailed)	.097	.030	.000	.	.000
		N	62	62	62	62	62
	Knowledge	Correlation Coefficient	.055	.211	.633**	.524**	1.000
		Sig. (2-tailed)	.668	.099	.000	.000	.
		N	62	62	62	62	62

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

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

Although the relationships between dependent variable (technological capability) and its independent variable is insignificant as noted in the table 4-5 above, the direction of relationship is as expected, except for capital.

Table 0-6: Correlation analysis of sustainable development factors

Correlations

			Sustainable Development	Economic	Social	Environment
Spearman's rho	Sustainable Development	Correlation Coefficient	1.000	-.212	-.087	.006
		Sig. (2-tailed)	.	.099	.503	.963
		N	62	62	62	62
	Economic	Correlation Coefficient	-.212	1.000	.661**	.547**
		Sig. (2-tailed)	.099	.	.000	.000
		N	62	62	62	62
	Social	Correlation Coefficient	-.087	.661**	1.000	.650**
		Sig. (2-tailed)	.503	.000	.	.000
		N	62	62	62	62
	Environment	Correlation Coefficient	.006	.547**	.650**	1.000
		Sig. (2-tailed)	.963	.000	.000	.
		N	62	62	62	62

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

All the factors are weakly correlated, insignificant and have unexpected signs. This signals weak relationship and lack of statistical evidence to support the casual relationship as shown in table 4-6. All variables p values are greater than 0.05.

4.5.2 Regression Analysis

Pallat (2012) describe regression as a refined extension of correlation analysis used to assess the predictive capacity of independent variables on a continuous variable.

Technological Capability

The model summary is presented below.

Table 0-7: Model Summary: Technological Capability

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.785[a]	.617	.590	.41754

a. Predictors: (Constant), Capital, Regulatory, Management, Knowledge

The adjusted R^2 is 0.59 showing that the variables of capital budgets, regulatory framework, knowledge and capital budgets account for 59% of the variation of technological capability development and there are other variables which affect technological capability. This finding is in alignment with the literature review under chapter 2, on factors influencing technological capability accumulation of firms.

The F Value of 22.94 shown in the ANOVA result table 4-8 below shows that the relationship between the dependent variable (technological capability) and its explanatory variables (capital budget, regulatory framework, knowledge and management capabilities) is significant. The model can be used to predict the level of technological capability.

Table 0-8: ANOVA Table: Technological Capability

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	15.998	4	3.999	22.940	.000[b]
	Residual	9.938	57	.174		
	Total	25.935	61			

a. Dependent Variable: TC

b. Predictors: (Constant), Capital, Regulatory, Management, Knowledge

Table 0-9: Predictive Coefficient of the model: Technological Capability

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

1	(Constant)	-.264	.284		-.929	.357
	Regulatory	-.238	.123	-.207	-1.933	.058
	Knowledge	.036	.163	.028	.220	.826
	Management	1.099	.164	.687	6.695	.000
	Capital	.268	.106	.245	2.533	.014

a. Dependent Variable: TC

In the model above, Capital budget and management capabilities are significant estimators at 5% level, regulatory framework significant at 10% level whilst Knowledge (Skills and Training) is insignificant. The regression analysis show that the model:

Technological capability development= 0.245Capital Budget+0.687Management Capability-0.207 Regulatory framework

This model shows that management capabilities are critical factor in technological capability development, followed by capital budgets and Regulatory framework).

The effect of each variable in the model is as follows:

- A 100% increase in capital will lead to a 24.5% increase in Technological capability.
- A 100% increase in Management Capabilities leads to a 68.7% increase in Technological Capability.
- A more restrictive regulatory environment (increase in regulatory framework) will result in a decline in Technological capability with a magnitude of 20.7%.

Generally, the regression model shows a positive relationship between capital budget, management capabilities and technological capability, whilst the regulatory framework has a negative impact.

Sustainable Development

The regression model for sustainable development shows that R^2 is low at 0.305 implying that 70% of the variation can be explained by factors not considered in the study.

Similarly, the F Test show a low F value confirming that the model for sustainable development is not robust and predictive.

Table 0-10: Model Summary: Sustainable Development

Model	R		Adjusted R Square	Std. Error of the Estimate
1	.582[a]	.339	.305	.54660

a. Predictors: (Constant), Economic, Environment, Social

Table 0-11: ANOVA: Sustainable Development

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8.881	3	2.960	9.908	.000[b]
	Residual	17.329	58	.299		
	Total	26.210	61			

a. Dependent Variable: SD

b. Predictors: (Constant), Economic, Environment, Social

The Beta coefficients from the Table below for the sustainable development predictors show that only environment has a strong statistically significant relationship with sustainable development with a beta coefficient of 0.524 $p < 0.05$. Sustainable development and economic have insignificant relationship with economic issues with a beta of 0.177 and $p > 0.05$.

