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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Evaluation of beneficiation constraints for identified critical minerals in Zimbabwe

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MSc (50/50)	MSc By Research only	PhD
X		

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Engineering.

Johannesburg, 2021

DECLARATION

I declare that this Research Report is my own, unaided work. Where use has been made of the work of others, it has been duly acknowledged. It is being submitted for the Degree of Master of Science in Engineering in the University of the Witwatersrand, Johannesburg. It has not been submitted before in any form for any degree or examination in any other University.

Signed:



_____
Rumbidzai Denhere

This ___21_____ day of __October_____ 2021

DEDICATION

I proudly dedicate this Research Report to my husband, family, workmates and all my friends. Thank you for your endless love, sacrifices, prayers, unwavering support, for believing in me and encouraging me to strive for my dreams.

ABSTRACT

Firmly anchored on the notion that beneficiation in natural resources could be a driver of structural transformation and global competitiveness for developing countries such as Zimbabwe, this research sought to analyse existing and potential constraints in beneficiating identified critical minerals in Zimbabwe and give recommendations to achieve world level beneficiation. In particular, the study sought to discuss the theoretical and empirical beneficiation concepts, strategies and requirements, conduct literature review on beneficiation highlighting case studies for a few selected government approaches to mineral beneficiation, identify the critical minerals for Zimbabwe mineral industry for beneficiation indicating the available mineral resources for these minerals, identify and evaluate existing and potential beneficiation constraints and finally to provide recommendations on beneficiation constraints so as to be globally competitive for Zimbabwe's economic growth going forward for the identified critical minerals.

The researcher applied both qualitative and quantitative research methods. The research established that considerable success in mineral downstream activities can be achieved using a comprehensive beneficiation strategy that is rooted in a country's regulatory framework and policies. An enabling environment that is created as a result of good governance, fiscal discipline and robust policy framework, promotes investment in mineral downstream activities. Having a mineral policy that is in sync with a nation's overall economic development policies was also found to be important for effective implementation and sustaining of downstream activities. For successful beneficiation and value addition to take place, establishment of support structures is imperative, as well as establishment of joint ventures that increase the likelihood of easy access to markets, knowledge, expertise and technology. International trade agreements are also necessary to attract foreign direct investment and also for access to international markets for the finished or semi-finished product. Furthermore, it was established that export bans are not suitable for use by all commodity-dependant developing countries as the success of the strategy is mainly due to the lack of substitutes in the market and such bans on commodities that can easily be substituted in the market place should be avoided.

Zimbabwe's mining industry largely depends on gold, PGMs, diamonds, nickel and chrome as these are the top five contributors to the country's mineral revenue. Mineral criticality analysis on 32 different publications on critical minerals had REE, PGMs and indium as the three consistently identified critical minerals and lithium with its emerging critical role in the battery technology was also identified as a critical mineral in most of the studies. A survey conducted targeting government parastatal officials (Ministry of Mines, Chamber of Mines and Zimbabwe Mining Development Corporation), beneficiation and mining consultancy experts and mining

operations experts had PGMs, gold, diamond and lithium as the critical minerals that Zimbabwe should add value for economic growth and development.

The fact that Zimbabwe has the world's second largest PGMs reserves that are hosted in the Great Dyke, one of the largest lithium reserves hosted in pegmatites in the world and that PGMs and lithium are among critical minerals identified in literature shows that Zimbabwe can focus on these two minerals for beneficiation. From the critical mineral analysis, it was identified that PGMs and lithium are the two key minerals that the country should focus on for beneficiation.

Although it was evident that Zimbabwe has made reasonable strides towards PGMs and lithium beneficiation and value addition, constraints exist that impede the production of final products. This was mainly attributed to a lack of investment in the critical minerals' downstream activities and the country's political and economic instability that deter foreign investors from participating in the country. This lack of investment has resulted in over-reliance on outdated technology, inadequate power supply, poor transport network system and a generally high cost of doing business. Limited investment in research and development and the absence of smelting and refining infrastructure are also constraints to PGMs and lithium beneficiation.

The country should thus focus on beneficiating PGMs and lithium all the way to manufacturing to harness all potential beneficiation benefits, since these were identified as critical minerals and are in abundance in the country, by addressing the identified constraints. Zimbabwe should work on having a comprehensive beneficiation strategy that is supported in the country's national policies and enacted through regulatory framework. Attracting investments required in transforming its natural endowment into mineral related industries that support lithium and PGMs downstream activities is also of utmost importance. There is need to improve on the investment climate and having a detailed section in the country's mineral policy that seeks to promote creation of an enabling environment, invest in support structures that include research centres, use of trade agreements and strategic interventions to combat the highlighted constraints.

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LIST OF ABBREVIATIONS

AFDB	African Development Bank
AFRODAD	African Forum and Network on Debt and Development
AMV	Africa Mining Vision
CAP	Common Africa Position
CBM	Coal Bed Methane
CNRG	Centre for Natural Resource Governance
CoM	Chamber of Mines of Zimbabwe
COMESA	Common Market for Eastern and Southern Africa
DMR	Department of Mineral Resources
DRC	Democratic Republic of Congo
DTC	Diamond Trading Company
EAC	East African Community
GAH	Growth at Home
GDP	Gross Domestic Product
IEEA	Indigenisation and Economic Empowerment Act
IGF	Intergovernmental Forum
INSG	International Nickel Study Group
IUMP	Industrial Upgrading and Modernisation Programme
MIP	Manufacturing Investment Programme
MMCZ	Minerals Marketing Corporation of Zimbabwe
MPRDA	Mineral and Petroleum Resources Development Act
Mt	Million tonnes
NGP	New Growth Path
NTP	National Trade Policy
Oz	Ounces
PGMs	Platinum Group Metals
PMA	Precious Metal Act

RBZ	Reserve Bank of Zimbabwe
REE	Rare-earth elements
RISDIP	Regional Indicative Strategic Development
RTGS	Real-Time Gross Settlement
SADC	Southern African Development Community
SEZ	Special Economic Zones
SIRDC	Scientific and Industrial Research and Development Centre
STERP	Short Term Emergency Recovery Programme
UNCTAD	United Nations Conference on Trade and Development
UNECA	United Nations Economic Commission for Africa
UNIDO	United Nations Industrial Development Organisation
USD	United States Dollars
USGS	United States Geological Survey
VAT	Value Added Tax
WEF	World Economic Forum
WTO	World Trade Organisation
ZANU-PF	Zimbabwe African National Union-Patriotic Front
ZCDC	Zimbabwe Consolidated Diamond Company
ZIM-ASSET `	Zimbabwe's Agenda for Sustainable Socio-Economic Transformation
ZIMLII	Zimbabwe Legal Information Institute
ZMDC	Zimbabwe Mining Development Corporation
ZNIP	Zimbabwe National Industrial Policy
ZPC	Zimbabwe Power Company
ZETDC	Zimbabwe Electricity Transmission and Distribution Company
ZRA	Zimbabwe Revenue Authority

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Beneficiation of natural resources is a very common policy initiative for structural transformation and a fight against the natural resource curse (Baissac *et al*, 2015). Harding and Venables (2016) showed that countries with abundant natural resources had lower economic growth and industrialisation as compared to less endowed countries at similar stages of development. According to the natural resource curse theory the developing countries that are well endowed with natural deposits are dependent on the export of raw commodities to countries with industrial capability and infrastructure to produce the finer product (United Nations Conference on Trade and Development, UNCTAD, 2018). The well-endowed developing countries lack the industrial capability and infrastructure to produce an advanced quality product with a higher saleable value and of economic potential.

While mineral endowments are generally associated with minimal economic growth and industrialisation, the experiences from countries such as Finland, United States, Sweden and Norway with highly developed economies show that promoting side-stream, upstream and downstream linkages can act as a catalyst in improving economic diversification and human welfare (Walker and Jourdan, 2004). Walker (2004) analysed resource-based industrialisation in Finland and noted that the metal industry in the country remained unimportant until the mid to late 20th century. During this period the government intervened and placed an emphasis on beneficiation amongst other interventions and this resulted in an improvement in the mining sector as it ended up being among the three most economically significant sectors in the country.

Downstream processing is done to cushion countries from raw materials price fluctuations. A continuous reliance on raw commodities for export revenues can result in slow economic diversification as a result of minimal localisation of value chain benefits such as tax and technology and minimal expert development (UNCTAD, 2018). Processing of minerals and the associated value addition can result in creation of jobs and retention of the natural resource wealth for structural transformation as finished products prices are less susceptible to price fluctuations (Mungoshi, 2011 and Baartjes, 2018). Africa is among the top world producers of mineral commodities such as platinum, diamonds and vanadium and according to Baissac *et al,* (2015), most of these minerals are being exported as raw commodities without significant downstream processing. Mineral downstream activities are being advocated for by the majority of African countries so as to move away from exporting raw commodities (Morris *et*

al, 2011). These African countries are advocating for mineral downstream processing due to the fact that during colonialism that is from around 1870 to 1900 the African countries were exporting their wealth in raw form without developing their own processing capabilities (Wright, 2003 and Baissac *et al,* 2015).

A key continental framework, Africa Mining Vision (AMV), was adopted in Africa in 2009 to promote mineral resource-based development and economic diversification of the African continent. According to Africa Union (2009, v), the AMV framework *"seeks to foster a transparent, equitable and optimal exploitation of mineral resources for broad-based sustainable growth and socio-economic development"* and has downstream processing as one of the linkages necessary for economic growth and diversification. Agenda 2063 of the Africa it wants, has transforming Africa's economies through beneficiation of mineral resources as one of the goals of its first aspiration (Africa Union, 2013).

According to Fessehaie and Rustomjee (2018), whether a resource-based industrial development strategy succeeds or fails depends on the country and management of the available natural resources. For instance, the economy of Botswana largely depends on diamond exports and the cutting and polishing diamond industry was established in the country after the government implemented initiatives to promote diamonds beneficiation through its beneficiation policy (Fessehaie and Rustomjee 2018). The mining sector is also of importance to Zimbabwe's industrialisation and economic diversification as it is contributing significantly to the revitalisation and growth of the country's economy after the drop in the contribution of the agriculture and manufacturing industries (Baissac *et al*, 2015). The underlying further potential that can increase the mineral sector's contribution to both Gross Domestic Product (GDP) and total exports is the export of finished products instead of raw and semi-processed products. There is need to analyse beneficiation constraints in the country and give recommendations for the country to fully benefit from its mineral endowment.

1.2 Research Background

The mining industry contributes a large portion of Zimbabwe's GDP, and its significance to the country's economy is growing (Chigumira *et al*, 2017). The GDP contribution from the mining sector rose from 9% in 2016 to 13% in 2017 (CoM, 2019). The mineral sector is the biggest contributor to export earnings having contributed about 55% in 2018 and 56% in 2019 with gold, platinum, ferroalloys and diamonds being the yearly major contributors to mining exports (CoM, 2019).

Mineral concentrating, refining and manufacturing final products have been selected as some of the key ways for promoting Zimbabwe's industrialisation and economic diversification. Mineral value addition creates employment of skilled personnel, cushions against fluctuating commodity prices and also leads to localisation of value chain benefits (Matinde *et al,* 2014). Mineral beneficiation is among the four pillars that were identified by the government for employment enhancement and ultimately structural transformation from the country's largely under-exploited resource-base (Ministry of Mines of Zimbabwe, 2014). In 2013, Zimbabwe's Agenda for Sustainable Socio-Economic Transformation (ZimAsset) reflected the need to use mineral beneficiation for the country's economic growth and industrialisation. ZimAsset is a sustainable development program that includes beneficiation as part of its strategic clusters (Baissac *et al,* 2015). The ability to derive economic benefits from various aspects of the mineral value chain is crucial for structural transformation.

The country's mineral industry is largely dependent on platinum group metals (PGMs), diamond, gold, nickel and chrome and prioritisation for beneficiation is being given to PGMs, coal bed methane, diamonds, chrome and nickel (Ministry of Mines of Zimbabwe, 2014). The rare-earth elements (REE), PGMs and indium are the three most frequently recognised as critical minerals out of a total possible 57 mineral elements analysed globally as these minerals are essential to the economy and supply can be disrupted (Hayes and McCullough, 2018). Most studies identify germanium, niobium, tungsten, cobalt, gallium, tantalum, lithium and antimony as critical mineral commodities (Hayes and McCullough, 2018). Identifying critical minerals in the country is of utmost importance and same as prioritising the critical minerals for beneficiation as these are essential to the economy and their absence would have significant consequences.

In resource-rich countries, various levels of expectation exist about the degree to which mining companies are obligated to engage in downstream value-adding processes. The mining companies in Zimbabwe are expected by the government to establish smelters and refineries as a bid to foster beneficiation prioritising PGMs, nickel, coal bed methane, diamonds and chrome (Baissac *et al,* 2015). The manufacturing sector in the country is responsible for the fabrication of autocatalysts and jewellery from the PGMs and the manufacture of lithium-ion batteries. It is from this background that the researcher is keen on identifying the critical minerals now and also in the future, indicating the available resources from literature that the mining companies and the Zimbabwean government can focus on for downstream activities. The research will also evaluate existing and potential constraints to mineral refining and manufacturing of final products.

Zimbabwe's mineral resources are incredibly diverse; coupled with a wide mineral resource-base of about 60 minerals of potential economic value (Ministry of Mines of Zimbabwe, 2014). The Great Dyke which is a layered igneous intrusive complex, hosts the second largest PGM mineral resource in the world after South Africa's Bushveld Complex (African Development Bank, AFDB, 2013). Jourdan *et al,* (2012), estimated the PGMs resource in the Great Dyke to be at 2.8 billion tonnes with an average in-situ grade of 5.54 grams per tonne platinum, gold, rhodium and palladium (4Es). Three mines are currently producing the PGMs in the Great Dyke and these are Zimplats, Mimosa and Unki mining companies.

Diamonds being produced in the country are from kimberlitic pipes, placer and alluvial deposits from re-workings of conglomerates (Mhembere, 2009). Zimbabwe's greenstone belts host approximately 90% of the silver and gold and it is also host to substantial nickel, copper, cobalt, iron ore, podiform chromite and antimony resources (Mugumbate, 2014). The Karoo basins host considerable resources of coal bed methane, coking coal and bituminous coal with bituminous coal resources estimated at about 26 billion tonnes (Hawkins, 2009). Lithium mining is done in hard rock pegmatites that can be subdivided into petalite pegmatites and spodumene pegmatites with an estimate of 62.9 million tonnes lithium mineral resource base.

Figure 1.1 shows the geological map of Zimbabwe where the different minerals are hosted. There is a need to identify the critical minerals that the country should focus on for beneficiation and derive maximum value from them. This study aims to assess the beneficiation constraints of known essential minerals in Zimbabwe and make recommendations on how to use beneficiation as a policy tool to effectively exploit mineral resources for economic growth.

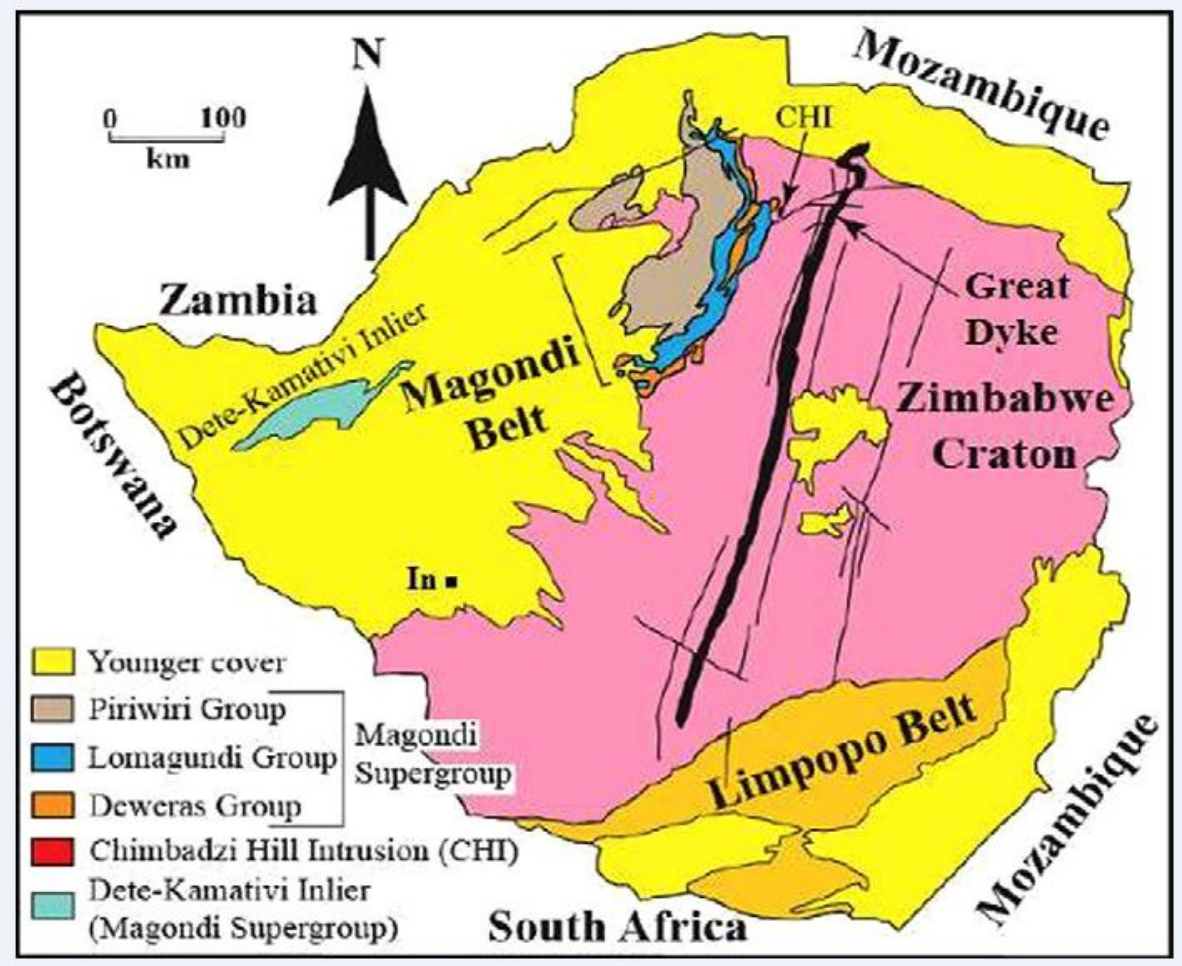


Figure 1.1: Zimbabwe Geological Map (Source: Hawkins, 2009)

Zimbabwe has a high mineral endowment as is shown by the Great Dyke that is rich in PGMs, extensive greenstone belts with considerable gold and silver resources and Precambrian and Karoo basins that host a variety of minerals (Hawkins, 2009). The mineral resource endowment in the county gives it a comparative advantage and as with other developing countries the exports are from raw commodities and the country still depends on these raw products exports for economic growth and development. Table 1.1 shows the mineral resource estimate in Zimbabwe.

Table 1.1: Mineral Resource Estimation

Mineral	**Estimated Resource (Tons)**
Gold	13 million
Platinum	2.8 billion
Chromite	10 billion
Nickel	4.5 million
Coal	26 billion
Diamonds	16.5 million carats
Iron Ore	30 billion
Copper	5.2 million
Coal Bed Methane (CBM)	25 billion
Lithium	62.9 million

Source: (Ministry of Mines of Zimbabwe 2014; Jourdan et al, 2012 and Mugumbate, 2014)

To revive the economy and drive meaningful development, the government is trying to optimize resource extraction for industrialisation and economic diversification using beneficiation and value addition to unlock economic potential. The declining performance of the country's economy and the need for security of investment have led to the formulation of several policy documents since 2012 and beneficiation was at the centre of these policies. One of the goals of the National Trade Policy (NTP) from 2012 to 2016 was to promote increased mineral processing and value addition of raw products in all sectors of the economy in order to generate jobs and reduce the trade deficit (Ministry of Industry and Commerce, 2012). ZimAsset, an initiative that was formulated for sustainable development using beneficiation and value addition as some of its strategic clusters, was released in 2013 and the beneficiation objectives included improving capacity utilisation, creating employment and increasing fiscal revenues (Bonga, 2014).

The Draft Mineral Policy of 2013 was formulated, according to Dhliwayo (2014), to resolve the shortcomings of the Mines and Minerals Act of 1961, which was geared towards mineral resource extraction with little regard for sustainable development and paid minimal attention to value addition and beneficiation strategies. Manhando (2017) noted that no material movement has been realised in developing the policy for adoption since 2014 where the Ministry of Mines engaged key stakeholders. Resolutions passed by Zanu PF party in 2014 focused mainly on reducing the exportation of mineral products in their unprocessed state (Baissac *et al*, 2015). To date most minerals are still being exported as mineral concentrates and according to Bonga (2014), exporting minerals in their unprocessed state can lead to loss of revenue and employment.

The Draft Mineral Policy intends to achieve mineral processing by using a penalty or tax system that uses both incentives and disincentives (Dhliwayo, 2014). The policy proposes the

imposing of an export tax if smelting or refining is shown to be commercially viable by an independent party (Chigumira *et al*, 2017). The Zimbabwean government highlighted its intention to ban the export of chrome ore initially in 2009 and the intention was later waived as a result of inadequate capital resources in the chrome sector and the country in general (Baissac *et al*, 2015). Chrome ore exports were then subjected to a 15% export levy in the same year and this was increased to 20% in 2010. The export ban was effected in 2011 and later lifted in 2015 as the ban failed to create opportunities for smelters to invest in new technology due to falling chrome prices to sub-economic levels and high electricity tariffs (Chigumira *et al*, 2017). Small-scale chrome miners also lost their economic venture and livelihood.

In 2011 the government announced its intention to impose a 15% tax on the export of platinum concentrates (Baissac *et al*, 2015). Smelting the concentrates was considered as beneficiation and such matte was not liable for an export tax only after the presentation of solid plans for platinum refineries construction. The export tax on raw platinum was reduced to 5% in 2017 before the 2011 tax was implemented and through the 2019 National Budget the export tax was deferred to January 2022 (CoM, 2018). No refinery is functional in the country to date. From this background the key question in this research is: what are the beneficiation constraints for the mineral industry in Zimbabwe?

1.3 Research Aim and Objectives

This research report aims to evaluate existing and potential constraints in beneficiating the identified critical minerals in Zimbabwe and provide recommendations to achieve world level beneficiation. The objectives include:

- Discuss the theoretical and empirical beneficiation concepts, strategies and requirements;
- Conduct literature review on beneficiation concepts highlighting case studies for a few selected government approaches to mineral beneficiation. Policy reforms and beneficiating strategies from South Africa, Botswana, Australia and Indonesia will be evaluated. Botswana is well known for its successful diamond industry, South Africa for its PGMs industry, Indonesia is known for beneficiating nickel and bauxite, and Australia for its lithium-ion battery industry;
- Identify the critical minerals for Zimbabwe mineral industry for beneficiation indicating the available mineral resources for these minerals;
- Identify and evaluate existing and potential beneficiation constraints; and

- Provide recommendations on beneficiation constraints and solutions in order to be globally competitive for the identified critical minerals and for Zimbabwe's economic growth going forward.

1.4 Research Scope

The project seeks to identify beneficiation constraints of identified critical minerals in Zimbabwe. Critical minerals are geologically dispersed, concentrated in a few areas or can be recovered as a by-product of another commodity (Hayes and McCullough, 2018). Baartjes (2018) identified four groups of critical and strategic minerals and these are electronic equipment, photovoltaic, battery and catalyst technologies. Mineral commodities in the battery and catalyst technologies will be analysed for the Zimbabwean mineral industry as these have been reported to be in abundance and evaluate the beneficiation constraints for the identified minerals.

The minerals from the catalyst technologies group give good existing information and plans as this is a relatively mature industry. Baartjes (2018) stated that an increase in global industrialisation, vehicle production and vehicle sales can foster potential opportunity for the catalyst technologies group of minerals. According to Gil-Alana and Monge (2019), the battery technology demand will increase as the use of portable and mobile equipment increase.

The project will identify critical minerals that the government of Zimbabwe should focus on for beneficiation, highlight the current resource estimate for the identified critical minerals, highlight the current level of beneficiation of the critical minerals against government's expectation, evaluate existing and potential constraints to critical mineral beneficiation and provide recommendations on enhancing beneficiation after analysing the available data.

1.5 Significance of the research

It is of paramount importance to engage in mineral beneficiation and worth noting are the existing and potential constraints and how these constraints can be addressed. Policies and strategies have been put in place to encourage beneficiation and according to literature countries such as Finland and Botswana are beneficiating successfully but minerals are still being exported in their unprocessed form in other African nations such as Zimbabwe.

As a result, this study is being undertaken to analyse and evaluate the geological, economic, technological and political constraints to beneficiation for Zimbabwe's mining industry. The report will indicate the available mineral resources for the identified critical minerals for the

industry, analyse policies and strategies being implemented in selected countries that are benefiting from beneficiation, evaluate beneficiation constraints for the identified critical minerals and provide recommendations to these constraints. Since beneficiation is one of the four strategic clusters in the country as it works towards economic recovery and industrialisation, it is critical to examine its constraints and make recommendations for full implementation of the strategy.

1.6 Methodology

In carrying out the research the following research methods will be used:

- Analysis of theoretical and empirical perception/concepts of beneficiation;
- The researcher will conduct literature review highlighting case studies for selected countries' approaches to implementing mineral beneficiation. Policy reforms and strategies from South Africa, Botswana, Indonesia and Australia will be evaluated. South Africa is well known for its PGMs industry, Botswana is known for diamond beneficiation, Indonesia is known for nickel and bauxite beneficiation and the lithium-ion battery industry in Australia will also be analysed;
- Critical analysis of the mineral industry, mineral policy and beneficiation strategies of the country;
- The researcher will analyse credible public and private domain data to identify critical minerals;
- The researcher will use information from the Zimbabwean geological database and official company production reports for evaluation of mineral resources for the critical minerals;
- The researcher will apply both qualitative and quantitative research methods by interviewing officials from the Ministry of Mines and Mining Development in Zimbabwe, the Chamber of Mines of Zimbabwe and subject experts for information on beneficiation in Zimbabwe. This will be achieved through interviews with the officials and using questionnaires; and
- Analysis of the critical mineral value chains for identification of constraints.

Primary data from government policy and statistical documents, audited financial reports from companies and mineral resource and reserve statements from mining companies will be used in conducting the research. Semi-structured interviews with government policymakers, mining industry specialists and officials from mining organizations will be conducted. Information from scholarly articles, journals and credible internet sources will be used to supplement the primary

data in analysing the beneficiation constraints and propose solutions to counteract these constraints. Data collected will be protected in encrypted files and confidential emails and this data can be availed upon request.

1.7 Outline of the study

Chapter 1 of the research report gives an outline of the research highlighting research background, aims, objectives and methodology. Chapter 2 covers the literature review on theoretical and empirical beneficiation concepts, strategies and requirements. Chapter 3 examines beneficiation case studies paying particular attention to policies and strategies being implemented and the results thereof after implementing such policies and strategies. Chapter 4 discusses the economic and political setting of Zimbabwe as these have a direct bearing on the success of beneficiation. It also analyses Zimbabwe's mineral industry, mineral policy and the beneficiation policy being implemented in the country. Chapter 5 highlights the critical mineral basket for Zimbabwe mining industry that the country should focus on for beneficiation and the mineral resources quantum for the critical minerals available for downstream activities.

Chapter 6 evaluates the existing and potential critical minerals' beneficiation constraints focusing on geological, economic, technological, political constraints and any other constraints as analysed from the critical minerals' value chains. Chapter 7 summarises the findings of the study and give a conclusion that is based on the research findings. Finally, Chapter 8 contains the recommendations that the government can adopt to promote critical mineral beneficiation for economic growth and development.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The aim of Chapter 2 is to examine theoretical and empirical beneficiation concepts and expectations from around the world. As a theoretical concept, transforming a country's mineral resource enrichment into high quality commodities is generally considered a valuable approach. The capacity of a resource-rich nation to benefit economically from various facets of the mineral value chain is crucial for economic expansion and the government plays a critical role in facilitating beneficiation and value addition processes. According to Baissac *et al,* (2015), beneficiation is the downstream process in the mineral value chain from mineral processing to market distribution and selling of final goods such as watches, diamond jewellery or stainless steel, capturing all potential economic benefits. Beneficiation is being adopted by many countries that are rich in mineral endowment as a policy strategy for socio-economic development.

2.2 Economic growth and development

Governments attract foreign investment for economic growth and development. Otto and Cordes, (2002) defined economic growth as the continuous increase in a country's GDP or gross national product. A country's GDP is calculated from its national accounts and can be defined as the total income earned in any given year in the country (Haller, 2012). It captures a country's economic output. Otto and Cordes, (2002) highlighted that economic growth can be attained when a country efficiently uses its available natural resources and also by increasing its production capacity. Standards of living are generally higher in countries that have a larger GDP as these countries tend to have goods and services being generated within them in greater amounts. Such countries have low unemployment rates as a result of a rise in the number of job opportunities and this will positively impact the standard of living of the general populace.

According to Erum and Hussain (2019), the potential for economic growth can be inhibited by the availability of productive inputs that include natural resources, labour, capital and technology and as the quantity and quality of these inputs increase, the potential for growth also increases. Hence quality mineral endowment is always linked to economic growth. Inadequate infrastructure, inefficient use of natural resources, and undue government interference are among the obstacles to economic development (Sun *et al*, 2018).

Economic development refers to the consequences of growth and the ability to sustain the growth over time leading to a better and more complete satisfaction of human needs (Otto and Cordes, 2002). The ability of a country's economy to grow rapidly is dependent on its ability to plan long-term operations, which necessitates political, monetary, and legislative stability (Haller, 2012). It also relies on the efficient use of resources and the proper distribution of current earnings and output. Growth and development are ongoing processes that have a stimulating impact on a country's economy, and both processes require the effective use of resources (Otto and Cordes, 2002). The ultimate goal of both growth and development is to raise the general population's standard of living and life quality.

The ability of mineral resource exploitation to positively contribute to economic growth and diversification is largely determined by the size of the retained income, the ability to maintain a steady flow of revenue and the usage of resource rentals (Morris *et al,* 2011). As previously stated, beneficiation entails the conversion of a primary product obtained through mining and extraction activities into a secondary commodity with a higher saleable value. This can translate to a higher magnitude of the accrued revenue. Diversifying away from exporting mineral resource primary products can lead to economic growth and development as exporting primary products over time results in a decline of trade benefits.

2.3 Economic linkages

Minerals resources are finite and non-renewable resources hence their economic value must be wholly captured during the mine life time for the benefit of the host countries. According to Baissac *et al,* (2015), mineral-rich countries are gradually realising that it is possible to incorporate the mineral sector into other economic linkages to revitalise a country’s economy. Extractive industries have been enclave industries working in isolation from other industries as their investments decisions neither sustained broader economic growth and development nor reduced vulnerability to commodity price volatility (UNCTAD 2016). Developing linkages with the rest of the economy is of paramount importance for economic growth and diversification. Vertical integration processes in production chains also known as linkages, have had a great influence on economic reforms in many nations. Such linkages (Figure 2.1) strongly impact a nation’s economic growth and development (Hausmann *et al*, 2008).

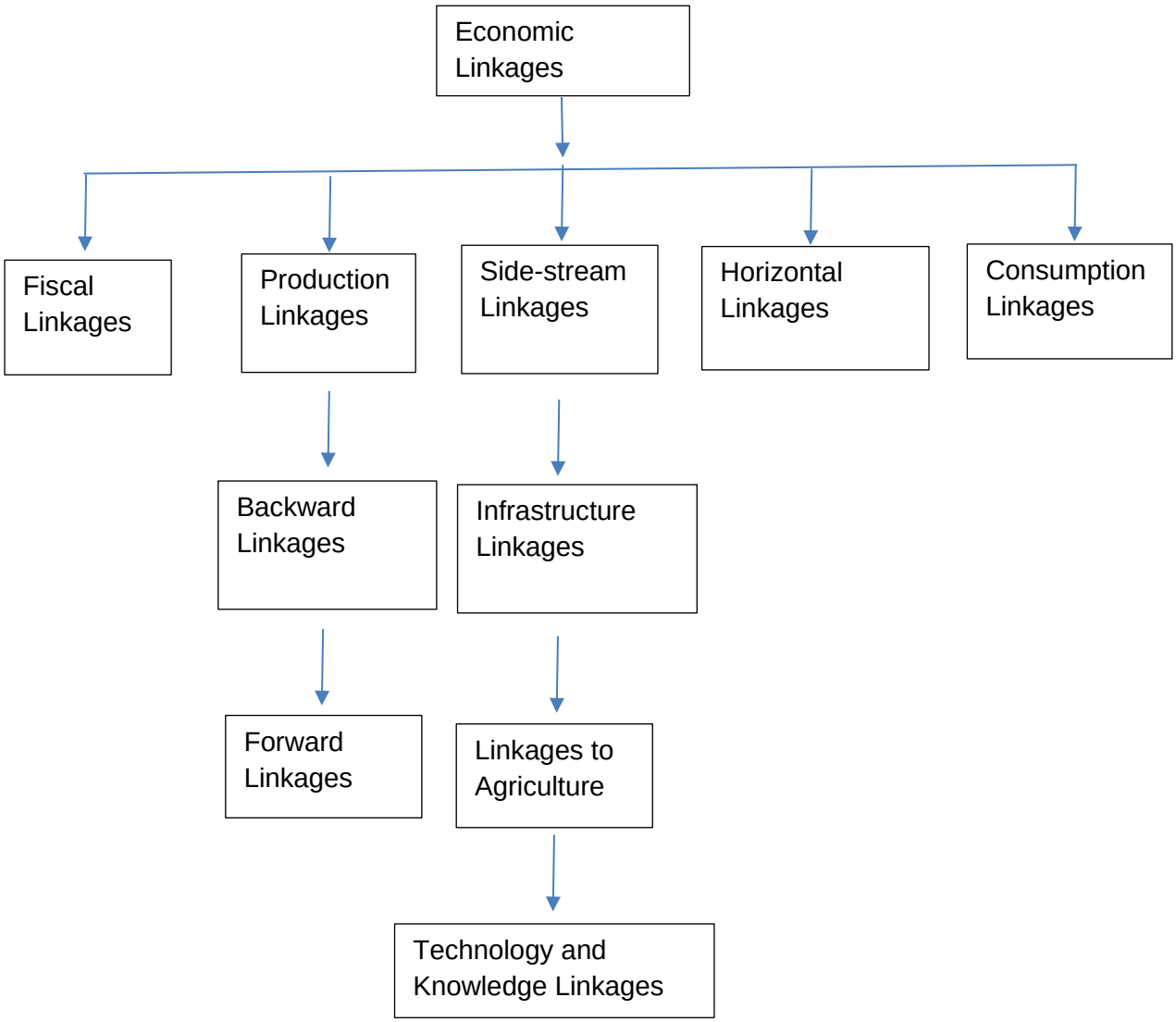


Figure 2.1: Types of Economic Linkages (Modified from: www.extractiveshub.org)

Fiscal linkages are laws and regulations that are used to capture resource rents and subsequent strategic use of the accrued resource revenue to boost wider economy. Beare (2017) noted that there is need to balance between government maximising revenue and investors getting a worthwhile return in a risky mining environment. According to UNCTAD (2016), backward linkages involve inputs to the extractive industry from the national economy. This involves hiring local residents and buying goods and services from local businesses and as a result, salaries and taxes are spent in the community, boosting local growth. Incentives for mining companies to provide on-the-job training and the creation of government-funded training institutions are examples of local content policies (Beare, 2017).

Forward linkages, also known as promoting downstream manufacturing, completing supply chains, beneficiation and, increasing value-added, are policies that encourage companies to minimise exporting raw materials and instead focus on processing them. According to Baissac

et al, (2015), governments can provide fiscal instruments to promote investors to support beneficiation. Hausmann *et al*, (2008) highlighted that investment in human capital, physical and economic infrastructure in downstream activities is requisite for economic growth and development. Side-stream linkages involve the development of critical infrastructure such as railways, roads, pipelines and power generation plants to enable extraction of natural resources. Infrastructure linkages can help in opening up opportunities in different sectors of the economy as the local industry created can promote the shared use of infrastructure for development (Beare, 2017). Local economic development incentives can be used to promote side-stream linkages.

Horizontal linkages include skills development in the extractive sector that can also be transferred to other sectors. Beare (2017) defined consumption linkages as the increased spending as a result of the rise in labour income and profits from the extractive industry. The spending can ignite local structural change as the income is reinvested in the national economy. Extraction of natural resources does not necessarily translate to economic diversification and better human development outcomes but there is need to manage and strengthen economic linkages that exist between the natural resources and the whole economy at large.

Good governance that is able to mobilise and integrate human, technical and financial resources are of paramount importance as these can be used to link the resource sector to broader economic development (UNCTAD, 2016). Successfully strengthening linkages between the natural resources and entire economy within a robust and transparent governance framework can enable the use of natural resources as a platform for structural transformation in a country.

2.4 Beneficiation in the Mineral Value Chain

The main activities in the mining process can be classified generally into extractive related and processing related activities. Extractive related activities include exploration, development and primary extraction of ore from the ground while processing activities encompass mineral processing, smelting and refining and other value adding activities (Figure 2.2) (Sigam and Garcia, 2012). Mineral beneficiation is the process of separating ore from gangue minerals. It entails the size reduction of valuable minerals to create a mineral commodity with a high value that can either be locally consumed or exported to other countries (Lydall, 2010).

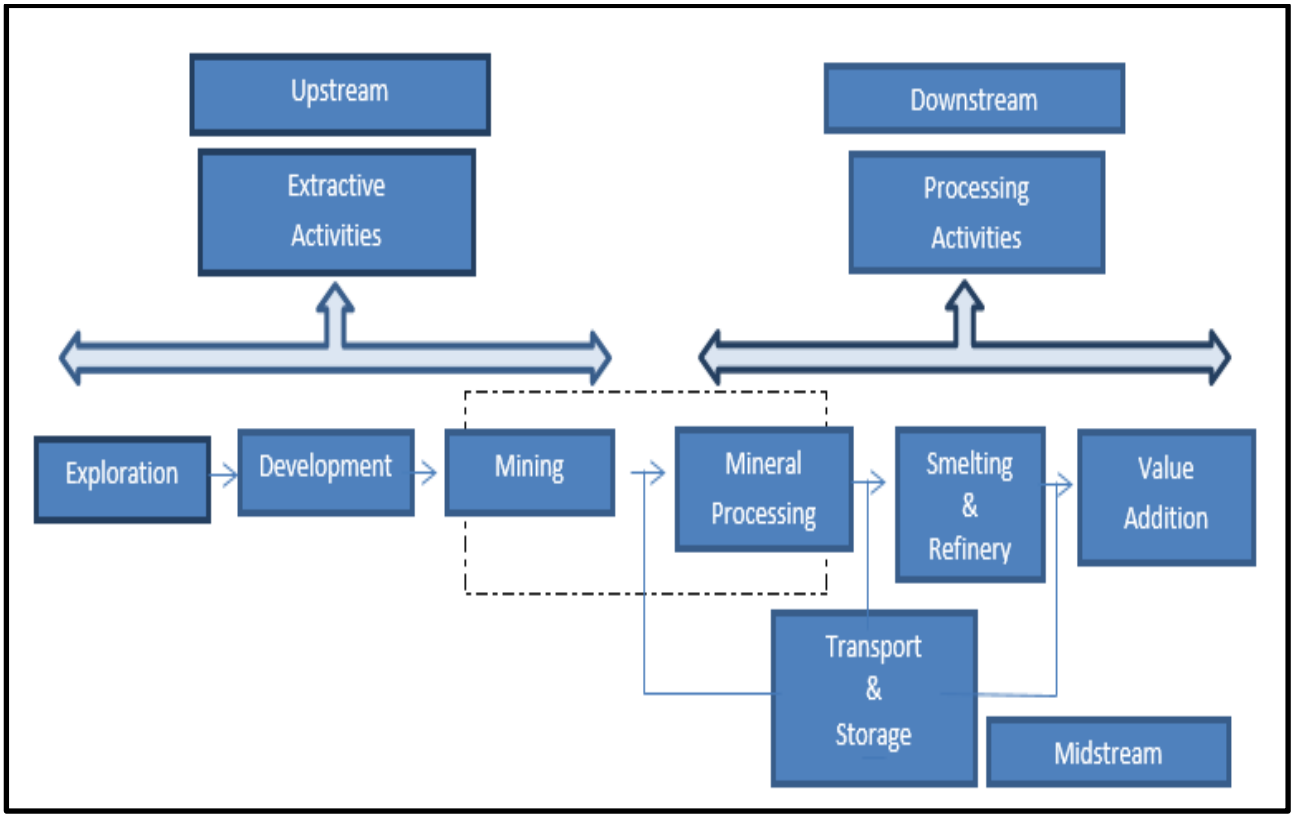


Figure 2.2: Mining Industry Structure. (Source: Sigam and Garcia, 2012)

Dryzymala (2007) defined beneficiation as mineral processing where activities involved increase the mineral content of ore to a higher or more saleable state. These processes include ore crushing, smelting, refining, fabrication and manufacture of consumer goods, market distribution and selling of final goods. Most developing countries with mineral endowments view the mineral value chain as a basket of economic benefits that can lead to economic growth and development.

