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Rebuilding an economy: Modelling Zimbabwe's Mining Sector with Scenario Planning

By

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Executive Summary

"Once among sub-Saharan Africa's most prosperous and promising states, Zimbabwe has been driven by mismanagement to social and economic ruin." [1]. Zimbabwe is a country known for political and economic instability, yet it has great potential for economic growth and development, particularly in the mining sector. A new strategy for effectively managing the uncertainty inherent in the mining industry is required.

Forecasting methods have been criticised by Collard *et al* [2] as changing a business strategy undermines the usefulness of the data obtained under the old policy and thus renders the forecast obsolete. Therefore, the project has used Scenario Planning (an Operations Research and Business Engineering technique) and engineering economics to analyse Zimbabwe's mining sector.

Four scenarios (Chinese Checkers, Check Mate, Patience, and Full House) and two strategies (Whole Hog, and Slow & Steady) have been developed to analyse the Zimbabwean mining sector's future and its contribution to economic growth.

A questionnaire was sent to industry experts and the results were analysed using AHP and a robust strategy selection method. Both methods concluded that Whole Hog was the more robust strategy.

Benefits for Zimbabwe and the Zimbabwean mining sector include:

- A clear understanding of the future of Zimbabwean mining and what must be done to achieve the best case scenario.
- Adaptability to global changes resulting in Zimbabwe being leaders in the mining industry.
- Increases in foreign investment and ultimately the strengthening of the Zimbabwean economy.

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Acronyms

AHP	Analytical Hierarchy Process
GDP	Gross Domestic Product
GNU	Government of National Unity
IMF	International Monetary Fund
MADM	Multi-Attribute Decision Making
MDC	Movement for Democratic Change
PEST	Political, Social, Economical, Technological
PGM	Platinum Group Metal
RBZ	Reserve Bank of Zimbabwe
SADC	Southern African Development Community
SWOT	Strengths, Weaknesses, Opportunities, Threats
UN	United Nations
ZANU-PF	Zimbabwe African National Union – Patriotic Front

1. Introduction

1.1 Background

1.1.1 Zimbabwe's Economic Climate

Zimbabwe, formerly Rhodesia, gained independence on the 18 April 1980 with ZANU-PF's (Zimbabwe African National Union – Patriotic Front) Robert Mugabe winning a landslide victory in the first election. Mugabe has remained in power ever since. Zimbabwe has an estimated population of 13.3million people, inhabiting a land area of 386 669 sq km [3]. Zimbabwe's main currency earners include agriculture (Tobacco, Soya, and Maize), tourism, and mineral exports (Gold, Platinum, Coal, Copper, Nickel, Tin, and Clay) with Anglo Platinum and Impala Platinum being the largest foreign mining companies in the country [4].

In the 1980's and 1990's Zimbabwe experienced positive economic growth with an average of 5.0 percent and 4.3 percent GDP growth per annum, respectively [5]. However, since 2000 the economy has taken a dramatic downturn as Zimbabwe continued to pour millions into the civil war in the Democratic Republic of the Congo (DRC). Debts were not paid to the IMF (International Monetary Fund), government land distribution policies evicted over 4 000 white farmers, elections were rigged and widespread corruption continued. Severe economic mismanagement has resulted in shortages of foreign exchange, hyperinflation (estimated at 89.7 x10^{21} percent in 2008) [6], food and supply shortages, unemployment of 80 percent [6], failing healthcare and education, closing of mines, and a 75 percent reduction in visitors to Zimbabwe. The GDP "slumped 14 percent in 2008, adding to a cumulative decline of over 40 percent between 2000 and 2007." [7]. The current total GDP (PPP)[1] is $2.210billion (it was as

low in 1971 when Rhodesia was under severe international sanctions) with per capita GDP (PPP)[1] at $188 [8].

Zimbabwe is on the verge of economic collapse; however recent power-sharing deals which appointed Morgan Tsvangirai as Prime Minister, Tendai Biti as Finance Minister, and gave control of 13 of the 31 ministries [9] to the MDC (Movement for Democratic Change) suggest a possibility of improvement. The project aims to provide a possible means of reconstructing the Zimbabwean economy by focussing on the development of the mining industry.

1.1.2 Overview of the Mining Sector

Zimbabwe is a country richly endowed with mineral reserves; it has more than 35 mineral commodities of which the most notable are Gold, Platinum Group Metals (the world's second largest source after South Africa), Nickel, Cobalt, Chromium, Diamonds, Coal and Asbestos [10]. Most of Zimbabwe's mining occurs along the Great Dyke (Appendix A).

The mining sector contributed 27 percent [11] of Zimbabwe's GDP in 2002 and despite economic pressure and political instability, "has the potential to contribute around a third of total export earnings" [12]. There are approximately 1 000 small-scale mines in Zimbabwe; these have been hardest hit with numerous mines closing since 2000. Platinum Group Metals (PGMs) have, however, grown with the opening of a new PGM mine in 2003 and substantial investments and expansion from Zimplats and most recently Camec. If economic and political stability are achieved, the opportunities for Zimbabwe's mining industry will grow rapidly.

[1] Purchasing Power Parity – the effects of inflation are removed from the GDP

1.2 Problem Description

"Without a well functioning economy, democracy and human rights are impossible and equally without a well functioning democracy, economic development is not feasible." [13]. To improve Zimbabwe's situation the economy needs to be boosted by foreign investment [13], but this can only happen if the Zimbabwean economy becomes more stable and attractive to investors.

Zimbabwe needs substantial assistance in rebuilding and stabilising its economy [12]. Improvements in the mining sector will have the greatest positive impact on economic growth in Zimbabwe.

According to the Global Competitiveness Report (2009) [14]

> *"Policymakers are presently struggling with ways of managing these multiple shocks intelligently while preparing their economies to perform well in an economic landscape characterized by growing volatility. In an unstable global financial environment, it is more important than ever for countries to put into place the fundamentals underpinning economic growth and development."* [14]

Zimbabwe is currently in a political position to take constructive steps towards growing its economy. The current global economic crisis has highlighted that the future is never certain, thus the policy makers of Zimbabwe's mining sector need an adaptable strategy that will combat this uncertainty and sustain its economic growth.

1.3 Project Aim

This project aims to create a set of strategies for Zimbabwe's mining sector using the scenario planning technique. Different scenarios of the mining sector's future will be developed; a strategy will be selected from the set of strategies based on robustness across all scenarios. Indicators of a possible change in the economic landscape will also be formed.

1.4 Project Scope

1.4.1 Project Target

This project will develop scenarios and a robust strategy for Zimbabwe's mining sector and assist decision makers in dealing with uncertainty. The project is limited to the mining sector, and does not include the agricultural, manufacturing, or tourism sectors.

The Zimbabwean economy will benefit from the development of the scenarios and ensuing strategies since they will assist in the reconstruction of the economy and development of the mining sector. Mining companies such as Implats, Mimosa, Camec, and Zimplats will benefit from the improved economic stability and may expand operations in Zimbabwe. Inturn the Zimbabwean people will benefit from the improvement of their economic situation.

The following stakeholders have been identified for this project:

- The Student
- The University of Pretoria
- Zimbabwe
- Mining companies and investors

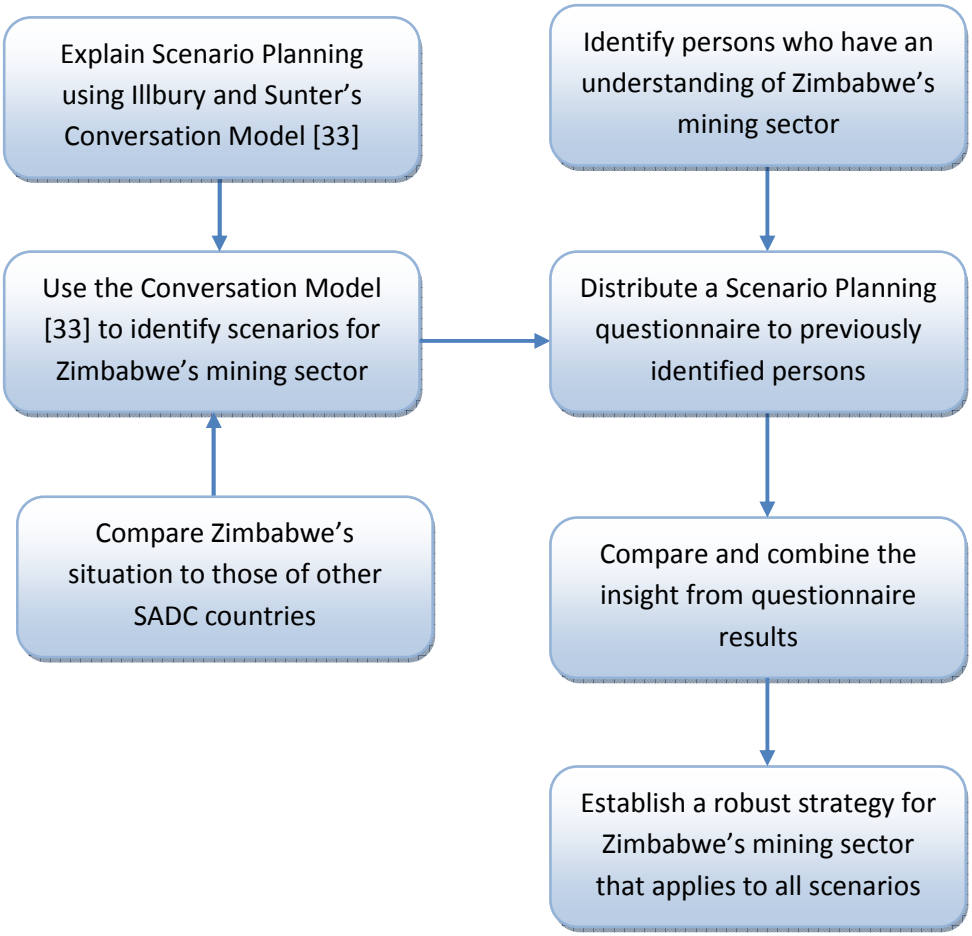
1.4.2 Project Tasks

The following tasks will be performed in completing the project:

- Selection of an appropriate scenario planning method
- Development of a set of scenarios
- Identification of indicators of changing scenarios
- Development of a set of strategies
- Preparation of a questionnaire to validate the scenarios and select the best strategy
- Analysis of questionnaire results

1.5 Research Strategy

Figure 1 Research Strategy



2. Literature Survey

2.1. Strategic Planning Methods

There are many strategic planning typologies, which are suitable for the formulation of the strategies of a country. Some such methods are discussed below with an appropriate example:

☙ Generic Strategic Planning Methods

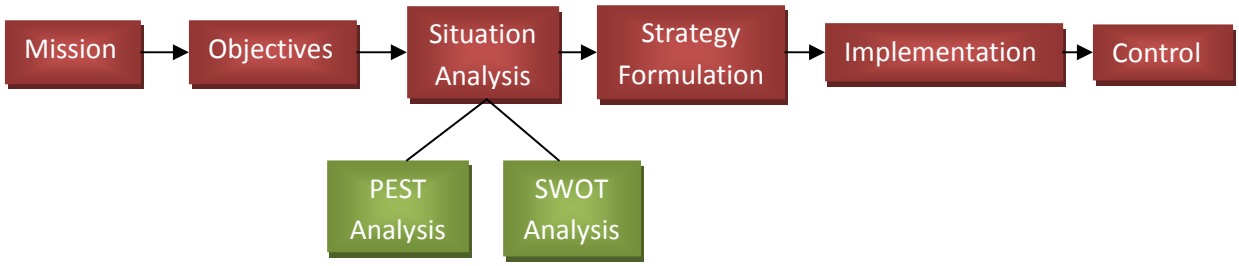
a) The strategic planning framework [15] asks four questions which have been modified below:

1. Where is the country now?
2. Where does the country want to be?
3. How will the country get there?
4. How does the country ensure success?

Appendix D shows a diagrammatic expansion of these questions. This method has been used for the strategic planning of water utility services in developing countries [16] and demonstrates that governments may use commercial management principles to improve governance.

b) Another similar strategic planning process [17] is outlined in the figure below:

Figure 2 The Strategic Planning Process [17]



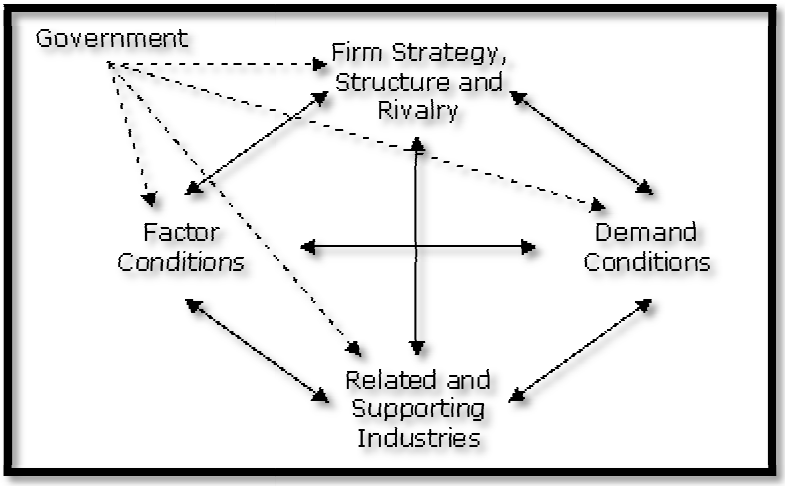
A similar process has been followed in developing Ghana's *Country Strategic Plan (2004-2010)* [18]. Although ongoing, this strategy has seen positive results in the healthcare sector with the HIV/AIDS prevalence rate decreasing from 4.1 percent [18] in 2003 to 2.7 percent [19] in 2005.

c) Michael Porter's five forces analysis [20] is used mainly in the business environment. It analyses the competitive environment of a business in terms of:

1. The threat of entry.
2. The power of buyers.
3. The power of suppliers.
4. The threat of substitutes.
5. Competitive rivalry.

This model has been adapted for countries to include the role of government and its interactions with the market.

Figure 3 Porter's Diamond Model for the Competitive Advantage of Nations [21]



The Porter model has been used in the *Cluster Mapping Project* [22], which groups interconnected companies within geographical locations of the USA. The project monitors the economic performance of each region and identifies the drivers of economic growth [22].

- **Macro-econometric modelling**

"Macroeconomics is the branch of economics that deals with a nation's total economic behaviour" [23]. Macroeconomic models are commonly used to formulate economic policy in a country by testing theories about the economy and forecasting the impact of these theories. Macroeconomics uses statistics to model the relationship between various economic mechanisms to evaluate policy [24].

The Central Bank and Financial Services Authority of Ireland has used macro-econometric models to formulate monetary policy, perform forecasting exercises and policy simulation [25]. Such models have some shortcomings; the model "assumes stability" [25], it makes use of past data [25], and it "requires a long consistent time series" [25].

- **Scenario Planning**

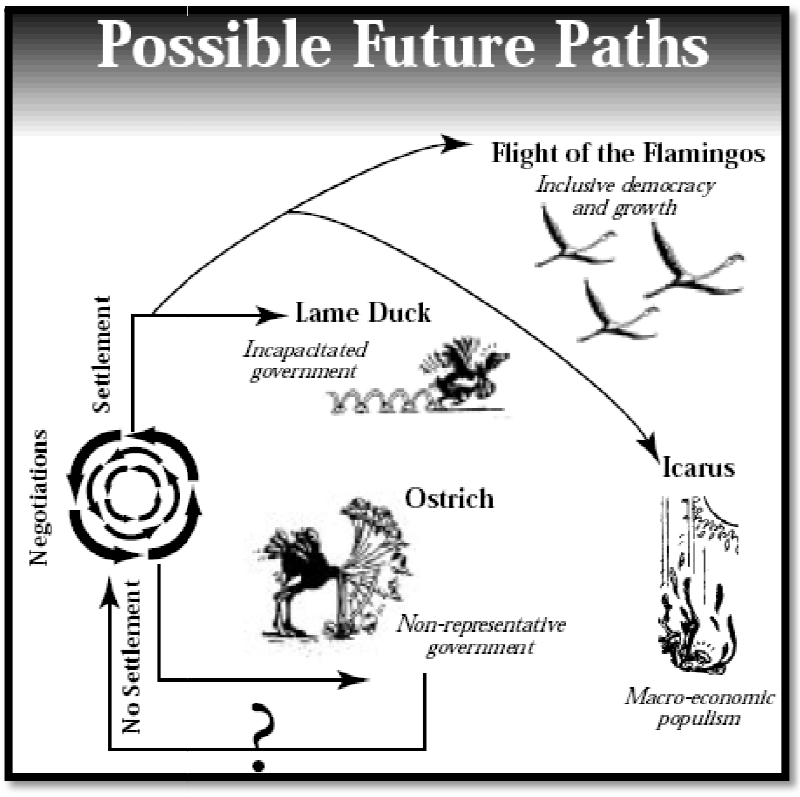
Scenario planning was originally a technique used in military strategy studies until Wack [26] transformed scenario planning into a business tool for Royal Dutch/Shell in the 1970's. This inspired use of scenario planning prepared Shell for the oil crisis of 1973 and enabled them to react quickly to the suddenly changed business environment [26].

Wack says, "Scenarios deal with two worlds; the world of facts and the world of perceptions. They explore for facts but they aim at perceptions of decision-makers. Their purpose is to gather and transform information of strategic significance into fresh perceptions. This transformation process is not trivial—more often than not it does not happen. When it works, it is a creative experience that generates a heartfelt 'Aha' … and leads to strategic insights beyond the mind's reach." [27]. "Scenarios are stories, stories are about meaning: they help explain why things could happen in a certain way. They give order and meaning to events" [28].

The aim of scenario planning is to create a series of alternative futures by acknowledging the uncertainty inherent in any strategy and making it part of one's reasoning [28]. Thus new, more dynamic strategies for each alternative future, that are not based on the "assumption that tomorrow's world will be much like today's" [26], can be developed. An integral part of scenario planning is the development of indicators; indicators warn a company that a certain scenario is about to transpire, and allows the company to act, according to a predetermined plan, on what they know is about to happen instead of reacting once it has already happened [28].

Scenario planning was used effectively in 1991 in South Africa with the Mont Fleur Scenarios [29]. The Mont Fleur project involved a broad spectrum of influential South Africans who discussed the possible futures of South Africa with regards to the end of Apartheid and the prospect of a negotiated settlement. The figure below illustrates the four resulting scenarios. One of the important conclusions of this project was that a positive outcome in the peaceful establishment of an inclusive government was possible.

Figure 4 The Mont Fleur Scenarios [29]



2.1.1. Selected Method: Scenario Planning

Scenario planning has been chosen to model Zimbabwe's mining sector since:

- Any data relating to the mining sector is outdated and/or incomplete.
- It widens the perspectives of decision makers to consider future circumstances.
- Scenario planning offers early warning indicators providing Zimbabwe with ability to adapt to changing circumstances [28].
- Decision makers gain an understanding of the key factors which affect the mining sector's future and how to control or mitigate these factors.
- Robust strategies are developed.

The Zimbabwean mining sector is a highly uncertain environment considering the current global economic crisis. Zimbabwe must prepare for these uncertain events so that rapid action in the future can assure the global competitiveness of their mining sector. Scenario planning will be used to change the perspectives of decision makers by identifying possible futures that exist for Zimbabwe's mining sector and establishing a suitable strategy which will lead the mining sector to the desired scenario.