Table 0-12: Predictive Coefficient of the model: Sustainable Development

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.118	.434		2.578	.012
	Economic	.201	.123	.177	1.630	.108
	Social	-.241	.130	-.202	-1.850	.069
	Environment	.589	.122	.524	4.843	.000

a. Dependent Variable: SD

The model for sustainable development in the platinum mining sector can be summarized as:

Sustainable Development = 0.524Environment

The effect of the model is that a 100% improvement in the environment will lead to 52.4% improvement in the sustainable development. Generally, in mining, as a depletable and non renewalble resource – only improvement in the environmental aspects such as discovery of new mineral deposits, land use management, air quality control and water and energy conservation will enhance mining sustainability.

4.5.3 Hypothesis testing

H_1: Internal factors have an impact on technological capability building.

As shown in Table 4-9, Management capabilities and Capital Budgets which are internal factors have a positive impact on technological capability. Therefore, H_1 is supported.

H_2: External factors have an impact on technological capability building.

As shown in Table 4-9, regulatory framework and knowledge which are external factors have no significant impact on technological capability. Therefore, H_2 is not supported.

H_3: At least one of social, economic and environmental factors have an impact on sustainable development.

As shown on Table 4-12 Environment with $p<0.05$ is true and H_3 is accepted. Environment issues have an impact on sustainable development. Social and economic issues are rejected and thus have no impact on sustainable development.

4.7 Discussions and Findings

4.7.1 Assessment of current levels of Technological Capability and Sustainable Development in the platinum mining sector in Zimbabwe

Regulatory Framework

The study investigated how the regulatory framework is currently affecting technological capability building.

The indigenization and economic empowerment framework which was recently revised to suite sector specific needs stills has a negative impact to most mining companies. However, the revision of royalties and deferment of export taxes on unbeneficiated platinum gave modicum of relief to platinum miners and allowed them to invest in exploratory activities and building of technological capacities.

Although there are some positives in the platinum sector, policy discord in the diamond sector and some portions in the gold mining industry derails sustainability and technological capabilities. Furthermore, the recent stall between the major producer Zimplats and the Government over the compulsory acquisition of Zimplat's 27,000ha of mining claims constraints sustainable investment and development in the sector.

Introduction of ground rentals of $1,000/ha/year in SI:56 of 2014 had negative impact in miners operations. However, the subsequent reduction to 10$/ha/year in SI:10 of 2016 reduced miners operational costs and improved their ability to invest in technological capabilities.

Knowledge (skills and training)

From the regression results, knowledge and skills has no significant impact on technological capabilities. Although there are institutions to support accumulation of technology in the mining sector such as the School of Mines, academic institutions such as the University of Zimbabwe that produces engineers and geologists, their efforts to date have not yield positive results due to massive brain drain. However, from the results organisations themselves are increasing their skills through internal training and usage of consultancy. Positively, the companies have strong skills development programs under their internal human resources department. Each mining operation has a training centre although the findings suggests otherwise.

Management capabilities

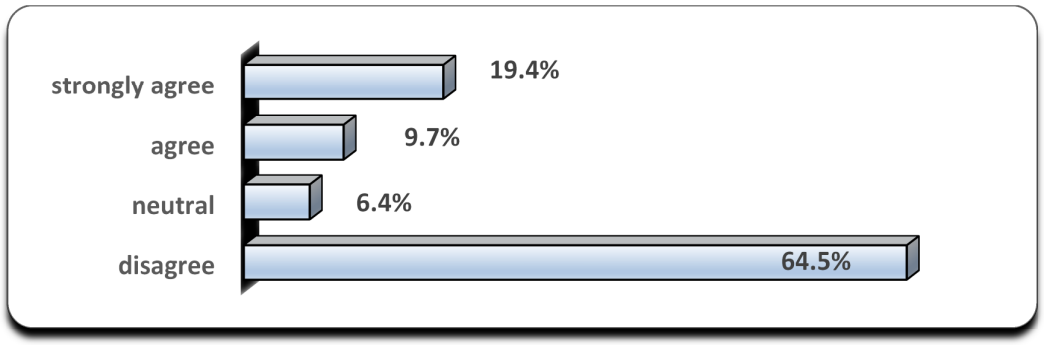


Figure 0-5 Management capabilities

From our findings, management capabilities have a strong impact on technological capabilities. This implies that the management has the necessary capabilities in terms of knowledge of and proficiency in activities involving planning, controlling organizing, directing and controlling as well as methods, processes and procedures. The inputs into management capabilities are education and qualifications, ongoing formal and informal training, development and experience and management rules and other environmental factors (Tamkin et al. n.d.). In the current environment were most business operations are struggling, management has focused on turn around strategies of operations in terms of increasing productivity and reducing costs through improved efficiencies, which are centred on technological changes.