According to Dube (2016), the economic influence of mining goes well beyond the extraction and processing of minerals as other industries such as transportation, storage facilities, construction, research and development are created. Baissac *et al,* (2015) stated that the mineral value chain involves primary activities that are directly related to value generation and a range of supporting activities that support the value generating activities (Figure 2.3). As such, supporting industries from transport, storage and telecommunications make up the mineral value chain. Hence beneficiation is a process or sequence of events that occur within the mineral value chain.

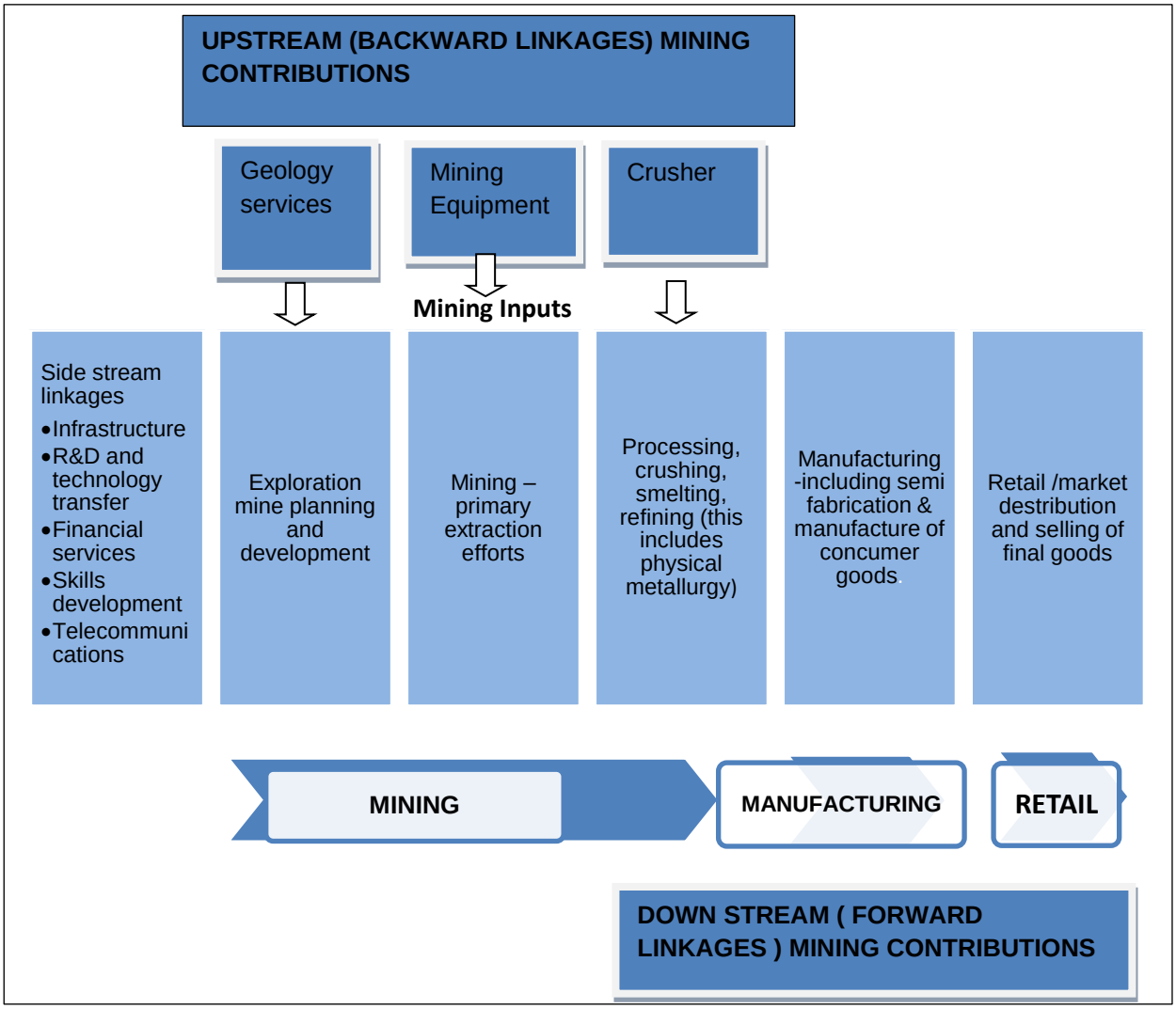


Figure 2.3: Mineral Value Chain Processes. (Source: Baissac et al, 2015)

2.5 Beneficiation as a policy paradigm

Beneficiation in natural resources is a very common policy initiative for structural transformation and fight against the natural resource curse. Venables (2016) stated that many of the resource-rich countries are extremely dependent on natural resources for export sales and fiscal revenues, have low savings, poor growth performance and the resource revenues are highly volatile. This has been termed the natural resource curse where resource rich countries are performing poorly in terms of growth and development as compared to their counterparts. Mineral beneficiation is being used by most governments of resource-rich countries as a tool for economic growth and industrialisation (Baissac *et al,* 2015).

As previously mentioned, the AMV was introduced in Africa to foster mineral resource-based growth and institutional change in the region, as well as to combat the natural resource curse. It tackles African countries' lack of a shared vision and policy strategy for using their mineral wealth to promote effective socio-economic transformation (Africa Union, 2009). It is a well-

planned strategy and collection of agreed-upon goals for using mineral resources for economic growth, with beneficiation being used as one of the policy instruments. Industrialisation and economic diversification is set to be achieved by enacting a progressive fiscal regime that ensures the capturing of a greater share of the resource rents and the use of the captured resource rents to eliminate poverty and inequalities. According to Africa Union (2009), local value adding was to be done using local supply of inputs, investment in research and development and skills upgrading.

Agenda 2063, Africa's robust framework and plan for socio-economic transformation that will result in global competitiveness, was formulated in 2013. It pushes for Africa's broad-based growth that is sustainable and socio-economic development through beneficiation of mineral resources as one of the goals of its first aspiration (African Union, 2013). Diversifying away from exporting mineral resource primary products can result in economic growth and development as more sales can be realised on a more finished product. Agenda 2063 of the Africa Union also proposes that extractive companies should capture a greater share of resource rents to transform Africa's mineral sector for sustainable development.

The Industrial Upgrading and Modernisation Programme (IUMP) of the United Nations Industrial Development Organisation (UNIDO) aims to *"contribute to economic growth and facilitate regional integration of developing countries by increasing the capacities of local industries for value added generation, economic diversification, exports and employment creation"* (UNIDO, 2020, 3). UNIDO was established in 1966 as a dedicated organisation of the United Nations for promotion of poverty reduction and globalisation and operates worldwide (UNIDO, 2020). IUMP focuses on stimulating competitiveness and diversification of downstream activities through the use of policy and technical support, robust regulatory and institutional framework, efficient use of technology and natural resources and management of financial and human resources.

The United Nations Economic Commission for Africa (UNECA, 2013) study on making the most of Africa's commodities placed natural resources at the centre of structural transformation and regional prosperity and highlighted the urgent need for Africa to exploit the resources using strategic interventions for socio-economic development such as beneficiation. The study highlighted the need for African countries to come up with and implement a coherent industrial policy and industrial policy roadmaps for value addition. It also emphasised the importance of having a well-tailored local content policy that focuses adding value locally and boosting local skills and technological capabilities.

The revised Regional Indicative Strategic Development Plan of SADC (RISDP) of 2015 pursues programmes that are aimed at increasing regional integration level through the manufacture of higher valuable goods taking advantage of Africa's rich natural resources endowment (Southern African Development Community, SADC, 2017). It advocates for the need to strengthen industrial linkages to the commodity sector, utilising regional policy frameworks and being involved in trade agreements with industrialised economies in order to enter new markets for value added products. Common Africa Position (CAP, 15) On the Post 2015 Development Agenda has natural resources management as its fourth pillar with one of its objectives being *"promoting value addition, research and development and technology innovations for sustainably harnessing the natural resource base"*. It highlighted the need to promote mutually beneficial partnerships and regional trade agreements (UNECA, 2014). These continent-wide blueprints and master plans serve as regional guides on beneficiation and value addition in a bid to increase economic diversification.

The SADC Industrialisation Policy Framework that was adopted in 2015 by the SADC states prioritised mineral processing for structural transformation and economic diversification taking advantage of the continent's mineral endowment (SADC, 2015). The Action Plan for SADC Industrialisation and Roadmap 2015-2063 that was adopted in 2015 acknowledged the central challenge being faced by many African countries of how to move from being in a commodity dependent growth path to value-adding industrialised nations (Southern African Research and Documentation Centre, 2016). It was noted that Africa is predominantly producing and exporting primary products as well as an importing finished goods. Under the SADC Mineral Beneficiation Cluster as outlined in the Action Plan for SADC Industrialisation and Roadmap, Zimbabwe is assigned for the beneficiation of platinum, diamonds, iron and steel in order to strengthen the mineral value chain (Table 2.1) (Southern African Research and Documentation Centre, 2016).

Table 2.1: SADC Minerals and Beneficiation Clusters

Mineral Cluster	**Countries**
Diamonds	Botswana, Namibia, South Africa, Zimbabwe
Copper	Democratic Republic of Congo (DRC), Zambia
Platinum	South Africa, Zimbabwe
Iron and Steel	Mozambique, South Africa, Zimbabwe
Soda Ash	Botswana
Oil and Gas	Angola, Mozambique, Madagascar, South Africa, Tanzania

Source: (Southern African Research and Documentation Centre, 2016).

The government of Finland agreed on improving the living conditions of its people through development of appropriate and innovative beneficiation processes in the Finland's Mineral Strategy of 2011 (Geological Survey of Finland, 2011). This was as a bid to structurally transform Finland's economy using natural resources moving with the notion that mineral resources extracted in Finland should be refined and processed in Finland. The Tanzanian Mineral Policy (2009) has one of its objectives being to *"promote and facilitate value addition activities within the country to increase income and employment opportunities"*. It highlighted the need to exploit the mineral resources of Tanzania efficiently and profitably so as to benefit the local people (Ministry of Energy and Minerals, Tanzania, 2009)

The Industrial policy in Namibia promotes investment into various sectors of the economy including beneficiation and value addition of mineral resources (Ministry of Trade and Industry, Namibia, 2013). The Mineral Policy of Namibia provides guidelines for value addition and beneficiation addressing the losses to the economy brought by exporting raw and semi-processed commodities (Ministry of Mines and Energy, Namibia, 2003). Namibia's draft phased Growth at Home (GAH, 2014) provides a framework for applying the Industrial policy with one of its strategies being supporting beneficiation of local minerals.

Beneficiation and value addition are common themes in national industrialisation policy blueprints, which are in line with regional and continental policy structures, although the extent of guidance varies. The success or failure of resource-based industrialisation is determined by country and industry, as well as the country's political and economic circumstances. Good governance is generally regarded as important in developing and implementing policies relevant for linking the resource sector to broader economic development.

The Zimbabwe National Industrial Policy (ZNIP) of 2019 to 2023 is in line with the African Union's Agenda 2063 as it has beneficiation and value addition as one of its guiding principles (Ministry of Industry and Commerce, Zimbabwe, 2019). Mineral beneficiation is one of its key pillars for structural transformation and Zimbabwe has a comparative advantage because of the quantity of natural resources that open opportunities for local beneficiation and value addition (Ministry of Mines of Zimbabwe, 2014). Under the mineral beneficiation and value addition pillar, the main activities include promoting local processing of raw materials such as smelting and refining of platinum and local value addition of lithium and promoting the formation of other industrial clusters such as services and consumable suppliers, around mining and mineral processing (Ministry of Industry and Commerce, Zimbabwe, 2019). In this project definition of beneficiation in the mineral value chain will be used that is processes involved in creating a mineral commodity with a high value.

2.6 Role of mining industry

The mining industry is involved in the extraction of valuable minerals from the earth. According to Baissac *et al*, (2015), mining companies have a role to play in the beneficiation process and the extent of obligations differs from one country to the other. Some countries extend the role of mining companies to manufacturing and others just to refining of mining products. The main activities in the mining process involve exploration, mine development and ore extraction and processing related activities which incorporate processing, ore smelting, refining and other value adding activities (Sigam and Garcia, 2012). Mineral processing that is separating the mineral from the waste material preparing it for further refinement is usually done at the mine and concentrates are transported to smelters and refineries for further refining.

The government of South Africa extends the obligation of mining companies in the beneficiation process to manufacturing and Zimbabwean government targets smelting and refining (Baissac *et al*, 2015). According to Khama (2014), there is trust deficit between the mining organisations and the government in many African nations. The mining industry and the host government need to understand their roles for effective mineral resource exploitation and partner together to increase the likelihood of success.

2.7 Competitiveness in beneficiation

The end product of beneficiation is a specialised and refined product and the sale of such a product is dependent on the degree of competitiveness of the product (Lin, 2013). Zhang and London (2013) noted that for beneficiation to be a success and to realise benefits from the process the beneficiated products must be competitive in both quality and price globally. According to Deardorff (2014), industry competitiveness is a key determinant in whether a beneficiation model succeeds or fails as industrialisation and globalisation have increased competition.

Global competitiveness is described by the World Economic Forum (WEF) (2019, 1) as *"the ability of a nation to achieve high rates of growth in GDP per capita,"* and competitiveness is defined by Zhang and London (2013, 95) as *"the ability of an economy to compete equally and effectively in global markets for traded goods and services"*. Porter (2011) argues that the study of competition should be the one that measures efficiency. Deardorff (2014) described productivity growth as the ability to lower the cost of producing the same outputs while also upgrading lower-value-added resources to higher-value-added materials.

According to Baartjes (2018) drivers of competitiveness include those that are of factor, innovation and efficiency driven economies. Figure 2.4 shows a summary of drivers of competitiveness, measure of competitiveness and examples of countries per category. Zimbabwe as an example falls under the factor driven economies. The success or failure of an industry's performance in global markets is determined by its competitiveness within industries, and according to Zhang and London (2013), the main thrust is to increase a nation's global competitiveness in a specific sector so as to meet demand of products in global markets.

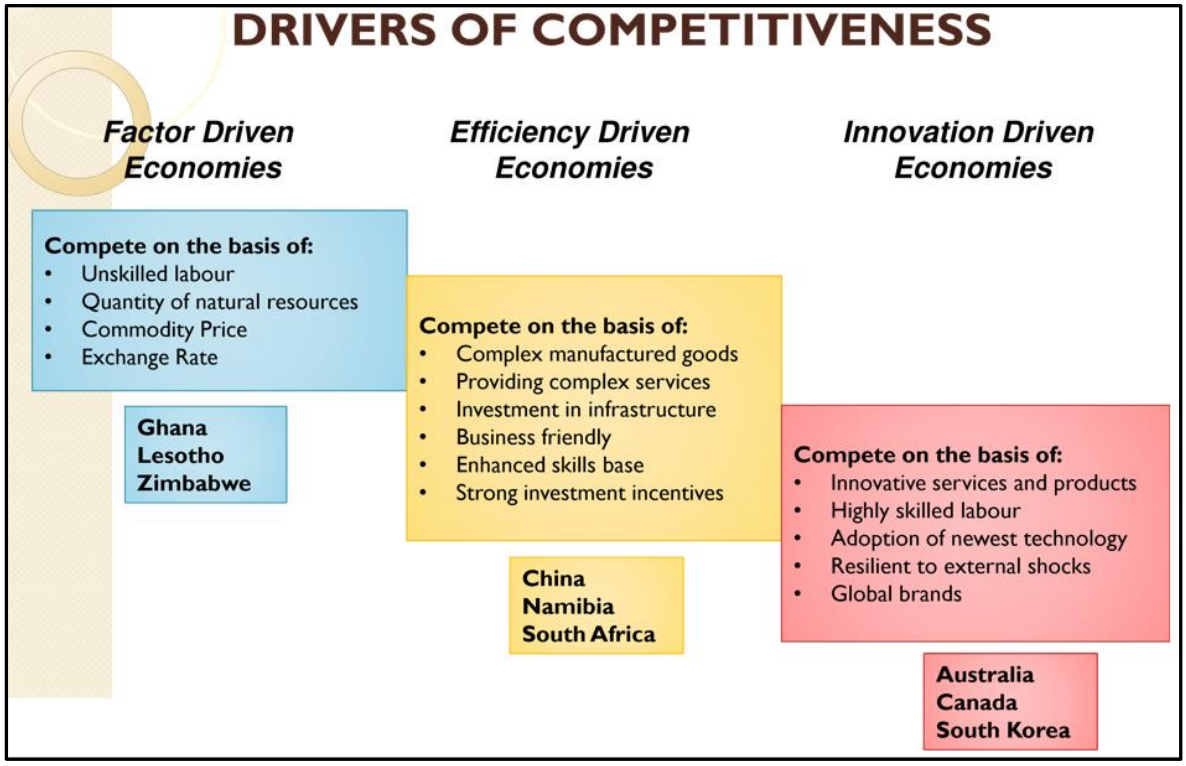


Figure 2.4: Drivers of competitiveness (Source: Baartjes, 2018)

2.8 Why beneficiation?

Many countries are moving towards mineral beneficiation as mineral beneficiation has been seen as a way of transforming a country's economy. This is based on a number of anticipated benefits that include the following:

- Creation of employment

Mineral beneficiation has been categorised into different stages that ranges from converting extracted ore into a highly concentrated product to selling of an end product that meets the requirements of the end user (Dryzymala, 2007). Various skills are involved in the transformation. Beneficiation also creates supporting industries that are interdependent to

each other and it is seen as a mechanism for job creation as each stage and supporting industries create employment and ultimately contributes to economic growth and poverty alleviation.

- Cushion against fluctuating commodity prices

The mineral sector plays a role in resource rich countries by significantly contributing to GDP and government's tax revenue (Baissac *et al*, 2015). According to the African Forum and Network on Debt and Development (AFRODAD, 2017) raw commodity prices are relatively volatile compared to prices of finished products. Economies dependent on mining exports with little to no beneficiation are vulnerable to price drops, which increases difficulties in formulating tax and spending policies to mitigate poverty and improve socio-economic transformation (AFRODAD, 2017).

- Localisation of value chain benefits

As earlier stated, mineral value chain involves primary activities that are directly related to value generation and a range of supporting activities that support the value generating activities. Benefits such as tax revenues and technology can be derived throughout the whole value chain (Matinde *et al,* 2014). The general consequence of exporting raw minerals is that of not being able to reap the full supply chain benefits associated with mining (Dube, 2016). Importing countries' economies stand to benefit as they add value and sell finished goods at higher prices than exporting countries' economies. As a result, beneficiation would ensure that more profits from the value chain remain in the country, resulting in other multiplier effects such as increased income and spending, which would stimulate economic growth and development (AFRODAD, 2017).

- Cost savings from imports

Many countries export raw mineral commodities and then import finished products from the mineral commodities exported (Dube, 2016). According to UNCTAD (2018), this does result in importing finished products at a higher cost. If the final products are locally manufactured goods, the beneficiated product tends to be much cheaper than importing. Manufacturing goods locally can result in a cheaper final product that can also translate to more sales (Matinde *et al,* 2014).

- Expert skills development and economies of scale

The creation of a local market for raw mineral commodities through the establishment of beneficiation facilities can result in economies of scale. According to Baissac *et al,* (2015), economies of scale can represent cost savings and can also lead to competitive advantages. Beneficiation supports the development of downstream supporting industries creating demand

for skilled expertise. As a result, it is predicted that beneficiation will result in the production and growth of expert skills (Dube, 2016).

- Infrastructure development

Successful beneficiation requires energy, water and transport infrastructural networks. Matinde *et al*, (2014) highlighted that while such infrastructure is designed to promote beneficiation, it will also help to improve economic sectors that are already in existence and growth of development corridors that are independent of the beneficiation industry once it is in place. This can result in socio-economic transformation of the country with boosted economic sectors (Chigumira *et al*, 2017).

It is in line with these anticipated benefits that many countries world-wide are putting systems and policies together to promote beneficiation especially in African nations. The Zimbabwean government also subscribes to the positive beneficiation factors thus the push to capitalise from the country's rich mineral endowment through beneficiation.

2.9 Beneficiation Strategy

Beneficiation strategy is a framework for turning a nation's comparative advantage from natural resources enrichment into a competitive advantage (Department of Mineral Resources, DMR, South Africa, 2011) (Figure 2.5). According to Chigumira *et al*, (2017), countries with high mineral endowment face issues that include commodity market and price volatility, governance challenges, challenges in capturing and accounting of mineral resource rents and appreciation of the real exchange rate that often lead to corruption and failures in planning. Beneficiation strategies can include the use of a legislative structure, international trade agreements, beneficiation support structures, comprehensive industrial policy that takes into account beneficiation issues, multi-stakeholder forums and value adding intervention measures to resolve problems and ensure that beneficiation is a success.

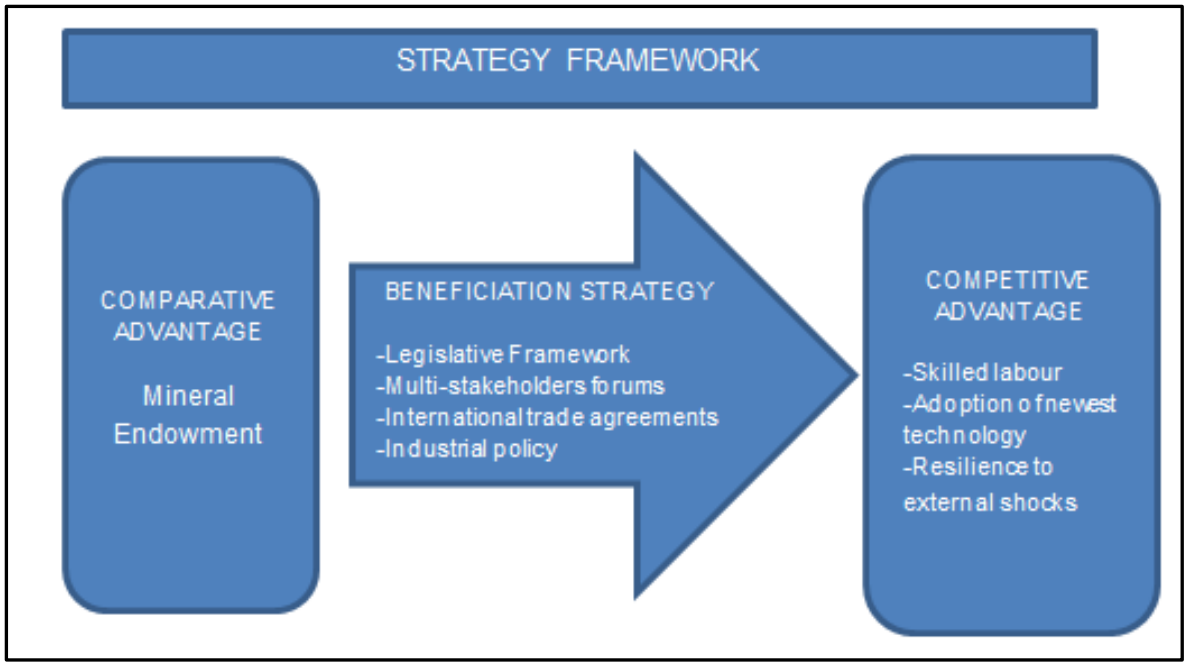


Figure 2.5: Beneficiation Strategy (Modified from DMR, 2011)

According to Baissac *et al,* (2015), the positive and negative incentives approach are the two main approaches being used in implementing beneficiation policies. The positive incentive approach is where the government can incentivise downstream activities by reducing operating costs for investors. Incentive measures involve the use of tax exemptions/reductions, energy or water subsidies and provision of advantageous loans to encourage beneficiation (Rousseau and Caruso, 2016). The Intergovernmental Forum (IGF), (2016) noted that incentives to reduce costs can also be given to vertically integrated companies that build into mineral processing plants.

The positive incentive approach was successfully used by the Mozambican government in 1997 in establishment of the Mozal Aluminium smelter (Grygen and Sekakela, 2015). The incentives used included a 50-year tax holiday and energy subsiding while the builders of the Mozal Aluminium smelter invested in infrastructure to make the aluminium beneficiation project a success. An exemption from paying taxes on profits was granted to companies investing in the refinery sector in Singapore for 5 years and the Singapore government also invested in infrastructure required for the refinery sector (IGF, 2016). According to Talkin (2016), to encourage investment in the steel industry, Australia used restrictive measures such as customs duties and import restrictions. The positive incentive approach was also used in Botswana where incentives were used to support the cutting and polishing industry with a guaranteed long-term allocation of De Beers' diamonds projects at 20% below the market price (Grynberg, 2013).

According to Klavier (2017), incentives are given to promote downstream activities that are capital intensive and also to make marginal downstream projects economically viable. The downside of such incentives is that tax administration becomes complicated, an environment conducive for corruption can be created and it can also be a potential unnecessary loss of government revenues (Morris *et al*, 2011).

The negative incentive approach which is also called prescriptive measures involves the use of regulation and legislation to force mining companies to beneficiate or facilitate beneficiation mainly through the use of bans, quotas and export duties on raw commodities (Dube, 2016). According to Ramdoo and Bilal (2014), twenty-one countries in Africa use the negative incentive approach on extractive industries to promote local processing.

Besides Zimbabwe, the negative incentive approach was also used in Zambia as the government, through the Zambian 2008 national budget, introduced a 15% export tax on copper concentrates in an attempt to encourage local processing (Grygen and Sekakela, 2015). The export tax was later lifted in 2013 for a year after mining companies cited inadequate refining capacities in the country. A mining bill was signed into law by the government of Indonesia calling for a full ban on the export of unprocessed minerals within five years. This was done as a bid to foster local mineral processing. The ban was put into action in 2014 for bauxite and nickel ore and then lifted in 2017 (IGF, 2018).

In their 2018 paper, IGF noted that the negative incentive approach is less attractive as this can hinder future mining investments since it provides a negative perception of the investment environment. According to Baissac *et al,* (2015), such an approach can lead to the closing down of marginal projects that do not have the cash flow to invest in downstream processing as projects will only be favourable when prices are high.

Governments might successfully impose downstream requirements during drafting of a mining contract using local content policies (IGF, 2016). According to Chigumira *et al*, (2017), there is need to have a strong bargaining position such as valuable deposit, high market interest in such a deposit and also taking advantage of renewal of licences window period. The government of Botswana negotiated a downstream package with De Beers as a condition of renewing its mining licence in the country and used the criticality of the diamonds deposit. IGF (2016) noted that the advantage of using negotiations is that downstream requirements can be successfully imposed without foregoing tax revenues but negotiations have a disadvantage of creating corruption opportunities as they are usually done behind closed doors.

Governments can include downstream processing as part of their bidding process and companies that bid for a mining concession and include processing activities are rewarded in the evaluation of their bid (IGF, 2016). A Chinese company won the bid for Afghanistan Aynak copper deposit by offering to locally smelt the copper in their bid (IGF, 2016). If there is a lot of demand for a deposit and businesses are vying for the license, the government will get the best offer possible (Chigumira *et al,* 2017). Improving quality of geological data is important for competitive bidding. Companies can overbid so as to win the tender and then ask for renegotiations at a later stage. Another strategy that the government can use is of taking lead by directly investing in downstream processes. The Nigerian government invested in the refinery sector to serve domestic and export markets (IGF, 2018). Table 2.2 summarises the strategies being employed and conditions required to implement the strategy and the possible strengths and weaknesses of employing such a strategy.

Table 2.2: Strategies and conditions for implementing beneficiation

Strategy	**Conditions**	**Comments**
Positive incentive approach	• Given to capital intensive projects • Usually targets marginal projects to make them viable • Incentives should be time-bound to evade from creating dependency • Incentives given should be lifted gradually to avoid financial shocks	• Favorable for investors • Can result in a complicated tax administration • Creation of an environment conducive for corruption • Potential unnecessary loss of government revenues • Some aim at guaranteeing domestic markets and protecting them from global competition
Negative incentive approach	• Favorable when market prices are high • Need for a strong bargaining position such as valuable deposit • Requires long time frames from announcement to implementation	• Accomplished by either making raw mineral exports less favorable or making exports conditional on processing. • Can hinder future mining investments • Can result in closing down of marginal projects
Negotiations	• Need for a strong bargaining position such as valuable deposit that the company relies on for survival • The company should have already invested a considerable amount of money • Need to capitalize during renewal of licences	• Potential unnecessary loss of government revenues • Creates corruption opportunities

	• Government requires strong negotiation skills, good governance and transparency	
Bidding (include processing activities in the bid)	• Market interest for the deposit has to be very high • Bid feasibility should be assessed by good technical experts • Bidding process to include transparent evaluation criteria	• Risk of companies overbidding and later asking for renegotiations • Creates opportunities for corruption
Government led investments	• Require strong business models and good governance • Require upfront capital investment • There should be limited political interference in technical decisions	• Give countries direct control over economic development • Creates corruption opportunities

(Source: Baissac et al, 2015; IGF, 2016; IGF, 2018 and Klavier, 2017)

Beneficiation has been identified by the Zimbabwean government as one of the pillars for economic development and industrialisation from the country's mineral resources. To accomplish this, it is important to identify critical minerals that must be prioritized, as well as to provide an estimation of the mineral resource quantity available for beneficiation. There is a need to analyse the policies currently in place to encourage beneficiation and other factors to be considered for beneficiation. The report aims to evaluate the existing and potential challenges for beneficiation in the mineral sector for identified critical minerals and how these can be solved. Recommendations will be given for Zimbabwe to increase its competitiveness in the mining industry from a beneficiation perspective.

2.10 Chapter summary

The literature surrounding structural transformation and government policies shows that across the world many countries are adopting beneficiation, among other economic linkages, as a policy tool for industrialisation and economic diversification. Encouragement of local mineral value addition rather than the exportation of unprocessed products at a lower value is often seen as an important part of African governments' growth strategies. The locally beneficiated products should be globally competitive in both quality and price in order to benefit from beneficiation.

The anticipated benefits from beneficiation include employment creation, cushioning against fluctuating commodity prices, cost savings from reduced imports, localisation of value chain benefits, economies of scale, expert and infrastructure development. It is because of these

anticipated benefits that many countries world-wide are promoting beneficiation. A beneficiation strategy to move downstream includes the use of a robust fiscal regime that captures a reasonable share of resource rents without deterring investors. These rents are useful in investing in downstream activities and can also be used to reduce poverty and inequality.

Countries working towards mineral beneficiation should adopt and implement a coherent industrial policy with transparent industrial-policy roadmaps for value addition. The industrial policy should be effective in boosting investment infrastructure and sharing skills and technology. Beneficiation strategy also include negotiating trade agreements with industrialised countries, government support in establishing marketing links and promoting mutually beneficial partnerships.

Other approaches being used include positive incentives approach, negative incentives approach, imposing downstream requirements during drafting of a mining contract and as part of bidding process. Improving the quality of geological data is important for competitive bidding and more equitable return on mineral sector investment. Good governance is generally regarded as important in developing and implementing policies relevant for linking the resource sector to broader economic development. Beneficiation remains an interesting topic of discussion in many countries especially at a time of declining mineral commodity prices and mineral industry crisis.

CHAPTER THREE: BENEFICIATION POLICIES AND STRATEGIES

3.1 Introduction

Chapter 3 will highlight case studies for selected countries' approaches to implementing mineral beneficiation. Policy reforms and beneficiation strategies from South Africa, Botswana Indonesia and Australia will be considered. Botswana and Indonesia were selected as these countries have comparable levels of development with Zimbabwe. South Africa and Australia have comparable regional concentrations with Zimbabwe. Botswana is well known for its diamond industry, South Africa for its PGMs industry, Indonesia known for the beneficiation of nickel and bauxite and in Australia the lithium-ion battery industry will be analysed. The common drive of the national industrialisation policy blueprints is beneficiation and value addition that is in sync with regional and continental policy frameworks although these policies can differ on level of guidance. Many resource-rich countries are moving towards mineral beneficiation as mineral beneficiation has been seen as a way of transforming a country's economy as a result of anticipated benefits alluded to earlier on.

3.2 Botswana

According to the AFDB report (2013), Botswana was once among the world's poorest countries at independence time in 1966 but it has turned to be one of the world's development stories. This is attributed to the substantial diamond wealth, robust governance and fiscal discipline. The economy of Botswana largely depends on the diamond sector and mining is the largest contributor to GDP and a major contributor to government fiscal revenues being generated (World Bank, 2020). The diamond industry accounted for 80% export earnings in 2019 and real GDP growth in the country in 2018 and 2019 was 4.6% and 3.5% respectively. According to the World Bank (2020), the growth in GDP is mainly attributed to continued recovery in diamond production, appropriate macroeconomic, exchange rate and fiscal policies among other factors.

3.2.1 Diamond production

Botswana is richly endowed in diamond, cobalt, copper, soda ash, nickel, coal, salt and gold and the mining sector growth and earnings have been mainly driven by diamond mining (AFDB, 2016). Figure 3.1 shows average mineral contributions to the mining sector in 2019. The production of diamonds started in 1970 and has been increasing over the years (World Bank, 2014) and the production is from six mines with Jwaneng and Orapa being the two largest open pit mines. Botswana had the world's second largest diamond reserve at the end of 2020 (Statista, 2021).

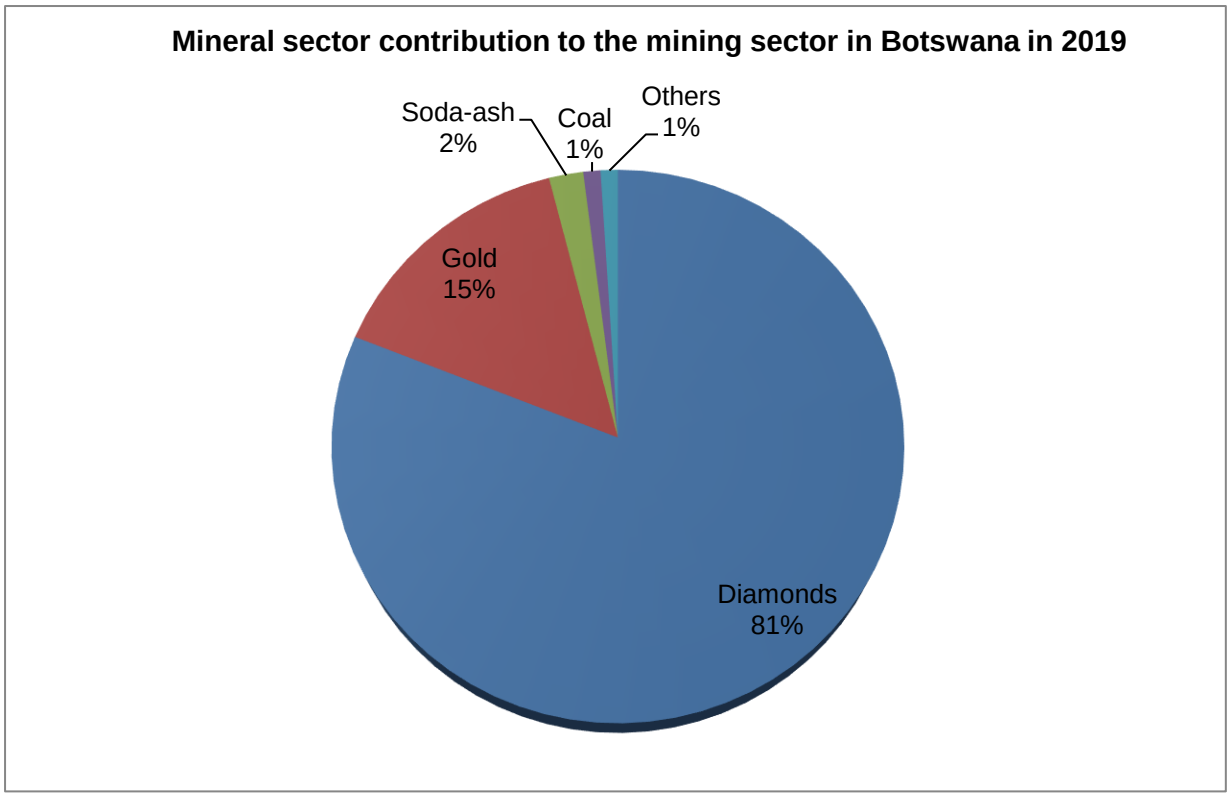


Figure 3.1: Diamond contribution to mining sector. (Source: Statistics Botswana, 2020)

3.2.2 Diamond Beneficiation Policy

Chigumira *et al*, (2017), noted that most of the minerals in Botswana are being exported in their raw form although there is a steady move along the value chain for diamonds. The industrial policy in Botswana pursues the growth of the country's manufacturing sector. It has increased the level of value addition in the economy and attaining economic diversification into other non-diamond mining activities as some of its objectives (Ministry of Finance and Economic Development, Botswana, 2017). The Botswana's National Development Plan cites the continued growth of the economy through mineral beneficiation and the need to encourage the development of the private sector to drive mineral processing (Ministry of Finance and Economic Development, Botswana, 2017). The strategies for beneficiation in the mineral sector include among others the establishment of an enabling environment to foster beneficiation projects and the extension of the diamond beneficiation beyond cutting and polishing.

According to Jefferis (2013) and Grynberg (2013), the government of Botswana formulated a mineral policy that had the following objectives:

- Maximising economic benefits for Botswana while enabling private investors to earn competitive returns;
- Creating a competitive environment for private sector investment in mineral beneficiation through use of incentives and tax levies to promote diamond local beneficiation;
- Creating linkages within the economy by creating a supply chain network for the industry and expanding value addition activities;
- Employment and training of local people in cutting and polishing skills; and
- Safeguarding the environment

3.2.3 Policy implementation

The company that is currently mining diamonds in Botswana is Debswana, which is a 50-50 joint venture between De Beers and the government of Botswana. The government of Botswana negotiated for an increase in shareholding in Debswana from 15% to 50% when De Beers was applying for further mining licences (Chigumira *et al*, 2017). Botswana had the bargaining power of having one of largest diamond reserves in the world and this gave it a significant leverage in negotiations. This enabled the government to get more profits from the diamond industry and make them more influential in De Beers' operations. According to Chigumira *et al*, (2017), joint ventures increase the likelihood of easy access to new markets, distribution networks, new knowledge, new expertise, advanced technology and increased capacity.

According to Grynberg (2013), before 2006 all diamonds being produced by Debswana were sold to a London based De Beers marketing arm called the Diamond Trading Company (DTC). In 2006 De Beers established a branch of the DTC in Gaborone, Botswana's capital city, to carry out diamond sorting and aggregating processes in response to diamond local processing in Botswana (Jefferis and Nemaorani, 2013). Local processing of the diamonds that were being mined in the country was supposed to be equal to 15% of the country's total rough diamond production.