2.2. Analytical Tools

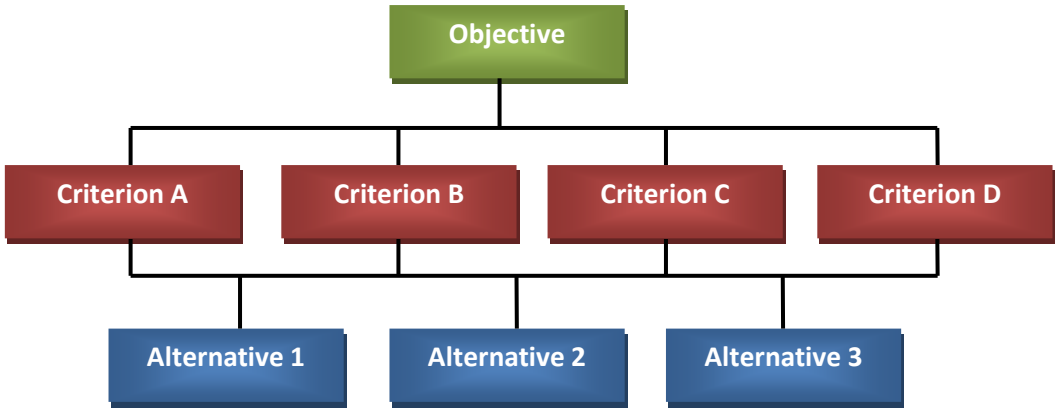
Scenario planning offers a technique which identifies possible future scenarios and expressly includes uncertainty in the development of strategies, but a mathematical method of evaluating the strategies is required. Some of the analytical tools used in conjunction with scenario planning are listed below:

☙ Multi-attribute decision making (MADM)

MADM "is a methodology designed for evaluating options taking into account decision makers' multiple, and often conflicting, objectives." [30]. It uses structured mathematical techniques to evaluate complex decision alternatives [31].

Analytical Hierarchy Process (AHP) is one of the most common MADM techniques. AHP weights each criterion according to its importance to achieving the objective [32]; this is usually done using pair-wise comparison of criteria and matrix multiplication to determine the eigenvector. Each alternative is then evaluated according to the criteria and the highest ranking alternative is chosen to meet the objective. AHP is shown diagrammatically below. Additional sub-criteria may also be included.

Figure 5 Analytical Hierarchy Process [33]



Augmenting scenario planning with MADM has been discussed in [34]. This paper concludes that MADM and scenario planning complement each other since the combination of these techniques aids decision makers in choosing robust strategies [34]. Montibeller *et al* [30] have used two case studies (Insurance brokering in England and warehouse development in Italy) to illustrate the benefits of using MADM in conjunction with scenario planning. This paper demonstrates that

scenario planning offers a solution to decision making under uncertainty and MADM "adds a detailed appraisal of options" [30]. Some difficulties have been experienced with this approach as decision makers find it difficult to assign weights to the criteria [30].

- **Fuzzy Set Theory**

Fuzzy set theory was developed by Zadeh in 1965 [35] and is used to solve complex systems for which crisp or numerically precise numbers are insufficient as there is a degree of uncertainty [36]. Fuzzy numbers are described by a membership function $\mu(x)$, i.e. such numbers have a certain degree of membership to the fuzzy set.

Fuzzy logic is often used to model linguistic variables. For example, for the linguistic set {very young, young, old, very old} a man who is thirty years old might have the following membership function [36]:

Table 1 An example of fuzzy linguistic variables

Linguistic variable	Very young	Young	Old	Very Old
Degree of Membership	0.1	0.75	0.1	0.05

Fuzzy linguistic variables have been used in conjunction with scenario planning in [37] and [38]. In both cases fuzzy linguistics is used to determine the degree of importance of analysis factors to the scenarios, demonstrating that fuzzy logic is useful in modelling the uncertainty intrinsic to scenario planning.

2.3. Research Instruments

Ideally a scenario planning session should be held with the decision makers or the top management of a company. Decision makers that are part of the scenario planning process know their 'game' better than anyone else, thus they create better scenarios and strategies than any consultant could [39]. As the scenarios are developed they are awakened to the various futures that the company faces and are more likely to buy into the resulting strategies. In this case the decision makers would be the government of Zimbabwe as well as members of the Chamber of Mines. It is therefore not possible to involve these decision makers in the scenario planning process. Although not preferable, the resulting scenarios will still influence decision makers should they be made aware of the possible futures that Zimbabwe faces.

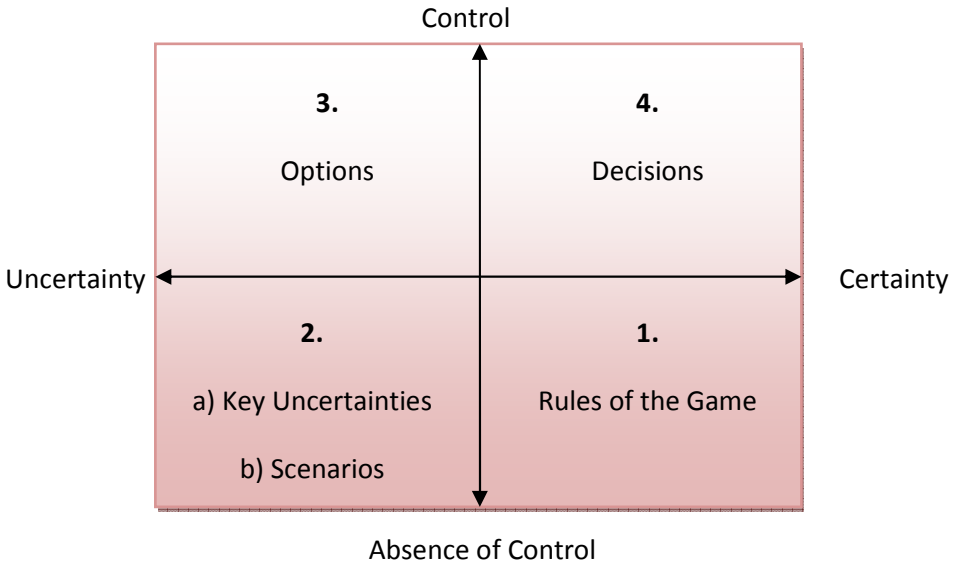
A questionnaire will be sent to industry experts who will weight the importance of the criteria to each scenario and each strategy. Linguistic variables will be used in the questionnaire to aid respondents with the weighting of criteria; the results of such variables will be translated using fuzzy set theory. The results of the questionnaire will then be analysed using AHP to determine which strategy performs best under all scenarios.

3. Methodology

3.1. The Conversation Model

There are many techniques of performing scenario planning; The Conversation Model [31-33] will be used since it not only facilitates the development of scenarios, but also provides tools for effective decision making. The Conversation Model has been adapted over the course of three books. *The Mind of a Fox – Scenario Planning in Action* [28] outlines the scenario planning matrix below, which aims to assist businesses (or countries) in facing uncertainty.

Figure 6 Foxy Matrix [31]



1. Rules of the Game can be compared to viewing the business landscape; they "shape the parameters within which one can operate" [28]. The decision makers have no control over the rules of the game, yet they must abide by the rules to stay in the

game [28]. Having a good understanding of the rules can, however, give a company or a country a competitive edge as they utilise the rules to gain advantage. For example, a law might exist that controls the carbon emissions of a petroleum company (a rule of the game). The company might choose to reduce emissions by amounts greater than required, thereby attracting 'green' investors (using the rules to gain advantage).

2. a) Key Uncertainties or driving forces are uncertain future events that may pose a major threat or afford a major opportunity [39]. Should such events occur they will have the greatest impact on an organisation, thus scenarios are formulated around key uncertainties.

   b) "Scenarios are stories about possible futures" [28] that may transpire as a result of the occurrence or non-occurrence of specific events. Decision makers identify what will happen if a previously identified key uncertainty comes into play as well as their possible reactions to such events. Both positive and negative scenarios should be created to give the decision makers a clearer view of their future [28].

3. Options are the different courses of action that a company could take to move from the current scenario to the desired scenario. Options must be brainstormed and then narrowed down to those actions which are within the company's control and which can be realistically implemented.

4. An informed decision about the best course of action for the organisation can then be made.

This *foxy matrix* has been substantially modified into the Conversation Model; although many more analysis tools have been included, the basic idea still remains. The Conversation Model from *Games Foxes Play – Planning for Extraordinary Times* [39] follows:

Figure 7 The Conversation Model [39]

This model is also explained in *Socrates and the Fox – A Strategic Dialogue* [40] by using ten questions that decision makers can ask themselves when planning for the future. These questions are quoted in a modified fashion from [40] below.

"Defining the Game

1. Context: How has the game changed in the industry, where is it heading and how has the company fared?

2. Scope: What is the playing field today, and could it expand (or contract) in light of the developing context and the available resources?

3. Players: Who are the players that can most advance or retard the strategy, and how should one handle them in the future?

4. Rules: What are the rules of the game that are most likely to govern the strategy under all scenarios?

5. Uncertainties: What are the key uncertainties that could have a significant impact on the game and divert the course either positively or negatively?

6. Scenarios: What are the possible scenarios on the game board and where would one position oneself in relation to them now?

Playing the Game

7. SWOT: What are the strengths and weaknesses possessed by the company; and what are the opportunities and threats offered by the game?

8. Options: Within one's span of control, which options are available to improve the current performance and longer-term prospects in the game?

9. Decisions: Which options should be turned into decisions right now, and what is the initial action associated with each decision?

10. Outcomes: What is the meaning of winning the game in five years' time, when expressed as a set of measurable outcomes?" [40]

The project will make use of the methods proposed in all three of Ilbury and Sunter's books. The project will focus on *Games Foxes Play – Planning for Extraordinary Times* [39] as it offers more structured thinking tools.