Capital Budgets

Table 0-13: Capital budgets responses

Capital Budgets	**strongly agree**	**agree**	**neutral**	**disagree**	**strongly disagree**
Total value of capital employed in the platinum sector is inadequate for technological capacity development	14.5%	38.7%	17.7%	21%	8%
Enough capital is available for research and development in the platinum mining sector	11.3%	14%	19.4%	37.1%	9.6%

The research findings suggests that capital budgets are important for technological capability. Total value of capital employed in the platinum sector in Zimbabwe is inadequate for technological capacity development. Mudd, (2012) states that the total value of capital employed, including plants, infrastructure and working capital are measured by monetary units. Smelting abilities are insufficient due to lack of capital, it is only Zimplats who have smelting capability inherited from the closed BHP mine at Selous (Zimplats Annual Report (2007)). The Government's drive for value addition and beneficiation in the platinum necessitates capital budgeting for that technological advancement.

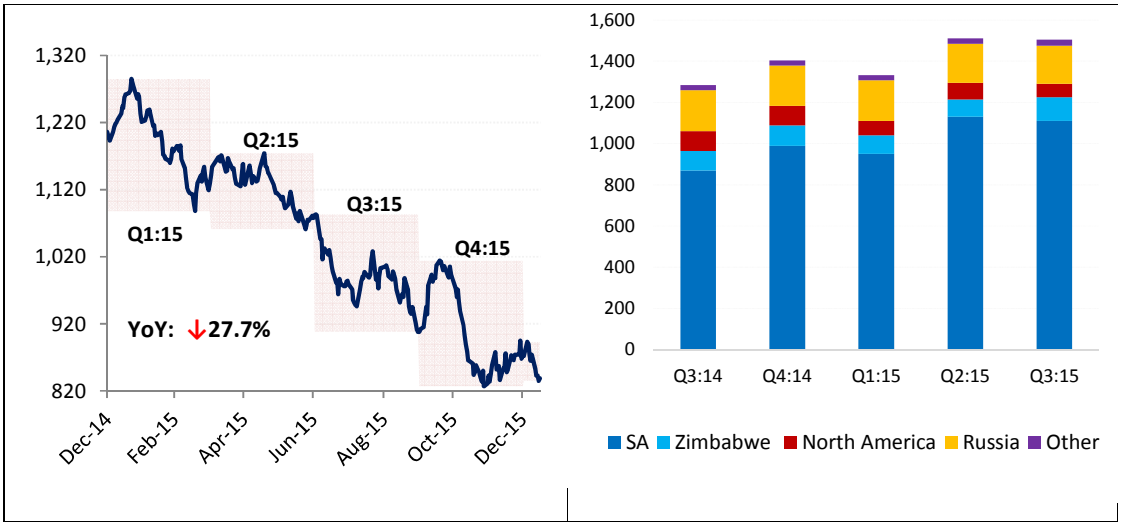
Positively, other operators such as Unki and Mimosa have plans to construct smelting capacities in their operations which reduces the technological gap and improves sustainability.

In addition to the study findings He et al. (2012) argues resources are relevant in the accumulation of technological capabilities in the mining sector as each firm uses its internal resources capital, skills and knowledge, experience and innovation capability to develop its technological capabilities to its advantage.

Economic issues

Table 0-14: Economic issues responses

Economic issues	strongly agree	agree	neutral	Disagree	strongly disagree
Revenue from the platinum sector is stimulating growth of other sectors through the supply chain	14.5%	38.7%	17.7%	21%	8%
The macroeconomic environment is conducive for sustainable development in the platinum mining sector	9.7%	17.7%	16.1%	46.8%	6.5%
Enough capital is available for research and development in the platinum	11.3%	22.6%	19.4%	37.1%	9.6%
Platinum Prices US$/oz		**Global Share of Production (US$/oz)**			



According to the mining sector survey (Chamber of mines (2016)), average capacity utilisation in the mining sector declined to 60% in 2015 from 71% in 2014. The decline is due to depressed international prices, lack of capital, obsolete machinery, power challenges and high freight charges. With the negative economic environment, investment in sustainable development activities are decreasing. Mining expansion and exploration plans are being postponed. From the regression analysis, the economic environment is regarded as insignificant. However, the researcher feels that the economic factors are important for sustainable development because without the economic resources the social and environmental issues of sustainable development will not be managed. As discussed in literature review, these factors are integrated and they overlap.