A diamond hub was established under the Ministry of Minerals, Energy and Water Resources in support of the diamond beneficiation policy to create economic linkages (Chigumira *et al*, 2017). The diamond hub had four core activities that were creating a trading centre for rough and polished diamonds, a centre for cutting and polishing the diamonds, a centre for producing jewellery and establishing strategic alliances that support diversification in the diamond industry (Grynberg 2013). The hub was also formulated in order to have a separate diamond marketing arm that is independent from the De Beers system.

As a way to promote cutting and polishing of the diamonds, the government of Botswana subjected the cutting and polishing firms to a 15% corporate tax as compared to a 20% tax that was being paid by other manufacturing industries in the country (Jefferis and Nemaorani, 2013). The country improvised special visas called multiple entry business visas to make it easy for skilled expatriates to get into Botswana and train locals in skills required for cutting and polishing of the diamonds. These skilled expatriates were also meant to train the local people on repairing of equipment used in the downstream activities for diamond (Chigumira *et al*, 2017). Such training centres were exempted from paying training levies and qualified for rebates claiming for accredited training programmes.

Exporting rough diamonds attracted a tax levy on exports and an exemption from paying the tax was given to exports of polished diamonds to promote local diamond beneficiation (Collier, 2012). The government also negotiated for the sale of unprocessed diamonds to domestic firms at a reduced price to assist the domestic companies in being globally competitive (Chigumira *et al*, 2017). The government's diamond beneficiation strategy aims to establish downstream activities in the cutting and polishing industry, jewellery manufacturing industry and diamond trading industry.

3.2.4 Beneficiation policy a success or failure?

Botswana's move to establish a local downstream diamond industry is considered as a success and the country used a combination of export penalties, restrictions and fiscal incentives in implementing the beneficiation strategy. According to Fessehaie and Rustomjee (2018), the beneficiation policy in Botswana has been effectively implemented and this has seen Botswana moving up the diamond value chain within a decade and as a result its participation in sorting, cutting and polishing increased. A vibrant local cutting and polishing industry was established to promote downstream processing for the diamond industry (Chigumira *et al*, 2017).

In 2012 approximately 18-20% of Botswana's rough diamonds being produced locally were cut in the country and employment in the diamond cutting and polishing industry increased from 2200 workers in 2008 to 3750 in 2013 (World Bank, 2014). Sorting of De Beers diamonds that used to be done in London is now being done in Gaborone after the establishment of the Diamond Trading Corporation Botswana in 2012 (Fessehaie and Rustomjee, 2018). Good governance and credible political leadership ensured that training firms relocated to Botswana and invested in skills development for the local people. The government of Botswana managed to use its work permit regulations to maximise the development of local cutting and

polishing skills and these skills were acquired through on the job and local training (Fessehaie and Rustomjee, 2018).

3.2.5 Beneficiation lessons from Botswana case study

- An enabling environment was created as a result of good governance, fiscal discipline and robust policy framework that promoted investment in diamond downstream activities;
- Having a mineral policy that is in sync with the nation's overall economic development policies is important for the effective implementation and sustaining of downstream activities. Botswana's mineral policy was in line with the country's development plans;
- Beneficiation strategic interventions using a combination of penalties, fiscal incentives and export restrictions in promoting beneficiation.
    - The government of Botswana reduced the corporate tax for the manufacturing industries as compared to other industries to encourage investment in the manufacturing sector;
    - Introduced an implicit tax on rough diamonds exports to discourage exporting of rough diamonds;
    - Exemptions on training levy and rebates on training expenses of accredited training programs and this resulted in skills development;
    - Rough diamonds being sold to domestic firms at discounted prices for product competitiveness at international markets;
    - Special immigration arrangements for trainers of skills required for the beneficiation industry.
- Establishment of support structures to promote beneficiation
    - Dedicated diamond office and diamond industrial hub to ensure growth of all aspects of the diamond downstream activities;
    - Diamond Trading Company to carry out local sorting and aggregation activities for diamond.
- Establishing joint ventures that increased the likelihood of easy access to markets, knowledge, expertise and technology.

3.3 South Africa

South Africa has a high mineral endowment and is considered to be one of the world's wealthiest mining country. Baartjes and Gounden (2011) estimated the mineral endowment to be worth USD 4.71 trillion and that the PGMs contributed about 49% of the value. Citibank (2011) reported that the Bushveld Complex, world's largest layered intrusion, hosts 55% of

the country's mineral wealth with the Witwatersrand Basin contributing approximately 16%. The Witwatersrand Basin is the host to the country's gold and uranium. According to the Department of the Mineral Resources, South Africa (2017), the economy of South Africa is the second largest in Africa and represents approximately 30% of the continent's GDP. The mining sector has attracted valuable foreign direct investment to South Africa for many years.

3.3.1 Platinum Production

Major mining sectors in South Africa include diamonds, platinum, coal, chrome, vanadium and titanium (Mineral Council of South Africa, 2020). The Bushveld Complex is host to more than 50% of the PGMs in the world and other associated minerals such as chromium and vanadium. It hosts 80% of the country's PGMs (Department of Mineral Resources, South Africa, 2017). South Africa is the highest supplier of PGMs in the world (Mineral Council of South Africa, 2020). Figure 3.2 shows the mineral sector contribution to mining exports in 2019 and PGMs are the highest contributor. An increase in the use of fuel cell technology is expected to increase PGMs demand and the introduction of stricter emission standards for motor vehicles is also expected to increase PGM demand due to their use in catalytic converters (Mineral Council of South Africa, 2020).

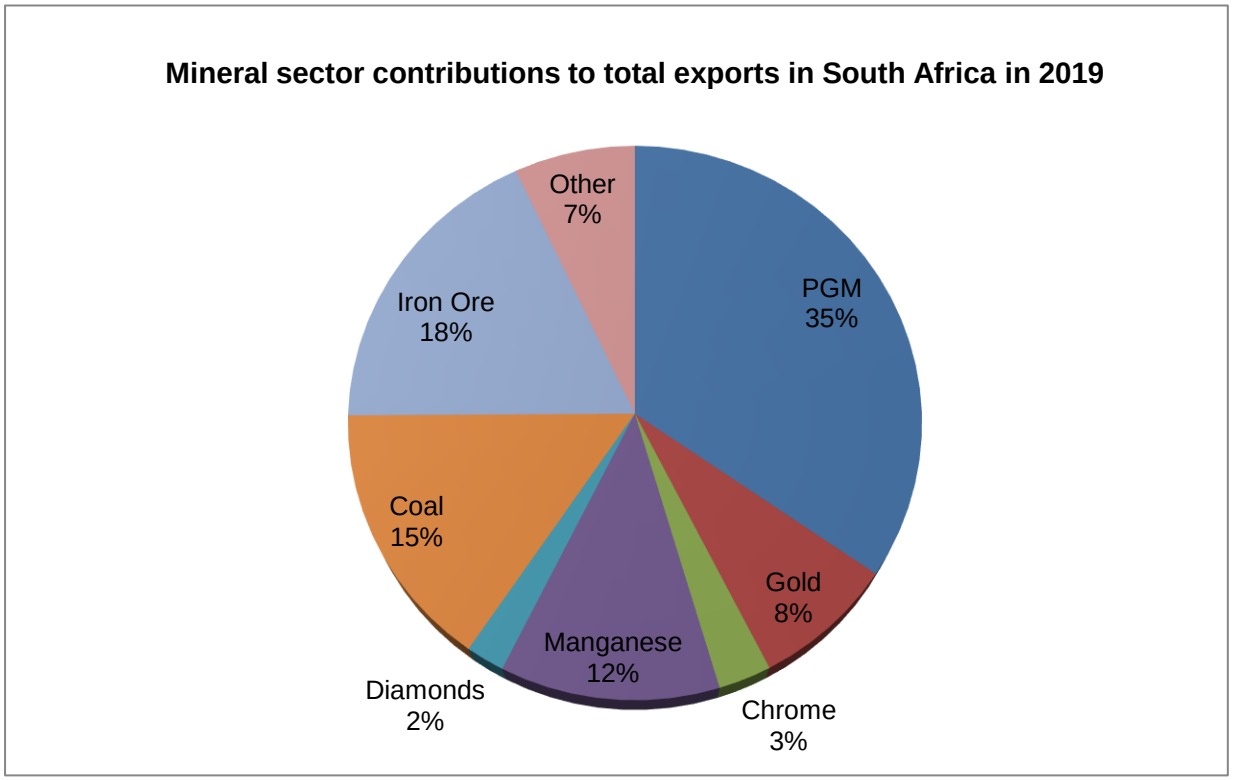


Figure 3.2: Mineral sector contributions to export. (Source: Mineral Council of South Africa, 2020)

3.3.2 South Africa Beneficiation Strategy

South Africa formulated a beneficiation strategy for the mining industry in 2011 and it provides a backbone to translate the country's comparative advantage to a competitive advantage through the development of specific value chains. The intention of the beneficiation strategy was to outline a framework to enable downstream processing of South African minerals in an orderly manner that will benefit the entire populace (DMR, 2011). According to the DMR 2011 report, the vision set out in the document was to establish an enabling environment and advance development through the following:

- Upgrading of mineral commodities to more valuable products;
- Economic diversification facilitation through industrial opportunities;
- Job creation that will reduce unemployment rate and help alleviate poverty;
- Linkages optimisation in the mineral value chain; and
- Development towards a knowledge based economy

3.3.3 Beneficiation Strategy implementation

The beneficiation strategy identifies a number of instruments that would be used to achieve the objectives of the strategy and these included legislation, policies and incentives (DMR, 2011). The government adopted the New Growth Path (NGP) in 2011 that identified mineral beneficiation as a policy tool for employment creation. Eleven strategic minerals were identified in the 2011 beneficiation strategy and these are gold, chromium, vanadium, manganese, coal, nickel, uranium, platinum, diamonds and titanium (DMR, 2011).

The strategy is rooted on various regulatory framework and policies established by the government to ensure a mineral competitive advantage in the country. The Mineral and Mining Policy of 1998, a comprehensive mineral policy document, seeks to create an enabling environment for the country to realise its full potential from the mineral wealth (DMR, 2011). The policy also identified the need to encourage investment for the downstream activities in the mineral sector through competitive costs such as transport and electricity.

The Mineral and Petroleum Resources Development Act of 2002 (MPRDA) expresses clearly the Minerals and Mining Policy of 1998 as regulations and 2015 amendment further clarifies and strengthens beneficiation provisions. Some of the provisions in the MPRDA 2002 included the Minister in charge of the mineral sector being able to prescribe incentives to encourage mineral beneficiation in the country and ensure that the processing industries have a reliable supply of inputs. The MPRDA of 2002 highlighted the need of a written permission from the

Minister of Mineral Resources from any person intending to beneficiate minerals from South Africa outside of the country (DMR, 2011)

The Broad-Based Socio-Economic Empowerment Charter for the Mining Industry (Mining Charter) encouraged both downstream and side stream beneficiation through the beneficiation element as well as the procurement and enterprise development element. The beneficiation element required the mining companies to offset 11% of their ownership requirements against the value of their levels of beneficiation (DMR, 2011). The procurement and enterprise development element required that the procurement by mining companies be a minimum of 40% capital goods, 70% services and 50% consumables from Black Economic Empowerment entities. According to the Department of Mineral Resources, South Africa, (2017), by 2010 the procurement provisions were already being enforced.

The Precious Metal Act, 2005 (PMA) was formulated to ensure that priority was given to applicants with downstream processes at the final stage of the mineral beneficiation value chain. Priority was also given to applicants with a positive impact and those getting to the last stage of beneficiating in the mineral value chain. The Income Tax Act of 1962 stipulated incentives to be given for training of workers, manufacturing and research and development activities. The Manufacturing Investment Programme (MIP) is an incentive that was designed to revamp investment growth in the manufacturing sector in support of the country's National Industrial Policy Framework (DMR, 2011). The MIP was also devised to increase the sustainability of manufacturing investment projects through grants to small enterprise and those marginal projects on the borderline of sustainability.

A new state-owned mining company was established to implement the government's developmental agenda of giving security of supply for local mineral beneficiation and mobilisation of resources to develop the mining value chain (Chigumira *et al*, 2017). Supporting structures such as the beneficiation strategy task team and steel task team were created to identify and promote specific value chains in order to attain growth in downstream activities. The Industrial Development Corporation, a finance institution owned by the government, was established in a bid to encourage growth in industrial development (DMR, 2011).

International trade agreements of multi-stakeholders supporting different beneficiation aspects were created to examine specific value chains and also to support the government's beneficiation policy (DMR, 2011). The partnership agreement with China was done to escalate Chinese investment in downstream activities in the country. Other international trade agreements included the African Growth and Opportunity Act, the Southern African

Development Community Trade Agreement, Trade agreement with the European Union and the Trade agreement with Zimbabwe (DMR, 2011).

A 9-point plan was announced in 2015 during the State of Nation Address by the then President Jacob Zuma and advancing local beneficiation and adding value to minerals was one of the points in the plan. Amendments were made to the MPRDA to support the 9-point plan in promoting downstream activities (Lovells, 2017). The Act provides that every producer of strategic minerals must offer a prescribed percentage of its production to local beneficiaries in prescribed qualities, quantities and timelines and at a specified price. The amended Act also stated that those producers not compliant with the law could only export the designated minerals after being given a written consent from the Minister of Mineral Resources. Figure 3.3 summarises the tools being used to implement the beneficiation strategy.

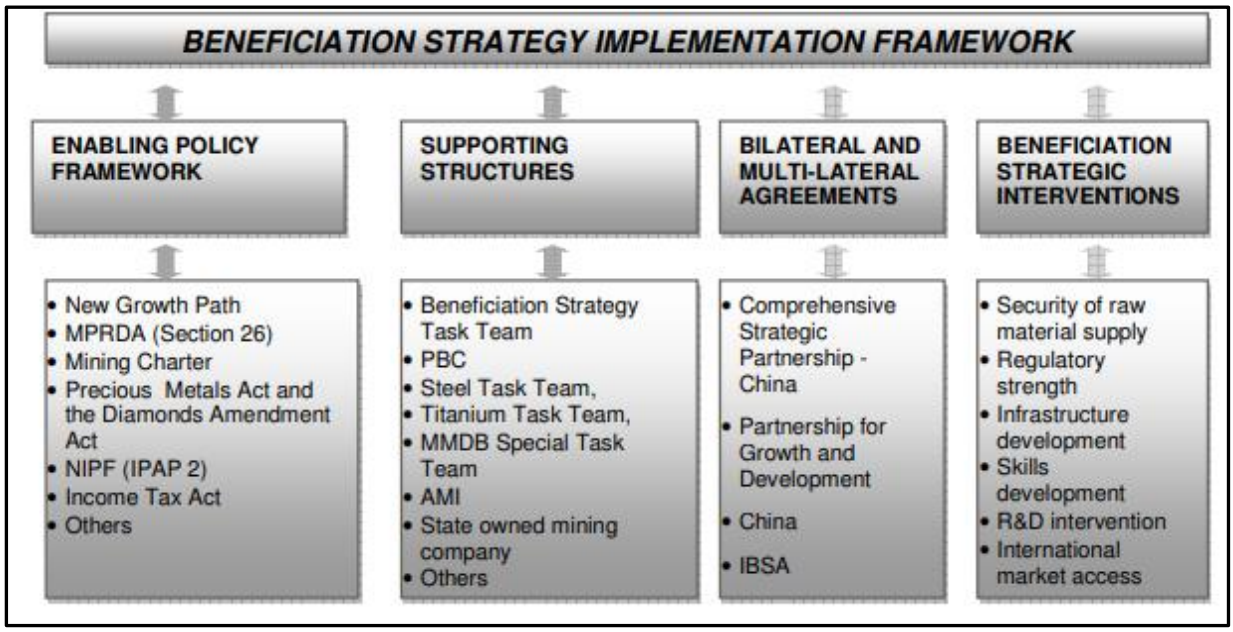


Figure 3.3: Beneficiation strategy backbone. (Source: DMR, South Africa, 2011).

3.3.4 Beneficiation strategy a success or failure?

South Africa is reported to have steadily improved its ratio of processed to unprocessed commodities over the years. According to Skinner (2018), the catalytic converter industry is reported as one of success stories in South Africa and the auto-catalyst business remained with significance as one of the very few downstream industries that sustained a global footprint. By 2012 South Africa produced 13% of the world's auto catalytic converters, created 5 000 direct jobs and 30 000 indirect jobs (Lovells, 2017). There were significant results due to incentives in the beneficiation industry as the amount of platinum consumed in South Africa since 1995 had grown from 2% to 20% in 2012.

Skinner (2018) noted that potential opportunities created by PGMs beneficiation are in place and successful and what is now required is to protect and nurture the industry for sustainable growth. South Africa is isolated in relation to demand markets as the country is not geographically located near major automotive manufacturing hubs and transportation of catalytic converters is costly and this comes as a hurdle to the PGMs downstream activities (Baartjes and Gounden, 2011). According to Baissac *et al*, (2015), most analysts agree that it is still early to fully articulate the economic impacts of beneficiation in the country. There has been some criticism over the wide discretion granted to the Minister for the minerals in the strategies (Lovells, 2017).

3.3.5 Beneficiation lessons from South Africa case study

- An enabling environment was created through the use of policy and regulatory framework:
    - The Minerals and Mining Policy which highlighted the importance of creating favourable conditions to fully benefit from the country's mineral wealth;
    - The MPRDA acted as the mineral beneficiation regulatory framework; and
    - The MIP was established to stimulate investment in the country's manufacturing industry.
- South Africa's beneficiation policy is considered to be one of the most comprehensive strategies being employed by the government to encourage downstream activities. This is an example that could be used by other countries in refining their own policies.
- To implement the beneficiation strategy, the government established support structures.
    - Beneficiation strategy task team to put forward beneficiation strategy interventions so as to attain a coordinated and sustainable growth in mineral beneficiation; and
    - Industrial Development Corporation to promote growth in industrial development.
- Use of international trade agreements to attract foreign direct investment and have access to international markets for the finished or semi-finished product.

3.4 Indonesia

Indonesia, largest economy in Southeast Asia, is recognised in the global mining industry because of its significant nickel, copper, gold, bauxite, tin and coal production (UNCTAD, 2017; World Bank, 2020). As in many countries Indonesia's mining industry contributes significantly to government revenues, the nation's GDP and ultimately economic diversification

in the country. The mining sector contributed about 5% to the GDP of Indonesia in 2018 and in the same year the country had a 5.2% GDP growth (World Bank, 2020). According to the Nickel Institute (2016), Indonesia was ranked the largest producer of nickel in the world in 2013 with an average yearly nickel production of 400 000 metric tons before the 2014 export ban.

3.4.1 Nickel production

Ministry of Energy and Mineral Resources (2020) reported that nickel exports accounted for 7.3% of the total mineral exports in 2019 (Figure 3.4) and that most of the nickel ore that was being produced in Indonesia was being exported to China for downstream processing. Apart from being a significant resource, the Indonesian nickel deposits are of high quality with the archipelago deposit hosting more than 40% of total high grade lateritic nickel ore in the world (International Nickel Study Group, INSG, 2014). Major nickel producers include Indonesia, Philippines, Russia and New Caledonia and Indonesia is reported to host the world's largest reserves of nickel followed by Australia (www.statista.com).

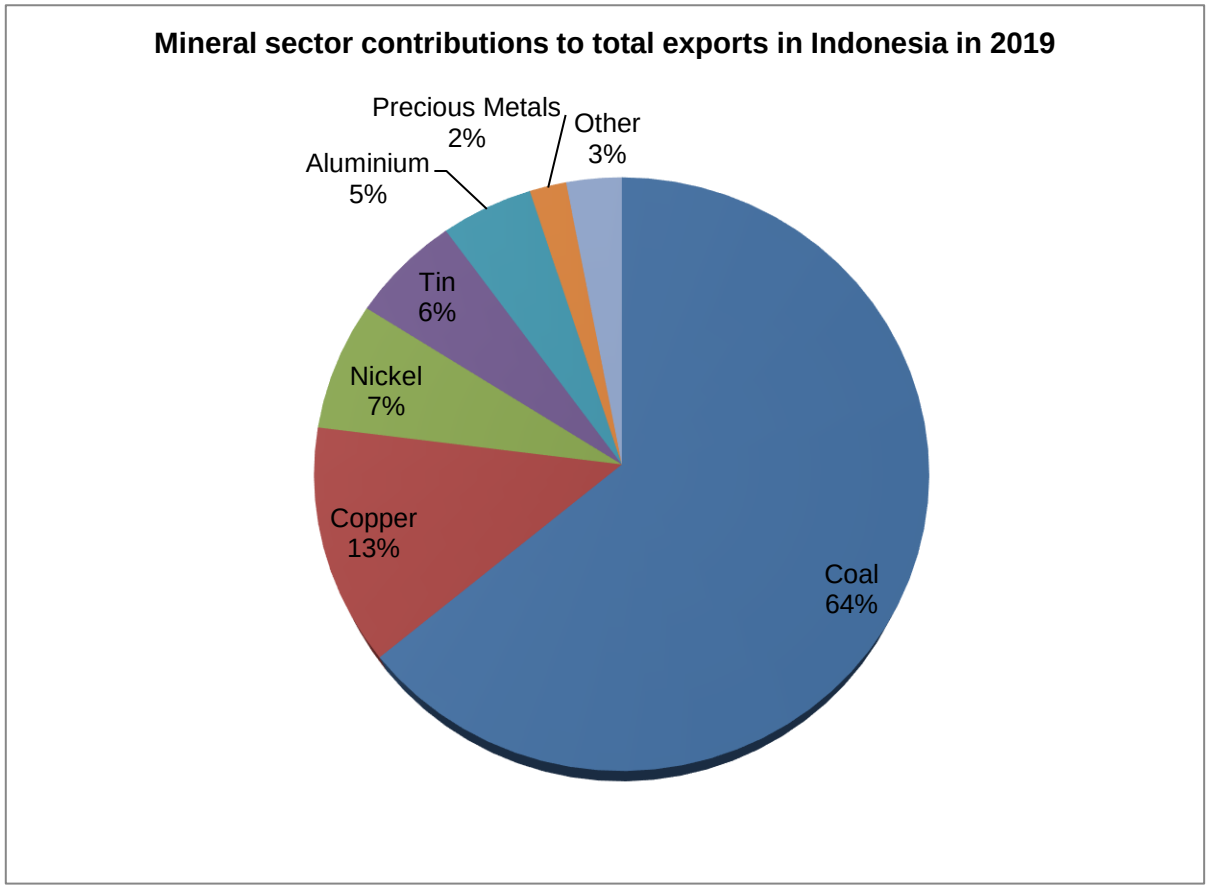


Figure 3.4: Export percentage by mineral. (Source: Ministry of Energy and Mineral Resources, 2020)

3.4.2 Indonesia's Mining Downstream Policy

National and sector specific policies assist governments in administering economic activities and influencing development outcomes. According to Chigumira *et al,* (2017), the effectiveness of such policies depends on policy design as well as policy consistency and effective policy implementation and coordination. The industrial policy for Indonesia focuses on ensuring that there is an increase in the contribution of non-oil and gas manufacturing sector due to increased value addition of the country's resources (Ministry of Energy and Mineral Resources, Republic of Indonesia, 2014). The country's mineral policy has local mineral value adding to generate greater benefits for the people in Indonesia and improving local supply of mineral commodities as some of its objectives (Ministry of Energy and Mineral Resources, Republic of Indonesia, 2014).

Indonesian Mining Law, No.4/2009, set an obligation to improve the quality of mining products by mining companies mining in the country (Finasisca and Hayati, 2019). The Indonesian Mining Law required license holders to conduct mineral adding value through processing and refining of mineral products under article 102 and 103 of Law No.4/2009 and the mining companies were supposed to begin adding value to mineral products within five years of enactment of the law (IGF, 2017). Restrictions under the law included an increase in mining tax and royalties and high export tariffs on unprocessed minerals. Mineral processing obligation and restrictions were formulated to reduce Indonesia's dependency on primary commodity exports (Finasisca and Hayati, 2019). The mining law also cited the use of regulations to control mineral ore exports.

According to Patunru *et al*, (2018) and Finasisca and Hayati (2019), mineral downstream obligation had the following objectives:

- Reducing excessive mineral exploitation in the country;
- Promoting development of downstream industries through increased development of smelters and refining industries;
- Creating a competitive mineral processed final product; and
- Ensuring the availability of local mineral raw materials.

3.4.3 Policy implementation

The enactment of the law began with a consistent move that required the implementation of mineral downstream through the issuance of regulations that support mineral beneficiation (Finasisca and Hayati, 2019). Government Regulation Number 10 was issued in 2010 and it stated that mining companies should prioritise processing and refining of mineral products as

adding value processes (Patunru *et al*, 2018). The government also published another regulation regarding mineral downstream processing under the Ministry of Energy and Resources Regulation No.7/2012 entitled “Improving Value Added Mineral Processing and Purification through Mineral Activities”. The regulation stated the banning of exporting raw mineral materials (IGF, 2017).

To locally add value to the minerals in its country the Indonesian government imposed an export ban on unprocessed nickel, bauxite, copper, gold, silver, tin and zinc (IGF, 2017). In January 2014 the Indonesian Ministry of Energy and Mineral Resources published Regulation No.1/2014 on Improving Value Added of Minerals through Mineral Processing and Purification Activities outlining conditions for the mineral export ban (Patunru *et al*, 2018). According to UNCTAD (2017), the export ban had provisions for two types of mineral categories. Type 1 minerals that included nickel, tin, bauxite, chromium, silver and gold were required to be refined before exporting. Type 2 minerals that included iron, copper, lead, ilmenite, manganese and zinc were allowed to be exported as concentrates until January 2017 giving the mining companies time to construct processing and smelting facilities.

The government of Indonesia argued that a tight ban was the only way to compel mining companies to move towards downstream development (Finasisca and Hayati, 2019). The Ministry of Finance introduced an export tax on type 2 minerals at 20% in 2015 increased to 60% in 2016 under the Minister of Finance Regulation No.6/2014 on the Determination of Exported Goods Subject to Export Duty and Export Duty Tariff (Patunru *et al*, 2018). According to INSG (2014), the Regulation No.7/2012 required nickel ore to be processed to a matte with more than 70% nickel content and companies that would have constructed or in the process of constructing a smelter were liable for an export licence.

The UNCTAD (2017) paper stated that the Indonesian government resorted to using the export ban so as to harness benefits that come with increased downstream activities and also reduce nickel ore extraction rate amid the 2006 to 2013 export boom. The export ban was necessitated by the fact that nickel smelting capacity did not change during the export boom and the country was being short changed on downstream benefits from the ore being extracted and also the boom resulted in major deforestation in the country (INSG, 2014).

Indonesia used the export ban as a trade policy to support national development objectives and these bans are sometimes referred to as commodity-led development strategies. According to Chigumira *et al*, (2017), the use of mineral commodity export bans blew up during the 2003 to 2011 boom in commodity price and that more than 50% of the export bans world-wide by 2012 were effected after 2009. UNCTAD (2017) noted that the Indonesian ban was

that of a trade policy with long term development objectives that were not entirely related to price boom but capturing a greater share of rents from the different avenues of the value chain.

The government passed another regulation in January 2017, Government Regulation No.1/2017, on the Implementation of Mining Company Activities for Mineral and Coal Mining (Patunru *et al*, 2018). The regulation allowed the export of raw nickel, bauxite and copper to resume but under certain conditions. The conditions as outlined by Patunru *et al*, (2018) included the need for mining companies intending to export raw materials to apply for a permit to the Ministry of Energy and Mineral Resources. Such permits were only granted after companies had shown progress in developing mineral processing facilities. The regulation also required companies in possession of export permits to allocate 30% of nickel concentrates to local smelters in a bid to continue encouraging nickel downstream processing (Finasisca and Hayati, 2019).

Support structures such as the Research and Technology Application Body and the Indonesian Science Institute provided technical support in the development of mineral processing and refining industry paying particular attention to the development of nickel processing technology (Patunru *et al*, 2018). Indonesia is a signatory of the ASEAN Free Trade Agreement and this gives the country access to the Asian markets for its mineral beneficiated products.

3.4.4 Beneficiation policy a success or failure?

Forbes, (2014) stated that the announcement of the export ban in Indonesia resulted in more than 250 companies applying to set up smelting plants an indicator of the capability of some companies to do local beneficiation for the benefit of the host country. According to IGF (2017), 25 companies invested USD 6 billion in processing facilities and by 2016 Chinese investments into nickel processing facilities had gone up to USD 15 billion. The nickel export ban compelled the construction of 9 new smelters with some being small scale before the ban was lifted in 2017.

Mining companies initiated partnerships with Indonesian companies to build smelters and refineries (Forbes, 2014). Nickel smelting capacity increased by almost 50% after the ban to beginning of 2016 and this resulted in an increase in Indonesia's share of value added to its nickel resource (UNCTAD, 2017). Exports revenues significantly reduced during the first year of the ban (IGF, 2017) and according to Patunru *et al*, (2018), the policy paid off in the years that followed especially for nickel. The export ban was lifted in 2017 even though insufficient smelters and refineries had been built due to mounting pressure from plunging government

revenues and increasing unemployment rates (Chigumira *et al*, 2017). The strategy to ban the export of nickel ores resulted in some investment for processing facilities but could not sustain optimal growth of the industry.

3.4.5 Beneficiation lessons from Indonesia case study

On analysing the Indonesian approach to encourage beneficiation UNCTAD (2017) noted that the export ban might not be suitable for use by all commodity-dependant developing countries as its success was mainly due to the lack of substitutes of the high-grade lateritic nickel ore. Indonesia is host to a high metal content nickel deposit and this geological quality resulted in Indonesia being able to force mining companies in the country to go downstream.

The export ban was made for both nickel and bauxite. The export ban for bauxite was a failure as bauxite companies in Indonesia closed down and aluminium refineries sourced the bauxite from other bauxite producing countries (IGF, 2017). This showed that export bans on commodities that can easily be substituted in the market place should be avoided. The cost of operating a nickel smelter is determined to a greater extend by quality of the ore. High grade ore is usually preferred as less energy is required for its processing and also smaller processing units are used and as a result operating costs will be reduced.

Figure 3.4 showed that coal was the major mineral export contributor at 63.9% followed by copper at 12.6% and nickel at 7.1%. According to (UNCTAD 2017), the government of Indonesia might have chosen nickel and bauxite as these represented a small percentage of the total mineral export. Impacts of failing on such commodities will not be heavily felt and they can be used as a trial before tackling more economically important mineral commodities.

The crash in commodity prices from mid-2014 to mid-2016 resulted in a fall in government revenues and also limited the amount that could be reserved for smelting and refining projects by the mining companies. According to UNCTAD (2017), the lifting of the ban during the crush in commodity prices period shows that trade policies are most feasible when commodity prices are high enough to counteract losses to be encountered.

The enablers for mineral beneficiation came from legislative framework that was used to pressurise mining companies to comply with government requirements. The country also used support structures such as Research and Technology Application Body and the Indonesian Science Institute to provide technical support for the downstream activities. The ad hoc responses in implementing the beneficiation policy using export bans was as a result of a lack of well formulated comprehensive beneficiation strategy. According to Finasisca and Hayati, (2019), effective implementation of policies is as a result of maximum coordination between

the government and the business community and consistency and transparent policies are key to the success of a beneficiation strategy.

3.5 Australia

The mining industry in Australia is one of the few that have full integration with the economy and have a local skilled labour force (Minerals Council of Australia, 2019). It contributes significantly to the national economy as it is the country's largest export earner and also highest generator of government revenues (U.S. Geological Survey, 2020). The country is highly endowed with high quality and close to the earth's surface mineral resources enabling the mineral sector to be competitive on both quality and price on a global scale. The mineral sector is an export-oriented sector with an estimate of more than 70% contribution to revenue in 2019 that is profoundly influenced by commodity prices and global supply trends (U.S. Geological Survey, 2020). The mining sector accounted for 6% of GDP in 2017 and as a result it was the fourth largest contributor to the Australian economy and 54% of Australia's total exports (Minerals Council of Australia, 2019).

3.5.1 Lithium production

According to the USGS (2020), Australia hosts the third largest lithium reserves in the world and is the world's largest producer of hard-rock lithium spodumene contributing about 55% of the world's lithium production in 2019. Australian Trade and Investment Commission (2018) noted that the world's largest hard-rock lithium spodumene deposit is the Greenbushes project situated in Western Australia. The Greenbushes deposit produces nine of the ten mineral elements needed to manufacture lithium-ion batteries. These minerals include copper, nickel, cobalt, manganese, iron, phosphate, titanium, aluminium and bauxite with the exception of graphite. The increase in global lithium demand will result in lithium producers responding to the market conditions.

3.5.2 Lithium Beneficiation Strategy in Australia

In their 2018 paper IGF noted that there are no regulatory provisions to directly address the beneficiation of mined minerals in Australia but the government has put in place policies, initiatives and strategies to leverage the country's mineral resources. The industrial policy in Australia boosts investment in infrastructure and sharing of skills and technology. The policy recommends investment incentives to attract foreign investors and also incentives for research and development. It also mentions the need for increased government and industry involvement in industry development (IGF, 2018).

The Australian government adopted an enabling policy framework that promoted local and regional development using mineral resources. Australia managed to establish economic linkages in the country such that issues like rail and port infrastructure connects mineral production provinces to global infrastructure (Australian Trade and Investment Commission, 2018). An enabling environment was also created through benefit sharing mechanisms. Benefit sharing is considered as the distribution of monetary and non-monetary benefits generated through mining activities and its purpose is to ensure that a significant amount of the resource rent remains in the region in which it was generated (Soderholm and Svaln, 2015). The benefit sharing mechanisms included taxation, payable royalties, local procurement frameworks, training and developmental frameworks, joint ventures and investment funds. Developmental frameworks such as rail and port infrastructure allow the country to supply raw and finished products to global markets (Australian Trade and Investment Commission, 2018). Training of staff led to the country having world-leading expertise in effective resource exploitation and mineral processing.

A significant number of research activities were conducted that related to battery minerals and processing. Studies that were done by the Regional Development Australia Silicon Valley outlined the development of a focused lithium processing and battery mineral hub in the country citing possible hub areas (Australian Trade and Investment Commission, 2018). The report also prioritised the production of high-quality lithium end products. The Chamber of Commerce and Industry for Western Australia commissioned a business case in 2018 to unpack the economics of developing a lithium battery industry in Australia. The report highlighted that the inputs to the battery manufacturing sector should be readily accessible and this should be done by ensuring that Australia attracts investment in the development of precursor materials and also attract international companies that combine the precursor materials into cathodes and eventually battery packs.

The government released a strategy to move downstream and become competitive in lithium-ion battery manufacturing sector in 2018. The strategy, Austrade's new lithium-ion battery value chain: New Economy Opportunities for Australia acknowledged the comparative advantage that the country has that includes a strong economy, favourable business environment, stable political system, good governance, skilled workforce, well-established infrastructure networks and high rankings in global competitiveness (Australian Trade and Investment Commission, 2018). It highlighted the need for the country to attract investment for the battery manufacturing industry and the government has adopted prioritising attracting foreign direct investment as a key feature of the country's economic initiatives. The

government also used support structures to implement the beneficiation strategy, coming up with initiatives for long-term development that included the following:

- Royalties for Regions Program - the program was initiated by the government in 2008 and is provided by an annual investment of 25% of the royalties from the mining within the states (Soderholm and Svaln, 2015). The program promotes long-term investment in projects that include infrastructure and downstream activities.
- Resources 2030 Taskforce was established in 2018 to find ways of promoting competitiveness in the resources sector and also bolstering investment in the sector (Australian Trade and Investment Commission, 2018). Report released in 2018 recommended:
    - The need for a high-quality resource base that can easily attract investment;
    - Government to work hand in hand with the communities, public and private companies and all other stakeholders in building stronger communities and regions; and
    - Developing a skilled workforce.
- Future Battery Industry Cooperative Research Centre support lithium-ion battery manufacture through a research and development program that targets to optimize the country's competitiveness through the battery value chain. The government invested money in the centre so as to create a generation of highly skilled workforce that is equipped to create a vibrant industry sector (IGF, 2018).
- Industry Growth Centre initiative supports industry research collaborations and help industries to diversify into high value goods and services and becoming internationally competitive (Australian Trade and Investment Commission, 2018). The government established growth centres of key sectors with direct significance to the battery manufacturing sector such as the Advanced Manufacturing Growth Centre and the National Resources Growth Centre.

Australia used initiatives to support lithium downstream activities that included the following:

- The government invested a considerable amount of money and time in research and development supporting industry-led initiatives towards battery manufacture (Future Smart Strategies, 2017);
- 20% carry-forward tax offset on investment in battery value chain that was non-refundable; and

- Tax incentive of ten-year capital gains tax exemption for qualifying investments held for twelve months.

China, South Korea and Japan are the major battery manufacturers in the world and Australia's portfolio of Free Trade Agreements awards preferential access to some of the world's largest markets (Australian Trade and Investment Commission, 2018). Future Smart Strategies, an advisory firm that offers strategic advice on a wide range of issues that include market, policy, regulatory and sustainability, issued out a report on value chain analysis for beneficiating lithium resources for Australia in 2017. The study highlighted the rising global demand for lithium, the comparative advantage that Australia has and the need for Australia to act now to make the most out of the opportunity. The advisory firm released a roadmap (Figure 3.5) for the battery industry that the Australian government adopted that will see Australia at 100% local processing of lithium concentrate by 2025 and supplying 30% of global demand for lithium ion batteries by 2030.

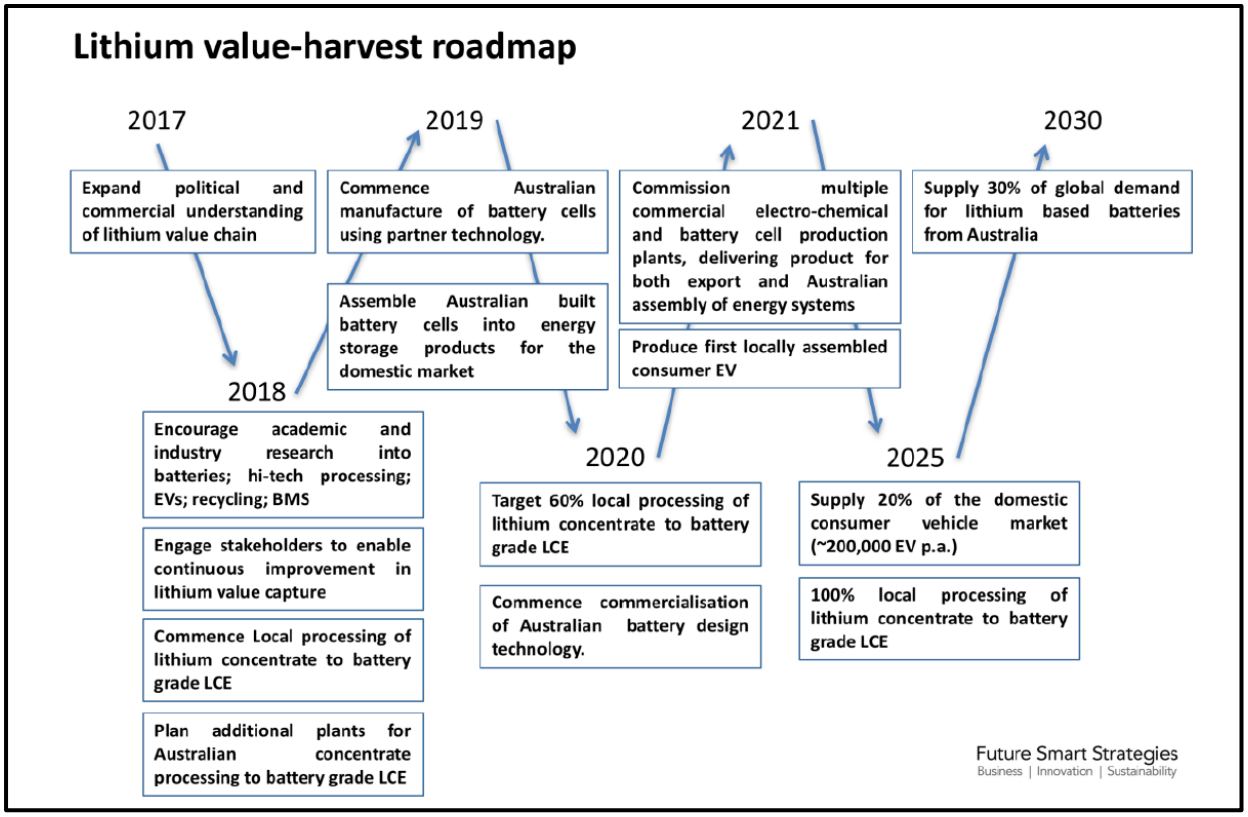


Figure 3.5: Lithium value-harvest roadmap in Australia (Source: Future Smart Strategies, 2017)

3.5.3 Beneficiation strategy a success or failure?

Most of Australia's hard rock lithium concentrate was being exported to China for processing and South Korea and Japan for transformation into battery packs (Australian Trade and

Investment Commission, 2018). The government realized the opportunity that was being missed in the battery value chain given the accelerated growth in demand for lithium-ion batteries. The government focused on policies that promoted investment in the sector and research and development so as to acquire skills and technology to be able to efficiently mine, process and assemble lithium battery packs. The policies and initiatives promoted incentives for foreign investments, incentives for research and development and increased government and industry involvement in the battery value chain.