3.2. Scenario Planning for Zimbabwe's Mining Sector

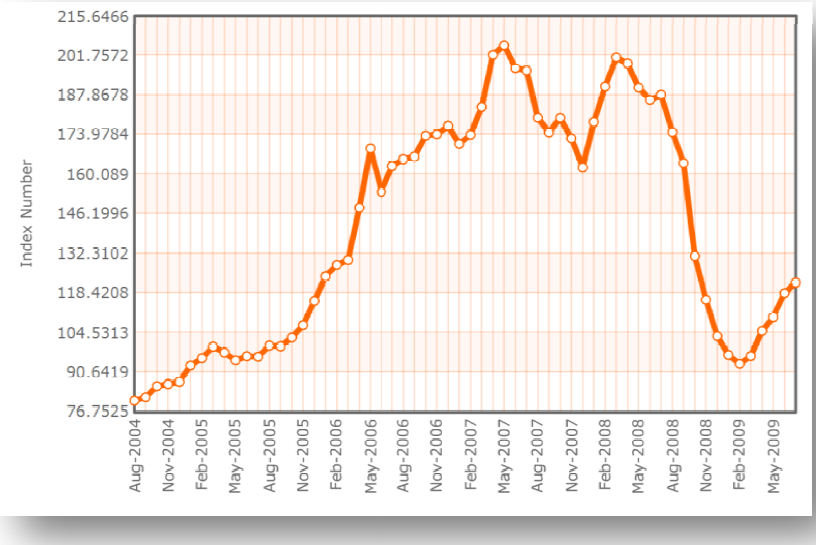
3.2.1. Defining the Game

1. Context

Investment: The Frasier Institute Annual Survey of Mining Companies for 2008/2009 says that, "the mining sector expects dramatically decreased investment plans along with a large number of bankruptcies in the sector." and, "More than four out of five miners believe that at least 30 percent of exploration companies will be forced out of business in the current economic downturn." [41].

Commodity Prices: Commodity prices have dropped rapidly since July 2008. "Since then, commodity prices have recovered to some extent; investors, however, seem unconvinced of a sustained recovery in commodities." [42]. The fluctuation in commodity prices over the period August 2004 to May 2009 is shown in the figure below. See Appendix B for more detail on the Gold price and PGM prices.

Figure 8 Commodity Metals Price Index (2004-2009) [43]



How has Zimbabwe fared?

The World Economic Forum Global Competitiveness Report ranks countries based on the competitiveness of their economies; of 134 countries Zimbabwe was ranked poorly at 133 [14]. Zimbabwe also scored poorly in the World Bank Global Ease-of-Doing-Business Index coming in at 154th of 181 countries [44]. (**See Appendix C** for the main reasons thereof)

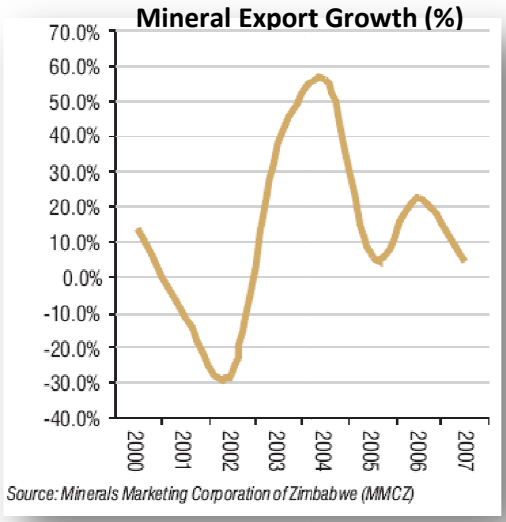
1. The Reserve Bank of Zimbabwe Report [45]

The graph below shows the decline in Zimbabwe's mining sector from 2003 to 2007. During this time global mineral prices were high, yet Zimbabwe's mining sector remained depressed. The Reserve Bank of Zimbabwe (RBZ) report attributed this to:

- Parallel market activities due to a high difference in official and international prices
- High production costs due to the hyperinflationary environment
- Power outages
- Technological challenges such as machinery failure
- Foreign exchange constraints
- The 'brain drain' and high staff turnover
- New environmental impact assessment requirements, which are too stringent for small scale mines
- Heavy rains affecting open cast coal mines

In 2008 the global recession, which also affected the mining sector of neighbouring countries like South Africa, added to the decline in Zimbabwe's mineral export growth.

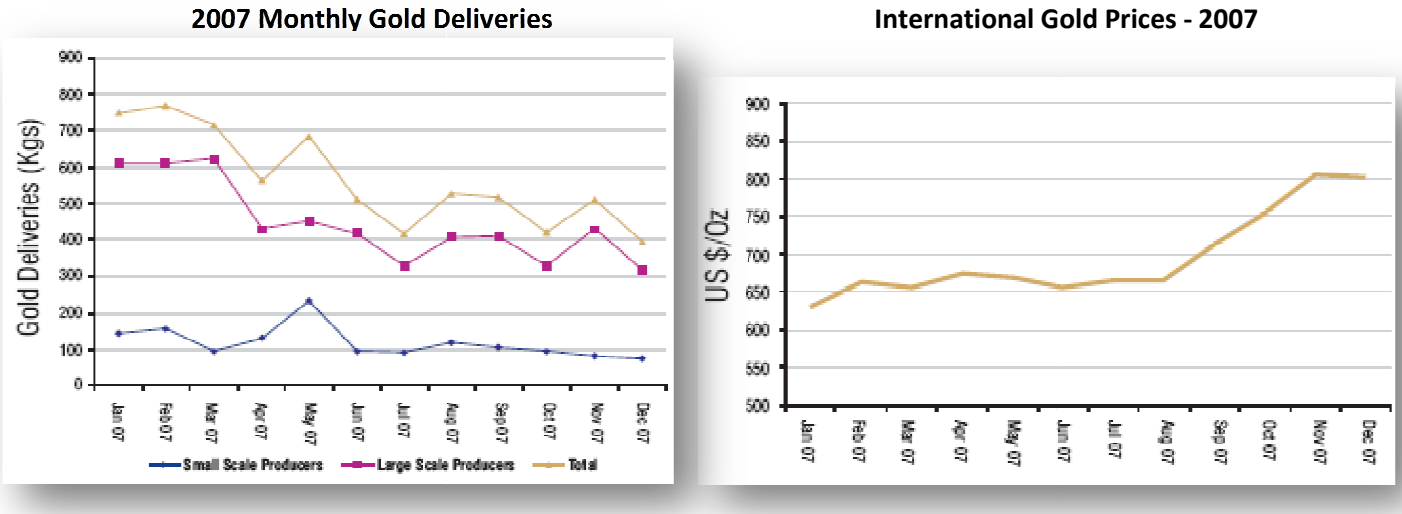
Figure 9 Mineral Export Growth [45]



Platinum production did however, increase in this time due to expansion projects initiated by Zimplats and Mimosa, as well as firming international platinum prices.

The graphs below show the disparity between gold prices and Zimbabwe's gold production. When the gold prices are relatively low Zimbabwe's gold production is high. As international gold prices increase Zimbabwe's production falls. This disparity is caused by the difference in official and international gold prices. It is not profitable for companies to produce more when international prices are high, as they do not receive a fair price. This is a lost opportunity for Zimbabwe to create income for the economy.

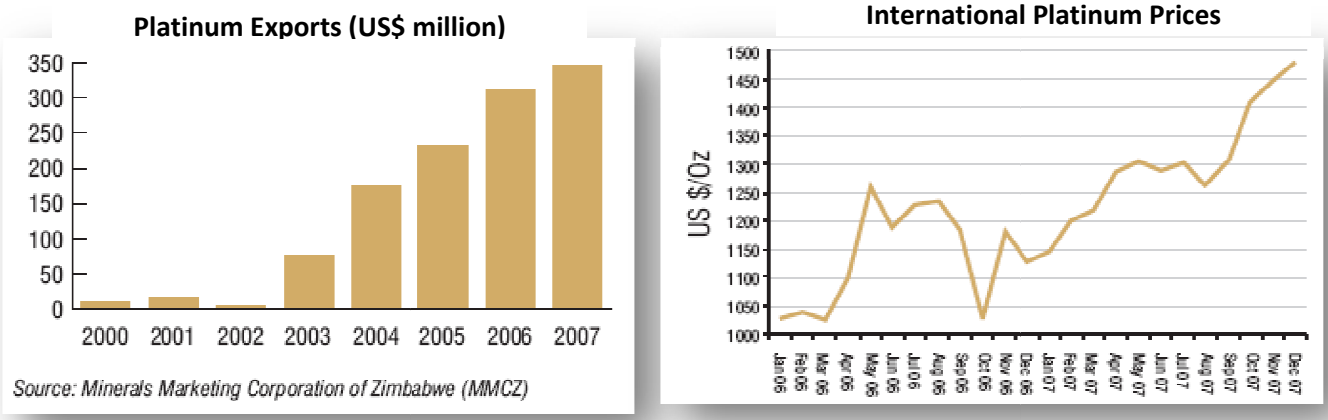
Figure 10 Gold Performance [45]



The international platinum prices also increased over 2007, as did Zimbabwe's platinum exports (see graphs below). High prices and high production result in a higher contribution to the GDP, which has a favourable impact on Zimbabwe's economy.

The external auditors report also states that "the ratio of gold and foreign assets to foreign liabilities is equal to 20% [sic], which was below the prescribed ratio of 40% [sic]". This means that Zimbabwe owes more money than its value in gold and assets [45].