Social Issues

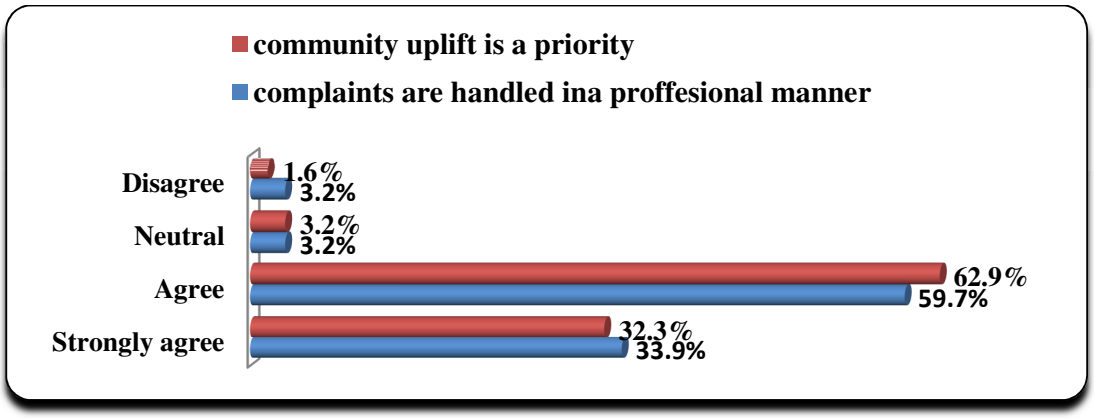


Figure 0-6 Social Issues affecting sustainable development

Although the findings show no relationship between social factors and sustainable development, Corporate Social Responsibilities play a major role in sustainable development. According to Zimplats reports, the company has assisted communities of Ngezi and Norton in infrastructural projects. Similarly, the other operators have also established community share ownership trusts with seed capital of US$10 million each for community development projects in areas of their influence.

However, land degradation and environmental pollution as a result of open pit mines have affected agricultural activities of surrounding communities.

Environmental Issues

Environmental Management Authority (EMA) has played a crucial role in managing environmental aspects related to platinum mining. Air, water and land pollution in the platinum sector is lower compared to other mining operations due to improved investment in environmental friendly technologies. As expected, the study concludes that environmental issues are important for sustainability in the platinum mining sector and can be applied to other mining sector as well. The sector is also actively monitoring and managing usage of water and energy which are key for performance indicators of perpetual sustainability.

4.7.2 Establishment of Institutional mechanisms in place to support technological capability and sustainable development in the platinum mining sector

Regulatory Framework

The study investigated the extent to which company policies are in alignment with national technological capability building through nurturing value addition initiatives. The findings suggest that regulatory compliance is important for technological capability from an operator's perspective.

The three miners' company policies are in alignment with national technological capability building through their value addition initiatives. All the operations complied with the Government's call for value addition by submitting their plans. Internal company policies also favour skills development and innovation. The study also agrees with the findings of Panda and Ramanathan Model (1996) which states that the organization capability in developing value addition is linked to the organization's technological capability.

Knowledge (skills and training)

The research established that operators utilise both internal and external sources of skills development to increase institutional knowledge capacity, although the factor is insignificant. Contractors are also being used to bridge the skills gap in terms of mining and processing.

Management capabilities

The study reveals that management capabilities are high.

Capital Budgets

The study shows that institutions have insufficient capital for acquisition of plant and machinery and usage in R&D activities which are important for technological capability.

Economic issues

Although statistically insignificant, the researcher found that the platinum mining sector revenue is stimulating growth of other sectors through the supply chain.

Social Issues

On social issues, the research has established that the operators view community issues as very important and have established departments to handle social related issues. In terms of employment, platinum miners' internal policies favour local talent in their mining regions to other talents.

Environmental Issues

The research found that platinum miners are conscious of environmental issues affecting them and they have active programs to manage emissions, water energy and waste. They also have provisions for post closure rehabilitation which they review regularly. Miners actually set aside funds for post closure rehabilitation.

4.7.3 Establishment of critical success factors for technological capability building

Regulatory

The researcher established that there is strong support for the notion that the Government support and funding of R&D activities is critical. As a developing nation, Government support is crucial for sustainability and technological capability.