Australia succeeded in encouraging academic and industry research into batteries, electric vehicles, high technology processing, recycling and promoting investment in the battery value chain. China and United States of America invested in processing lithium concentrates with three processing plants being developed in Western Australia resulting in the local processing of lithium concentrate (Association of Mining and Exploration Companies, 2018). Energy Renaissance, Australia's first battery manufacturing facility is set to be commissioned in 2021 and will have an initial battery capacity of 66MWh per annum that will increase with time and over 1700 direct jobs will be created (Commonwealth of Australia, 2020). The Energy Renaissance project aligns with the Federal Government's Technology Investment Roadmap, which identified Australia as a potential leader in battery manufacturing industry.

Commonwealth of Australia (2020) identified the need for the country to continue attracting foreign direct investment and transfer of technology from matured lithium-ion battery manufacturers. This will facilitate the development of the required level of battery production capability and progress by local Australian companies in developing relevant skills, technologies and low capacity lithium-ion production was noted. The Federal government provided funding to accelerate research and development to ensure the kick starting of the manufacturing of batteries (Commonwealth of Australia, 2020).

3.5.4 Beneficiation lessons from Australia lithium industry case study

- The need to have an attractive investment climate. Australia is highly ranked for ease of doing business and global competitiveness as a result of strong regulatory settings, little political risk or uncertainty, stable mining regime, highly educated workforce, high quality infrastructure and world class scientific and research institutions.
- Funding and facilitating investment in research and development so as to be able to break through the battery technology is of utmost importance. Lithium battery industry is a high technology industry and Australia invested a lot in research and development so as to be competitive in the lithium downstream sector.

- Australia used battery industry growth initiatives to promote lithium downstream activities that included the following:
    - Industry growth centre initiatives that promoted industry research collaborations;
    - Tax incentives to promote investment in lithium downstream activities;
    - Investment of 25% of royalties to long-term projects including infrastructure and downstream activities;
    - Resources 2030 Taskforce initiatives that promoted competitiveness and investment in the resources sector;
    - Future Battery Industry Cooperative Research Centre initiatives of creating a generation of highly skilled workforce.
- Use of support structures that included:
    - Research centres that focused on research and development in the battery value chain;
    - Resources 2030 Taskforce;
    - Regional Development Australia Silicon Valley;
    - Future Smart Strategies.
- Use of Free Trade Agreements that gave Australia easy access to some of the world's largest markets in Asia, Europe and North America.
- Establishing economic linkages important for structural transformation in a country.
- Use of benefit sharing to promote local and regional development.

3.6 General lessons

Table 3.1 summaries points that Zimbabwe can benchmark on in implementing beneficiation as a policy tool for economic growth and structural transformation. In selecting downstream policies, it is of paramount importance to understand the markets and trends of the finished products through market and cost benefit analyses for the beneficiation process to be a success.

Table 3.1: Lessons for Zimbabwe to benchmark on.

Issue	**Lesson**
Comprehensive Beneficiation Strategy	• Considerable success in the development of downstream activities achieved by countries with comprehensive downstream policies • Couple the comprehensive policy with strong governmental strategic interventions to fully realize downstream benefits • Policies should be stable, clear, certain, accountable and transparent for effective implementation and attracting of investment in downstream activities • Policy framework creates an enabling environment that can promote local and regional development • Lack of a well formulated comprehensive strategy can lead to ad hoc last minute responses in implementation
Legislative Framework	• The government uses legislation to provide the foundation for expediting downstream activities
Research and Development	• Downstream sectors are high technology activities and there is need for research collaborations for manufactured products to become internationally competitive • Government to take keen interest in research and development and invest time and funding
Support Structures	• Support structures are needed to implement the beneficiation strategy, coming up with initiatives for long-term development

	• Support structures provide technical support in the development of mineral processing and refining technology
International trade agreements and joint ventures	• To attract foreign direct investment and have easy access to international markets for the inputs and finished or semi-finished products • For technology transfer from matured downstream industries
Export bans	• Not suitable for use by all commodity dependent developing countries • Export bans on commodities that can be easily substituted in the market place should be avoided • Important to understand the markets and trends of the finished products • Most feasible when commodity prices are high
Use of a combination of both incentives and restrictions	• A success story for Botswana but with a use of more incentives than restrictions • Incentives should be time bound to avoid creating dependency
Government involvement	• Government to establish beneficiation support structures • Beneficiation strategy to offer support to the extractive industry • Protective measures from the government can create an industry that is not globally competitive when such interventions are lifted • Establishing economic linkages important for economic growth and development • Mining generated benefits to be used for local and regional development

3.7 Chapter summary

Beneficiation is being used by many resource-rich countries as a policy initiative to better manage their natural resources and fight against the resource curse. Promoting local value addition of minerals instead of exporting them in their unprocessed state at a reduced value, is usually perceived as an integral part of resource-rich governments' development strategies. The success of mineral beneficiation is country and commodity specific and also depends on other inter-related factors such as the ability to attract investment, research and development and the presence of beneficiation support structures. The success also requires the use of different and appropriately custom-made policy instruments and also depends on the maturity of a country's economy.

In trying to ensure the success of mineral beneficiation different countries are implementing different combinations of strategies that are enjoying different degrees of success. The most widely used implementation model is the positive incentive approach of positive incentives and this has also been recognised as a successful beneficiation policy benchmarking its use in the Botswana diamond case study. The negative incentive approach of more legislated control on the other hand is perceived to discourage investments, reduced job creation and less revenue in the short term with benefits, if any, being realised in the long term.

CHAPTER FOUR: ZIMBABWE MINERAL INDUSTRY, MINERAL POLICY AND BENEFICIATION POLICY

4.1 Introduction

Zimbabwe has a diversified and significant mineral resource base and the mineral sector has been identified as a means of fostering economic recovery, stabilisation and ultimately growth through beneficiation and revenue generation for the government. Chapter 4 discusses the country's political and economic setting as this has a bearing on the success of downstream activities. The chapter also discusses the mineral industry, mineral policy and beneficiation strategies being employed in the country. The government of Zimbabwe is cognisant of the mineral potential in the country and the impact policies and legal framework have on the successful exploitation of the resource base hence the formulation and implementation of strategies governing beneficiation.

4.2 Zimbabwe political context

Zimbabwe is a landlocked and resource rich country with an estimated 14.8 million people and a rural percentage of about 68% and those under 24 years at about 60% (World Bank, 2020). Political challenges and economic hardships have had a great impact on the well-being and upkeep of the citizens resulting in half of the professional class and some of the underprivileged leaving the country to seek better opportunities in countries such as United Kingdom and South Africa (World Bank, 2019).

According to AFDB (2018), Zimbabwe is characterised by a record decline in human welfare backdating to Ian Smith's Unilateral Declaration of Independence government with a struggle for civil and political rights. The 15-year armed struggle for independence achieved majority rule and independence in 1980 however the new constitution maintained political misrepresentation (World Bank, 2019). Adherence to the rule of law and human rights remain poor despite the positive messages that were being sent by the government. The new constitution after independence deferred efforts to adopt reforms to address historic marginalisation of indigenous Africans (AFDB 2018).

Zimbabwe has been going through political and economic transformation following the resignation of President Robert Mugabe in November 2017 and also the passing of the long-time opposition leader Morgan Tsvangirai. The 2017 transition came with the assurance for change and progressive steps towards a more democratic country for the Zimbabweans (World Bank, 2019). The ruling party, the Zimbabwe African National Union – Patriotic Front

(ZANU PF) won the 2018 national elections and Mr Emmerson Mnangagwa was re-elected president.

The current government has committed to amicable settlements of disputes including compensation of farmers who had land expropriated during land reform program (AFDB 2018). The government is also committed to economic and structural reforms ensuring macroeconomic stability and growth, clearing external debt arrears and improving governance and the business environment. In their 2019 report the World Bank noted that to date measures to a democratic country put in place ranged from the introduction of free state medical care for elderly and children to the arrest of high-profile figures on corruption allegations and the establishment of anti-corruption courts.

4.3 Economic context

Zimbabwe's economy was once among the most advanced economies in African continent but today it is among the most vulnerable with its declining agricultural and industrial base. According to AFDB (2018) and World Bank (2021), Zimbabwe was once a lower middle-income country with a life expectancy of 61 years and GDP per capita of $1205 in 1982 but this has translated to a GDP per capita of $1128 and a life expectancy of 60 years in 2020 earning a low-income status. Real GDP growth has been on the decrease from 2018 to 2020 (Table 4.1) and this has been attributed to policy mis-steps, exchange rate misalignment, unsustainable fiscal deficit, unsustainable expenditures, international isolation and COVID-19 effects (World Bank, 2019 and World Bank, 2021). Mineral sector contribution to GDP has been on the rise from 2015 to 2017 showing the importance of the sector to the country's economy and this also decreased from 2018 to 2020 (Table 4.1).

Table 4.1: Mineral sector contribution to GDP from 2010 to 2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GDP by Industry Growth Rates	**12.7**	**15.4**	**14.8**	**5.5**	**2.1**	**1.7**	**0.6**	**3.4**	**4**	**-6**	**-4.1**
Agriculture and forestry	7.2	1.4	7.8	-2.6	23	-5.2	-3.6	14.6	12.4	-17.8	-0.2
Mining and quarrying	**37.4**	**24.4**	**8**	**11.7**	**-3.4**	**0.4**	**8.2**	**8.5**	**13**	**-12.4**	**-4.7**
Manufacturing	2	13.8	5.3	-0.6	-5.1	0.2	-4	1	1.7	-8.7	-9.6
Electricity and water	19.5	6.4	0.3	5	5.4	-5.7	-23.4	10.7	3.2	-19.2	-7.9
Construction	14.1	65.1	23.5	3.9	6.9	4	4.9	2.2	7.7	-13.9	-11.4
Distribution, Hotels and restaurants	8.8	4.3	4.3	3.9	2.5	3.8	7.6	1.3	5.6	-8.2	-7.5
Transport and communication	4.7	0	6.7	7	1.1	4.9	-3.2	2.4	3.1	12.9	3.2
Finance and Insurance	-18.8	-4.1	49.2	14.2	-21.9	5.5	10.2	0	0.5	-6.1	-7.1
Government Services	72	61.9	36.2	7.2	7.5	-0.8	4.4	0.8	-0.8	1.4	-2.1
Real Estate Activities	4.9	48.9	59	0.7	4.8	11	3.1	2.2	0.1	-2.6	-2.1

Source: (Ministry of Finance and Economic Development, 2017 and World Bank, 2021)

Tyson, (2017) noted that the Reserve Bank of Zimbabwe (RBZ) prioritised funding of the fiscal deficit and this became one of the primary causes of liquidity challenges. Expenditure in the country is mainly driven by command agriculture and employment costs. Liquidity challenges and use of multiple currencies crippled the nation's economy. According to the World Bank (2019), introduction of new bond notes and the Real-Time Gross Settlement (RTGS) dollars did not help in increasing the cash flow as liquidity and foreign currency shortages continue to intensify. About 85% of Zimbabwe's foreign exchange comes from tobacco, gold, platinum, chrome and diamonds and its economy and livelihoods depend on natural resources.

Zimbabwe remains in debt and this reduces the country's ability to attract investment and access capital for structural transformation. In their 2019 paper, the World Bank highlighted that Zimbabwe's rank on the World Bank's Ease of Doing Business remains subdued because of lack of policy consistency and high levels of corruption in industries. Informal employment increased from 80% in 2004 to 95% in 2014 and this resulted in a gradual shift in resources from high to low productivity sectors leading to lower wages, higher poverty rate and a weakened tax base (Tyson, 2017). The poverty rate in the country increased from 70.9% in 2001 to 72.3% in 2011.

Structural transformation is considered to drive economic growth and manufacturing is also of crucial importance in the process. Transforming from resource extraction to manufacturing activities is important for increasing productivity, creating employment and poverty reduction. The November 2017 transition saw reforms efforts that included the following (AFDB, 2018 and World Bank, 2019):

- Budget deficit reduction through acceleration of macroeconomic and currency reforms;
- Imposing expenditure controls;
- Reviewing the Indigenisation and Economic Empowerment Act to ensure that only platinum and diamonds get to be subjected to the 51% ownership equity;
- Operationalising the "Zimbabwe is Open for Business" agenda to stimulate investment in the private sector;
- Reviewing the country's royalty rates and mining fees in the budget statement for 2018; and
- Revising export taxes for raw PGMs and chrome products

4.4 Zimbabwe mineral endowment

Zimbabwe is highly endowed in mineral resources that are found in prominent geological features such as the Greenstone belts, the well-known Great Dyke, Magondi Supergroup, the Karoo basins, the Carbonatite Igneous Complex, kimberlite pipes, pegmatites, alluvial and placer deposits (Figure 4.1) (Ministry of Mines and Mining Development, 2018). According to Mugumbate (2014), the geological formations host more than 60 minerals of economic value ranging from metallic ores, coal, industrial minerals and gemstones.

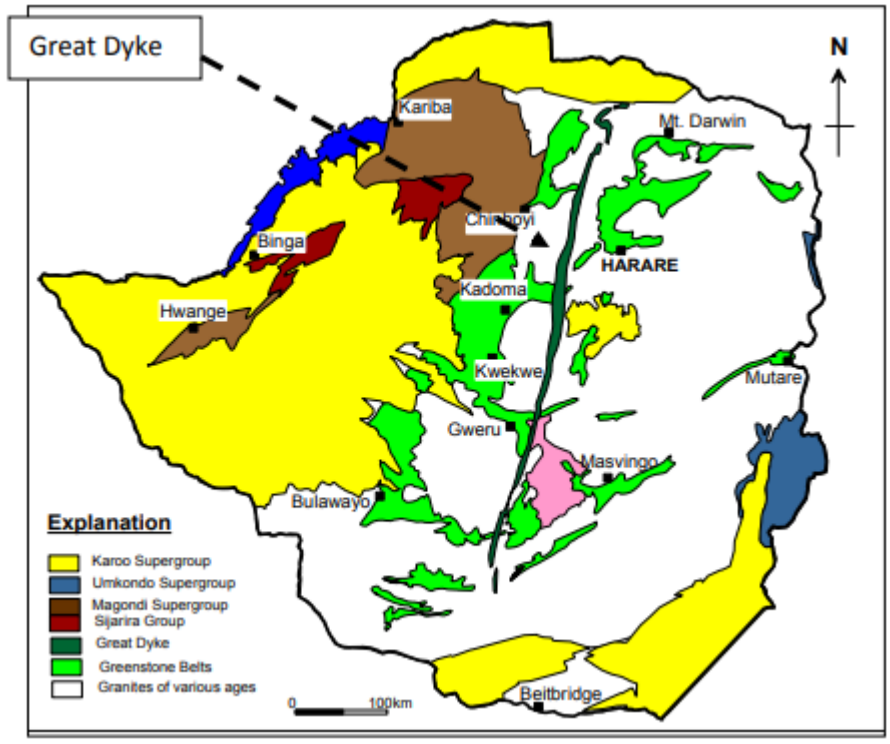


Figure 4.1: Prominent geological features in Zimbabwe. (Source: Veasey, 1997)

In the greenstone belts minerals are hosted in granite-greenstone terrains that can be recognised within the Zimbabwe Archean Craton (Veasey, 1997 and Wilson, 1983). The belts constitute the volcanic and sedimentary belts (Wilson, 1983) that host the bulk of the gold, chromite, silver, copper, iron ore, cobalt and nickel deposits (Jourdan *et al*, 2012). The Great Dyke is an elongated layered mafic intrusion that cuts across almost the whole N-S length of the Zimbabwe Craton. It is host to one of the largest high-grade chrome in the world, second largest PGM resource and significant gold, nickel, rhodium and copper (Ministry of Mines and Mining Development, 2018). The Magondi Supergroup is rift-related continental back-arc basins that were metamorphosed into a fold-thrust belt that is the Magondi Belt (Veasey, 1997).

The Karoo basin is composed of sedimentary and basaltic rocks that host high quality coal and coal bed methane resource. Diamonds are usually found in kimberlite rocks and the bulk of the kimberlite dykes and pipes are found in the Mwenezi cluster (Wilson, 1983). Pegmatites are igneous rocks with large crystals that form during the final stages of magma crystallization and host to minerals rarely found in other rock types. They are important sources for rare metals such as lithium, tantalum and cassiterite (Jourdan *et al*, 2012). Alluvial and placer deposits contain mineral deposits formed by the concentration of moving particles by gravity (Mugumbate, 2014).

4.5 Major minerals overview

4.5.1 Gold

The exploration and mining of gold in Zimbabwe has been ongoing from ancient times and according to the Ministry of Mines of Zimbabwe (2014), over 4000 deposits have been recorded with most of them located in ancient workings. The gold being mined occurs mainly in shear zone and hydrothermal vein deposits with some gold being recovered as a by-product of copper deposits and from alluvial sediments. Small scale miners accounted for 62% of the gold that was produced in the country in 2018 (Chamber of Mines, Zimbabwe, CoM, 2018).

4.5.2 PGMs

PGMs are hosted in the Great Dyke and they occur in a layer that is known as the Main Sulphide Zone and approximately 3m thick. The PGMs consist of platinum, iridium, palladium, osmium, ruthenium and rhodium (Ministry of Mines of Zimbabwe, 2014). The PGMs are mainly useful for their catalytic properties and they are also used in the manufacturing of jewellery (Mugumbate, 2014). According to Jourdan *et al*, (2012), the PGMs head grade in the Great Dyke is generally less than 4g/t and the head grade is lower than that of South African ores. PGM mining along the Great Dyke is currently being done at Zimplats, Mimosa and Unki Platinum Mines and Mimosa mine is Zimbabwe's oldest platinum mine with exploitation back dating to early 1920s (Mugumbate, 2014). A number of platinum projects are currently underway and Karoo Resources, one of the platinum projects, is expected to be one of the biggest PGMs producers in the country after reaching full capacity (CoM, 2018).

4.5.3 Diamond

Diamonds are being mined from kimberlites and according to the Ministry of Mines of Zimbabwe (2014), about 120 kimberlites have been discovered to date. Kimberlites of economic grades are found in the Murowa Diamond and the River Ranch Mines (CoM, 2017).

Discovery of diamonds in the Umkondo Basin in Chiadzwa has resulted in the opening of the Zimbabwe Consolidated Diamond Company (ZCDC).

4.5.4 Nickel

In Zimbabwe nickel occurs in the komatiite rocks of the Archean craton and currently production is at Trojan mine in Bindura and this is the only primary nickel producer in the country (Ministry of Mines and Mining Development, 2018). Nickel is also produced in the Great Dyke together with the PGMs and the country has huge nickel potential in laterite and serpentinite areas in the hydrothermal shear zones and greenstone belts respectively (Chigumira *et al*, 2017).

4.5.5 Coal

High grade coal deposits occur in the lower Karoo sediments that host about 12 billion tonnes of quality coal (Mugumbate, 2014). Major coal producers are Hwange Colliery and Makomo Resources. The coal industry has been weighed down by low coal prices offered by the Zimbabwe Power Company, capital shortages and inadequate foreign exchange allocations (CoM, 2018). Full potential of the industry is yet to be exploited as a number of coal projects are expected to come on board such as the Sunlight Energy and Liberation Mining.

4.5.6 Chrome

Zimbabwe is reported to have the world's second largest chromium ores of high quality after South Africa (Ministry of Mines and Mining Development, 2018). The Great Dyke in the country host the high grade chrome and this is mainly where mining is taking place. In their 2018 annual report, the CoM reported that chrome industry is being affected by high production costs, capital shortages, low ferrochrome prices and inadequate foreign exchange allocations.

4.5.7 Lithium

According to the World Bank (2019), Zimbabwe is ranked the fifth producer of lithium and nearly all lithium production comes from the Bikita pegmatite, one of the world's largest lithium-bearing pegmatite. Lithium has emerged to become the mineral for the future with its increased demand in the battery technology. Current investment projects include the Prospect Resources project in Arcturus and the Zulu Lithium exploration project in Fort Rixon.

4.6 Current state of the mining industry

Mineral output growth recorded a decrease in 2014 and 2015 (Figure 4.2) due to the fall in commodity prices. An improved production from gold, platinum, diamond, chrome, coal, nickel

and lithium has resulted in the mining industry growth of 8.5% in 2017 and 12% in 2019 (CoM, 2019).

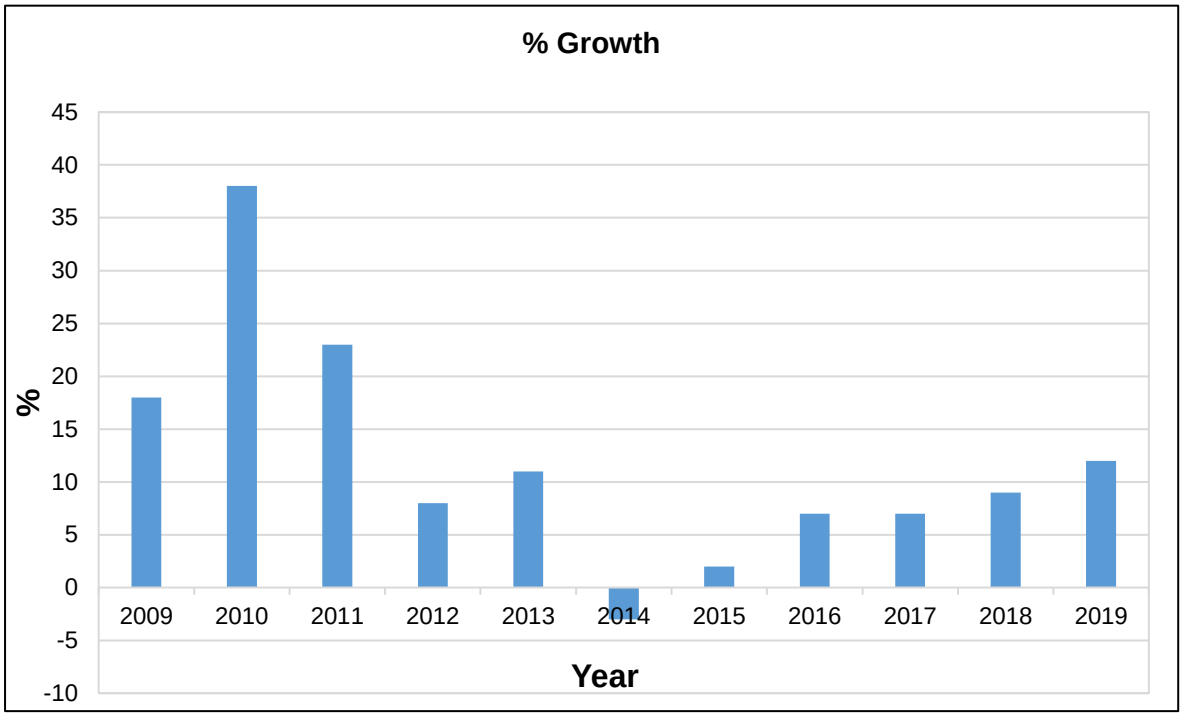


Figure 4.2: Mineral output growth. (Source: CoM, 2019)

4.6.1 Mining sector contribution to GDP

The mineral sector contribution to real GDP has been increasing from 2010 to 2013 and a drop in 2015 (Figure 4.3) due to depressed international commodity prices and foreign currency shortages. The sector contribution is on an upward trend, with an average contribution of 9.5% in 2019, showing the increasing importance of the sector to the country's economy (Figure 4.3). The policy focus on beneficiation and value addition in Zimbabwe prioritises the mining sector because of the finite nature of the resources. According to the Chamber of Mines (2019), this level of contribution to GDP is comparable to other nations such as Botswana (11.1%) and South Africa (7.3%) for the 2019 period.

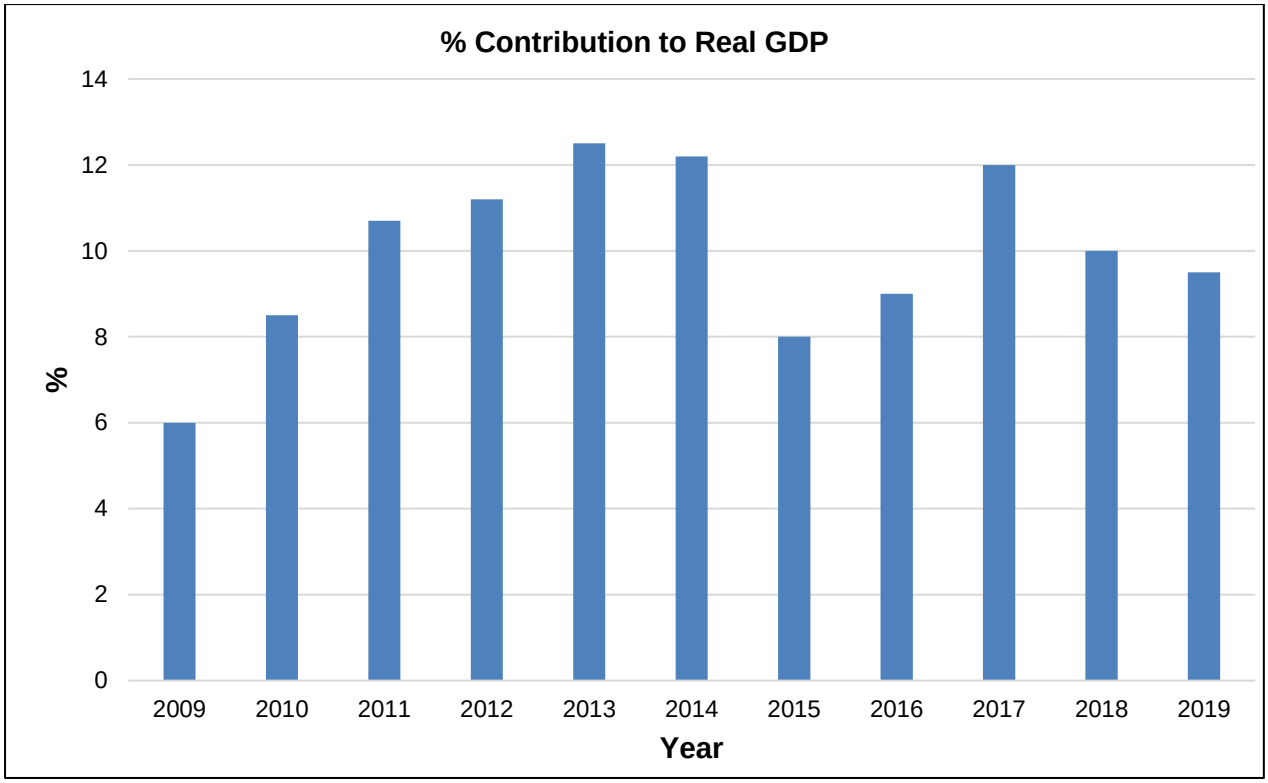


Figure 4.3: Mineral sector contribution to real GDP. (Source: CoM, 2019)

4.6.2 Mineral sector contribution to total exports

The mineral sector is the biggest contributor to export earnings having contributed about 59% of total exports in 2016 and 56% in 2019 (CoM, 2019). Figure 4.4 shows mineral sector contribution to total exports from 2012 to 2019 and a dip in 2015 resulted from a fall in mineral commodity prices. Yearly major contributors to mining exports are gold, platinum, ferroalloys and diamonds. Gold which is sold in refined form constitutes the bulk of the mineral exports as most minerals continue to be exported in their raw form hence the reason why the government is advocating for mineral beneficiation (Chigumira *et al*, 2017).

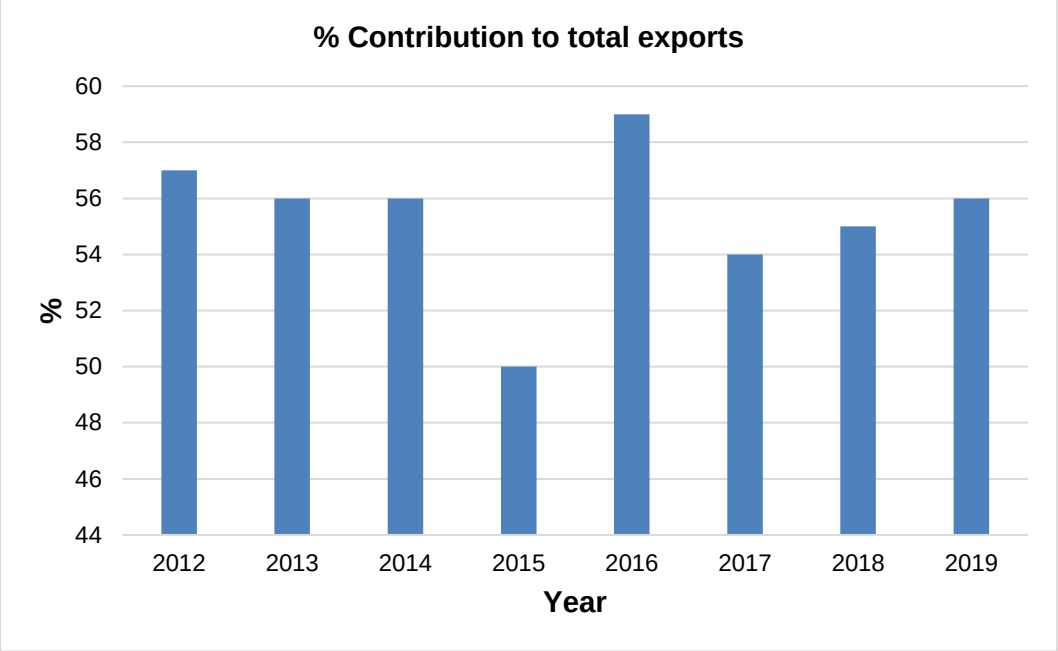


Figure 4.4: Mineral contribution to total exports. (Source: CoM, 2019)

4.6.3 Contribution to total fiscal revenue

The mining sector contributes to the government's fiscal revenue through royalties, Value Added Taxes (VAT), taxes on income and profits and custom duties (Dube, 2016). The increase in mining sector contribution from 2009 to 2014 (Figure 4.5) shows that the government was putting more focus on the tax measures in the mining sector as compared to other sectors. Statistics from the Ministry of Finance and Economic Development (2020) shows that royalties contribute more than half of the revenue collected from tax in the mining sector averaging about 53% of total mining fiscal revenues. Royalties increased from 2009 to 2014 noticeably for platinum that increased from 3% in 2009 to 10% in 2012 (Chigumira *et al*, 2017).

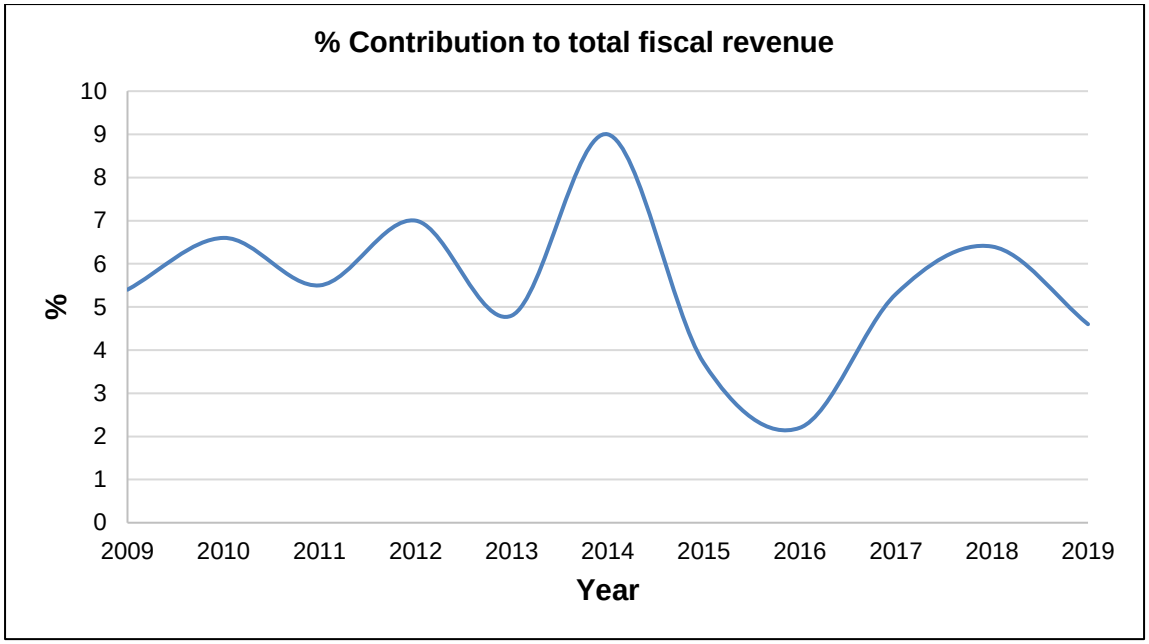


Figure 4.5: Mining sector contribution to total fiscal revenues. (Source: Ministry of Finance and Economic Development, 2020)

Gold and platinum continued to dominate in terms of contribution to mineral revenues accounting for 57% of total mineral revenue in 2019 (CoM, 2019). Gold, platinum, palladium, diamond and nickel, top 5 mineral contributors (Figure 4.6), accounted for 87% of total mineral revenue in 2019 compared to 91% in 2016.

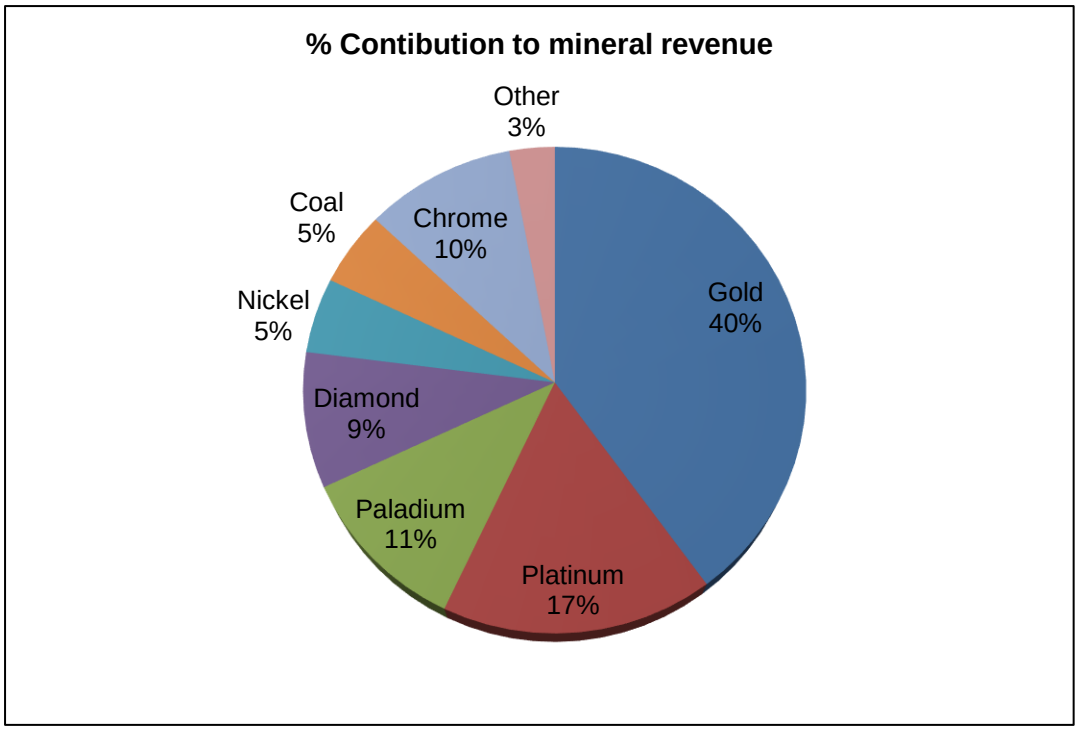


Figure 4.6: Distribution of mineral revenue. (Source: CoM, 2019).

4.7 Zimbabwe beneficiation policy

The minerals and metals in Zimbabwe present great potential to boost the economy and foster economic development. This potential of the mineral sector to contribute to economic growth and development is influenced by the mineral policies and legal frameworks surrounding the exploitation of the minerals. The formulated policies and legal frameworks and their implementation can either assist or undermine the possibility of deriving maximum benefits from the significant mineral endowment. Zimbabwe has implemented various beneficiation strategies over the past few years in trying to foster downstream activities and subsequently ignite economic growth and development.

4.7.1 Mines and Minerals Act

The Mines and Minerals Act [Chapter 21:05] of 1961 is the principal act that governs the mining sector and other Acts and Regulations stem from this Act (Chamber of Mines of Zimbabwe, CoM, 2019). Under Section 159 (3) part (iii) of the Mines and Minerals Act, an applicant for a special mining lease should show the mining commissioner *"a marketing plan setting out proposals and a timetable for the beneficiation and disposal of the output of the proposed mine together with any relevant marketing studies (72)".* Part (iv) of the Act states the need of proposals for the method of mining and ore treatment that will result in economic exploitation of the mineral deposit and the dates on which such treatment will start (CoM, 2019).

Section 243 (4) of the Mines and Minerals Act acknowledges the need to use incentives to encourage beneficiation as it states that a rebate of royalty will be given for any mineral or mineral bearing products used entirely in Zimbabwe or taken to any approved beneficiation plant in Zimbabwe (CoM, 2019). The Mines and Minerals Act has little requirements for beneficiation and value addition as it is not mandatory for minerals to be beneficiated before being exported. The finite nature of resource extraction requires a mining legislation that is robust to ensure resource-based economic development that can be sustained hence the need to finalise the Mines and Minerals Act amendments to align with current needs and realities related to mineral beneficiation (Ministry of Mines and Mining Development, 2018).

4.7.2 Draft Mineral Policy

For maximum benefits to be derived from the mining industry a beneficiation policy is expected to be articulated through a comprehensive policy framework that guides the mineral sector. Zimbabwe does not have a comprehensive mineral or beneficiation policy but beneficiation framework can be gathered from various pieces of legislations, policies and ministerial statements. Currently a Draft Mineral Policy that is yet to be finalised into a Mineral Policy

exists that discloses the government's drive on beneficiation. The Draft Mineral Policy developed in 2013 has its vision aligned with the Africa Mining Vision adopted by the African nations in 2009 (Ministry of Mines of Zimbabwe, 2014).