Figure 11 Platinum Performance [45]

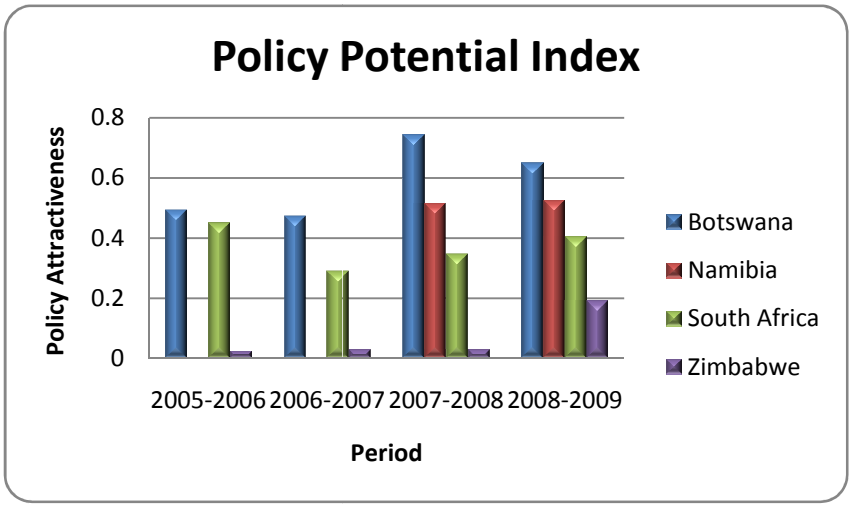


2. The Frasier Institute Annual Survey of Mining Companies [41]

'The Fraser Institute measures and studies the impact of competitive markets and government interventions on individuals and society.'[41]. This report is an annual survey of 658 mining and mining exploration companies, which is used to assess the effect that government regulations have on foreign investment in a country's mining sector. Currently seventy-one jurisdictions are included in the survey. The results for Botswana, Namibia, South Africa, and Zimbabwe are shown. Note that Namibia was not part of the survey in 2005/2006 and 2006/2007.

Policy Potential Index: A report card to governments on how attractive their policies are from the point of view of an exploration manager [41].

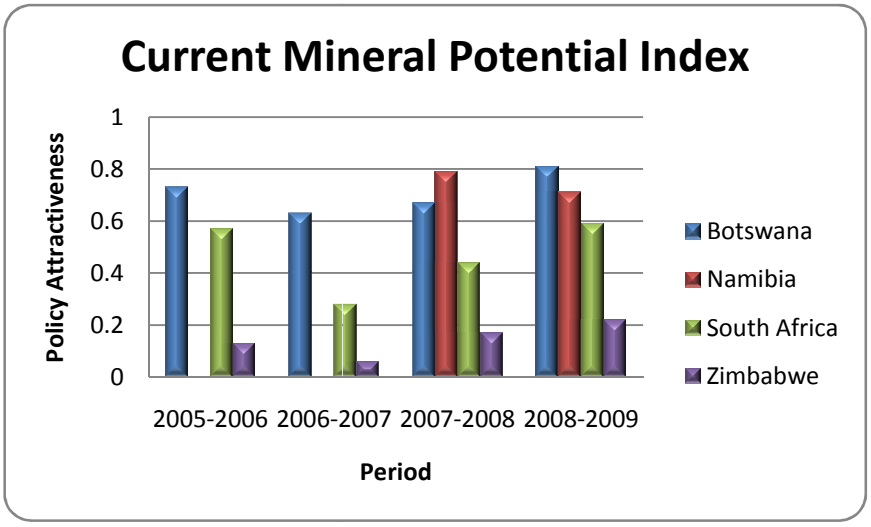
Figure 12 Policy Potential Index [41]



As seen in the graph above Zimbabwe's mining and mineral policies (such as the Indigenisation policy whereby government can claim 51 percent ownership of a mine) were not attractive to investors. However in 2008/2009 Zimbabwe's policy potential has increased, most likely due to the changes in the political situation and the conception of the Government of National Unity (GNU).

Current Mineral Potential Index: The level to which a jurisdiction's mineral potential, under the current policy environment, encourages or discourages exploration [41].

Figure 13 Current Mineral Potential Index [41]



Zimbabwe is rich in mineral resources, but their policies regarding mining exploration deter investment. The index above shows that when compared to Botswana, Namibia and South Africa, Zimbabwe is considerably less attractive to investors. As in the Policy Potential Index the 2008/2009 survey showed an improved confidence in Zimbabwe's mining sector.

Conclusion:

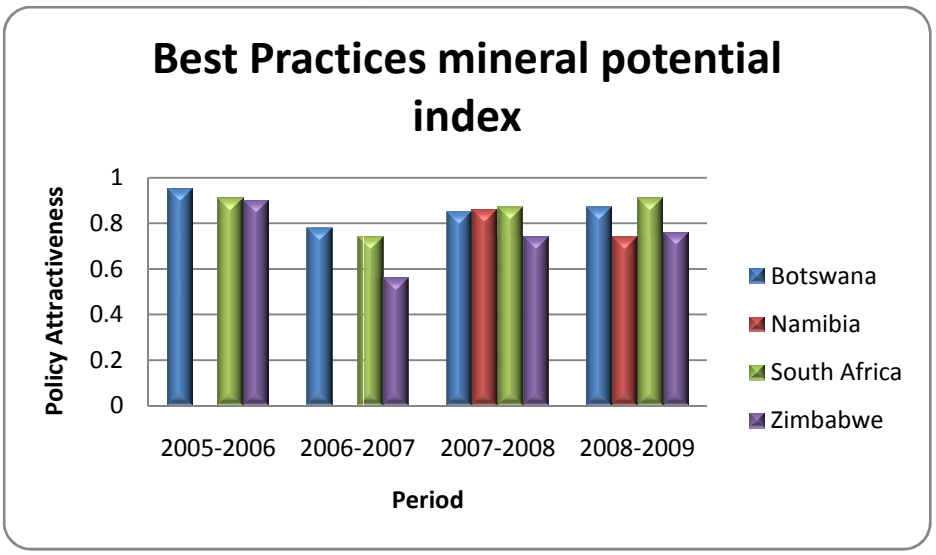
- The global economic crisis means that investment in the mining sector will decline.
- Commodity prices have fallen since 2008, and are making a slow recovery. This means a further reduction in mining investments.
- As shown in the Frasier Institute Report and the RBZ report above Zimbabwe has not faired well in the mining game as mineral export growth has declined and investor confidence is low due to poor mining policies.
- Zimbabwe's economic competitiveness ranking is poor and an improvement of its ease-of-doing-business index is required should it wish to attract investment.

2. Scope

The Playing Field: The Frasier Institute report also shows that Zimbabwe has the potential to attract foreign investment should it change its mining policies (see graphs below).

"Best Practices" Mineral Potential Index: "Pure" mineral potential assuming a "best practices" regime [41].

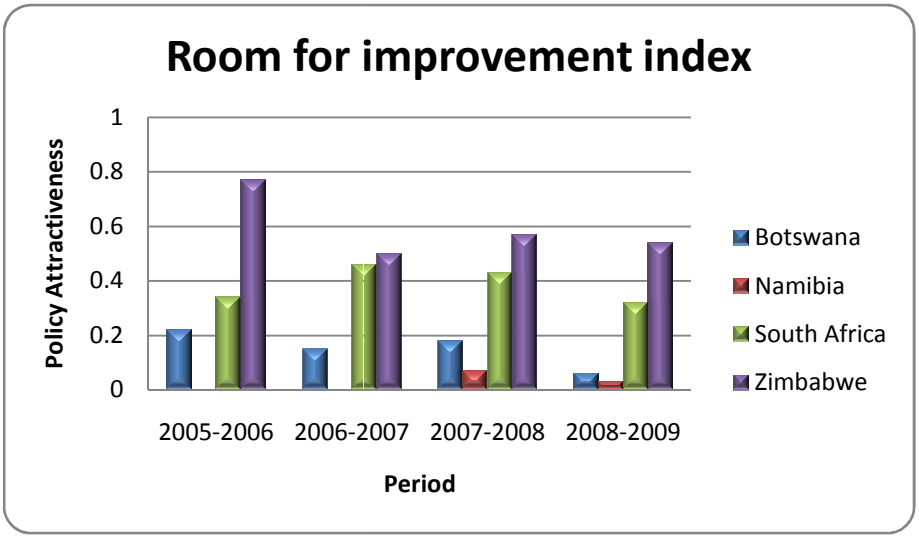
Figure 14 Best Practices Mineral Potential Index [41]



Survey participants indicated that under the best mining policies Zimbabwe is attractive for investment. This shows that Zimbabwe has mineral wealth and the potential to become a sought after mining country.

Room for Improvement Index: The difference between the "Best Practices" Mineral Potential and the Current Mineral Potential [41].

Figure 15 Room for Improvement Index [41]



This index shows that Zimbabwe has great room for improvement when compared to Botswana, Namibia and South Africa. Under the correct mineral and mining policies Zimbabwe could have a very successful mining sector since their mineral resources are large.

How does Zimbabwe want to expand?

1) Short Term Emergency Recovery Plan (STERP)[13]

STERP is Zimbabwe's Short Term Emergency Recovery Plan, initiated by the new Inclusive Government, for resuscitating the economy. It aims to "stabilise the macro- and micro-economy, recover levels of savings, investment and growth, and develop a mid- to long-term economic programme to change Zimbabwe into a progressive developmental state." [13].

STERP recognises that “the mining sector, a major earner of foreign currency, has been performing below its potential.”[13], and has outlined several policy changes.

1. Reviewing the framework for:
    a. Mining rights
    b. Pricing of minerals – “The pricing gap in respect of which domestic prices lagged behind international prices is a thing of the past” [13].
    c. Surrender requirements – “No retention on commodity earnings will be made by any authority in Zimbabwe”; “No amount will be retained by the Reserve Bank” [13].

2. Securing foreign investment by:
    a. Promoting joint venture strategic partners whereby investors will receive majority ownership as well as “special dispensations and privileges” [13].
    b. Investing in global technology developments so that “our [sic] industries can integrate technologically with the rest of the world.” [13].
    c. Stabilising the macro-economy by trading in South African Rands or US Dollars, and thereby eliminating the hyper-inflation problem related to the Zimbabwean Dollar.
    d. “Rehabilitating and maintaining the country’s infrastructural base.” [13].