However, more regulatory framework is required to curb brain drain such as National Service for all youths to limit the impact. Protection of intellectual property rights and respect of mining rights are also critical in promoting investments in technology. The Government may also consider implementing incentives such as tax rebates on miners that invest in R&D.

Indeginisation laws and policy inconsistencies are hindrances to development. The researcher recommends the Government to relook into its indeginisation laws and align them to its developmental goals.

Knowledge (Skills and Training)

The research established that educational institutions that is specialised training institutions such as the School of Mines and higher learning institutions like universities are not producing enough quality talent to meet the requirements of the platinum mining sector. Institutions such as SIRDC should also provide support services to the sector's needs. Higher learning institutions are recommended to assist in technological development through research. Mining operations also have responsibility of developing customised skills internally and safeguard them through long term contracts, bonding and specialisation.

Capital Budgets

The study established that capital is important for importing, acquiring and adapting technologies. This is manifested in the form of advanced technologies in plants and machineries. Unavailability of local capital have seen the sector fully controlled by foreign firms resulting in a pass on effect in terms of technology. Generally, capital constraints inhibit R&D activities and ultimately technological capabilities.

Management Capabilities

One of the key management capabilities is to create an enabling environment for innovation, intrapreneurship, skills development and team work. Engaging consultants and importing skills is also an important are for management. From the research, it has

been found that some of the managers of platinum miners attended some training workshops from their parent companies. For example most managers in Unki mines received training from their parent and diversified miner Anglo American Platinum (Amplats). This enhances their capability, a key ingredient to technological adaptation and innovation.

4.7.4 Establishment of critical success factors for sustainable development

Economic Issues

The research found that economic issues have no influence to sustainable development. However, economic issues influence the success of the other factors of sustainable development. Economic, social and environmental factors have been found in many studies to work inter alia.

Social Issues

Social issues were also found to have no significant impact to sustainability. However, some of the social issues influence technological capabilities which in turn contributes to sustainability. Technological advances have been criticized of negatively affecting welfare through reduction in labour requirements by miners through mechanisation of operations. Operating miners social programs are recommended to intimately involve the local community for them to lead to sustainable development. This buy in by local community is critical for the establishment of the social licence to operate that lesser conflicts between the miners and the communities.

Environmental issues

Environmental issues are most dominating and critical aspects of sustainable development as found from the regression and correlation analysis. Generally, mining has adverse effects on the environment and the resource endowment. Mining also affects the surrounding communities and their ecological balance through negative externalities. Preservation of natural resources is indispensable and use of environmental friendly technologies such as green fuels is necessary in this era of increased global warming.

4.8 Chapter conclusion

In this chapter, the research results revealed that internal factors such as capital budgets and management capabilities as well as external factors such as regulatory framework are significant important determinants of technological capabilities. Only environmental factors are crucial for sustainability. The research findings also showed that economic factors and social factors were are statistically insignificant determines of sustainable development. Knowledge (skills and training) is statistically insignificant determinant of technological capabilities. Insignificant variables were discarded from the models and all the hypotheses were satisfied.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents conclusions, recommendations and limitations of the study based on the whole research paper as well as highlighting possible areas of further study. The study assessed the critical factors affecting technological capability development and sustainable development in the platinum mining sector. No previous similar studies have been undertaken in the platinum mining sector which is relatively new on the Zimbabwe mining landscape. Recommendations in this chapter are targeted at management of platinum mining sector and policy makers.

5.2 Conclusion

The study established the following models of Technological Capability and Sustainable Development.

Technological Capability Building = 0.245Capital Budget+0.687Management Capability-0.207 Regulatory framework ……..…….……(i)

Sustainable Development = 0.524Environment……(ii)

a) **What are the critical success factors for the development of technological capability and sustainable development in the platinum mining sector in Zimbabwe?**

The research concluded that management capability, capital budget and regulatory framework are the major determinants of technological capability. The study also concluded that technological capability is highly influenced by factors within the control of the platinum mining company. Management capability and capital budgets are all internal factors which are in direct of control of the platinum mining companies. External factor, regulatory framework which is not in direct control of platinum mining operations has a negative impact in technological capability. A very restrictive regulatory framework, where policy and regulations are perceived as prohibitive subdues technological capacity development.