The Draft Mineral Policy of 2013 (v) has its vision statement *"equitable and optimal exploitation of Zimbabwe's mineral resources to underpin broad-based sustainable growth and socio-economic development"*. This was to be achieved through a detailed study of the nation's mineral endowment and also through downstream linkages into mineral beneficiation and manufacturing among other aims. The draft policy also aimed at achieving a mineral sector that is a major player in competitive commodity markets.

The government understands the fact that mineral resources are a finite national asset hence the need to ensure that sustainable activities in sustainable sectors are catalysed by mineral extraction (Dube, 2016). The mineral policy document provides a framework for a sustainable management of Zimbabwe's mineral resources and the involvement of the government and other stakeholders. One of the mineral policy principles as detailed in "Getting Zimbabwe Moving again" is maximising of value addition through increased beneficiation and local content (Short Term Emergency Recovery Programme, STERP, 2009).

In terms of mineral governance, the draft policy requires the mineral sector to take advantage of initiatives at regional and international level that promote good governance for enhanced industrialisation and economic diversification (Ministry of Mines and Minerals, Zimbabwe, 2013). The government of Zimbabwe is cognisant of the need for special procedures that promote sustainable mining. The draft policy clearly defines value addition and local content obligations and stipulates local skilling and technology commitments among other beneficiation related frameworks (Ministry of Mines and Minerals, Zimbabwe, 2013). According to Jourdan *et al*, (2012), skills and technology development are an essential activity in developing downstream linkages.

The draft policy acknowledges the need to devise a fiscal regime that ensures a fair value to the country for its resources with the investors being offered adequate incentives (Ministry of Mines and Minerals, Zimbabwe, 2013). According to Baissac *et al*, (2015), beneficiation can be stimulated using the taxation system and the Draft Mineral Policy proposes a minor export tax if the next stage of beneficiation for any commodity being exported is proved to be feasible by independent consultants.

Zimbabwe does not have a stand-alone mineral policy and this can lead to ad hoc impositions of new royalties and legislations. The draft mineral policy, developed in 2013 through public

participation and consultation, has long term developmental objectives for the mineral sector that talks with the national, regional and international initiatives. The policy aims to utilise the comparative advantage that comes with the rich mineral endowment to a national competitive advantage through linkages that include beneficiation. The policy calls for the development of a new Minerals Development Act that promote backward and forward linkages and development of skills and technology. There is need to finalise and adopt the draft mineral policy as such policies contribute to the possibility of deriving maximum benefits from the significant resource base.

4.7.3 Indigenisation and Economic Empowerment Act

The Indigenisation and Economic Empowerment Act [Chapter 14:33] (IEEA) was formulated in 2007 and made into law in 2010. The act required that at least 51% of the shares of all companies be owned by indigenous Zimbabweans (Zimbabwe Legal Information Institute, ZIMLII, 2019). According to the act an indigenous Zimbabwean is any person who before independence in 1980 was disadvantaged by unfair discrimination because of his or her own race. Early statements by the Zimbabwe's Ministry of Indigenisation showed no flexibility particularly in the mining sector.

Support structures to the IEEA included the establishment and appointment of the National Indigenisation and Economic Empowerment Board whose duties were to advise on the economic empowerment strategies and devise implementation measures (ZIMLII, 2019). The IEEA Act stated the need for a National Indigenisation and Economic Fund that will provide financial assistance to indigenous Zimbabweans and also assist in expansion of economic projects. The National Indigenisation and Economic Empowerment Charter was set out to provide a framework for ethical and good business conduct (ZIMLII, 2019). Some of the Charter objectives include the need to sustainably utilise Zimbabwe's natural resources in developing a competitive and industrialised economy and promoting indigenous Zimbabweans to equitably access the wealth of the economy. The Charter was set to promote natural resource value addition, use of local raw materials, local research and development, technology transfer and development of skills base to empower indigenous Zimbabweans (Chigumira *et al*, 2017).

The act required local content policies to be configured in such a way that they support indigenous suppliers (Chigumira *et al*, 2017). The Finance Act of 2018 then limited the 51% ownership compliance to the platinum and diamond mining sectors as opposed to the initial announcement of all companies with no flexibility in the mining sector (ZIMLII, 2019). The Minister of Finance and Economic Development while presenting the 2019 midyear budget

review announced the intention to repeal the 51% indigenous equity requirement for the diamond and platinum sectors and the law is yet to be amended in line with the pronouncement. These acts and statements have a great impact on the investment of beneficiation activities.

4.7.4 National Trade Policy

Zimbabwe National Trade Policy (NTP) governed the period between 2012 to 2016 and has promoting beneficiation of primary products in all sectors and increasing the manufacturing sector contribution to export earnings as some of its objectives (Ministry of Mines and Mining Development, 2018). The policy gave guidance on the use of trade policy instruments such as tariffs and non-tariff measures in stimulating and promoting value-added exports as well as safeguarding domestic industry (Baissac *et al*, 2015).

The policy appreciated that Zimbabwe's exports is dominated by primary commodities that are prone to frequent price shocks and meant to progressively transform Zimbabwe from being a primary product exporter to a major exporter of high quality, value-added goods. This was to be achieved through the regulation of export of primary products to boost local product beneficiation (Chigumira *et al*, 2017). Greater emphasis was put on the production and export of processed goods in the mining industry. Trade policy instruments to control the exportation of primary commodities where value addition has proven feasible and support programmes for value addition were to be put in place at each level of beneficiation (Ministry of Mines and Mining Development, 2018).

The NTP intended to consolidate and expand existing markets and also explore for new markets in the region (Ministry of Mines and Mining Development, 2018). Zimbabwe signed bilateral trade agreements with countries that include Namibia, South Africa, Malawi, Botswana, Mozambique and Democratic Republic of Congo to broaden the scope for market access. Zimbabwe participated in the negotiations of the African Continental Free Trade Agreement to boost intra-African trade (World Trade Organisation, WTO, 2020). Zimbabwe also participated in the Common Market for Eastern and Southern Africa (COMESA)-East African Community (EAC)-SADC Tripartite Free Trade for joint implementation of regional programmes and harmonisation of trade regimes (World Trade Organisation, WTO, 2020). The Interim Economic Partnership Agreement between Eastern and Southern Africa and the European Union was implemented for easy market access in EU (Ministry of Mines and Mining Development, 2018). Zimbabwe signed the Trade Facilitation Agreement with the World Trade Organisation in 2018 (World Trade Organisation, WTO, 2020).

4.7.5 ZimAsset

In trying to domesticate the AMV's thrust on mineral processing and value addition the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset) was formulated in 2013 and planned to work through to 2018. ZimAsset was formulated to achieve sustainable development through optimal exploitation of the nation's abundant natural resources (Ministry of Mines and Mining Development, 2018). ZimAsset agenda is built around beneficiation and value addition as these are part of the four strategic clusters. Beneficiation and value addition cluster had objectives that included improving capacity utilisation, employment creation and increasing of fiscal revenues (Chigumira *et al*, 2017).

The ZimAsset projected Zimbabwean economy to grow by an average of 7.3% between 2013 and 2015 and some of the strategies under the beneficiation and value addition cluster included establishment of diamond cutting and polishing centres, evaluation and improvement of the country's mineral resources database and prioritisation of human capacity building and development (Ministry of Mines and Mining Development, 2018). Other support structure for the beneficiation and value addition cluster included the establishment of the Pan African Minerals University of Science and Technology to fully implement human capacity building initiative (CoM, 2019).

4.7.6 Zimbabwe Mining Development Corporation Act

The Zimbabwe Mining Development Corporation Act [Chapter 21:08] specified the development of a corporation known as the Zimbabwe Mining Development Corporation (ZMDC) that will have operations controlled by the Mining Development Board (ZIMLII, 2019). The duties and functions of the corporation included the engagement in the prospecting, exploring, mining and mineral processing programmes in the country. The other duties also included to design, organise and implement mining development on behalf of the government (ZIMLII, 2019).

4.7.7 Special Economic Zones Act

The Special Economic Zones (SEZs) Act [Chapter 14:34] was effected in 2016 and the SEZs Authority to consider the extent of beneficiation and value addition of local raw materials in approving investor's applications. The SEZs Authority to consider the extent to which the proposed investment will result in establishment of linkages with in the domestic economy and promote its industrialisation (www.zimseza.co.zw).

4.7.8 Research Centres

The Institute of Mining Research carries out strategic research and development in the mining sector (Ministry of Mines and Mining Development, 2018). The research centre has highlighted that the country is currently at a low stage of mineral beneficiation for most minerals and has put forward recommendations to promote beneficiation that included acquiring foreign direct investment, skilled labour and invest in research and development. The Scientific and Industrial Research and Development Centre (SIRDC) that was established in 1993 to carry out research and development in the manufacturing and mining sectors of the country is one of the beneficiation support structures in the country (Baissac *et al,* 2015).

4.8 Measures for local processing

The government of Zimbabwe initially expressed its intention to ban the export of chrome ore in 2009 and the intention was later waived as a result of inadequate capital resources in the chrome sector (Baissac *et al*, 2015). Chrome ore exports were then subjected to a 15% export levy in the same year and this was increased to 20% in 2010. The ban was then effected in 2011 and then lifted in 2015 as the ban failed to stimulate downstream activities in the ferrochrome industry. Small scale chrome miners also lost their economic venture and livelihood (Chigumira *et al*, 2017).

In 2011 the government announced its intention to impose a 15% tax on the export of platinum concentrates (Baissac *et al*, 2015). Smelting the concentrates was considered as beneficiation and such matte was not liable for an export tax and this was to move on to exemption only when solid plans for platinum refineries construction were presented. The export tax on raw platinum was reduced to 5% in 2017 before the 2011 tax was even implemented and through the 2019 National Budget the export tax was deferred to January 2022 (CoM, 2018). Unki and Zimplats now have operating smelters with the exception of Mimosa Mine. Zimplats is still the only mining company with a refinery but it's currently under re-furbishments. The government also announced its intention to ban the exports of unprocessed platinum in 2013 but with no fixed timeframes (Baissac *et al*, 2015). The three platinum mining companies are at the moment working together with the Platinum Producers Committee to meet the country's expectation on beneficiation. The effort from the platinum sector resulted in the government delaying effecting any ban and also suspending the proposed export tax on raw platinum (CoM, 2019).

A 15% levy on the export of raw diamond was imposed by the government in January 2014 and as a beneficiation initiative value added tax on diamond local cutters and polishers was removed (Chigumira *et al*, 2017). A 15% royalty on rough diamonds sold to local cutters and

polishers was also removed in January 2015. Export ban for rough diamonds announced in 2014 is still pending (Baissac *et al*, 2015). In 2015 the government licensed only three diamond cutting and polishing firms for effective accounting of the processed diamonds. Gold is sold in refined form and constitutes the bulk of the country's mineral exports. The requirement for gold is that it should be refined to 95.6% purity before being exported out of the country and only sold to Fidelity Printers and Refinery which is a subsidiary of the Reserve Bank of Zimbabwe (Chigumira *et al*, 2017). An export ban for unrefined gold was announced in 2009 and suspended in 2015 after an improvement in compliance to refining of the raw gold. Table 4.2 summarises the beneficiation strategy in Zimbabwe.

Table 4.2: Beneficiation strategy in Zimbabwe

Enabling business environment and investment climate	**Support Services**	**Regional and Multi-lateral Agreements**	**Government Interventions**

• Legal framework governing exploration, exploitation and beneficiation expectations
  ○ Mines and Minerals Act
  ○ Indigenisation and Economic Empowerment Act
  ○ National Indigenisation and Economic Empowerment Charter
  ○ Zimbabwe Mining Development Corporation Act
  ○ Special Economic Zones Act
• Fiscal framework
  ○ Corporate Income Act
• Policy support
  ○ National Trade Policy
  ○ ZimAsset
	• Zimbabwe Revenue Authority
	• National Indigenisation and Economic Empowerment Board
	• Zimbabwe Mining Development Corporation
	• Minerals Marketing Corporation of Zimbabwe
	• Special Economic Zones Authority
	• Platinum Producers Committee
		• Bilateral trade agreements with countries such as South Africa and Botswana
		• Regional Trade Agreement – African Continental Free Trade Agreement
		• COMESA-EAC-SADC Tripartite Free Trade Area
		• Interim Economic Partnership Agreement
		• Trade Facilitation Agreement with the World Trade Organisation
			• Establishment of National Indigenisation and Economic Fund
			• Export bans
			• Institute of Mining Research
			• Scientific and Industrial Research and Development Centre (Diamond cutting and polishing centre and establishment of the Pan African Minerals University of Science and Technology)
			• Strengthening of the Geological Survey Unit

4.9 Chapter summary

Mining is the main driver of Zimbabwe's economy and the nation is host to the second largest platinum reserves in the world and is the fifth largest producer of lithium globally. Lithium is emerging as the mineral of the future as it is essential for re-chargeable batteries, a commodity that in mostly used in technology devices in the world. The manufacturing sector has seen a decline while natural resources extraction is on the rise. Mineral commodities are being sold as unprocessed products as there is no vibrant manufacturing sector in the country and the country is not harnessing all the potential benefits in the mineral value chain. The resigning of President Robert Mugabe in 2017 has seen the country undergoing political and economic transformation with commitments to economic and structural reforms to generate the much needed structural transformation. The economy of Zimbabwe is still vulnerable with high poverty rates, unemployment, fiscal deficits, chronic cash shortages and low investments.

Zimbabwe does not have a stand-alone mineral policy although various policies and legal frameworks were formulated for mineral beneficiation. The government has adopted various beneficiation strategies in trying to foster downstream activities. It has been using more of the negative incentive approach with increased regulation and state intervention in the mining industry. Outstanding was the ban on chrome in 2011 that was later lifted in 2015 as it failed to stimulate downstream activities in the ferrochrome industry. Export tax levies were effected for chrome, platinum and diamond in an attempt to encourage downstream activities and foster economic growth and structural transformation. Ban for unprocessed platinum concentrates is being planned to be effected in 2022. From the previous chapters it has been seen that it is important to understand the markets and trends of the finished products for export bans to be successful and that export bans are most feasible when commodity prices are high.

The IEEA 51% ownership equity now only applied to platinum and diamond sectors only showing inconsistences when applying policies to corporations and the possibility of relaxing the ownership equity have been announced in the 2019 mid-year budget. Changes in royalties are also not being applied consistently to all mineral commodities. Decrease in global mineral commodity prices is hitting the mineral sector and making it difficult to impose bans on unprocessed minerals. The fact that the government of Zimbabwe is in the process of amending the Mines and Minerals Act, which is the principal act that governs the mining sector, to align it to sustainable mining and also finalising a stand-alone mineral policy is a positive development towards beneficiation. Beneficiation and value-addition has been crafted in many economic policies in the country showing the commitment by the government in implementing the beneficiation strategy.

CHAPTER FIVE: ZIMBABWE CRITICAL MINERAL BASKET

5.1 Introduction

The chapter seeks to identify beneficiation constraints for identified and other critical minerals in Zimbabwe. According to Hayes and McCullough (2018), critical elements are geologically dispersed, concentrated in a few areas or can be recovered as a by-product of another commodity. Chapter 5 will highlight critical mineral basket for Zimbabwe's mining industry and the mineral resources quantum available for downstream processing. It will also highlight the current level of beneficiation against the government's expectation for the identified critical minerals and the current supply and demand of the critical minerals. As noted earlier, the country's mining industry largely depends on gold, PGMs, diamond, nickel and chrome as these are the top five contributors to mineral revenue. The government of Zimbabwe is prioritising these mineral commodities for beneficiation including coal bed methane (Ministry of Mines and Minerals, Zimbabwe, 2013). The chapter will highlight critical minerals that Zimbabwe should focus on for downstream activities. There is need to focus on critical minerals as these are essential to the economy and their absence would have significant consequences.

5.2 Critical Minerals Determination

Almost all the products we use contain minerals, with the minerals contributing to healthcare, food provision, communications, shelter, infrastructure and defence. Rapid increase in types of materials being used in advanced technology and geopolitical events surrounding the supply of rare earth elements among other factors made the analysis of critical minerals important (National Research Council, US, 2007). According to USGS (2018), a critical mineral is one that is critical for both national and economic security of a country, whose absence would have significant consequences and whose supply chain is vulnerable to disruption. This can be summarised as essential in use and subject to disruption of supply.

Supply disruption can be as a result of natural ores becoming exhausted, or too difficult to extract economically or in an environmentally friendly manner and increase in mineral demand as technology evolves (Hayes and McCullough 2018). The critical question is whether or not the requisite minerals will be available as and when required to meet demand of current and emerging technologies. The criticality matrix as established by the National Research Council, US, 2007 and depicted in Figure 5.1, assesses the importance in use of the mineral on the horizontal axis and the likelihood of supply restrictions on the vertical axis.

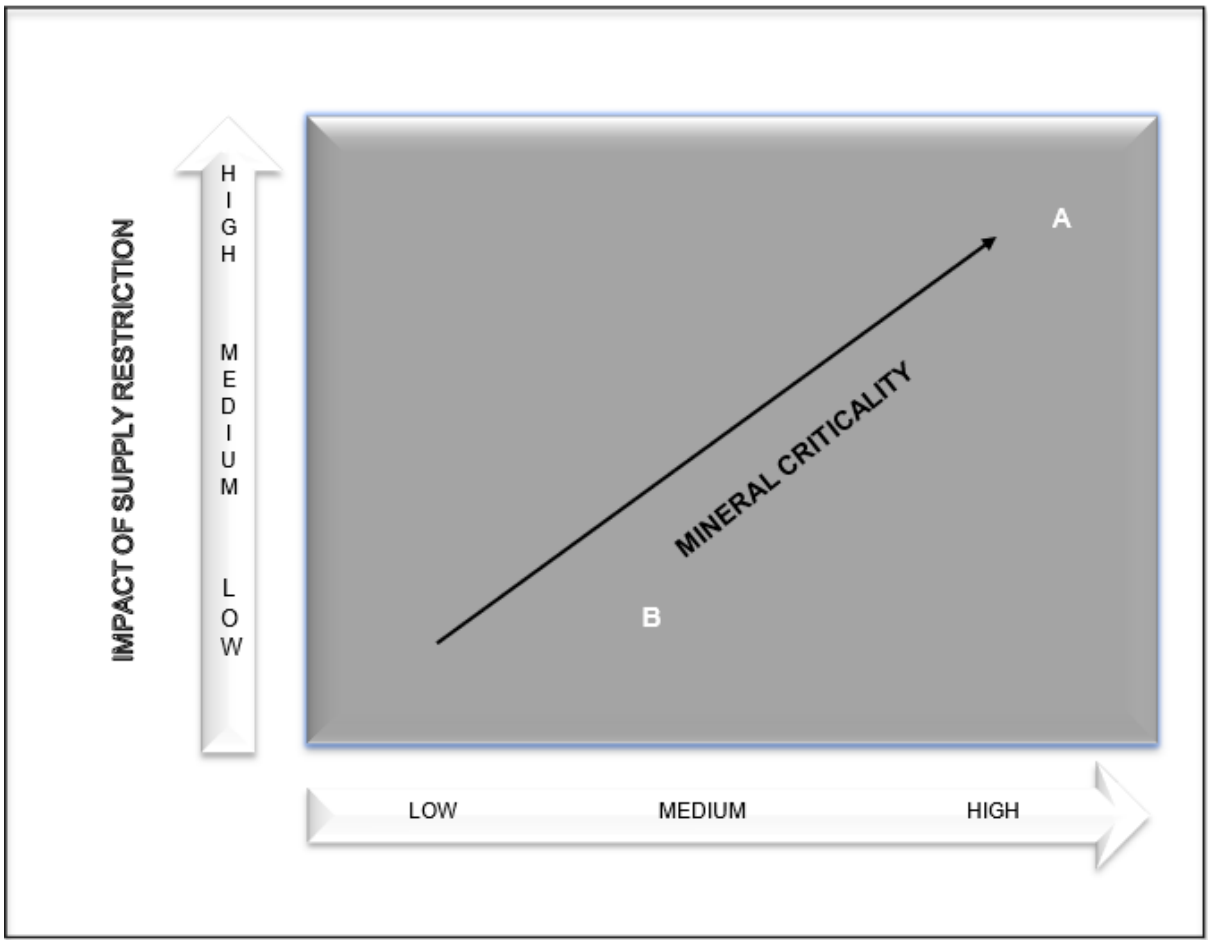


Figure 5.1: Criticality matrix. (Source: National Research Council, US, 2007)

According to the USGS (2018), the impact of restriction in a mineral supply is greater in cases where it is difficult to find a suitable substitute for that mineral. For instance, currently there is no viable substitute in existence for PGMs and rare earth elements for their application in automobile. The impact of the shortages in supply for these minerals will be greatly felt in the automobile industry. Importance of minerals can change over time with changing technology. Studies done by the National Research Council, US, (2007) identified 11 critical minerals (Figure 5.2), studies done by the USGS (2018) indicated 35 minerals as critical minerals including PGMs, REE and lithium. Baartjes (2018) categorised critical minerals as shown in Table 5.1 below.

Table 5.1: Groups of critical minerals

Electrical and Electronic Equipment	**Photovoltaic Technologies**	**Battery Technologies**	**Catalyst Technologies**
Tantalum Indium Ruthenium	Gallium Cadmium Germanium	Cobalt Lithium Nickel	Platinum Palladium Rare Earths

(Source: Baartjes, 2018)

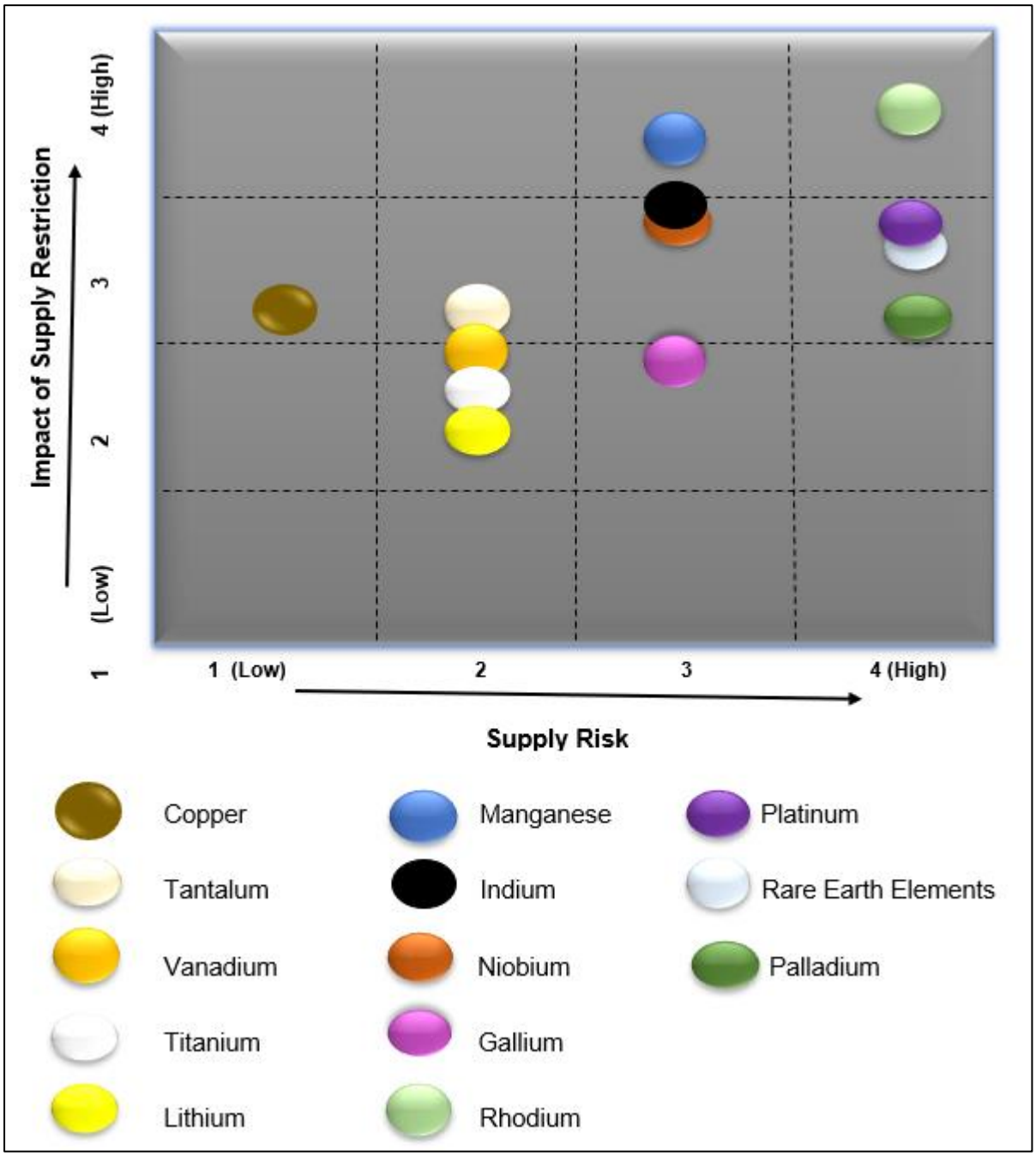


Figure 5.2: Critical minerals as identified by the National Research Council, US, (2007)

An analysis done by Hayes and McCullough (2018) on mineral criticality of 32 different publications identified REE, PGMs and Indium as the three consistently critical minerals. Several other studies further identified germanium, niobium, tungsten, cobalt, tantalum, lithium, antimony and gallium as critical. The PGM comprises platinum, rhodium, palladium, indium, osmium and ruthenium, and relative importance is high for the use in the autocatalytic industry for motor vehicle emission control (USGS, 2018).

A survey was conducted targeting government parastatal officials (Ministry of Mines, Chamber of Mines and Zimbabwe Mining Development Corporation), beneficiation and mining consultancy experts and mining operations experts. The survey targeted two participants per each of the three groups chosen. The chosen participants have vast experience and knowledge in the mining sector and high preference was given to experts with published beneficiation related papers. The survey had PGMs, gold, diamond and lithium as the top four critical minerals that Zimbabwe should focus on for beneficiation for economic development.

PGMs (platinum and palladium) are the second and third contributor to mineral revenue respectively and they contributed about 28% to mineral revenue in 2019 in Zimbabwe (Figure 4.6). The minerals in the catalyst technologies group give good existing information and plans as this is a relatively mature industry in the country. The country has the second largest reserve for PGMs and one of the countries apart from South Africa that is mining platinum as a primary product and is the third major country in global platinum production from 2015 to 2019 (Figure 5.3). The shallow depth of Zimbabwe PGMs deposits makes mining cheaper and easier (Chigumira *et al*, 2017).

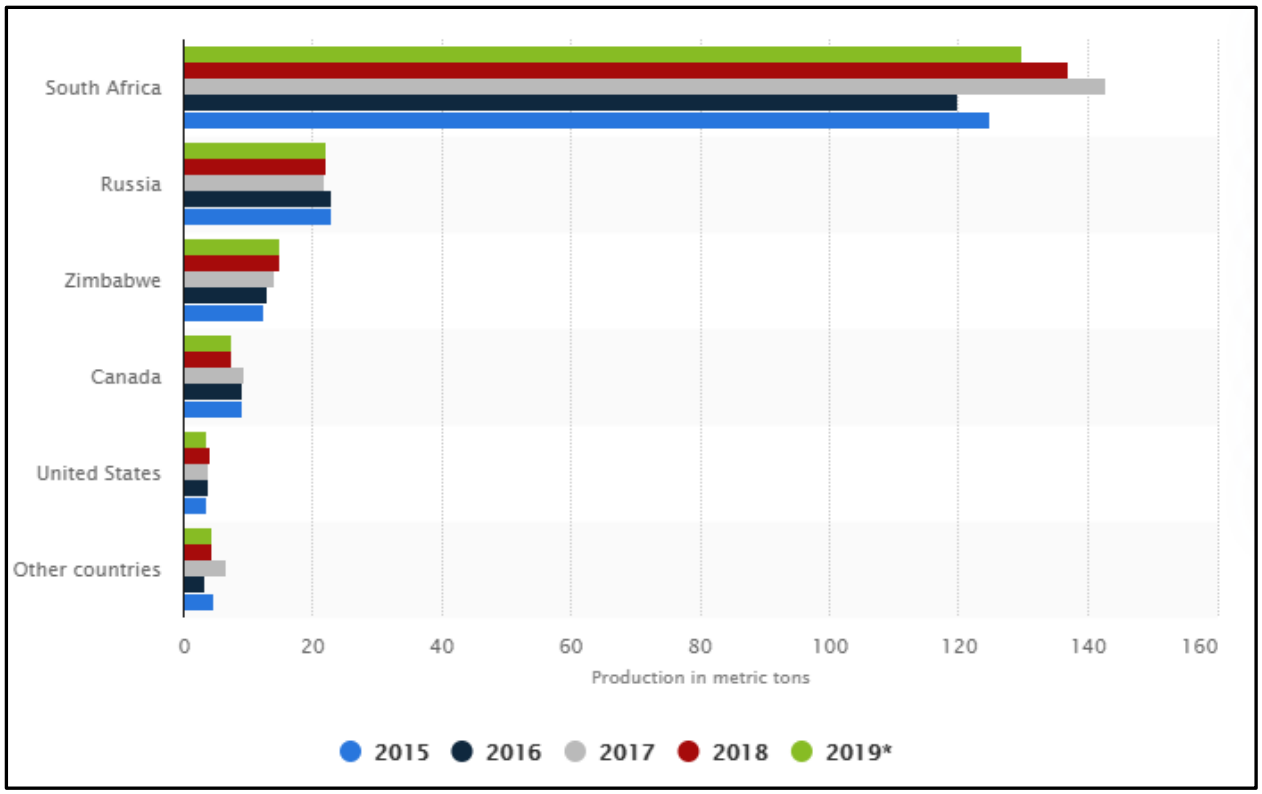


Figure 5.3: Major countries in global mine production of platinum. (Source: Statista, 2020)

Zimbabwe is the fifth producer of lithium globally (Figure 5.4) and lithium is emerging to become the mineral of the future with its increased demand in the battery technology. Lithium is used to a great extent in the manufacture of rechargeable Li- ion batteries and also drugs

for the treatment of several forms of mental ailments. Critical studies conducted and the survey done identified PGMs and lithium as critical minerals hence this research will focus on PGMs and lithium as critical minerals that Zimbabwe should focus on for beneficiation.

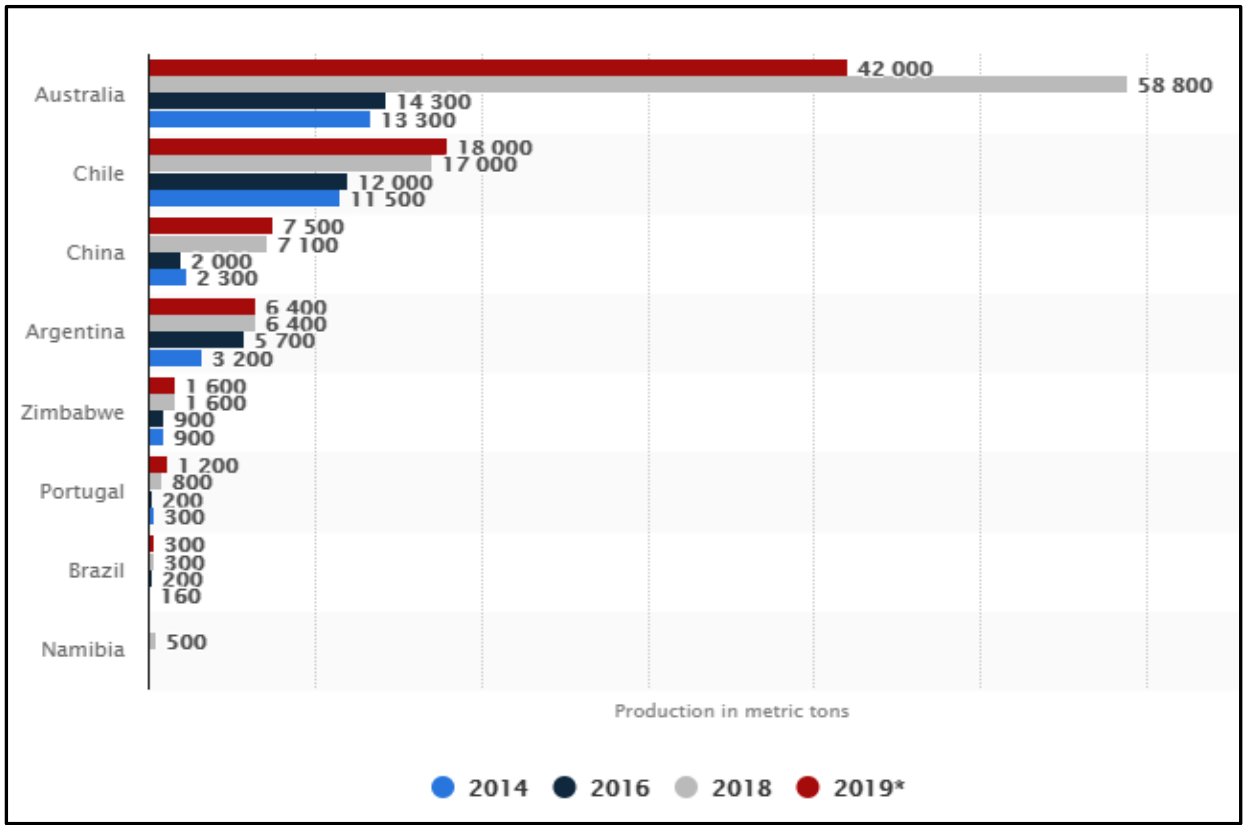


Figure 5.4: Major countries in global mine production of lithium. (Source: Statista, 2020)

5.3 PGMs Value Chain

As stated earlier on, mineral value chains denote the stages and processes that a mineral project goes through to produce final products and each stage is a representation of value addition on the previous stage. The Zimbabwean government targets smelting and refining as the obligation of PGMs mining companies in the beneficiation process. PGMs pass through sequential phases in producing the refined product (Figure 5.5). According to Dube (2016), mineral processing gives a composite concentrate containing PGMs, base metals and tailings. The dried concentrate is smelted in an electrical furnace to obtain a converter matte and sulphuric acid (Chigumira *et al*, 2017). After smelting, the matte undergoes base metal refining separating copper, nickel, cobalt and sodium sulphate from the PGMs concentrate. Thereafter the PGM matte is subjected to precious metal refinery to separate the PGMs, silver and gold (Dube, 2016). Fabrication is done to incorporate the PGMs into autocatalysts, jewellery and other industrial products.

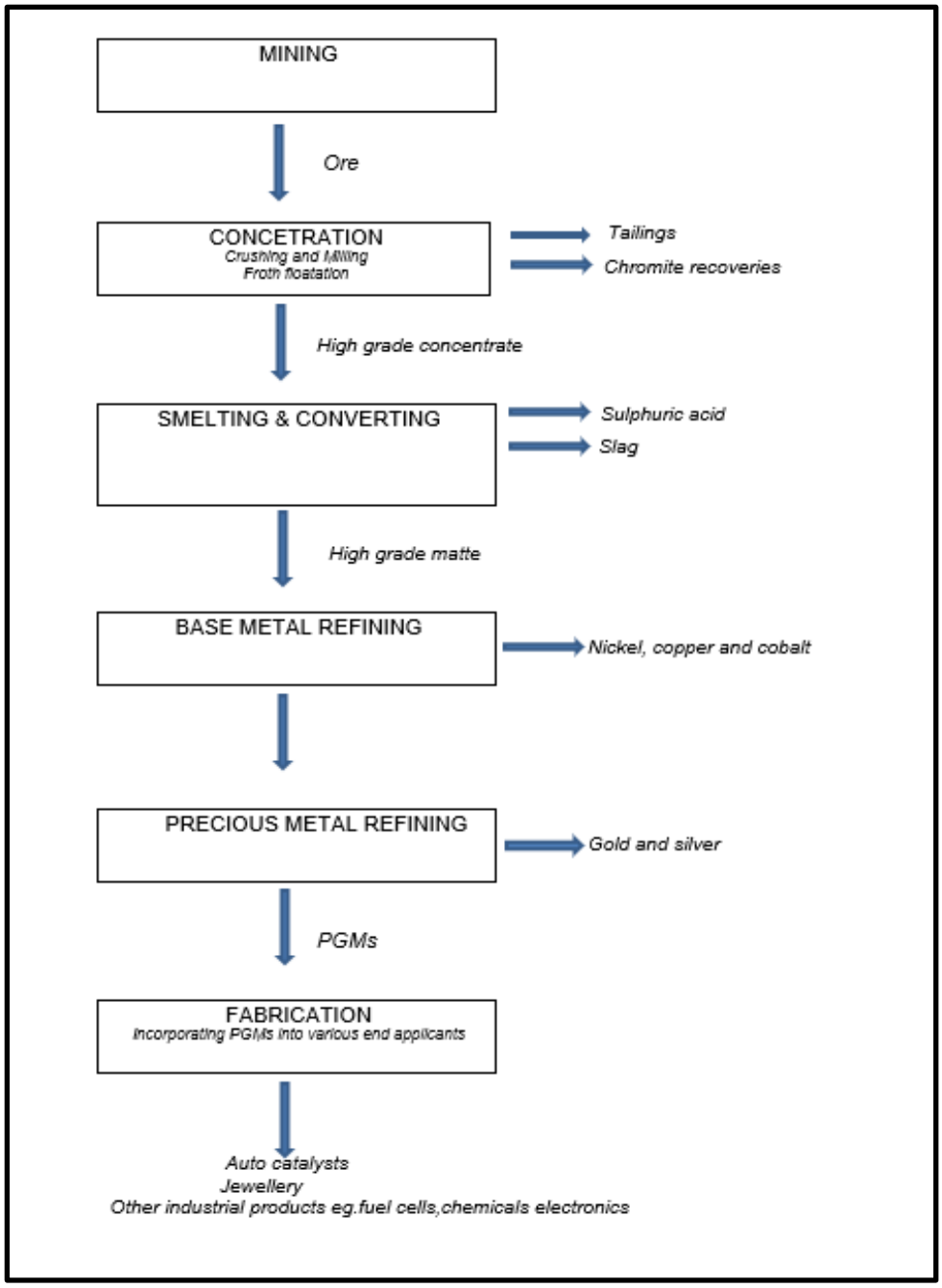


Figure 5.5: PGMs beneficiation flow diagram. (Source: Dube, 2016)

PGMs value chain and key players for each stage in Zimbabwe are shown in Figure 5.6. The Ministry of Mines estimated 2.8 billion tonnes PGM ore as earlier highlighted in Table 1.1. Mining along the Great Dyke is currently being done at Mimosa Mine, Unki Mine and Zimplats Mine. Mimosa Mine, jointly owned by Implats and Sibanye-Stillwater, has export activities for PGMs mostly confined to concentrates and resources of 6.4 million tonnes (Mt) Pt. ounces as at 30 June 2019. Unki Mine, whose main shareholder is Anglo Platinum has mineral resources as at 31 December 2019 of 10.7 Mt Pt. ounces (https://www.angloamericanplatinum.com). In the quest for supporting the government's development plans through committing to precious

metal beneficiation, Unki mines commissioned a smelter in 2018 of 62.110 tonnes per annum production capacity. The produced matte from Unki mine is then transported to Anglo American Platinum converter processing facilities in Rustenburg, South Africa, for further processing.