2) National Budget 2009 [12]

Zimbabwe’s 2009 budget, drafted under the new Inclusive Government, outlines the areas in which the government aims to make improvements and how such improvements will be made using good fiscal policy. It proposes linking expenditures to actual revenues with no spending outside the budget. The budget complements STERP and expands on the ways in which government will resuscitate the economy. “Acting Finance Minister Senator Patrick Chinamasa said the Budget's main focus was to

support productive sectors, stabilise inflation and restore the provision of basic public services." [46].

a) Mining [12]

Despite high mineral prices in 2007/2008 the Zimbabwean mining sector has seen a decline in "capacity utilization and production volumes" [12]. The current global economic crisis has resulted in:

- Decreased demand and low mineral prices
- Mining companies scaling back operations; deferring investments for expansion and exploration and many of Zimbabwe's mines have been put on care and maintenance

As "mining attracts large inflows of foreign exchange and foreign investor participation" [12] the following changes to the mining sector will be made to ensure its viability:

- Creating a consistent policy framework which offers incentives to investors
- Allowing easier access to foreign exchange, via the Reserve Bank of Zimbabwe
- Only using a market determined exchange rate
- Enabling mining houses to expand production
- Suspending exports of unprocessed minerals in support of greater beneficiation
- Increasing skills training at tertiary level

b) Energy [12]

The following problems have been experienced with regards to Zimbabwe's energy:

- Frequent power outages which have constrained operations in the productive sector.

- Deferment of investments for expansion projects has resulted in power generation and supply lagging behind demand. The current demand is 2279 megawatt and the potential electricity production is 1670 megawatt, yet ZESA (Zimbabwe Electricity Supply Authority) is currently only able to supply 569 megawatt [12].
- ZESA still relies on the government for financial support as reviewing of tariffs has been delayed [12].
- Vandalism of electricity transmission infrastructure is rife [12].

The National budget indicates that Zimbabwe plans to increase its power supply and generation. The Hwange Power Station will increase its power generation to 992 megawatt and once refurbished (in two stages) will be able to increase power supply by 480 megawatt for stage one and 380 megawatt for stage two [12]. Restoration of the thermal power stations in Harare, Bulawayo, and Munyati will generate a further 125 megawatt [12]. Imports of 400 megawatt will be required [12].

An energy supply of excellent availability is important for the running of mines. Thus Zimbabwe's energy generation and supply projects are of significant importance for attracting foreign investors to the mining sector. As Zimbabwe's infrastructural base improves, so does investor confidence.

Conclusion: Zimbabwe's mining sector has the potential to expand rapidly under the correct mining policies as it is rich in mineral resources. Improved mining policies will create an investor friendly environment resulting in expansion within the mining sector, which will support the growth of Zimbabwe's economy.

3. Players

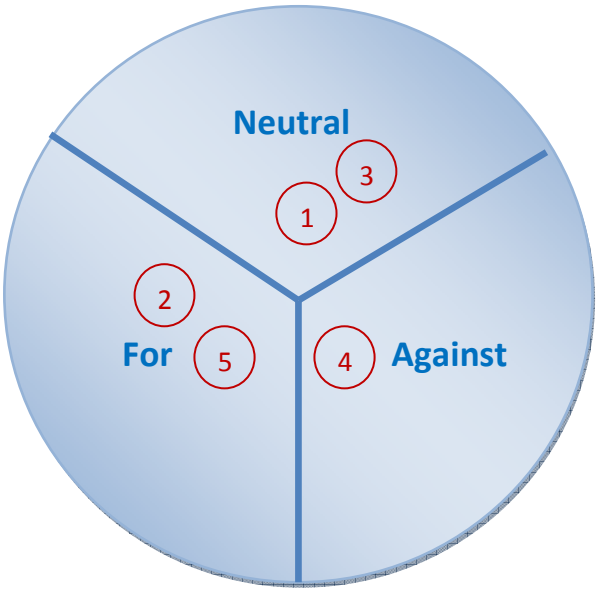
Table 2 Players in the Mining Game

Player	Impact	For/Against/Neutral
1.Mining Companies	Should mining companies choose to invest in Zimbabwe they will support the expansion of the mining sector and be able to fund infrastructure development. However, if mining companies pull out of Zimbabwe it could lead to the collapse of the mining sector. Ultimately mining companies will look after their own interests first and not the well being of Zimbabwe's mining sector.	Mining companies are *Neutral* players as they will support Zimbabwe if it is beneficial to the company and will withdraw support if not.
2. International Monetary Fund	"IMF staff will continue to provide policy advice and targeted technical assistance in the context of regular visits. Access to IMF financing would require donor financial support for arrears clearance to official creditors and a sustained track record of sound policies." [47]. The World Bank and African Development Bank are in similar positions to the IMF with regards to supporting Zimbabwe.	The IMF is *For* Zimbabwe as it is assisting Zimbabwe in its economic recovery.
3. China	"The Chinese trade delegations show a growing interest in the mineral resources of Zimbabwe, in particular, iron, steel, chrome and platinum" [48]. China is also expected to participate in Zimbabwe's economic recovery by offering financial support through "debt rescheduling or forgiveness, provisions of lines of credit and credit loan financing." [49].	China is *Neutral* as it will only invest in Zimbabwe's mining sector if this helps achieve China's economic objectives.
4.Western countries	The United Nations and The USA have yet to lift sanctions on Zimbabwe; the lifting of sanctions signifies political and economic confidence in Zimbabwe and will allow greater support of the mining sector. Western countries can also offer financial aid to Zimbabwe to build infrastructure and further develop the mining sector.	Western countries are currently *Against* Zimbabwe as they have not lifted sanctions.
5.SADC countries	Zimbabwe can learn from both the successes and failures of their neighbouring countries (see more detail below)	SADC countries are *For* Zimbabwe's mining sector as any trade in Africa benefits the African community

Table 3 Selected SADC countries

Player	Description	Global Competitiveness rank [14]	Ease-of-doing-business rank [44]
Botswana	At independence mining contributed only 1% to the GDP. It now contributes over 34%, which shows that Botswana has had significant success in this industry [3].	56	38
Namibia	50 percent of Namibia's exports can be attributed to mining. Although mineral reserves are not as high as in other countries, Namibia's good policies have enabled the growth of this sector [3].	80	51
South Africa	"South Africa is the leading producer for nearly all of Africa's metals and minerals production" [4].	45	32
The Democratic Republic of the Congo	The Democratic Republic of the Congo (DRC) has substantial mineral wealth, but due to political instability as a result of its ongoing civil war [3] is not competitive in the mining industry.	N/A	181
Angola	Angola has yet to show considerable success in the mining industry since the end of the 27 year civil war. This is mainly due to reluctance of companies to invest in a country previously known for selling blood diamonds as well as the "difficult operating and bureaucratic environment in the country" [50].	N/A	168
Zambia	Zambia instituted a new windfall tax on minerals in 2008 and consequently experienced problems with foreign investors threatening to delay projects [51].	112	100

Figure 16 Stance of Players towards Zimbabwe's Mining Sector



4. Rules of the Game

Descriptive: "Descriptive rules describe the predictable rules of the market" [39] and for Zimbabwe's mining sector include:

- Mineral resources are limited and exploitation cannot continue forever.
- Mineral resources will always be in demand, especially for countries such as China that have none.

Normative: "Normative rules are the moral rules of the game" [39]:

- Labour practices must meet international standards.
- Environmental protection laws must meet international standards.
- The mining sector must be corruption free.
- Security of investment (No unfair surrender requirements).

Aspirational: “Aspirational rules are the rules to win the game” [39], for Zimbabwe this means having:

- The most attractive mining policies.
- Incentives for investors.
- An extensive geological database.
- Infrastructure and technology which supports the mining sector.

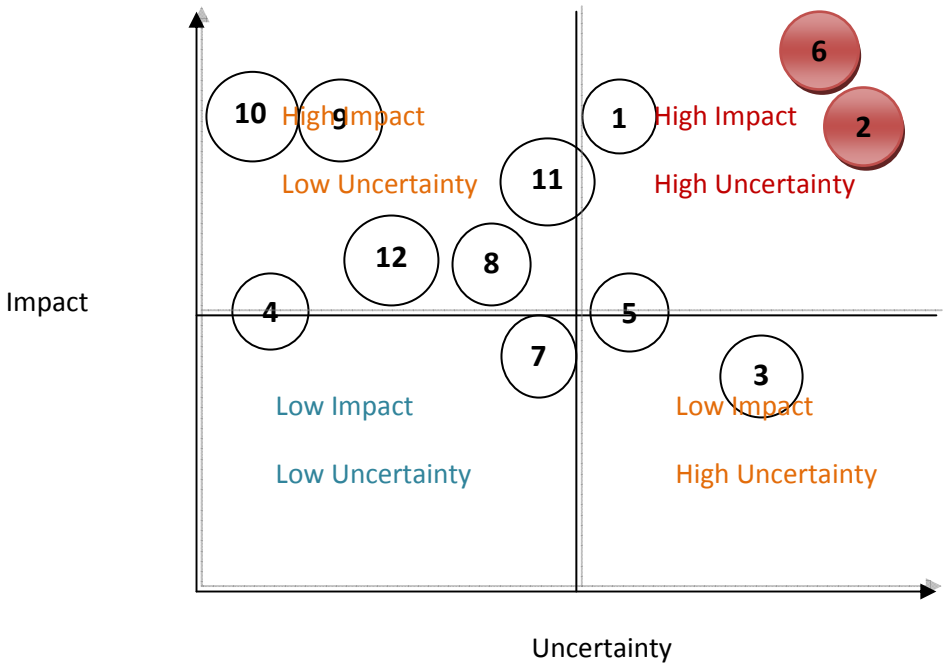
5. Key Uncertainties

The key uncertainties in the Zimbabwean mining game are:

1. Foreign investor interest
2. Commodity prices
3. Mineral wealth
4. Production capacity
5. Mining skills
6. Political stability
7. Production costs
8. Electricity supply
9. Regulations
10. The taxation regime
11. Land claims
12. Security

The key uncertainties have been plotted on the Impact/Uncertainty graph below:

Figure 17 Key Uncertainties Graph

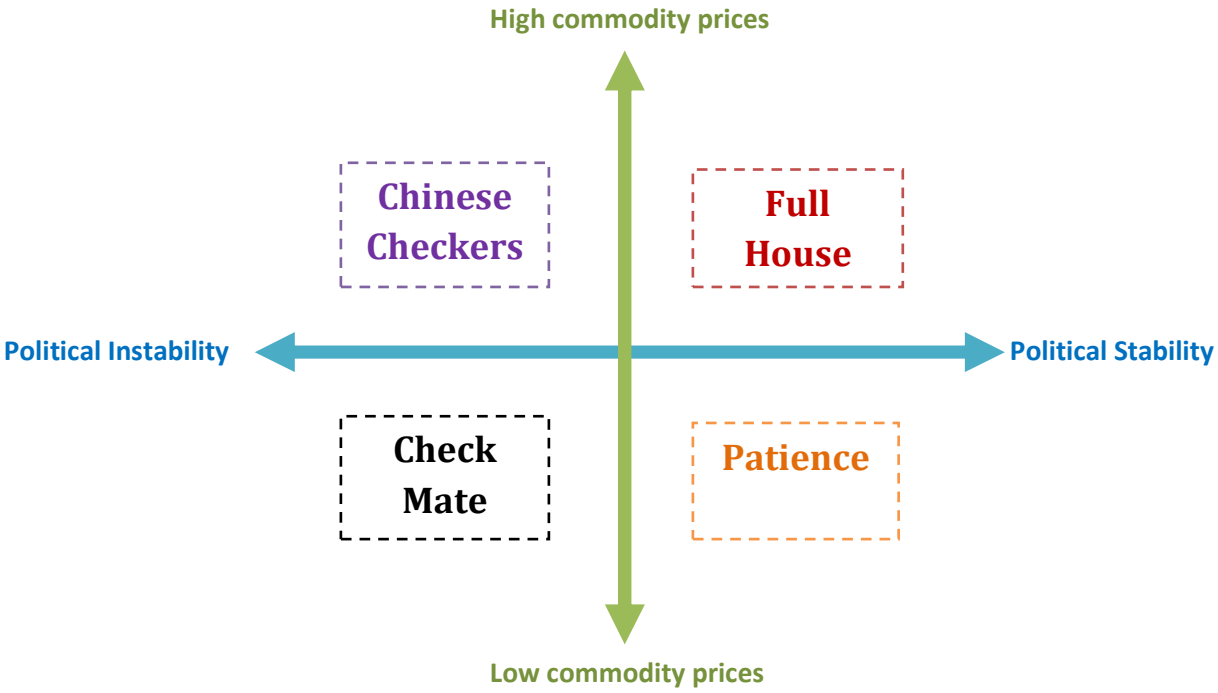


6. Scenarios

Political stability and commodity prices have the highest impact and the highest uncertainty. These two key uncertainties have been selected for developing scenarios.

Commodity prices are not within the Zimbabwean mining sector's control, however political stability and good policy making are within their control. This means that they can influence their position on the mining 'game board' below.

Figure 18 Scenario Game-board



Chinese Checkers

Political stability continues to elude Zimbabwe; despite high commodity prices Western countries and prospective investors balk at investing in a country where, for example, there are reports of "illegal diamond mining by Zimbabwean troops, leading to bloodshed and attacks against civilians." [72].

China, however decides to invest in Zimbabwe's mining sector as according to Stiftung [48] "The Chinese approach does not come shrouded in moral principles and universal values but is rooted on clearly defined economic objectives." Driven by "their ambitions of resource security" [52] China offers large amounts of financial aid to Zimbabwe, as well as investing in several mining companies. This mutually beneficial relationship assists in stabilizing the Zimbabwean economy and provides China with their required

mineral resources. In addition, China's stockpiling of resources drives commodity prices even higher and Zimbabwe reaps the benefits of mineral wealth.

Check Mate

Zimbabwe has lost the game, the king is cornered; its check mate!

The political situation does not improve; in fact it worsens as land claims, rigorous taxation regimes, poor security, corruption, and indigenisation escalate. The global economic slump is U-shaped instead of V-shaped and commodity prices drop further. The combination of these two factors results in prospective foreign investors looking elsewhere as mining in Zimbabwe is no longer profitable. Existing investors start to leave Zimbabwe and large scale closing of mines begins. To make matters worse all skilled labour abandons Zimbabwe for the greener pastures of South Africa and overseas. Over time all mining infrastructure is degraded beyond use and technology is outdated. Mineral richness is no longer important as exploitation is too expensive when commodity prices are so low.

Patience

The coalition government changes Zimbabwe's mining and other policies as outlined in STERP and the National Budget 2009 and Zimbabwe becomes politically stable. Gone are the days of corruption, indigenization and poor fiscal policy, making Zimbabwe's mining sector investor friendly.

Commodity prices however, are low and the global economic crisis means that many investors cannot afford to expand into Zimbabwe. This is a game of patience for Zimbabwe as the expansion of the mining sector is slowed due to lack of investment. Foreign aid allows for moderate expansion thus, Zimbabwe will be prepared for the sudden influx of new investors when commodity prices rise again.

For the bold investor this is the perfect time to enter Zimbabwe's mining sector as competition is low and the economic situation will improve in the future.

Full House

Zimbabwe achieves political stability and thus holds all the cards. As confidence in Zimbabwe is restored all sanctions are revoked and its mineral wealth, combined with high commodity prices, attracts large sums of foreign investment.

Zimbabwe now has the power to initiate greater beneficiation of minerals, creating more opportunities for Zimbabweans in the mining sector. The mining sector expands rapidly, quickly becoming a world leader in mineral production, mining techniques, skills and investor friendly policies. As the mining sector grows it has a ripple effect on Zimbabwe's other economic sectors resulting in a stable economy and the upliftment of Zimbabweans.

3.2.1.1. Indicators

Zimbabwe is currently in the Check Mate quadrant as commodity prices are low and political stability is yet to be achieved. Indicators aim to show decision makers what must be done to show foreign investors that Zimbabwe's mining sector is a viable investment option.

Political stability indicators include:

- **IMF funding** – Sound policies and a clearing of past debt are required before the IMF will offer financial assistance to Zimbabwe.

- **Free elections** – Free and fair elections held under the new constitution and within 18 months of the establishment of the Government of National Unity (as agreed in negotiations) show that the government is committed to political reform.
- **Lifting of international sanctions** – The USA and UN will lift sanctions on Zimbabwe once political stability is achieved.
- **Mining policy improvements** – Land claim and indigenisation policies are removed and replaced with appropriate tax laws and incentives for mining investors. Labour regulations, environmental protection laws, and socioeconomic agreements meet international standards.
- **Reduction in unemployment** – This indicates that Zimbabwe is able to support its people and that the country has experienced economic growth.
- **Reduction in crime** – Lack of security is a deterrent to investment, while security is indicative of a stable country with laws that protect investors.
- **Change in currency** – Changing to the South African Rand and US Dollar has stabilised the macro-economy by eliminating hyper-inflation. However, should Zimbabwe return to its own currency too soon the hyper-inflationary environment would also return [53].
- **Eradication of farm invasions** – Continued violent farm invasions indicates a lack of governmental control as well as a security risk for investors. The government must curtail these violent attacks and seek peaceful resolution.
- **Income equality** – "One measure of income inequality is the Gini coefficient which measures the distribution of the national income in a society" [54].
- **Free press** – Open and active reporting shows the world that Zimbabwe is adhering to democratic principles and also advertises the opportunities it has to offer foreign investors.

The following indicators of changes in commodity prices aim to make decision makers aware that changes in the global economy are soon to occur. This will assist in preparing for a change in scenario.

Indicators of increasing commodity prices:

- **Decreasing world real interest rates** – According to Frankel [55] high interest rates decrease the demand for commodities and consequently lower commodity prices; a decrease in interest rates will result in an increase in commodity prices.
- **Economic up-turn** – An up-turn in the global economy means that industrial production or global manufacturing activity has increased and as a result so has commodity demand, leading to higher commodity prices. According to Sunter [74] indicators of an economic up-turn include:
  - An increase in car sales
  - Reduction of debt
  - Increases in asset value (property and equities)
- **Weakening of the dollar** – Lipsky [56] notes that a weakening of the US dollar results in higher commodity prices.

3.2.2. Playing the Game

7. SWOT

Strengths	Weaknesses	Opportunities	Threats
Mineral wealth	Far from market	New exploration[2]	Economic crisis
Employment opportunities	Security of tenure and indigenisation	Better technologies available	Low commodity prices
Inexpensive labour	Taxation laws	Beneficiation	Debt
	Deteriorating infrastructure	New lines of credit and debt relief	Closing of mines
	Outdated technology	Supply of emerging markets (eg. China)	Power supply
	Skills shortage	Progressive policies (eg. In environmental and labour law)	Increase in production costs due to dollarization
	Lack of Geological database		

8. Options

Assume that Zimbabwe's mining sector aims to:

- Become a world leader in the mining industry
- Expand mining exploration and mining operations
- Grow the country's economy
- Provide jobs
- Attract skilled professionals
- Attract investors
- Relieve the country's debt

[2] According to Winkler [57] there has been no exploration since 2002 in Zimbabwe, which has '6000 recorded gold deposits which have not been fully explored' [58].