For sustainable development, the study concludes that only environmental factors are critical for the success.

b) **What are the current levels of technological capability and sustainable development in the platinum mining sector in Zimbabwe?**

The study concludes that current regulatory framework is not conducive to support technological capability development. High royalties and tax regimes, policy inconsistencies and unclear regulatory framework (ground rentals) are hampering technological capacity development. Management capabilities were found to be high and supportive to technological development capability. However capital budgets are low and insufficient prohibiting infrastructure expansion (smelting), exploration activities and acquisition of advanced technologies. Environmental issues are concluded to be supportive and well managed for sustainability. The research thus concludes that technological development capability is moderate and needs nurturing.

c) **What are the institutional mechanisms in place to support technological capacity building and sustainable development in the platinum mining sector in Zimbabwe?**

The study concludes that the platinum mining operations policies are in alignment with national technological capability building which is advocating for further beneficiation of platinum. The sector is benefiting from the use of consultants to nurture essential knowledge and skills required for technological capability development.

In addition, it is concluded that platinum mining companies have internal training programs that are being done to raise the level of competences of the staff members in their areas of responsibilities. The study also concludes that management have knowledge of and proficiency in activities involving methods, processes and procedures.

Total value of capital employed in the platinum sector is inadequate for technological capacity development. Inadequate capital is impacting research and development, production and investment capabilities in the platinum mining sector.

The research also concludes that the revenue from the platinum sector is stimulating growth of other sectors through the supply chain.

It was established in this research study that there are mechanisms in place for community engagement and acceptance of mining operations. Community uplift is a priority in areas where miners have operations and managed through community share ownership trusts.

The survey concludes that the emission and waste management by the companies in the platinum sector are so effective. Furthermore it is concluded in this study that post closure rehabilitation programs are formulated and reviewed regularly.

5.3 Hypothesis Validation

All the research hypotheses were supported by the research results. Management Capability has the greatest impact on Technological Capability of 68.7%. Environmental factors are the sole determinants of sustainable development. The following hypotheses were met from the research results:

H_1: Internal factors have an impact on technological capability building.

As shown in Table 4-9, Management capabilities and Capital Budgets which are internal factors have a positive impact on technological capability. Therefore, H_1 is supported.

H_2: External factors have an impact on technological capability building.

As shown in Table 4-9, regulatory framework and knowledge which are external factors have no significant impact on technological capability. Therefore, H_2 is not supported.

H_3: At least one of social, economic and environmental factors have an impact on sustainable development.

As shown on Table 4-12 Environment with $p<0.05$ is true and H_3 is accepted. Environment issues have an impact on sustainable development. Social and economic issues are rejected and thus have no impact on sustainable development.

5.4 Recommendations

The research proposes the following managerial and policy recommendations to managers in the platinum sector and policy makers in an attempt to improve technological capability and sustainable development in the platinum mining sector.

5.4.1 Managerial Recommendations

The research established that management capabilities are key to technological capability development. Managers in the platinum mining should continue upgrading or developing themselves through acquiring new skills and experience in this era of ever-changing technologies. Identifying and grooming new talent is also recommended. A flexible organizational structure which supports talent development at all levels of management is recommended.

Managers in the platinum mining sector are advised to make an analysis of the environment in which they are operating before adopting a style of leadership. This will increase effectiveness and lead to the attainment of organizational goals for sustainable development. The much needed beneficiation and value addition in the platinum sector can also be achieved through investment in technological capability building.

Capital budgeting which is a key function of top managers was found to be one of the major factor in supporting technological capability development. Management are recommended to enter into strategic alliance with capital partners and built capital reserves from organizational profits as opposed to dividend declarations.

5.4.2 Policy Recommendations

Regulatory framework was found to be deterring technological capability development. Policy makers are urged to review their policies especially the fiscal regime, indeginisation framework, mining rights and procurement laws and procedures to be aligned to needs of platinum operations. Consultations and engagement between policy makers and industry management is highly recommended in policy formulation.

The Government is also urged to come up with incentives such as tax rebates to organisations that invests in technological capability and sustainable development project. Taxes and royalties should be reviewed and set categorically linked to international prices to cushion platinum miners from adverse effects of international prices.

Moreover the study recommends that the local authorities should regulate rentals, rates and other utility bills such as water and electricity to platinum mining companies to ensure stability and growth of the sector through investment in technological capability development. At the current moment the amount charged for rentals are too high and this is contributing a large component to the costs of platinum mining companies in Zimbabwe and hence reducing the profitability of business operations. Rates should be predictable and regulated on a win- win situation.

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5.5 Generalisation of findings

The research findings can be generalized to the platinum mining sector and can be applied to other mining sectors in Zimbabwe as factors that contribute to technological capabilities and sustainable development are similar.