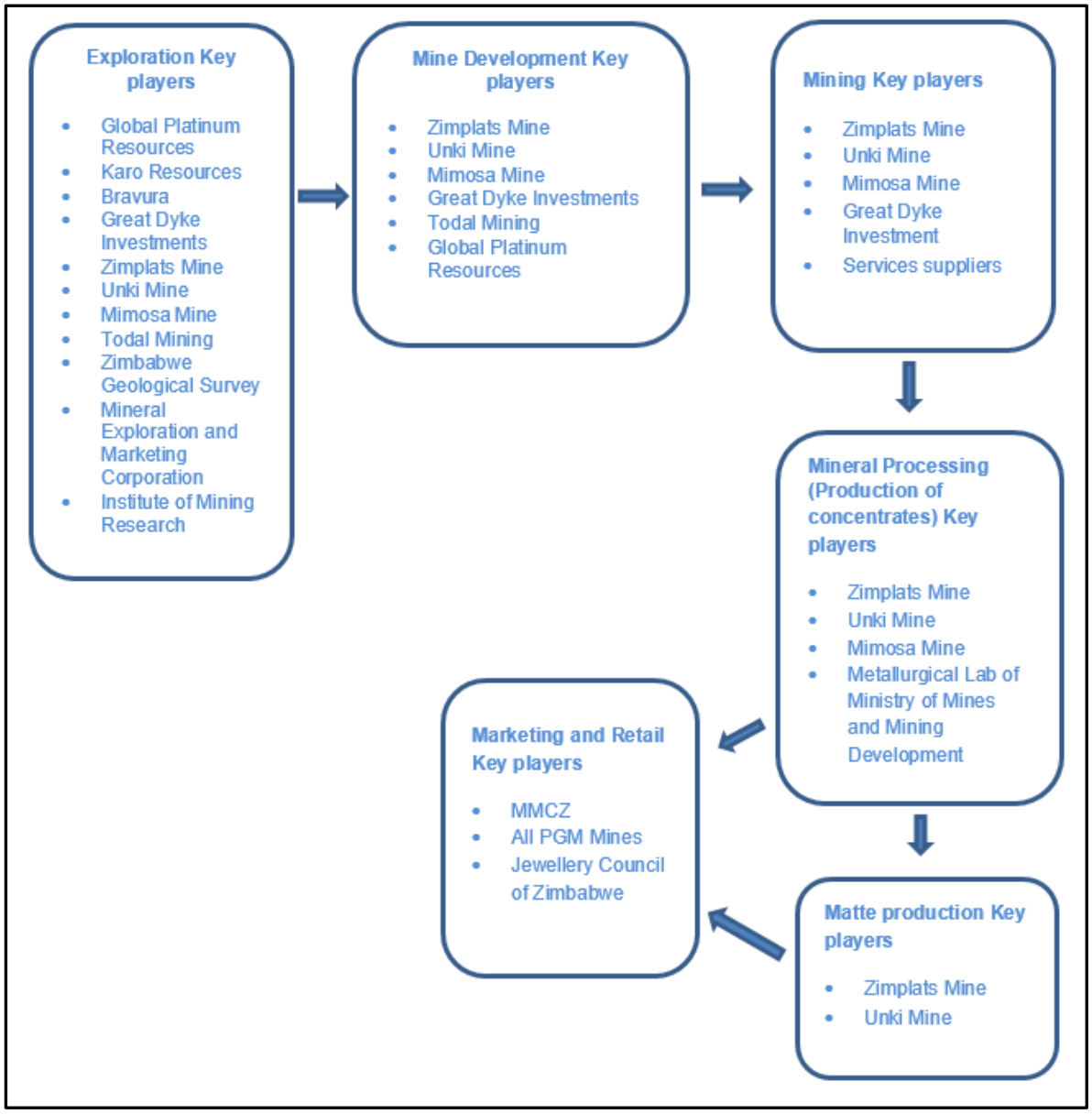


Figure 5.6: PGMs value chain. (Source: modified from Mlambo, 2016

Zimplats, whose main shareholder is Impala Platinum, is still the only mining company with a base metal refinery (https://www.zimplats.com). The base metal refinery is currently not in use as it is undergoing refurbishment projects. The matte from Zimplats is sent to Impala refining services in South Africa for subsequent precious and base metal recovery. Zimplats issued a 10% equity stake to its employees through the Share Ownership Trust Fund as part of its Indigenisation implementation plan. Zimplats mineral resources were 56.5 Mt Pt. ounces as at 30 June 2019 (https://www.zimplats.com). These three platinum mining companies are

working together with the Platinum Producers Committee, Chamber of Mines of Zimbabwe subcommittee, to meet national expectation on beneficiation. Efforts from the platinum sector resulted in the government suspending the proposed export tax on non-beneficiated platinum in the country (CoM, 2019).

The annual production capacities of the three mines for 2019 are shown in Table 5.2 as well as the estimated mineral resources. PGMs production has been gradually increasing for the three local mining companies (Zimplats, Mimosa and Unki) as shown in Figure 5.7.

Table 5.2: Platinum Annual Production and Mineral Resource Base, 2019

Mine	**Annual Capacity (Pt Oz/yr)**	**Mineral Resource (Million Oz Pt.)**
Mimosa	125 000	6.4
Unki	90 000	10.7
Zimplats	270 000	56.5
Total	**485 000**	**73.6**

(Source: Implats annual report, 2019, Anglo American annual report, 2019)

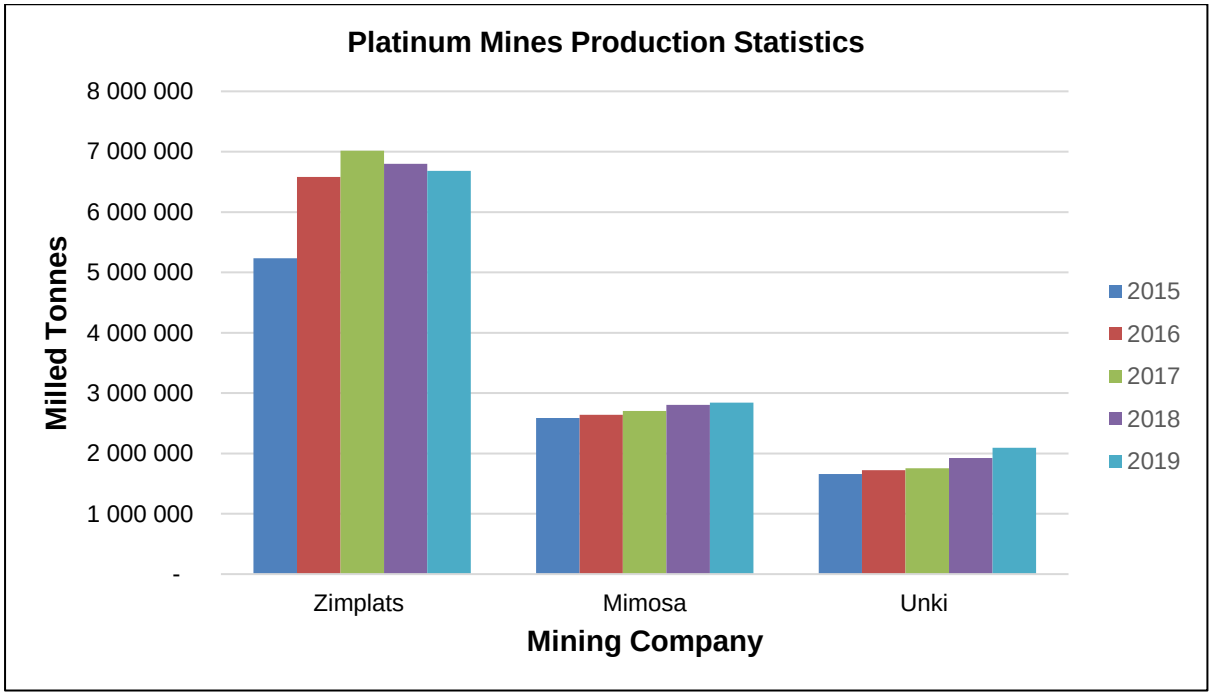


Figure 5.7: PGMs Production Statistics. (Source: Implats annual report, 2019 and Anglo American annual report, 2019)

The gradual increase in production was mainly driven by an increase in PGMs price and demand for the period under review. This gradual increase in production indicates the industry's ability to accommodate expansion projects in order to meet demand despite political and economic instabilities being faced by the country. However, increase in production is not

sufficient for conclusions to be drawn on the industry's ability to carry out downstream beneficiation.

There has been a remarkable rise in exploration and evaluation of PGM resources along the Great Dyke, owing to the increased demand for PGMs, with Todal Mining, Global Platinum Resources, Karo Resources, Bravura and Great Dyke Investments currently carrying out PGMs exploration on the Great Dyke. Great Dyke Investments is planning to start mining on the Great Dyke in 2021 as geological exploration, construction of two mine portals and surface infrastructure is close to completion (www.miningzimbabwe.com). According to CoM (2019), the Great Dyke remains largely under explored and the country needs to invest in the exploration and PGM evaluation of this well-endowed dyke.

5.4 PGM supply

World PGMs supply is currently from South Africa, Russia, America and Zimbabwe. Production statistics for the past five years were analysed and for the three PGMs (platinum, palladium and rhodium) South Africa and Russia are the leading producers. Zimbabwe is the third largest producer for platinum and rhodium but fourth producer for palladium. Palladium production in North America is high resulting in a higher total PGM production than Zimbabwe. The total 2019 primary and co-produced PGMs production is 14.9 million ounces (Johnson Matthey, 2020). South Africa contributed more than half of the 2019 production at 7.6 million ounces which is 55% of the world production (Figure 5.8). Russia accounted for 27% of the PGM world production at 3.8 million ounces' production followed by North America at 10% global production at 1.3 million ounces. Zimbabwe produced 870 000 ounces which is 6% of the world production (Johnson Matthey, 2020).

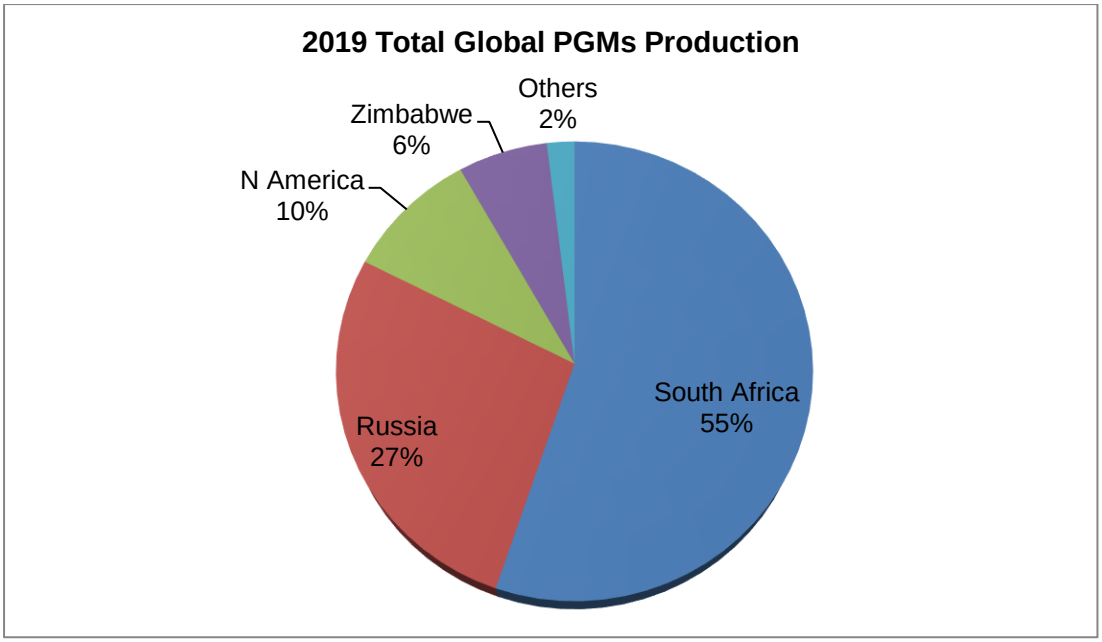


Figure 5.8: Country contribution to total global PGMs production for 2019. (Source: Johnson Matthey, 2020).

There has been a steady supply of PGMs from 2014 to 2019 (Figure 5.9) but the PGMs supply is forecasted to be severely impacted by the COVID-19 pandemic in 2020. The supply is expected to contract as a result of many mining operations temporarily shutting down and disruptions to the collection and refining of PGM containing scrap material. The effects of the pandemic are not yet quantified making it difficult to forecast supply of PGMs in 2020 during the time of writing. Measures taken to curb the spread of the virus have not only severely affected mining and refining activities but also transportation of the refined PGMs has also been heavily impacted.

As alluded to by Johnson Matthey (2020), there is an anticipated slight decline in South African PGM production levels, owing to the challenges the sector continues to face. The challenges include work stoppages as a result of safety concerns and labour disputes and the temporal closure of platinum mines that are not profitable. The ongoing expansion in platinum mines in Zimbabwe is projected to increase supplies from the country but this is however subject to the country's political stability.

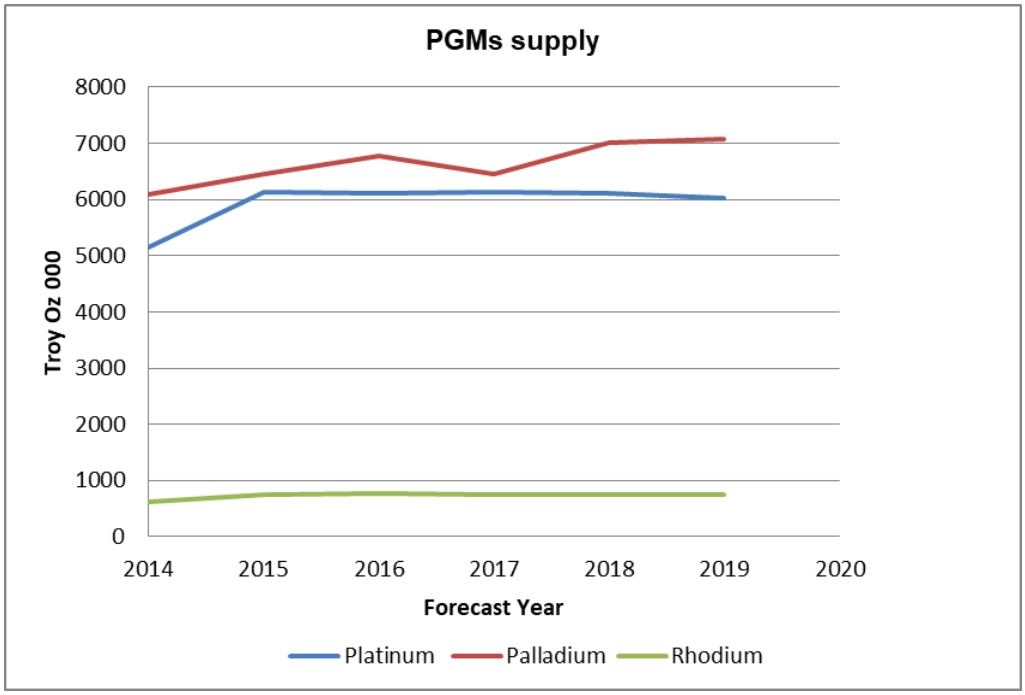


Figure 5.9: Total global PGMs supply. (Source: Johnson Matthey, 2020)

5.5 PGMs demand

PGMs demand is driven by specific industries such as auto catalysts, jewellery, industrial applications and investments. To be able to succeed in the local beneficiation of PGMs, knowledge of the downstream market demand is of critical importance. Demand sector analysis of platinum, palladium and rhodium for 2019 showed that 64% of the world total PGM troy ounces are used in the auto catalytic industry with 10% used in the jewellery sector, 20% in industrial applications and 5% in investments (Figure 5.10).

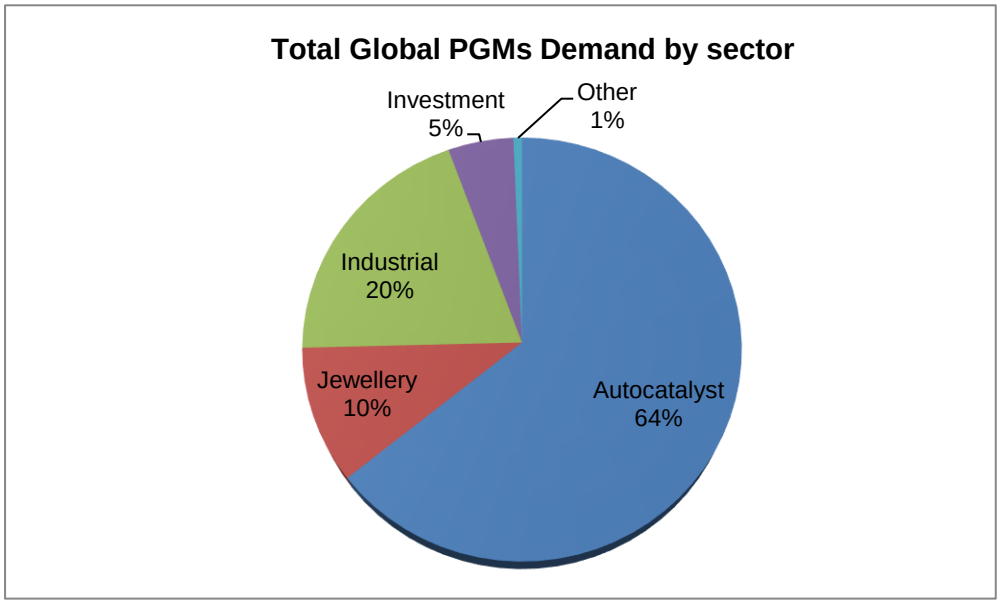


Figure 5.10: Global PGMS demand by sector for 2019 (Source: Johnson Matthey, 2020)

The performance of hybrid and gasoline automobile industry that require catalytic converters have a great impact on PGMs consumption in the autocatalytic industry (Johnson Matthey, 2020). According to Montmasson-Clair (2016), strict controls on emissions from vehicles driven by the clean air emission control legislation for automobiles has managed to sustain the demand for platinum, palladium and rhodium. Hybrid vehicles use more PGMs than the normal internal combustion engine vehicles and have been selling more than electric vehicles. Figure 5.11 shows that palladium is the dominant element in the autocatalytic sector constituting 71% being followed by platinum at 21%. In 2019 the autocatalytic industry consumed 88% of the global rhodium production.

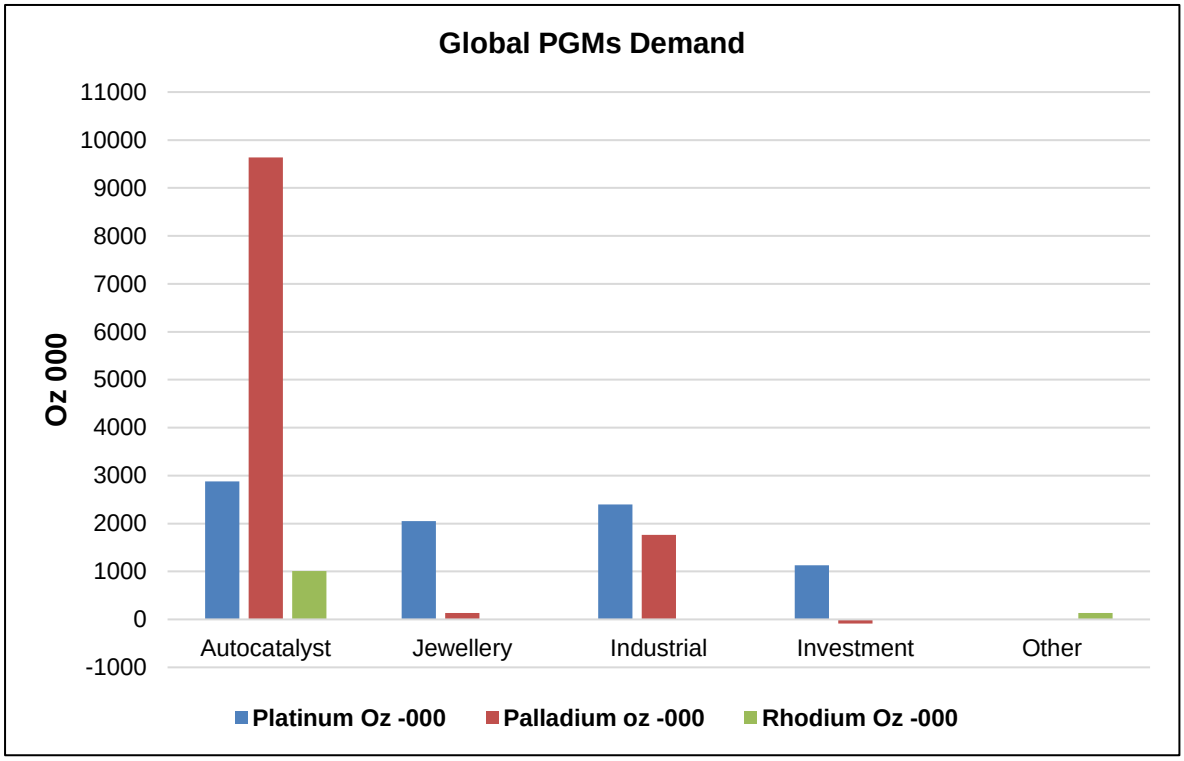


Figure 5.11: Global PGMs demand for 2019. (Source: Johnson Matthey, 2020)

Analysis of PGMs demand by region showed that 27% of the PGMs are consumed in China, 23% in Europe, 18% in North America, 11% in Japan and 21% rest of the world (Figure 5.12). The highest percentage of platinum at 29% is consumed in Europe and that of palladium and rhodium at 27% and 34% respectively is consumed in China. PGMs demand is more than the PGMs primary supply and according to Johnson Matthey (2020), the gap between demand and primary supply is expected to significantly grow in the future as PGMs demand increases.

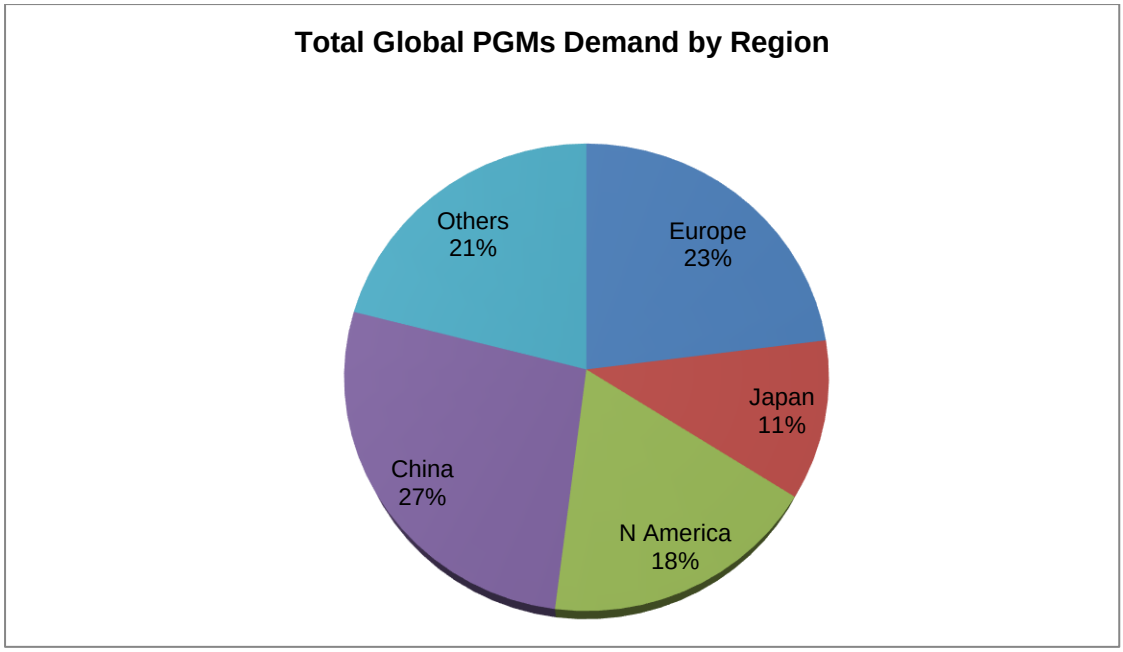


Figure 5.12: PGMs demand by region for 2019. (Source: Johnson Matthey, 2020)

5.6 PGMs Secondary Supply

PGMs supply that also affect international markets is from recycling and above ground stocks. PGMs recycling is defined by Ryan *et al,* (2010, 383), as *"the recovery of metal, contained in scrapped end-use products, back to the global PGMs supply stream"*. Figure 5.13 shows the total PGMs supply taking into account the contribution from recycling. Contribution from recycled PGMs increased from 5 540 000 ounces PGMs in 2018 to 5 942 000 ounces in 2019.

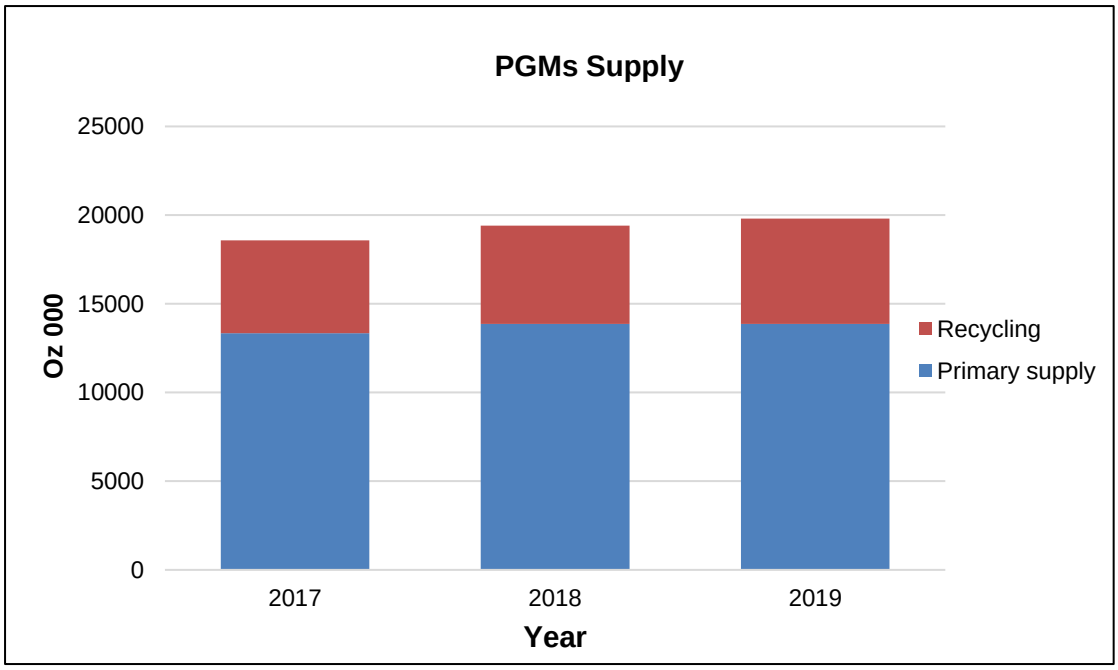


Figure 5.13: PGMs total supply 2019. (Source: Johnson Matthey, 2020)

Recycled PGMs contributes significantly to global PGM supply with a contribution of 30% in 2019 of the total global supply (Table 5.3) and according to Ryan *et al*, (2010), the recycled PGMs contributed 15% of total global supply in 2009.

Table 5.3: Recycling percentage contribution

Year	**2017**	**2018**	**2019**
Primary supply (Oz 000)	13349	13873	13859
Recycling (Oz 000)	5220	5540	5952
% Recycling contribution	28%	29%	30%

(Source: Johnson Matthey, 2020)

Recycling is making up PGMs market deficit and there is need for sustainable recycling methods to meet increasing global PGMs demand as the trend of ever tightening emission control legislation in China and stricter vehicle testing regimes in Europe's autocatalyst industry that require large amounts of PGMs to meet the legislative demands increases (Johnson Matthey, 2020). Montmasson-Clair (2016) highlighted the need to develop recycling systems with more advanced recovery techniques and also invest in research and development projects for the recycling systems.

According to Ryan *et al,* (2010), increasing recycling have an effect of sustaining PGMs supply that meets demand, and this results in the mitigation of metal price volatility. Recycling can also result in conservation of PGMs natural resources and limit climatic impacts of metal production as PGMs waste material have a much higher metal content as compared to ore from mining. Above ground stocks are defined as year-end estimates of PGMs held in investment stocks and the World Platinum Investment Council (2019), estimated above ground stocks at 2.85 million ounces at the end of 2018. The decision of above ground stockholders to sell or buy can be of influence on market prices.

5.7 Lithium value chain

Lithium mining in Zimbabwe is done in hard rock lithium pegmatites that can be subdivided into petalite pegmatites and spodumene pegmatites and the government of Zimbabwe targets production of lithium metal in the lithium beneficiation process. Lithium ore passes through sequential phases in producing the refined lithium and physical beneficiation is the first phase of processing the ore (British Geological Survey, 2016). The lithium ore is crushed and the lithium mineral physically separated using magnetic and gravity separation. Further lithium

concentration is achieved by dense media separation and froth flotation (www.premierafricanminerals.com). Dense media separation uses heavy liquids of an appropriate density that act in such a way that lighter minerals float with the denser ones sinking. Froth flotation uses water, compressed air and chemicals to separate the lithium minerals (British Geological Survey, 2016).

Gravity methods are used to separate lithium from heavy minerals such as cassiterite and tantalite and flotation methods are employed to separate lithium from feldspar and quartz so as to produce a lithium concentrate (Garret, 2004). Lithium concentrate is also produced by using high intensity separation methods that separate lithium from tourmaline and acid washing methods that separate lithium from iron and apatite. Lithium concentrates produced are then dispatched to a lithium carbonate plant for conversion to lithium carbonate and then to lithium metal for use in the lithium battery industry using the acid leaching process (British Geological Survey, 2016). Acid leaching is the most commonly used acid leaching process. Figure 5.14 shows processing of spodumene concentrate and Figure 5.15 shows lithium value chain and key players for each stage in Zimbabwe.

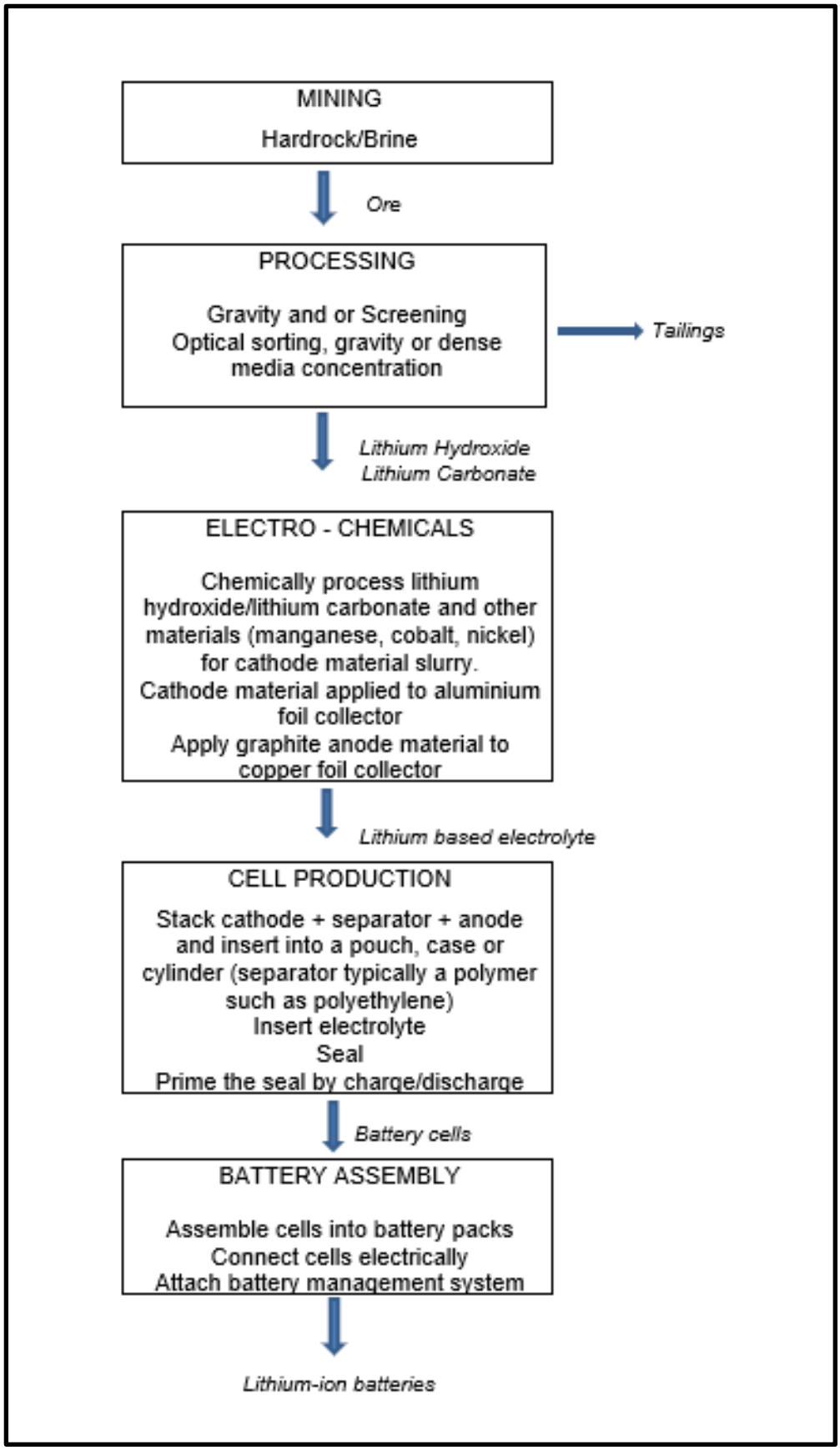


Figure 5.14: Flow diagram of the acid and carbonate leaching process for spodumene concentrate chemical beneficiation. (Source: British Geological Survey, 2016).

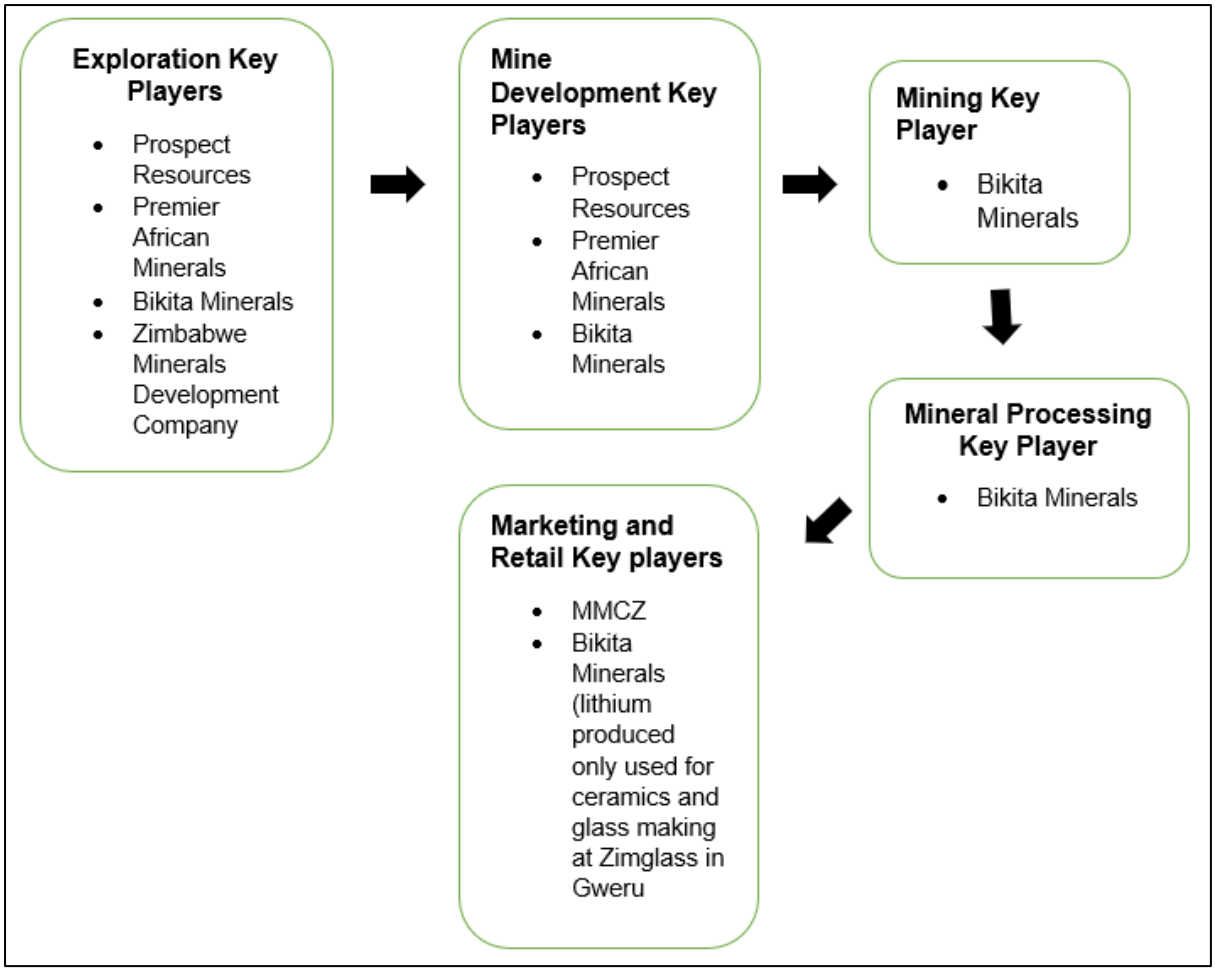


Figure 5.15: Lithium value chain, modified from www.premierafricanminerals.com

Bikita Minerals is currently mining one of the largest lithium mines in Zimbabwe, Bikita Mine, with reserves amounting to 11Mt lithium ore of 1.4% lithium grade (Ministry of Mines and Mining Development, 2018). Bikita mine has been in production for over 60 years and is recognised as one of the world's largest petalite deposit (Garret, 2004). Zimbabwe lacks the technological capability to beneficiate petalite ore into lithium and the concentrate produced is exported in its unprocessed form. Lithium that is produced at Bikita Minerals is only used for ceramics and glass making and government is looking at venturing into lithium-ion batteries manufacture.

The Arcadia lithium project in Zimbabwe is considered to be one of the biggest hard rock lithium resource in the world with a reserve estimate of 37.9Mt lithium ore deposit at 1.22% Li_2O (www.prospectresources.com.au). Prospect Resources is in the process of developing an open pit mine to extract lithium ore from the spodumene and petalite pegmatite and a concentrator which uses dense media separation and froth flotation technology that is ideal for a pegmatite orebody. Prospect Resources for the Arcadia project is in the process of

commissioning a lithium carbonate plant to produce lithium carbonate for the battery industry from petalite ore (www.prospectresources.com.au).

Zulu Lithium limited is a subsidiary of Premier African Minerals that currently holds various prospecting licenses for lithium in Zimbabwe's Matabeleland South province (www.premierafricanminerals.com). The lithium is also hoisted in spodumene and petalite pegmatites. Based on diamond drilling results an estimate mineral resource of 14Mt lithium ore at 0.90% Li_2O grade has been declared (www.premierafricanminerals.com). Further drilling is required to increase the confidence level in estimating the Zulu lithium project. Table 5.4 shows minerals resource base for Bikita Minerals, where mining is currently happening and the other two lithium development key players in the country.

Table 5.4: Lithium Mineral Resource Base and Estimated Grade

Mine	**Mineral Resource (Mt)**	**Grade (Li_2O)**
Bikita Minerals	11	1.4%
Arcadia lithium	37.9	1.22%
Zulu lithium	14	0.90%
Total	**62.9**	**1.18%**

(Source: Ministry of Mines and Mining Development, 2018; www.prospectresources.com.au; www.premierafricanminerals.com)

Figure 5.16 shows lithium production from 2015 to 2019. The production has been reported as a constant at 50 000 metric tonnes lithium carbonate production and this is from Bikita Minerals, the only mine that is currently operating.

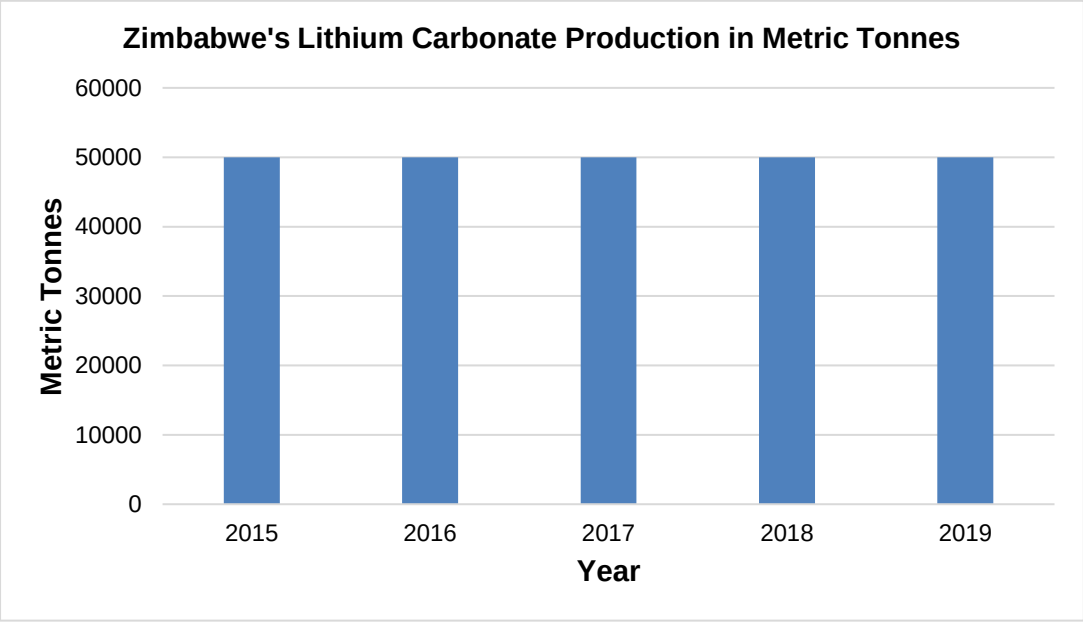


Figure 5.16: Lithium production in Zimbabwe. (Source: Statista, 2020)

5.8 Lithium supply

World lithium supply is mainly from Australia, Chile, China, Argentina, Zimbabwe, Portugal, Brazil and Canada. Production statistics for the past two years showed that Australia and Chile are the leading global lithium producers. Zimbabwe is the fifth largest producer of lithium in the world. Total 2019 lithium production was estimated at 77 000 tons and Australia contributed more than half of the 2019 production at 42 000 which is 55% of the world production. Chile accounted for 23% of the lithium world production at 18 000 tons followed by China that contributed 7 500 tons at 10% global production. Argentina supplied 6 400 tons of lithium content at 8% world production and Zimbabwe produced 1 600 tons which is 2% of the world production, Figure 5.17, (USGS, 2020).

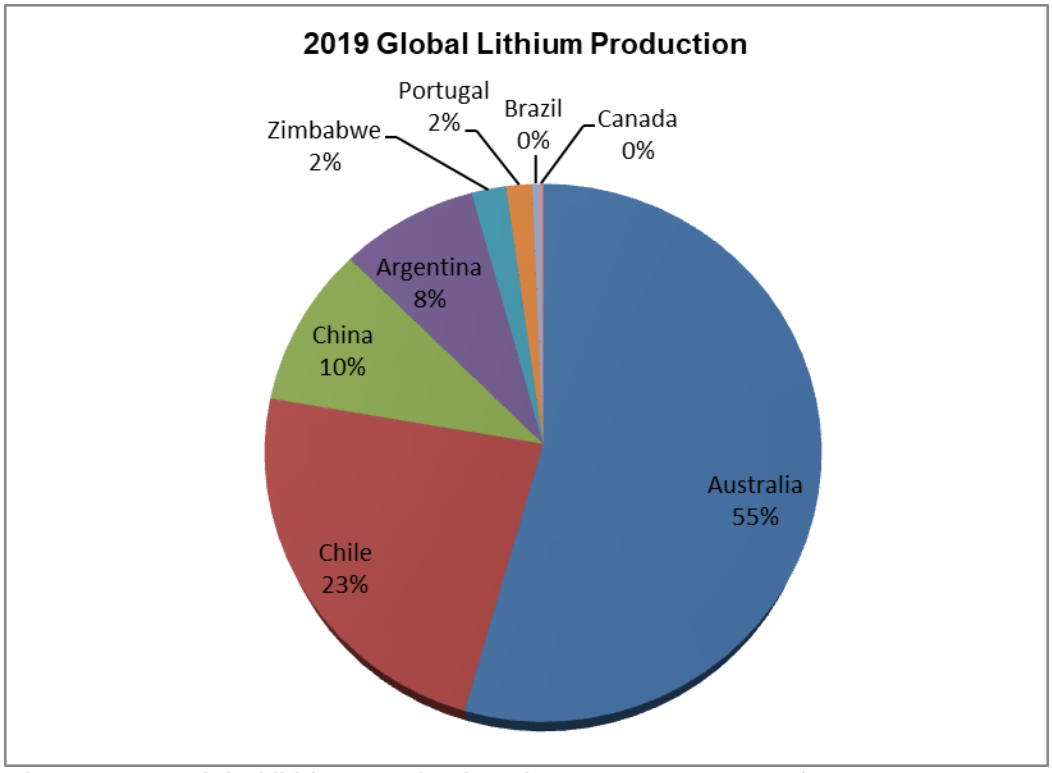


Figure 5.17: Global lithium production. (Source: USGS, 2020)

There has been a steady supply of lithium from 2014 to 2019 (Figure 5.4) and the lithium supply is also forecasted to be severely impacted by the COVID-19 pandemic in 2020. The supply is expected to contract because of mining operations temporarily shutting down.

5.9 Lithium demand

Lithium has increased its importance in the world due to the accelerated growth in demand for the mineral in the battery systems of portable electronics, energy storage systems and hybrid

cars (USGS, 2020). Global end-use markets for lithium can be grouped into industries such as batteries, lubricating greases, ceramics and glass, mould flux powders, polymer production and air treatment amongst others. Demand markets analysis for lithium shows that 65% of the world total lithium produced is used in the battery industry, 18% in the ceramics and glass sector, 5% in lubricating greases, 3% in polymer production, 3% in mould flux powders and 1% in air treatment (Figure 5.18). Rechargeable lithium batteries are extensively used in the growing market for portable electronic devices and increasingly in electric tools, electric vehicles and grid storage applications (British Geological Survey, 2016).

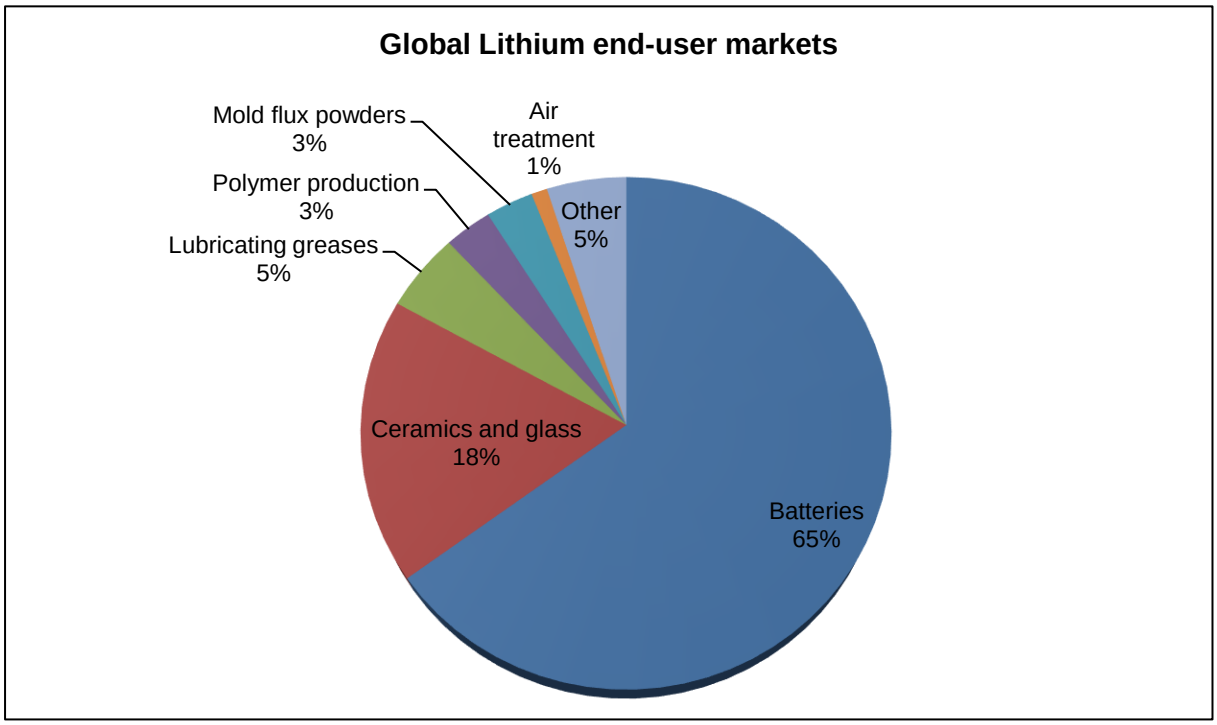


Figure 5.18: Global lithium end-use markets 2019. (Source: USGS, 2020)

Analysis of 2019 lithium demand by region shows that 39% of the global lithium produced is consumed in China, 20% in South Korea, 18% in Japan, 10% in Europe, 6% in North America and 7% in the rest of the world (Figure 5.19). China, South Korea and Japan are major battery manufacturers and electronics and this account for their high share of lithium consumption (www.statista.com).

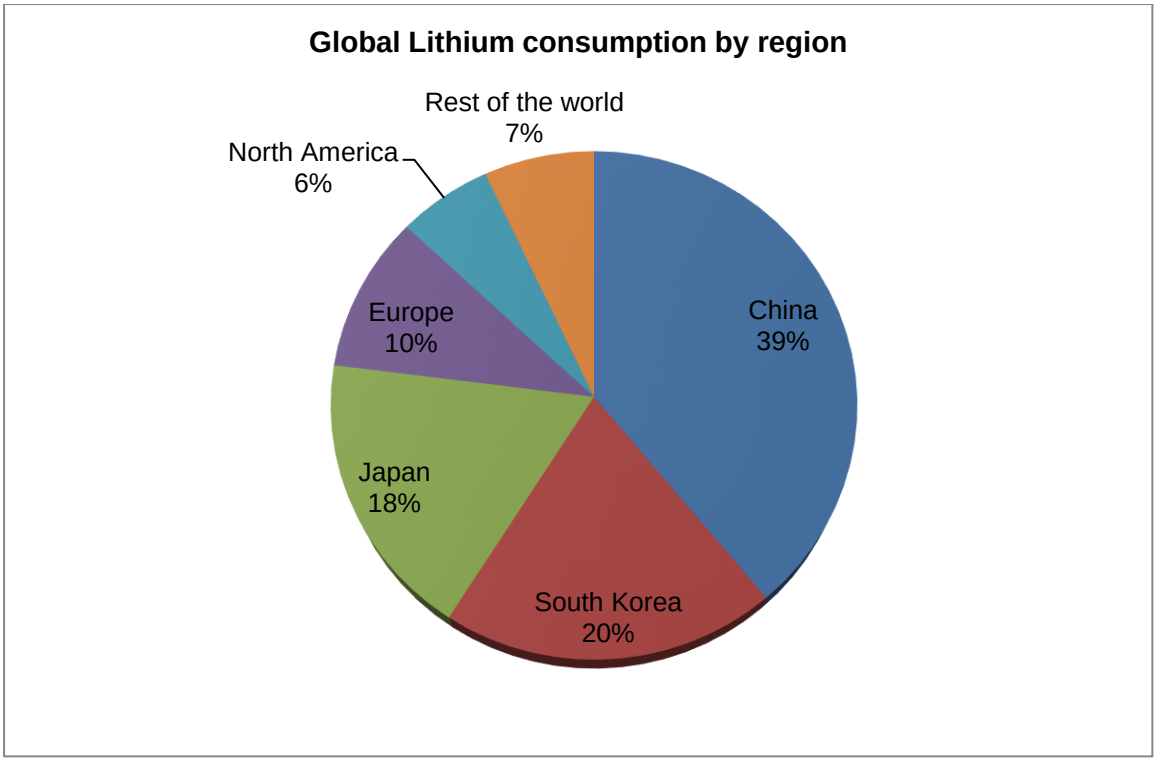


Figure 5.19: Global lithium consumption by region. (Source: Statista, 2020)

5.10 Lithium Secondary Supply

The demand for lithium has significantly increased over the past few years as a result of the extensive use of rechargeable lithium batteries in the growing electronic devices market such as electric vehicles, electric tools and grid storage application. USGS (2020) highlighted that there is need of security of lithium supply for the technology companies and recycling companies are rapidly expanding their recycling facilities with new companies entering the market. An increase in lithium recycling reduces the consumption of energy, reduces emissions of gas from greenhouse and results in considerable natural resource saving (USGS 2020). For sustainable supply of lithium-ion batteries there is need for joint ventures and strategic interventions among technology companies and exploration companies as well.

5.11 Commodity prices

Commodity prices have been on the decline at the international level from 2011 to 2014 (Figure 5.20). According to the World Bank (2015), the minerals and metal prices fell by approximately 35% during this period because of weak demand, ample supply and a strengthening United States dollar. A fall in mineral and metal prices also has a negative impact on foreign investor appetite to take part in beneficiation and can be as a result of a saturated market.

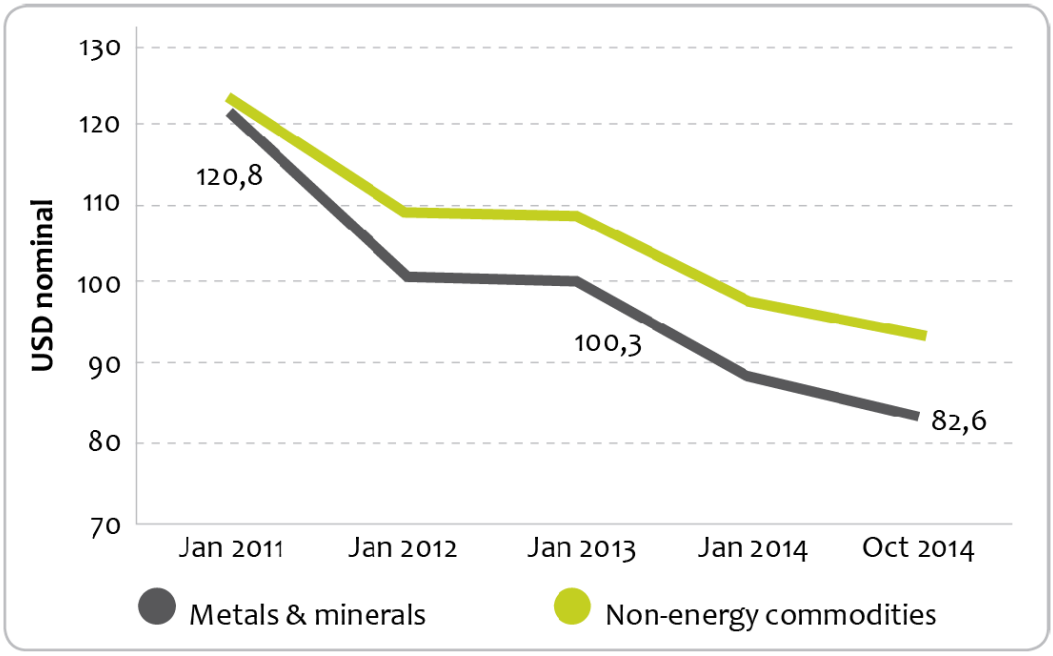


Figure 5.20: Declining commodity prices. (Source: World Bank, 2015)

Figure 5.21 shows the actual USD nominal values for non-energy, metals and minerals from 2014 to 2019 and the projected values from 2020 to 2030. Commodity prices increased from 2016 to 2019 and a dip in the prices is projected in 2020 because of the effects of the Covid-19 pandemic.

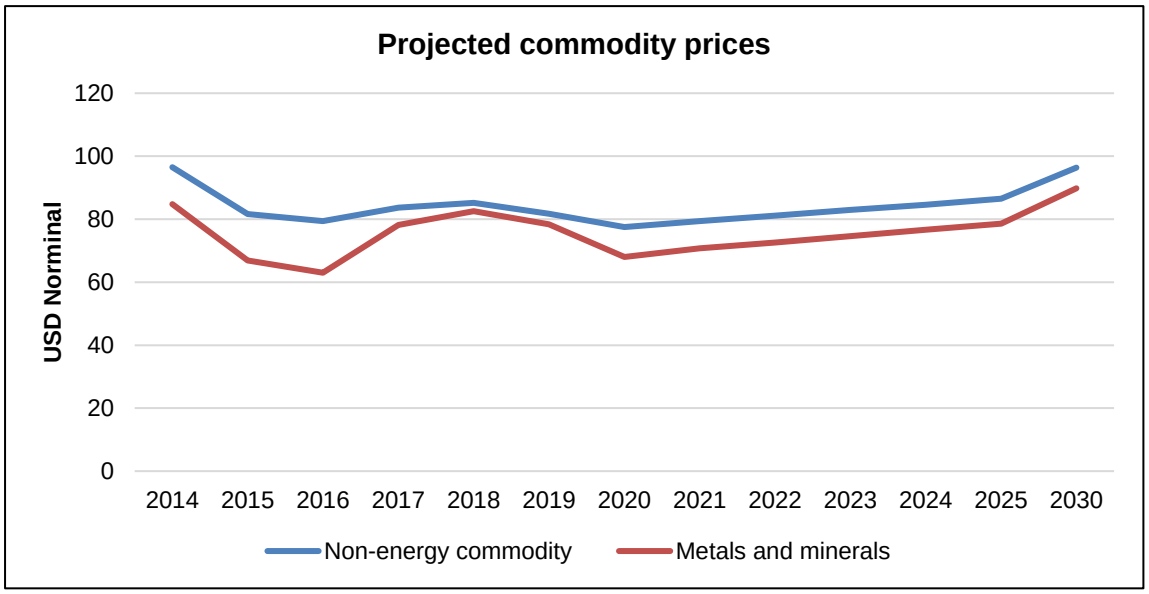


Figure 5.21: Projected commodity prices (Source: World Bank, 2020)

Platinum prices remained volatile over the years and the average market price for 2019 was reported to be USD864 per platinum ounce (Implats, 2019). The prices for palladium and rhodium have strengthened over the past years from 2016 to 2019. In their 2019 annual report

Zimplats Holdings stated that the strengthening of the palladium and rhodium prices is as a result of strong PGM demand from Europe and China. The average palladium market price increased by 49.5% to USD1539/oz in 2019 from USD1029/oz in 2018. Average rhodium market price increased to USD3914/oz in 2019 from USD2221/oz in 2018 which is a 50% increase. Figure 5.22 shows the market performance of the PGMs. Improvement in PGM basket price improves operating profits and increases ability to fund projects.

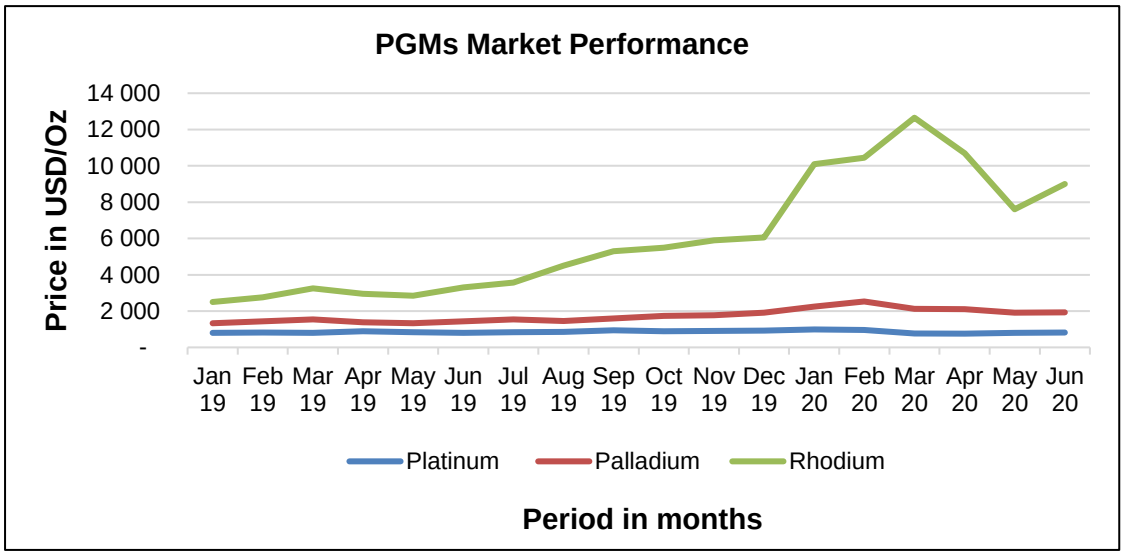


Figure 5.22: PGMs market performance. (Source: www.kitco.com)

Figure 5.23 shows the lithium market performance from 2015 to 2019. The price for lithium has strengthened from 2015 to 2018 and a drop from US$17 000 to US$13 000 in 2019. Price for lithium is projected to have a dip in 2020 due to the effects of the Covid-19 pandemic.

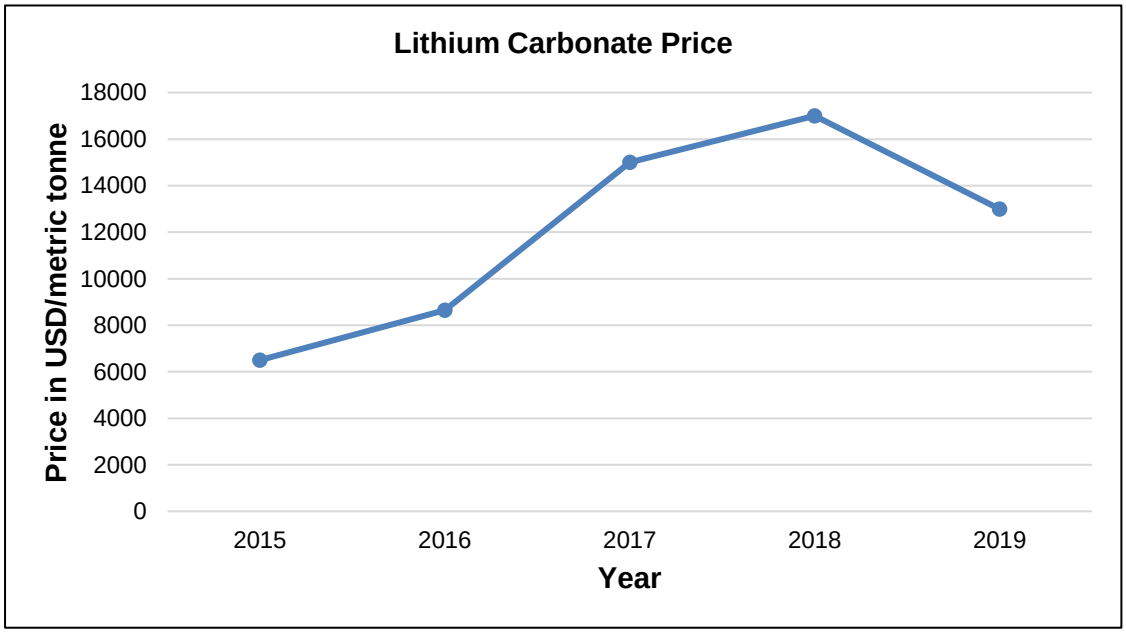


Figure 5.23: Lithium market performance (Source: www.kitco.com)

5.12 Chapter summary

Critical minerals are minerals that are essential in use and subject to disruption of supply. An analysis done on mineral criticality of 32 different publications had REE, PGMs and indium as the three consistently identified critical minerals. Lithium with its emerging role in the battery technology was identified as a critical mineral in most studies. A survey conducted targeting mining experts identified PGMs, gold, diamond and lithium as critical minerals that Zimbabwe should focus on for beneficiation.

The Great Dyke in Zimbabwe hosts the second largest known PGM mineral resource in the world after South Africa's Bushveld Complex at an estimated 2.8 billion tonnes PGM ore with an average in-situ grade of 3.54g/t 4E. Quantified resource for the three mines currently operating amounts to 73.6 million platinum ounces with a total annual capacity of 485 000 platinum ounces per year. Zimbabwe is the third major country in global platinum production and fourth for total PGMs production with South Africa and Russia being the largest world producers.

Lithium deposits in Zimbabwe are one of the world's biggest hard rock lithium resources. Quantified resources in the country, for one mine currently under production and two in development and exploration phases, amounts to 62.9 million tonnes at an average grade of 1.18% Li_2O. Zimbabwe is the fifth producer of lithium globally after Australia, Chile, China and Argentina. From the critical minerals analysis and survey conducted it is identified that PGMs and lithium are two key elements that the government of Zimbabwe should focus on for beneficiation.

Mimosa, Unki and Zimplats mines are currently the key PGMs mining players in the country. Mimosa mine is transporting its concentrates to South Africa as it does not have its own smelter, Unki mine commissioned a smelter in 2018 and the matte produced is also being transported to South Africa for further processing. Zimplats mine is in the process of refurbishing and modifying its base metal refinery and in the meantime the matte being produced is being transported to Impala refining services in South Africa. There is still room for improvement in the PGMs beneficiation industry in Zimbabwe as it is not yet where the government expects it to be. PGMs demand is mainly driven by auto catalysts, jewellery, industrial application and investments and consumption is high in China, Europe, North America and Japan.

Bikita Mine is currently the only lithium mining key player in Zimbabwe and it is mining petalite and spodumene pegmatites. Petalite concentrates are being exported in raw form as

Zimbabwe does not have the capacity to beneficiate petalite into lithium. Lithium concentrates from the spodumene pegmatites is being used for ceramics and glass making in the country. There is room for improvement to extend the use of lithium into the battery technology sector. Lithium demand is mainly driven by the battery and ceramics and glass sectors and the global consumption is dominated by China and South Korea. There has been a steady world supply of both PGMs and lithium from both primary and secondary sources. Demand and supply of both the PGMs and lithium is projected to be severely impacted by the COVID-19 pandemic in 2020. Currently commodity prices are on the rise save for a dip that is projected in 2020 as a result of Covid-19 pandemic effects.

The Zimbabwean government targets smelting and refining as the obligation of PGMs mining companies in the beneficiation process and the production of lithium metal in the lithium beneficiation process and the manufacturing sector to take care of PGMs fabrication into auto catalysts and jewellery and manufacture of lithium-ion batteries. Zimbabwe's mineral endowment is expected to expedite economic growth and structural transformation in the country, but this is more achievable if the mineral sector is administered in such a way that it harnesses all the opportunities along the mineral value chain. Currently the government of Zimbabwe is limited to smelting and refining in the PGM industry and production of lithium metal in the lithium industry leaving out the production of manufactured goods. For wider economic development and structural transformation Zimbabwe's beneficiation policy should provide a linkage to manufacturing.

CHAPTER SIX. BENEFICIATION CONSTRAINTS

6.1 Introduction

The Great Dyke in Zimbabwe host the world's second largest PGMs reserve after South Africa and is the fourth largest producer of PGMs globally. Zimbabwe has one of the world's largest lithium reserve and is the fifth producer of lithium ore globally. Lithium and PGMs have been identified as critical minerals that Zimbabwe should focus on for beneficiation. The government expects the PGMs mining companies to smelt and refine the PGM concentrate and currently there is no refining that is being done in the country. In 2011 the government announced its intent to impose a 15% tax on the export of platinum concentrates. The export tax on raw platinum was reduced to 5% in 2017 before the 2011 tax was implemented and through the 2019 National Budget the export tax was deferred to January 2022 (CoM, 2018). The government also announced its intention to ban the exports of unprocessed platinum in 2013 but with no fixed timeframes with the intention of enforcing PGMs beneficiation in the country.

The government expects lithium mining companies to produce lithium metal that can be used in the battery technology. Currently the lithium concentrate being produced from spodumene pegmatite is being used in the ceramic ware and glass sector and the lithium concentrate from petalite pegmatite is being exported in its unprocessed form for further processing as the country lacks the capability to refine petalite pegmatites concentrate. The manufacturing sector in the country is expected to fabricate autocatalysts and jewellery from the PGMs and to manufacture lithium-ion batteries. Chapter 6 analyses existing and potential constraints by focusing on geological, economic, technological, political constraints and any other constraints. Key sensitive areas such as input costs, taxation system and investment attractiveness will be reviewed as these affect the decision of going downstream. It has been noted earlier that a sound beneficiation strategy has a comprehensive mineral policy with strong governmental interventions, established Research and Development centres and support structures to assist in the implementation of the beneficiation strategy.

6.2 Beneficiation constraints

Mineral beneficiation is being adopted by many resource-rich countries as a policy strategy for socio-economic development from the economic benefits that can be derived from the different mineral value chain avenues. Despite Zimbabwe having a rich mineral endowment and efforts put in place for downstream activities, levels of beneficiation remain low. This section identifies current and potential constraints to effective implementation of beneficiation strategies for the country to realise a competitive advantage from the mineral endowment.

6.2.1 Unattractive investment climate

The Australian lithium-ion battery industry and the Botswana diamond industry case studies emphasised the significance of attracting investment for downstream activities. The unattractiveness of Zimbabwe's business environment is discussed below. There is need for investment in each of the downstream stages for both PGMs and lithium that is refining and fabrication of final products for beneficiation to be a success.

6.2.1.1 Political instability

It has been noted earlier that Zimbabwe is characterised by political challenges and as a result there is a decline in human welfare and a negative impact on the investment climate. Adherence to rule of law and human rights remain poor despite the positive messages being sent by the government. According to the World Bank (2019), Zimbabwe's political economy is characterised by policies that are unpredictable, minimal government capability, state corruption and elevated government interest in the mineral sector. State intervention in mineral resources exploration, mining rights, and production and investment decisions is seen as a risk when dealing with countries such as Zimbabwe.

For example, the application and execution of the Indigenisation and Economic Empowerment Act has seen substantial shift over the years as it initially required 51% indigenous Zimbabwean ownership of all companies. Early statements by the Zimbabwe's Minister of Indigenisation showed no flexibility but the minister later on announced the applicability of the policy only to foreign companies that will be exporting materials in their raw form. The Finance Act of 2018 then limited the 51% ownership to the platinum and diamond mining sectors. The intent to nullify the 51% indigenous equity obligation for platinum and diamond sectors was announced in 2019.

The announcement of the intention to retract the 51% ownership led to the birth of "use it or lose it" policy that was released to stimulate production amongst relaxed licensed mine owners who were reluctant to invest in their claims. This policy however affected mineral exploitation in the small scale and artisanal division as it hindered production. On the other side it created opportunities for large foreign companies which are risk tolerant when it comes to making investments (www.miningzimbabwe.com). Large foreign investment companies, such as Zimplats which has access to 56.5 million ounces of platinum and a platinum production of 270 000 ounces per year, are forced to ramp up production in order to meet up with requirements of the policy. The shortcoming of this policy is that it promotes extensive exploitation of the mineral resource with the mining products being exported in their raw form. These acts and statements have a great impact on the investment of beneficiation activities as high policy volatility reduces the likelihood of investment in local refining.

Progress on achieving goals of policies such as ZimAsset and National Trade Policy has been weak and according to Baissac *et al*, (2015), strategies were short on implementation details, relied on a number of assumptions for its realisation and the implementation responsibility of the growth plans lied solely on the public sector. ZimAsset had so many objectives which were not achieved within the given time frame. In addition to this there was no defined road map on how to reach the stipulated goals, which contributed immensely to its failure during the set period. According to Chigumira *et al*, (2017), for the policy to become a success it required USD27 billion, but somehow it lacked insight on how the funds were going to be secured. ZimAsset short comings included (Chigumira *et al*, 2017 and Mapuva and Makaye, 2017):

- Failure to attain a growth rate of 7.3% by 2015. In 2015 the growth rate was 1.7%
- The policy failed to alleviate poverty by the creation of jobs as unemployment rate remained high
- The tax revenue base that was targeted to supplement funding of the ZimAsset was limited as a result of high unemployment rates in the country.
- The Pan African Minerals University of Science and Technology to fully implement human capacity building initiative was not operational by 2018
- The country's mineral resources database not updated by 2018

6.2.1.2 Economic instability

Zimbabwe's economy is among one of the most vulnerable and this has been attributed to policy mis-steps, exchange rate misalignment, unsustainable fiscal deficit, unsustainable expenditures and international isolation. This can result in a reduced ability to attract investment and a negative impact on the performance of individual mines. For example, in its 2019 integrated annual report Zimplats mine made a net exchange loss of USD20 million for the year. This was as a result of the Real-Time Gross Settlement (RTGS) and bond notes being liberalised against the United States dollar formalising trading in foreign currency.

Zimbabwe remains in debt and this has resulted in international isolation and also reduces the country's ability to attract investment and access capital to implement large scale industrial transformation. Beneficiation is a high-cost project and requires access to affordable financial resources and Zimbabwe's limited access to long term financing for capitalisation has highly impacted on downstream activities (UNECA, 2013). Zimbabwe's rank on the World Bank's Ease of Doing Business that ranks countries based on the conduciveness of the regulatory environment to business operations, remains subdued (World Bank, 2019). It was ranked 140 out of 190 world economies in 2019, an improvement from the past few years as shown in Figure 6.1. Cost of doing business in the country is generally higher than surrounding countries and as a result foreign direct investment flows to other countries (Chigumira *et al*, 2017). The

country lacks investment and as a result there is over-reliance on out-dated technology by most of the industries including the manufacturing sector.

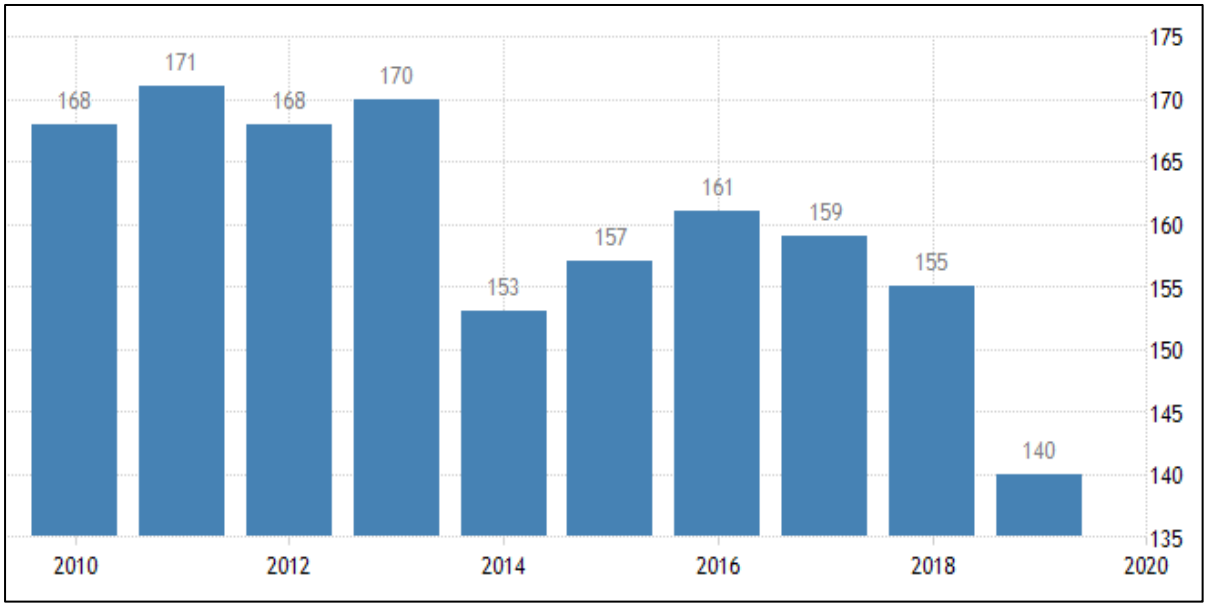


Figure 6.1: Zimbabwe ranking on ease of doing business. (Source: World Bank, 2019)

6.2.1.3 Taxation System

The fact that mineral resources are finite in nature present the rationale behind government capturing resource rents (Chigumira *et al*, 2017). The mineral taxation system in Zimbabwe has its own fair share of contributions towards the unattractiveness of the investment climate. The old fiscal regime which was amended through Mines and Minerals Amendment Bill of 2015 was characterized with multiplicity of taxes and uncoordinated collections of the resource rents by several state organisations such as Zimbabwe Revenue Authority, Minerals Marketing Corporation of Zimbabwe and Zimbabwe Mining Development Corporation (Ministry of Mines and Mining Development, 2018). Generally, the mining tax system in Zimbabwe is comprised of royalties, corporate income taxes, withholding taxes, capital gains taxes, and exploration fees. Royalties are the major mineral revenue contributor in the country. The uncoordinated collection of the taxes presented transparency and accountability challenges and compromises viability of the mineral industry (Chigumira *et al*, 2017).

The mineral royalty taxes in Zimbabwe are as follows diamond (15%), precious stones (10%), platinum (10%), gold (5%), and base metals (4%) (Ministry of Mines and Mining Development, 2018). This royalty regime is based on crude mineral product. The government through the Mines and Minerals Act of 2015 announced the reduction of taxes for refined minerals but does not give definite figures of the tax value, which somehow makes it ambiguous. In South Africa, the mineral royalties are capped at 5% for refined mineral and 7% unrefined mineral resource (Department of Mineral Resources, South Africa, 2017). In Australia, the mineral

royalties are as follows 7.5% crude minerals, 5% concentrates and 2.5% metal (Mineral Council of Australia, 2019). Hence for both South Africa and Australia the mineral royalties are well defined and quite low as compared to those of Zimbabwe.

High royalty taxes coupled with low metal prices have an effect of leaving mining operations financially strained. The simultaneous effect of low platinum prices and high mining taxes has led the miners to withhold potential expansion projects such as development of smelters and refineries in the past (Ministry of Mines and Mining Development, 2018). Another notable effect of high royalties is that they tend to become key production decision variables within an organisation. A high tax royalty will lead to a high cut-off grade, which can result in marginalization of low-grade ores, hence affecting the exploitation of the resource (Dube, 2016). Higher rates of royalties associated with the exportation of ore in Zimbabwe have a net effect of negatively impacting foreign direct investment.

The taxation system in Zimbabwe presents a gap due to its poor revenue collection system, transparency and accountability challenges. This has resulted in companies taking advantage in order to evade paying large sums of money in terms of their due taxes. The government of Zimbabwe needs to develop a reputable tax collecting system so that it does not lose potential revenue which can be used to turn around the mining sector in terms of its PGMs and lithium downstream beneficiation processes. In order to have a successful taxing system the government needs to come up with a mine taxing system which does not choke mining operations in terms of developments or expansion projects catering for value addition of the mined product. Reduce mining fees and royalties to be at least comparable with those in the region so as to increase foreign direct investment and at the same time boosting production statistics in the mining industry.

6.2.1.4 Lithium resource and reserve database

The lithium sector in the country is under-explored and work is currently being done to increase the confidence level in estimating lithium projects such as the Zulu lithium project. The government needs to fund lithium exploration activities across the country as improving quality of geological data can result in more equitable return on mineral resources and improves on the attractiveness of the mineral industry sector. Australia worked on having a high-quality lithium resource base that easily attracted foreign direct investment.

6.2.2 Constraints affecting the PGMs Value Chain

As has been earlier alluded to, the Zimbabwean government targets smelting and refining as the obligation of PGMs mining companies in the beneficiation process and the manufacturing

sector to produce autocatalysts and jewellery. There are however constraints affecting the sequential phases through which the PGMs pass in producing the refined product. Smelting is constrained by the absence of adequate smelting infrastructure as the country only have two smelters one for Unki and the other one for Zimplats and this is not enough to smelt all the concentrates that is being produced in the country. As a result, Mimosa mine is transporting its concentrate to South Africa for smelting.