5.6 Research Limitations

The research could not be conducted in other platinum mining jurisdictions such as South Africa, Russia and Canada due to time and financial constraints. The findings therefore, may not be generalized to the global mining sector.

5.7 Possible Areas of further study

1. The study was not conducted in other platinum mining jurisdictions such as South Africa, Russia and Canada. A similar study may be conducted in these jurisdictions to see whether the results will be the same.
2. The regression model of technological capability is only capable of explaining 59% of the variation in technological capability development in the platinum mining sector in Zimbabwe. This means that there are other variables to be explored that explain the technological capability that need further research.

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APPENDICES

Appendix 1: Letter of consent

Private and confidential

28 December, 2015

QUESTIONNAIRE FOR PARTIAL FULFILMENT OF MBA PROGRAMME

My name is Collins Mwatahwa an MBA student at University of Zimbabwe. I am doing research technological capability development and sustainable development. The research is meant to find out the critical success factors for technological capability building and sustainable development within the platinum sector. The study will benefit both industry and the policy makers.

I am kindly asking for about 15 minutes of your valuable time to complete the attached questionnaire. Your honesty in answering these questions will assist me in getting a valid understanding of the factors affecting technological capability development and sustainable development in the platinum sector. All your responses will be treated confidential and the information obtained from you will be used strictly for academic purposes.

Thank you

Collins Mwatahwa

Appendix 2: Questionnaire for mining companies in the platinum mining sector

Please tick in the box that suit your answer,

Section A: Demographics

1. Name of the Mining Institution

_____

2. Position of the Respondent in the Organisation

Junior management [ ] Middle management [ ] Senior management [ ]

3. Gender Male **[ ]** Female **[ ]**

Education Qualifications

Certificate/Diploma [ ] First Degree [ ] Post Graduate Degree [ ]

4. Profession

Technical **[ ]** Non-Technical **[ ]**

5. Duration at the organisation

Less than a year [ ] 1-5 years [ ] 6-10 years [ ] Above 10 years [ ]

KEY DEFINITIONS TO ENABLE YOU TO COMPLETE THE QUESTIONAIRE

TECHNOLOGICAL CAPABILITY-Technological capabilities are an intricate array of skills, technological knowledge and organizational structures required to operate a technology efficiently and achieve any process of technological change (Lall, 1992)

SUSTAINABLE DEVELOPMENT- sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs WCED,1987. Sustainable development encompasses a tripartite core structure of equitable consideration of economic, social, and environmental dimensions

6. What is the Level of technological capability in the organisation

Low [ ] Medium [ ] High [ ]

7. What is the Level of sustainable development in the organisation

Low [ ] Medium [ ] High [ ]

SECTION B: AN ASSESSMENT OF CURRENT LEVELS OF TECHNOLOGICAL CAPABILITY AND SUSTAINABLE DEVELOPMENT

Regulatory Framework

8. The macroeconomic environment is stable and predictable for sustainable development in the platinum mining sector?

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

9. The current taxation levels for the mining sector, including tax exemptions, in Zimbabwe are geared to assist the growth of the sector.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

10. The current taxation levels for the mining sector, including tax exemptions, in Zimbabwe are competitive when compared with other mining countries in Africa.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

11. The regulatory policies governing the platinum sector have been consistent since year 2010

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Knowledge (Skills and Training)

12. Members of staff possess the Core competencies required for effective technological change.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

13. The companies in the platinum sector have internal and external training programmes that are being done to raise the level of competencies of the staff members in their areas of responsibilities?

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

14. The labour market is saturated with skilled labour which can be engaged easily

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Management Capabilities

15. Management is able to recognize significant elements in a situation, and to understand the technological capacity development requirements.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

16. Our management is able to recognize significant elements in a situation, and to understand the technological capacity development requirements.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

17. Management entrenches a culture of creativity and innovation within the workforce.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Capital Budgets

18. Total value of capital employed in the platinum mine is adequate enough for technological capability accumulation

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

19. The plants, machinery and infrastructure are adequate for adoption of technological development in the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

20. Operating capital employed in the platinum mine is adequate enough to promote Research and Development in the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Economic issues

21. The company has operating profit enough to improve the performance of the organisation

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

22. Government is obtaining a fair share of the economic rent of the sector through fiscal arrangements

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

disagree [ ]

Social Issues

23. Do you think your catchment communities have benefited from incoming activities of the platinum mines?

Yes [ ] b. No [ ] c. Not sure [ ]

24. Mining companies contribute towards the socio-economic development in operational areas.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Environmental Issues

25. Land use management and rehabilitation is important for the sustainable development of the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

26. Emission and waste management are key for sustainable development in mining companies

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

27. Energy and water usage tracking is key to enhance sustainable development in mining companies

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

SECTION C: ESTABLISHMENT OF INSTITUTIONAL MECHANISMS IN PLACE FOR TECHNOLOGICAL CAPABILITY AND SUSTAINABLE DEVELOPMENT

Regulatory Framework

28. Company policies are in alignment with national technological capability building through nurturing value addition initiatives

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

29. Company policies are consistent on innovation and technological capability building

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Knowledge (Skills and training)

30. The platinum mining sector is benefiting from the use of consultants

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
strongly disagree [ ]

31. The company has internal training programmes that are being done to raise the level of competencies of the staff members in their areas of responsibilities?

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

32. The company utilises external training facilities and programmes to raise the level of competencies of the staff members in their areas of responsibilities?

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

33. The number of external institutions are enough to sustain technological capability development

Management Capabilities

34. Management entrenches a culture of creativity and innovation within the workforce**.**

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

35. Our management has knowledge of and proficiency in activities involving methods, processes, and procedures.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Capital Budgets

36. Total value of capital employed in the platinum sector mine is adequate enough for technological capability development.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

37. The plants, machinery and infrastructure are inadequate to foster technological capability development in the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

38.Enough capital is available for Research and Development in the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Economic Issues

39. The macroeconomic environment is conducive for sustainable development in the platinum mining sector?

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

40. The revenue from the platinum mining sector is stimulating growth of other sectors through supply chain.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

41. Governments is obtaining a fair share of the economic rent of the sector through fiscal arrangements

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

disagree [ ]

42. A percentage of revenue is allocated to a fund mineral resource generation designated for future generations

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Social Issues

43, Complaints from the community are handled in a professional manner

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

44. Health and Safety programs are held in esteem by companies in the platinum sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

45. Community uplift is a priority in areas where the operations are situated.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

46. Do you normally involve the local communities on the types of CSRs programs to implement?

Yes [ ] b. No [ ] c. Not sure [ ]

Environment issues

47. The emission and waste management by the companies in the platinum sector are effective

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ] Strongly disagree [ ]

48. Recognition of protected sites and sacred sites is at fore of the operations inland use management.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ] Strongly disagree [ ]

49. Post closure rehabilitation programs are formulated and reviewed regularly

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ] Strongly disagree [ ]

<u>Section D: Establishment of critical success factors for technological capability building</u>

For the following statements please tick the box that matches your view most closely.

Regulatory framework

50. Government support, participation and funding of R&DA activities will enhance Technological capability accumulation

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ] Strongly disagree [ ]

51. Technological capability development should be a top government priority

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ] Strongly disagree [ ]

52. Legislation should support technological change in the platinum mining sector including protection of intellectual property rights

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ] Strongly disagree [ ]

Knowledge (Skills and Training)

53. Training and upgrading of skills within the platinum mining sector is a requirement for Technological capability building.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

54. Science and technology including formal education are necessary for technological capability building.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

55. The number and quality of Science and technology institutions should be high enough to support the labour market for the platinum mining sector.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

56. Availability of external skills through consultants is an element in knowledge transfer

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Management Capabilities

57. Active involvement of the enterprise staff in the process of technological change is one of key management function

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

58. Engagement of consultants and acquisition of technical knowledge is necessary to address knowledge gaps.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

59. Entrenchment of learning efforts throughout the platinum mining sector is also key to enhancement of technological capability development

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

60. Recognition of entrepreneurship should be a top management priority

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Capital Budgets

61. Import of capital goods, equipment and machinery to effect technical change is required.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

62. Capital should be available for internal R&D activities

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Section E: Establishment of critical success factors for sustainable development.

Economic Issues

63. Operating profit should be high enough for investment in sustainable development activities

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

64. Investments in R&D activities foster growth and efficient extraction of the resource

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Social Issues

65. Involvement of key stakeholders in social responsibility programs is not necessary

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

66. Safety and Health programs are key to long lasting relationships of all stakeholders

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

67. Investment in local community development is a priority to the mining sector if it capacitates the local community to be less resource dependent in the future.

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

Environment Issues

68. Emission and waste management are vital for Sustainable development in the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

69. Energy and water usage tracking are key performance indicators in enhancing sustainable development in the platinum sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]

70. Land use management and rehabilitation is important for the sustainable development of the platinum mining sector

Strongly agree [ ] Agree [ ] Neutral [ ] Disagree [ ]
Strongly disagree [ ]