Beneficiation is an energy-intensive activity that requires a large and stable power grid for sustainable growth and expansion. Energy is required during smelting, refining and fabrication processes of the PGMs. The Zimbabwe Electricity Supply Authority Holdings (ZESA Holdings), a state-owned company, is primarily in charge of the energy sector. ZESA Holdings has two subsidiaries, Zimbabwe Power Company (ZPC) and Zimbabwe Electricity Transmission and Distribution Company (ZETDC), and these subsidiaries are responsible for the distribution of the electrical energy in the whole country (Ministry of Mines and Mining Development, 2018).

According to Chigumira *et al*, (2017) the availability of energy to power large scale operations such as PGMs smelting and refining remains a major challenge as production capacity is failing to meet demand due to the fact that minimal improvements and expansions have happened in the country's power generation sector. This has resulted in a supply deficit. Inadequate power supply is one of the main infrastructure problems surrounding the mining industry in the country. In 2016 Zimbabwe generated an estimate of 6.8billlion kilowatt (KWh) against a demand of 7.1 billion KWh and this trend of producing below par has been happening since 2004 (Chigumira *et al*, 2017).

In their 2015 report Baissac *et al*, approximated that beneficiation of the minerals identified by the government that is, PGMs, diamonds, nickel, chrome and coal bed methane, will increase electricity consumption in the mining sector by more than 19%. For the government of Zimbabwe to achieve the local PGMs beneficiation goal there is need to consider power requirements and ensure an adequate and steady power supply. Mining companies in the country are having discussions with the government to allow the mining sector to import its own power for sustainable production.

In-order to produce autocatalysts and jewellery, the industrial practitioners involved require in-depth technical skills and technological innovation. The knowledge economy is an essential element of the PGM mineral value chain and producing the necessary skills and technological interventions remain a major obstacle in Zimbabwe's education system, owing to the challenges with regards to accessing modern, state of the art devices and network

connectivity. In addition to this, political instabilities and economic hardships have greatly impacted the well-being and upkeep of the citizens resulting in half of the professional class leaving the country to seek better opportunities in countries such as United Kingdom and South Africa (World Bank, 2019).

A report by Zimbabwean Centre for Natural Resource Governance (CNRG) 2015 showed that there is a general lack of technical skills and funding capacity in the country to move into mineral processing activities. Concurring with the CNRG (2015), Implats, in their 2019 annual report, also noted that the potential for economic growth in Zimbabwe is driven by an abundant PGM resource base but one of the setbacks is shortage of technical skills and the financial capacity to venture into PGM mineral beneficiation activities. Available options mainly include equipping the relevant personnel in the Zimbabwean mining sector with the necessary skills through exchange programmes with countries such as Botswana and China. The government also has to lure foreign direct investment into the PGMs beneficiation sub-sector with a view to enhance the country's financial capacity to venture into mineral beneficiation activities. Even at a local level, the government must set aside a budget for the value addition activities of the PGMs minerals.

At the refining stage and fabrication stages, Zimbabwe faces constraints due to the absence of refining and fabrication facilities, hence leading to the exportation of Zimplats matte instead of local beneficiation and value addition. Zimbabwe's existing infrastructure can only mine, concentrate and smelt as the only refinery in the country for Zimplats is under refurbishment and does not have the capacity to cater for all the PGM production in the country. Thus, the converter matte produced is sent to South Africa for further refining at Impala Refining Services. The refining and fabrication processes also largely depend on economies of scale. On this note, lack of strategy by the Zimbabwean government on achieving the economies of scale also adversely affects the beneficiation and value addition endeavours. A study done by Jourdan *et al*, 2012 indicated that 240 000 ounces per annum of platinum is the rough threshold for the viability of a basic platinum refinery. Approximately 485 000 ounces of platinum were produced in 2019, an indication that two refineries can be sustained. Chigumira *et al,* 2017 estimated that about USD3 billion is required in setting up of a refinery and this calls for foreign direct investment.

Most of the mineral manufacturing companies in the world are found in the developed countries with an already mature and reputable market that consumes the product that is being manufactured by the industry (Baissac *et al,* 2015). An analysis of the PGM demand showed that most of the PGM troy ounces are used in the auto catalyst industry in China, Europe, North America and Japan. Zimbabwe's domestic manufacturing market is relatively small and

there is a limited sub-Saharan Africa demand for PGM beneficiated products aside from South Africa (Baissac *et al,* 2015). Zimbabwe's PGMs mineral downstream sector would have to access these international markets to sustain beneficiation growth objectives. Zimbabwe is geographically distant from the consumer market such as China and Europe and regional and world integration in the country for the transportation of goods and regulatory facilitation is minimal and this can have an effect of increasing input costs. The fact that Zimbabwe is a landlocked country further compounds the difficulties in accessing international markets and this has a negative impact on the competitiveness of the country's beneficiated products.

6.2.3 Constraints affecting the lithium value chain

According to the Australian Trade and Investment Commission (2018) report, production of quality outputs and processing know-how such as coating thickness uniformity, stack uniformity, drying formation and electrolyte additive is a measure of success during electrodes, cells and battery pack production. Downstream activities in the lithium mineral sector are technology-driven and require substantial investment to invent innovative equipment such that downstream companies are in a position to assemble quality end-user products at a reduced cost. Lower production costs result in downstream companies having a price competitive edge in a world market where there is an increase in consumer price sensitivity (IGF, 2016). One of the constraints in the lithium beneficiation sector is inadequate investment in Research and Development (R&D), technology and innovation. Advanced technology dictates the productivity growth in most industries with the extractive sectors included and R&D and innovation are considered to be the building blocks of industrial development (Baissac *et al,* 2015).

Zimbabwe has a limited exposure to research and development for the mineral downstream sector and this is a draw back to the country's beneficiation drive. Petalite concentrate is being exported in raw form since the country do not have the capability in-terms of the technology and innovation required to beneficiate petalite concentrate into lithium metal. Limited exposure to R&D and technology for mineral beneficiation implies that Zimbabwe will rely on and need to partner with developed countries such as China and Europe to drive the country's innovation. Australia invested in research and development prioritising lithium beneficiation for the lithium-battery ion industry in the country to be a success.

Production cost inputs that include energy, meeting regulatory requirements and materials required to produce lithium-ion batteries are also a constraint as the country lacks adequate capitalization because of economic instabilities. Production costs will also be increased as a result of transport infrastructure in the country that is in a bad state. The transport sector in

Zimbabwe includes the road, rail, aviation and inland water subsectors that are managed by the Ministry of Transport and Infrastructural Development (AFDB, 2018). Zimbabwe has a key hub within the road and rail transport infrastructure in the SADC region as a result of the numerous road and rail transport network linking its neighbouring countries. In their 2018 paper, AFDB recognised that poor transport infrastructure is a serious obstacle to investment. Infrastructure in good working order is considered as a key element of the investment climate as it enables people to easily access markets and reduces the cost of doing business.

Zimbabwe's transport infrastructure is largely degraded due to a lack of continuous infrastructure rehabilitation and lack of regular maintenance. Financial constraints in the country are aiding to the poor maintenance of the transport infrastructure. Over-reliance on road transport has resulted in an increased road networks depreciation and these now require serious rehabilitation (Chigumira *et al*, 2017). Poor transport infrastructure limits access to imported inputs and exports markets and these are crucial for lithium beneficiation to take place. Poor infrastructure also leads to uncompetitive costs of doing business.

There is need for a deliberate support of the lithium beneficiation sub-sector for it to easily access global markets, funding and the much needed technology. UNECA (2013) reported that R&D and innovation are not well supported in most member states in SADC and for industrialization to be fully realized countries need to strengthen research institutions such as the Institute of Mining Research in Zimbabwe, invest in material science and engineering for fundamental research in value addition and use to its advantage benefits of market access, extensive knowledge base and advanced technology that comes with partnering with countries such as China. Australia has strong and reputable research institutions and have partnered with countries such as South Korea for market access and technology transfer.

6.2.4 Constraints as highlighted from the survey

All the eight participants engaged acknowledged that beneficiation is necessary for economic growth and development and PGMs, gold, diamonds and lithium were the top four minerals identified as critical minerals that Zimbabwe should focus on for beneficiation. The survey participants highlighted the following as challenges to mineral beneficiation in Zimbabwe and lack of policy consistence was identified as a challenge by all participants:

- Lack of policy consistence
- An economic environment which discourages both local and foreign investment
- Inadequate infrastructure and technology
- Political risk

- Risk of nationalisation

6.3 Chapter summary

Despite the government of Zimbabwe's commitment on beneficiation and value addition of minerals, critical minerals are still being exported in raw form resulting in the country losing out on benefits that comes with value-added products. Zimbabwe has a comparative advantage of a large critical mineral resource base that it must be utilised for structural transformation. The lag in the development of a robust beneficiation system in the country is attributed to several factors but not limited to political and economic instability, energy and infrastructure constraints, gap in the knowledge economy and high input costs.

Zimbabwe's political economy is characterised by policies that are unpredictable, minimal government capability, and a high degree of state intervention. This has a net effect of reducing investor confidence in investing in the country. Zimbabwe has one of the most vulnerable economies due to policy mis-steps, unsustainable fiscal deficit and international isolation. This further reduces the country's ability to attract investment and access capital to implement high-cost projects such as critical mineral downstream activities. The cost of doing business in the country is generally high and as a result foreign direct investment flows to other countries. Addressing political and economic issues in the country will retain the professional class that is leaving the country for better opportunities. Access to capital will make it easy to supply the much needed energy and technology innovation that beneficiation of critical mineral requires.

CHAPTER SEVEN. SUMMARY OF FINDINGS AND CONCLUSIONS

7.1 Introduction

This chapter aims to summarise the findings of the study and give a conclusion that is based on the research findings. The research report aimed at evaluating beneficiation constraints of identified critical minerals in Zimbabwe. The objectives were to discuss beneficiation concepts, strategies and requirements highlighting case studies for a few selected government approaches to mineral beneficiation. The other objectives were to identify the critical mineral basket for Zimbabwe's mineral industry for beneficiation, identify existing and potential constraints to beneficiation and provide recommendations for Zimbabwe's mineral industry to be globally competitive.

7.2 Summary of Findings

Literature surrounding economic growth and development and government policies shows that many African countries are adopting beneficiation as a policy tool for structural transformation. Beneficiation is being used by many resource-rich countries as a policy initiative to better manage their natural resources and fight against the natural resource curse. There is generally an agreed upon challenge among African countries that is the ability to transition from commodity dependent growth path to value adding economies as it has been noted that many African countries mostly produce and export raw materials and then import finished products.

The AMV in Africa has been adopted to encourage development of countries from mineral resources and fight against the natural resource curse noted amongst African countries. The African policy blueprints and master plans highlighted in the research report such as the 2013 UNECA blueprint, 2015 CAP blueprint and SADC master plans serve as regional guides and principles on beneficiation and value addition in a bid to foster structural transformation. One of the findings on African countries' policies such as Tanzania, Zimbabwe, South Africa and Namibia is that the industrial policies' common drive is beneficiation and value addition that talks to policy blueprints in the regions and the whole continent. The fact that beneficiation is crafted in many of Zimbabwe's economic policies shows that the government is committed to spearhead mineral beneficiation and value addition for wider economic growth and development.

Beneficiation is perceived to bring with it benefits that include employment creation, economies of scale, cushion against fluctuating commodity prices, cost savings from imports, localisation of value chain benefits, expert and infrastructure development. The locally

beneficiated products should be globally competitive in both quality and price for easy penetration into international markets and full realisation of beneficiation benefits. Strategies that are being employed to encourage beneficiation include the positive incentive approach, negative incentive approach, imposing downstream requirements during drafting of mining contracts, as part of a bidding process and beneficiation due to government led investments.

Analysis of beneficiation policies from beneficiating countries such as Botswana, Indonesia, South Africa and Australia showed that different countries are implementing different combinations of strategies that are enjoying different degrees of success. The positive incentives approach is the most widely used model and one that is recognised as the most successful policy tool. The positive incentives should be time bound to avoid creating dependency. Export ban strategy under the negative incentive approach is seen as a logical progression to encourage downstream activities and improve trade performance but do not work as intended on commodities that can be easily substituted in the market place. Export bans are most feasible when commodity prices are high.

7.2.1 Beneficiation Policies and Strategies

7.2.1.1 Botswana Case Study

The following beneficiation lessons were drawn from the Botswana case study:

- An enabling business environment created as a result of good governance, fiscal discipline and robust policy framework promoted investment in diamond downstream activities;
- A mineral policy that is in sync with the nation's overall economic development policies important for the effective implementing and sustaining downstream activities. Botswana's mineral policy was in line with the country's development plans;
- Beneficiation strategic interventions using a combination of export limitations, penalties and fiscal incentives in promoting beneficiation.
    - The government of Botswana reduced the corporate tax for the manufacturing industries as compared to other industries to encourage investment in the manufacturing sector;
    - Introduced an implicit tax on rough diamonds exports to discourage exporting of rough diamonds;
    - Exemptions on training levy and rebates on training expenses of accredited training programs and this resulted in skills development;
    - Rough diamonds being sold to domestic firms at discounted prices for product competitiveness at international markets;

    - Special immigration arrangements for trainers of skills required for the beneficiation industry.
- Establishment of support structures to promote beneficiation
    - Dedicated diamond office and diamond industrial hub to ensure growth of all aspects of the diamond downstream activities;
    - Diamond Trading Company to carry out local sorting and aggregation activities for diamond.
- Establishing joint ventures that increase the likelihood of easy access to markets, knowledge, expertise and technology.

7.2.1.2 South Africa

The following beneficiation lessons could be drawn from the South Africa case study:

- An enabling environment that is created through the use of policy and regulatory framework
    - The Minerals and Mining Policy that highlighted the prerequisite to create favourable conditions to fully benefit from the country's mineral wealth;
    - The MPRDA acted as the mineral beneficiation regulatory framework; and
    - The MIP was established to stimulate investment in the country's manufacturing industry.
- South Africa's beneficiation policy is considered to be one of the most comprehensive strategies being employed by the government to encourage downstream activities. Other countries can use this as an example in modifying their own policies.
- To implement the beneficiation strategy, the government established support structures.
    - Beneficiation strategy task team to put forward beneficiation strategy interventions to attain a coordinated and sustainable growth in mineral beneficiation; and
    - Industrial Development Corporation to promote growth in industrial development.
- Use of international trade agreements to attract foreign direct investment and have access to international markets for the finished or semi-finished product.

7.2.1.3 Indonesia

The following beneficiation lessons were drawn from the Indonesia case study:

- The export ban might not be suitable for use by all commodity-dependant developing countries as its success is mainly due to the lack of substitutes.
- Export bans on commodities that can easily be substituted in the market place should be avoided.
- Trade policies are most feasible when commodity prices are high enough to counteract losses to be encountered.
- The enablers for mineral beneficiation came from legislative framework that was used to pressurise mining companies to comply with government requirements.
- Support structures such as Research and Technology Application Body and the Indonesian Science Institute were used to provide technical support for the downstream activities.
- The ad hoc responses in implementing the beneficiation policy using export bans was due to a lack of well formulated comprehensive beneficiation strategy.

7.2.1.4 Australia

The following beneficiation lessons were drawn from the Australia lithium industry case study:

- The need to have an attractive investment climate. Australia is highly ranked for ease of doing business and global competitiveness as a result of robust regulatory setting, little political risk or uncertainty, stable mining regime, highly educated workforce, high quality infrastructure and world class scientific and research institutions;
- Funding and facilitating investment in research and development to be able to break through the battery technology is of utmost importance. Lithium battery industry is a high technology industry and Australia invested a lot in research and development so as to be competitive in the lithium downstream sector.
- Australia used battery industry growth initiatives to promote lithium downstream activities that included the following:
    - Industry growth centre initiatives that promoted industry research collaborations;
    - Tax incentives to promote investment in lithium downstream activities;
    - Investment of 25% of royalties to long-term projects including infrastructure and downstream activities;
    - Resources 2030 Taskforce initiatives that promoted competitiveness and investment in the resources sector;
    - Future Battery Industry Cooperative Research Centre initiatives of creating a generation of highly skilled workforce.

- Use of support structures that included:
    - Research centres that focused on research and development in the battery value chain;
    - Resources 2030 Taskforce;
    - Regional Development Australia Silicon Valley;
    - Future Smart Strategies.
- Use of Free Trade Agreements that gave Australia easy access to the largest markets in Europe, Asia and North America.
- Establishing economic linkages important for structural transformation in a country.
- Use of benefit sharing to promote local and regional development.

7.2.2 Zimbabwe Beneficiation Policy

Zimbabwe does not have a comprehensive mineral or beneficiation policy, but beneficiation outline is in numerous pieces of policy statements and regulations. The beneficiation strategy that the country is currently employing includes the following:

- Enabling business environment and investment climate
    - Legal framework governing exploration, exploitation and beneficiation expectations
        - Mines and Minerals Act
        - Zimbabwe Mining Development Corporation Act
        - Special Economic Zones Act
    - Fiscal framework
        - Corporate Income Act
    - Policy support
        - National Trade Policy
        - ZimAsset
- Support Services
    - Zimbabwe Revenue Authority
    - National Indigenisation and Economic Empowerment Board
    - Zimbabwe Mining Development Corporation
    - Minerals Marketing Corporation of Zimbabwe
    - Special Economic Zones Authority
    - Platinum Producers Committee
- Regional and Multi-lateral Agreements
    - Bilateral trade agreements with countries such as South Africa and Botswana
    - Regional Trade Agreement – African Continental Free Trade Agreement

    - COMESA-EAC-SADC Tripartite Free Trade Area
    - Interim Economic Partnership Agreement
    - Trade Facilitation Agreement with the World Trade Organisation
- Government Interventions
    - Establishment of National Indigenisation and Economic Fund
    - Export bans
    - Institute of Mining Research
    - Scientific and Industrial Research and Development Centre (Diamond cutting and polishing centre and establishment of the Pan African Minerals University of Science and Technology)
    - Strengthening of the Geological Survey Unit

The government of Zimbabwe has been using more of the negative incentive approach with increased regulation and state intervention to encourage downstream activities in the mining industry. An export ban for chrome was effected in 2011 and later lifted in 2015 as the chrome industry was struggling to remain in business. Ban for unrefined platinum has been announced to be effected in January 2022 if platinum mining companies continue to export platinum as concentrates and matte. Export tax levies have been applied to chrome, platinum and diamond industries in an attempt to promote beneficiation activities for these minerals. The fact that the government of Zimbabwe is in the process of amending the Mines and Minerals Act, which is the prime act that governs the mineral sector, to align it to sustainable mining and also finalising a stand-alone mineral policy is a positive development towards beneficiation. The fact that beneficiation and value-addition has been crafted in many economic policies in the country shows the commitment by the government in implementing the beneficiation strategy.

7.2.3 Zimbabwe's mining industry

The country's mining industry largely depends on gold, PGMs, diamonds, nickel and chrome as these are the top five contributors to mineral revenue. The government of Zimbabwe has agreed on prioritising these mineral commodities for beneficiation. SADC assigned Zimbabwe for the beneficiation of platinum, diamonds and iron and steel to strengthen the mineral value chain (Southern African Research and Documentation Centre, 2016). An analysis that was done on mineral criticality of 32 different publications had REE, PGMs and indium as the three consistently identified critical minerals and lithium with its emerging critical role in the battery technology was also identified as a critical mineral in most studies. A survey conducted targeting mining professionals identified PGMs, gold, diamond and lithium as critical minerals that Zimbabwe should focus on.

The fact that Zimbabwe has the second largest PGMs reserves in the world that are hosted in the Great Dyke, one of the largest lithium reserves hosted in pegmatites and that PGMs and lithium are among critical minerals in the world show that Zimbabwe can focus on these minerals for beneficiation. Zimbabwe is currently undergoing political and economic hardships therefore the country should focus on these two critical minerals for beneficiation sorting out its political and economic issues. From the critical mineral analysis, it can be identified that PGMs and lithium are the two key minerals that the country should focus on for beneficiation.

The PGM mineral resource base hoisted in the Great Dyke is estimated at 2.8billion tonnes PGM ore with an average in-situ grade of 3.54g/t 4E. Currently there are three mines operating, Mimosa Mine, Unki Mine and Zimplats and the quantified resource for these three operating mines amounts to 73.6 million Pt. ounces with a yearly potential to generate 485 000 Pt. ounces and a life expectancy of above 100 years. A lot of potential still exist on the Great Dyke and there has been an increase in demand for exploration and evaluation of PGMs along the Great Dyke. Five companies, Todal Mining, Global Platinum Resources, Karo Resources, Bravura and Great Dyke Investments, are carrying out PGMs exploration on the Great Dyke. Great Dyke Investment Company is scheduled for production in 2021 as the company is done with mine portals construction and surface infrastructure is close to completion. PGMs demand is mainly being driven by auto catalysts, jewellery, industrial application and investments industries with the highest percentage being used in the auto catalysts industry. PGMs consumption is mainly in China, Europe, North America and Japan.

Lithium mining in Zimbabwe is done in petalite and spodumene pegmatites and currently one mine, Bikita Minerals, is under production with a quantified resource of 11 million tonnes lithium ore at an average grade of 1.4% Li_2O. Demand for lithium with its emerging critical role in the battery technology has resulted in the increased exploration of the mineral. Prospect Resources is currently developing an open pit mine at Arcadia Lithium and Premier African Minerals is finalising its evaluation of the Zulu lithium project. Lithium is mainly used in batteries, ceramics and glass with about 65% being used in the batteries technology industry. Lithium consumption is mainly in China, Japan, Europe, South Korea and North America. China, South Korea and Japan are the key major battery and electronics manufacturers.

The government of Zimbabwe targets smelting and refining as the obligation of mining companies in the PGMs value chain and production of lithium metal in the lithium beneficiation process. Zimplats is the only PGM mine that has a refinery although the refinery is currently under refurbishments and modifications. Unki mine commissioned a smelter with a production

capacity of 62.1 tonnes per annum in 2018. Mimosa mine is the only mine that is still sending its PGMs concentrate for smelting and refining in South Africa as it does not have a smelter.

Lithium concentrates from petalite pegmatites are being exported in their unprocessed state as the country is incapacitated to process petalite into lithium metal for use in batteries. Lithium concentrates from the spodumene pegmatites are currently being used for ceramics and making of glass in the country. There is little use of lithium metal in the battery technology industry. It has been noted that the level of beneficiation of the identified critical minerals in Zimbabwe is not yet meeting the government's expectations. It can also be highlighted that the government's expectations do not harness all the opportunities along the mineral value chain as it targets only smelting and refining.

7.2.4 Beneficiation Constraints

Despite Zimbabwe being rich in lithium and PGMs mineral endowment and efforts put for downstream activities, levels of beneficiation of these critical elements remain low. Existing political constraints to critical mineral beneficiation in the country include rule of law that is not being adhered to, policy unpredictability, minimal government capability, state corruption and elevated government interest in the mineral sector. Political instability has a negative impact on the investment climate. Zimbabwe's full critical mineral potential is under explored and the political setting in the country was cited as one of the hindrances to investment in the critical mining industry for exploration. Another constraint that is striking the beneficiation of critical minerals is the economic instability that has affected the country for the past few decades. These economic challenges include:

- Economic policy missteps;
- Exchange rate misalignment;
- Unsustainable fiscal deficit;
- Unsustainable expenditures; and
- International isolation.

Zimbabwe remains in debt and as a result the country has been isolated from the international world. This has a net effect of reducing the country's ability to access capital to implement high-cost downstream activities. Economic challenges in the country have resulted in a higher cost of doing business as compared to other neighbouring countries. The country is poorly ranked on the World Bank's Ease of Doing Business. These economic challenges have resulted in reduced foreign direct investment and as a result little investment in the PGMs and lithium beneficiation activities of the country.

The country lacks investment and as a result there is over-reliance on outdated technology in the manufacturing sector. Downstream activities in the PGMs and lithium mineral sector are technology driven and Zimbabwe has a limited exposure to innovation and technology. As a result, petalite concentrates from Bikita Minerals are being exported as concentrates and there is no involvement in the battery technology manufacturing industry. There is limited investment in Research and Development and as a result Zimbabwe will rely on countries such as China and Europe to drive the country's innovation.

An estimation done by Chigumira *et al,* 2017 showed that the platinum industry would need extra 115MW of electricity in the coming decade and that beneficiation of minerals identified by the government will see an increase in electricity consumption in the mining sector by more than 19%. Currently demand on the electricity grid is more than supply and timelines that the government is planning on forcing mining companies to beneficiate minerals should be calculated in such a way that it matches with the period that generation of electricity will meet demand because of substantial investment into electricity generation.

Downstream operations necessitate the movement of unprocessed and finished products and the transportation network in the country is in a poor state. This has a negative effect on the speed to access market and as a result translate to an increase in transactional costs. The current framework guiding beneficiation does not cater for transport issues. Beneficiation is a skill-intensive industry that is being advocated for at a time when professional skills in the country are scarce. Zimbabwe's political and economic challenges have resulted in some of the skilled labour leaving the country for better opportunities. As earlier noted, product competitiveness determines whether a beneficiation model succeeds or fails. Zimbabwe has a high cost of doing business and this poses a risk of higher production costs as compared to other countries exporting to foreign markets. If processing costs for both PGMs and lithium are high in Zimbabwe, establishing market for the beneficiated product would be difficult.

Currently the mining industry is subjected to:

- Adhoc various legal framework that govern the sector;
- Multiple agencies that collect revenue;
- An unstable tax regime;
- Royalty regime that is built on gross revenue instead of profit;
- High royalties in the region;
- Ground rentals and fees that are high; and
- Additional profit tax on special mining lease.

These have a net effect of deterring companies from investing in the country in downstream activities. Forcing mining companies to go downstream without addressing such issues would result in beneficiation facing viability challenges. Commodity prices including those of PGMs and lithium have seen an increase from 2016 and resource-rich countries should take advantage of these commodity prices and move downstream. Ore grades and geological nature of the PGMs and lithium present a great opportunity for investment in downstream activities as the ores are near surface and of relatively high grades.

7.3 Conclusions

The research concludes the following with regards to mineral beneficiation and value addition:

- Considerable success in mineral downstream activities can be achieved by countries with a comprehensive beneficiation strategy that is rooted on strong regulatory framework and policies.
- An enabling environment that is created as a result of good governance, fiscal discipline and robust policy framework promotes investment in mineral downstream activities.
- Having a mineral policy that is in sync with the nation's overall economic development policies is important for the effective implementing and sustaining of downstream activities.
- Special immigration arrangements for trainers of skills required for the beneficiation industry is key.
- For successful beneficiation and value addition to take place, establishment of support structures is imperative.
- Establishment of joint ventures that increase the likelihood of easy access to markets, knowledge, expertise and technology is also crucial.
- The need for international trade agreements to create conducive environment for investment and have access to foreign markets for the finished or semi-finished product can by no means be overemphasised.
- Export bans might not be suitable for use by all commodity-dependant developing countries as its success is mainly due to the lack of substitutes and export bans on commodities that can easily be substituted in the market place should be avoided.
- The use of support structures that include research centres that focus on research and development is also key in the mineral value chain.
- Although Zimbabwe has made reasonable strides towards PGMs and lithium beneficiation and value addition, constraints exist that impede the production of final products. This can mainly be attributed to a lack of investment in downstream activities. Zimbabwe's political and economic instability is deterring foreign investors from

participating in the country as the country lacks a conducive environment that attracts investors.

- The country should focus on beneficiating PGMs and lithium all the way to manufacturing to harness all potential beneficiation profits since these were identified as critical minerals and are in abundance in the country by addressing the identified constraints.

CHAPTER EIGHT. RECOMMENDATIONS

8.1 Introduction

According to Centre for Natural Resources Governance (2015), Zimbabwe's natural resources if managed properly and benefits captured on all stages of the mineral value chain, can be the foundation of economic growth and development. The anticipated benefits of beneficiation have been alluded to earlier and the previous chapter highlighted current and potential constraints to PGMs and lithium beneficiation. This chapter aims at giving recommendations to ensure the production of beneficiated products that are globally competitive.

8.2 Investment climate

Due to its political and economic instability, the investment climate in Zimbabwe is regarded as one that is unfriendly. There is need to improve on the investment climate. The country should work on attracting investments required to convert its natural endowment into mineral related industries that support downstream value addition. For the government to improve on its investment climate there is need to engage in the following:

- Ensuring that all citizens are equal before the law and adhering to human rights;
- Elections that are free and fair to normalise effective links with other countries in the world. Normalising relations between Zimbabwe and the international community is important for the structural transformation of the nation's economy;
- Ensure minimal state intervention in mineral resource exploration, mining rights and investment decisions;
- Ensure minimal policy volatility so as to increase confidence for foreign investors;
- Establish a strong institutional and legal setting that promote holding of the public accountable and transparency in the mining industry; and
- Development of a competitive mining fiscal regime.

8.3 Beneficiation strategy

Based on the analysis, Zimbabwe will benefit from having a formal beneficiation strategy and setting up of structures that ensure the full implementation of the strategy. The beneficiation strategy should include an enabling policy framework that promotes investment and implementation of the strategy, supporting structures, regional and international agreements to broaden the scope for market access and strategic interventions to assist in the implementation of the beneficiation strategy. Lack of a well formulated comprehensive strategy will lead to ad hoc responses in implementation. The enabling policy framework can be created through the use of policy and regulatory framework.

The government of Zimbabwe should devise a mineral policy that furnishes the mineral sector with logical statements that are easy to understand on what the government expects and targets from the mineral industry. The mineral policy to address the following:

- Relationship between the national mineral policy, the national agenda and the AMV;
- The roles of the government and mining companies in investment decision making;
- Responsibilities of the extractive companies and the government to the communities; and
- The legislative framework surrounding mineral beneficiation, applicable laws and issues to do with exploration rights, mining rights and security of ownership.

A detailed section in this mineral policy that addresses mineral beneficiation and value addition strategy. This section will provide a framework to translate the country's comparative advantage using mineral processing as a policy tool for structural transformation. The section will seek to promote the following:

- Creation of an enabling environment that is anchored on good governance, fiscal discipline and robust policy framework that promotes investment in mineral downstream activities;
- Investment in support structures that include research centres and state owned mining companies that promote PGMs and lithium beneficiation;
- Use of Free Trade Agreements to easily access largest markets in Europe, China, Asia and North America and using these international partnerships with developed and emerging countries to understand the requirements of the beneficiated goods and how to incorporate these requirements into mineral value chains.;
- The Zimbabwean government to take it upon itself to establish joint ventures that increase the likelihood of easy access to markets, knowledge, expertise and technology for the realisation of the beneficiation strategy; and
- Beneficiation strategic interventions that details the plan to combat the highlighted constraints that include infrastructure and skills development, international market access, security of raw material supply and research and development.
    - Interventions to employ and train local people in beneficiation skills as well as safeguarding the environment;
    - Improving local supply of mineral commodities;
    - Introduction of incentives and tax levies to promote mineral beneficiation. There is also need for constant monitoring of how the incentives and levies impact on the reduction of unemployment rate, poverty alleviation and development towards a knowledge based economy;

- Linkages between the mining sector and the economy at large are mandatory hence the government must create an environment for the creation of a supply chain network for the industry and expanding value addition activities; and
- The Zimbabwean government should make it mandatory for all licensed mining companies to conduct mineral value addition through processing and refining of mineral products;

GLOSSARY TABLE

Phrase	Descriptions
Black Economic Empowerment Entities	Empowerment policy that targets the enhancement of economic participation of Black people in the South African economy
Comparative advantage	A situation where the opportunity cost of production is low for producing a product in different countries
Critical minerals	A mineral whose absence would have significant consequences and whose supply chain is vulnerable to disruption.
Economies of Scale	Cost advantages companies experience when production becomes efficient as costs can be spread over a large amount of goods
Enclave industries	Export based industry that extracts resources from another country and works in isolation from the other industries
Extractive industries	Processes that involve different activities that lead to the extraction of raw materials from the Earth, processing and utilisation by consumers
Implicit tax	Effect of tax on the price of an asset
Nationalisation	Process of transforming privately-owned assets into public assets under national government or state ownership
Natural resource curse	Phenomenon of countries with abundant natural resources but less economic growth as compared to countries with fewer natural resources
Policy paradigm	Beliefs or concepts that govern the policy process
Political misrepresentation	False statements of truth made by political parties which have the potential of affecting decisions of other affected parties
Raw commodities	Input goods needed to manufacture end products
Structural transformation	The movement of an economy from low productivity to high productivity
Vertical integration	Is when a country or firm is engaged in different parts of the value chain for example being involved in production of raw materials, transporting, manufacturing and marketing

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APPENDICES

Interview Questions

1. Is the mining sector of importance to the Zimbabwean economy? If so how can we improve its significance?

   The Mining sector is important to the Zimbabwean economy especially in terms of forex earnings, services, industry support and employment creation. Policies guiding mining should be clear and consistent to ensure investor confidence. The manufacturing industry should use raw materials/mining outputs as inputs to some manufacturing industries to add value to the traditional direct mining outputs

2. Is it important as a country to have a stand-alone mineral policy and if so are there any chances that Zimbabwe's draft mineral policy will be adopted?

   The mining mineral policy is important and it should be clear and forward looking. In addition, it should seamlessly link with other related industries policies, for example the manufacturing industries to avoid undesirable gaps. It is highly likely that Zimbabwe mineral policy will be adopted. The key question is will it be accepted by stakeholders and does it inspire confidence to motivate implementation.

3. What are the strategic and critical minerals for the Zimbabwean mining industry?

   The following are strategic minerals to Zimbabwe from an economic development point of view
   PGMs, Gold, Diamonds, lithium, Nickel, coal and gas, chrome and Agri-industry minerals

4. What are the mineral resources of the strategic and critical minerals in Zimbabwe?
   Same as 3 above

5. Is beneficiation/value addition necessary for economic growth and industrialisation? If so should Zimbabwe carry out beneficiation and beneficiating which minerals and why?

   Beneficiation is already happening. The gap is extent of beneficiation and not the whole basket of minerals. PGMs, chrome and nickel up-to smelting stage. What we need is value addition and industrialisation – that is converting minerals into refined minerals

and using the fully processed minerals to make tangible products that consumers and industry users can usefully use, for example PGMs – making catalytic convertors for export, chrome, iron and nickel to make steel and coal to produce petrol chemical products. Diamonds, beyond polishing (basic value addition) but making jewellery. This way, value additions can drive economic growth sustainably and significantly outside the commodity prices cycle risks. Zimbabwe has to beneficiate. Unfortunately there is no power in the short to medium term because industrialisation needs power. Technology and skills we can import.

6. What are the policies that are currently in place to encourage beneficiation in the mining sector?

   There is no clear, signed and consistent policy. We are getting verbal intentions from authorities. The legislated beneficiation requirements have been discouraging investments in addition to being very controversial and seemingly give no dividends if all factors are put together. The concept has to be crafted, implemented and supported by all in good faith whenever it's introduced.

7. What other factors should be considered for beneficiation/value addition?

   Power, technology, incentives and business returns to investors.

8. What are the challenges to mineral beneficiation in Zimbabwe?

   Inadequate power, the perception that it's compulsory and risk of nationalisation. We do not have technology and are unlikely to get consent from global technology owners given our country reputation and relationships over that past 20 years.

9. How can these challenges be solved?

   We need to kill and prove beyond reasonable sought that Zimbabwe is an equal investment destination, where investors are respected and protected practically and through policies.
   Invest in power supply (now clean energy sources), respect property rights given that mining is capital sensitive and long term and therefore investment risk has to be very low comparatively.

10. Is there currently a balance/convergence between the interests/expectations of the government, mining companies and the local community? If not what can be done to strike a balance between these three interested parties?

    There is no convergence of expectations between and among each of the above stakeholders. Communities expect free business benefits under the assumption that they own resources, government thinks mining companies are over benefiting indirectly and directly and in any case they should feel blessed to be allowed to mine (very incorrect perception).Industry feels conditions for beneficiation are not in place especially the overall business environment including taxation such that returns are negative. The first two stakeholders suffer from over expectation and the feeling that they have stronger and uncontested bargaining positions – not true in the global system.

11. What can Zimbabwe do to increase its competitiveness in the mining industry from a beneficiation/value addition perspective?

    Avail power, competitive investment climate and convince investors on respect of property rights including freedom to take out dividends as and when investors so wish. Do not prescribe JV partners – allow free business partnerships anywhere (mineral/industry), by anyone for the period and type of relationship of their choice. Put in place business policies that are clear, consistent and sustainable with certainty guaranteed over generations for mining assets are fixed, long ;lasting and take time to liquidate if need be.

Interview Questions

1. Is the mining sector of importance to the Zimbabwean economy? If so how can we improve its significance?

   The mining sector is currently the biggest contributor to the countries' GDP and is therefore of great importance to the economy. The sector employs a significant number of people ranging from non-skilled to skilled manpower and is the source of raw products used in other downstream industries in the manufacturing sector e.g. Iron and Cobalt for steelmaking as well as lithium for battery manufacture. The significance of the sector can be improved through value addition of its products as well as government support through legislature that is pro-production and aimed at creating an enabling business environment e.g. enacting policies/laws that strengthen issues of property rights (the right to and protection of mining claims) and providing access to capital for small to medium enterprises.

2. Is it important as a country to have a stand-alone mineral policy and if so are there any chances that Zimbabwe's draft mineral policy will be adopted?
   It is important to have a stand-alone mineral policy due to the strategic nature of the mining sector to the country's economy. Successful adoption of the policy is however unlikely given the policy inconsistences that have been observed in the last decade where for example issues to do with indigenisation of and value addition in the mining sector were and still are very topical and debatable. The Indigenisation policy still remains unclear and changes can be effected at any given point like what has been happening in the past decade.

3. What are the strategic and critical minerals for the Zimbabwean mining industry?
   PGMs, Gold, Diamond, Coal

4. What are the mineral resources of the strategic and critical minerals in Zimbabwe?
   Zimbabwe has the second largest chrome reserves in the world, second to SA. It also has significant Platinum reserves.

5. Is beneficiation/value addition necessary for economic growth and industrialisation? If so should Zimbabwe carry out beneficiation and beneficiating which minerals and why?

Beneficiation is necessary in terms of job creation, expanding the economic space by allowing engagement of more players in the economy which results in widening of the supply chain. Cost cutting as well as increased forex inflows are also some of the advantages of beneficiation. Zimbabwe should carry out beneficiation in order to grow its economy through the aspects stated above. PGMs, Gold and Diamond are the main minerals to target for beneficiation due to the high value of the of the finished products e.g. Jewellery for Platinum, Diamond and Gold as well as catalytic converters and computer parts for Platinum

6. What are the policies that are currently in place to encourage beneficiation in the mining sector?
   The value addition laws were PGM mines are supposed to establish refineries to process matte to finished products
   Diamond polishing laws.

7. What other factors should be considered for beneficiation/value addition?
   The need for technology development in schools and tertiary institutions to enable inventions that suit the Zimbabwean situation.

8. What are the challenges to mineral beneficiation in Zimbabwe?
   Lack of policy consistence, an erratic economic environment which discourages both local and foreign investment

9. How can these challenges be solved?
   Stabilising the economy and attracting foreign direct investment. This can only be achieved through creating a stable political environment which instils confidence to all stakeholders

10. Is there currently a balance/convergence between the interests/expectations of the government, mining companies and the local community? If not what can be done to strike a balance between these three interested parties?

    There is some level of balance in other sectors of the mining industry e.g. the PGM industry. However for mines in the Gold sector there is generally disgruntlement with respect to the interventions of Government in terms of forex disbursements from their mineral exports from the central bank. The sector feels short-changed on forex receipts from their gold sales and this is affecting daily operations as well as capital projects.

11. What can Zimbabwe do to increase its competitiveness in the mining industry from a beneficiation/value addition perspective?

Stabilise the economy through creation of a politically stable environment. This involves an all-inclusive participative approach from all stack-holders in both the business and political sectors. This will enable policy consistence which will in-turn promote investor confidence.