Strategies are developed using brainstorming methods; this allows decision makers the opportunity to explore all options before selecting the viable options to formulate strategies.

Figure 19 Brainstorming options

A high input option is exclusive; if Zimbabwe chooses such an option it will exclude all other options. An inclusive option allows for more than one option being chosen since resource input is low [39]. A low leverage option requires high input for a small return, thus high leverage options are usually superior as they offer higher returns for lower inputs [39].

Figure 20 Leverage graph [39]

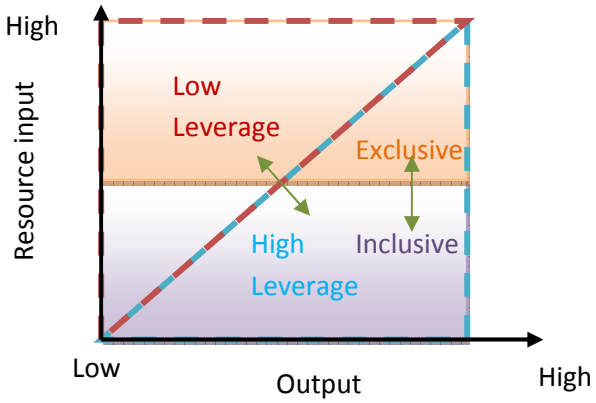


Table 4 Assessment of Options

Option	Inclusive	Exclusive	High leverage	Low Leverage	Worthwhile option
1	X	✓	X	X	X
2	X	✓	X	✓	X
3	✓	X	X	✓	✓
4	✓	X	✓	X	✓
5	✓	X	✓	X	✓
6	✓	X	✓	X	✓
7	✓	X	X	✓	✓
8	✓	X	X	✓	X
9	✓	X	X	✓	✓
10	✓	X	✓	X	✓
11	✓	X	✓	X	✓
12	✓	X	X	✓	✓

If the cost of investing in new technology and restoring the infrastructure is high, options five and six may also be considered exclusive.

The past has shown that doing nothing is not a worthwhile option as it will not result in the growth of the mining sector. The mining sector, "if properly funded, has the

capacity to turn around the economy in a short time frame" [59], thus Zimbabwe should not exit the mining game. Disbanding the unity government is not a worthwhile option as investor confidence would be negatively affected.

The worthwhile options have been combined below to form two strategies:

1. **Slow and Steady**
   - Incremental changes are made to mining policies over a period of five to ten years. For the time being indigenisation and tax laws remain intact, but the Government of National Unity works to stabilise Zimbabwe's economy through improved fiscal policy and budgetary control.
   - Government spends moderately on infrastructure improvements.
   - Prioritization of minerals, such as PGMs, takes place. Exploration and expansion is focused on these minerals only.
   - Zimbabwe limits unprocessed mineral exports and invests in technology which will promote beneficiation.
   - Negotiations with emerging nations such as China and India are initiated.
   - Government petitions for debt relief, financial aid, and foreign investment.

2. **Whole Hog**
   - A total policy overhaul is undertaken within the next year; best practices from around the world are used to formulate new:
     - mining and mineral exploration policies
     - environmental laws
     - labour laws
     - tax laws
     - mining administration policies
     - land ownership redistribution policies

- Also within the next year a transparent, free, and fair election is held; proving that Zimbabwe is politically stable.
- The government markets Zimbabwe as the new mining hub, in order to secure financial aid, foreign investment and skilled professionals. Investors will receive 'special dispensations and privileges' [13].
- Large amounts of money are pumped into:
    - Developing sustainable infrastructure
    - Purchasing the latest mining technologies
    - Mining exploration projects
- Once the mining sector is prosperous there will be a gradual shift towards beneficiation of minerals.

9. Decisions

In the next section industry experts have given their opinion of which strategy will perform best across all scenarios; the Zimbabwean government should then decide if one of these strategies should be implemented in the mining sector.

10. Measurable Outcomes

A strategy will be deemed successful if it results in:

- Economic growth.
- Debt relief and financial aid.
- Foreign investment.
- A decreased unemployment rate.

4. Research Results

This section presents the findings of a questionnaire (See Appendix E), which was sent to industry experts (see Appendix F) to validate the scenarios and to asses which strategy would perform best across all scenarios.

4.1. Questionnaire results

Question 1

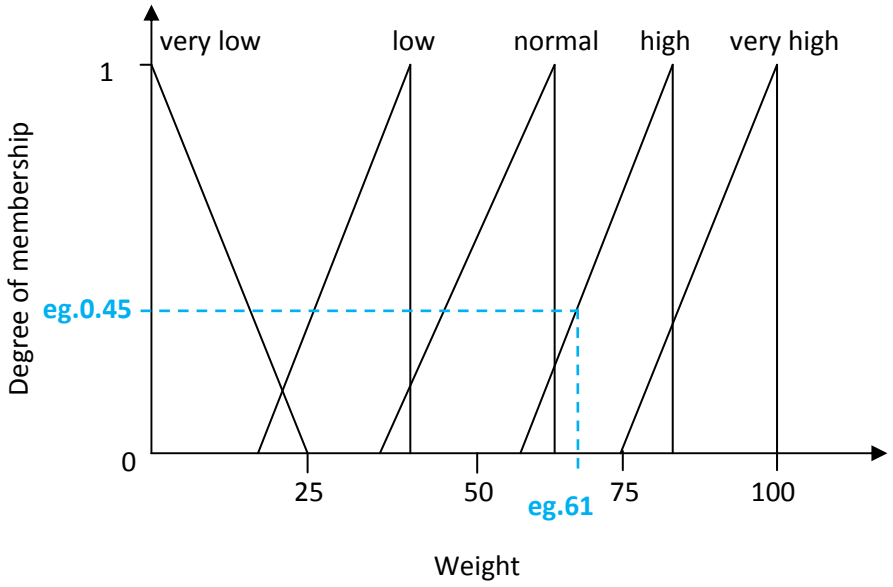
Industry experts were asked to rank twelve key factors on the basis of the level of certainty/uncertainty and the level of impact of each factor. The averaged results are shown below:

Factor	Level of impact	Level of certainty/uncertainty
Foreign investor interest	4.46	3.11
Commodity prices	3.77	2.75
Mineral wealth	4.19	2.17
Production Capacity	3.37	2.89
Mining Skills	3.74	2.68
Political Stability	4.65	3.69
Production Costs	3.30	2.65
Electricity Supply	3.84	3.30
Regulations	4.18	3.54
The Taxation Regime	3.79	3.30
Land Claims	4.11	3.63
Security	3.91	3.12

Question 2

Industry experts then ranked the effect of three of the above factors on the previously described scenarios. The chosen factors are commodity prices, political stability, and foreign investor confidence. The ranking was done using linguistic terms of the set {very low, low, normal, high, very high} and the results were interpreted using fuzzy logic. The scale of fuzzy weights is shown in the figure below.

Figure 21 Fuzzy Linguistic Weights



As shown in the figure above a triangular membership function was chosen; the formula is:

Equation 1 Triangular membership function [60]

$$\mu(x|a,b,c) = \begin{cases} \dfrac{2(x-a)}{(b-a)(c-a)} & ;for\ a \le x \le c \\ \dfrac{2(b-x)}{(b-a)(b-c)} & ;for\ c \le x \le b \\ 0 & ;otherwise \end{cases}$$

The results of the questionnaire were used to determine the degree of membership of each factor to the fuzzy set. The results are shown below:

Table 5 Degree of membership to commodity prices

Commodity Prices					
	Degree of membership				
	very high	high	normal	low	very low
Chinese Checkers	0.11	0.45	0.18	0.25	0.02
Check Mate	0.16	0.23	0.32	0.16	0.13
Patience	0.07	0.30	0.32	0.25	0.05
Full House	0.27	0.45	0.18	0.05	0.05

Table 6 Degree of membership to political stability

Political Stability					
	Degree of membership				
	very high	high	normal	low	very low
Chinese Checkers	0.14	0.21	0.14	0.38	0.13
Check Mate	0.38	0.16	0.07	0.20	0.20
Patience	0.25	0.41	0.27	0.07	0.00
Full House	0.52	0.32	0.09	0.05	0.02

Table 7 Degree of membership to foreign investor confidence

Foreign Investor Confidence					
	Degree of membership				
	very high	high	normal	low	very low
Chinese Checkers	0.13	0.14	0.16	0.48	0.09
Check Mate	0.25	0.16	0.13	0.23	0.23
Patience	0.18	0.41	0.30	0.11	0.00
Full House	0.52	0.36	0.09	0.04	0.00

The highest degree of membership for each scenario was determined and used to calculate the weight of each factor for each scenario.

Table 8 Calculated weights of key factors

	Weight		
	Commodity Prices	Political Stability	Foreign Investor Confidence
Chinese Checkers	0.6089	0.2075	0.2096
Check Mate	0.3645	0.7617	0.7578
Patience	0.3645	0.6082	0.6082
Full House	0.6089	0.7662	0.7662

Question 3

Eleven essential success factors for Zimbabwe's mining sector were established based on the SWOT analysis. Industry experts were asked to give each essential success factor an importance score (between one and five); the averaged results are shown in the table below.

Table 9 Importance of essential success factors

Essential Success Factor	Average importance
IMF funding	2.93
Free elections	3.84
Lifting of sanctions	3.32
Improved tax laws	3.58
Foreign investment	4.68
Free press	3.12
Security of tenure	4.72
Environmental protection laws	2.81
Sound fiscal policy	3.77
Economic growth	3.42
Skills development	3.79

Question 4 and 5

The two strategies, “Whole Hog” and “Slow and Steady”, were compared on the basis of meeting four of the essential success factors and mitigating the risks of four of the key uncertainties. This question was based on binary logic since the industry experts could only respond with a true or false answer. The results are depicted in the graphs below as percentage true/false.

Figure 22 Graph of comparison of strategies based on essential success factors

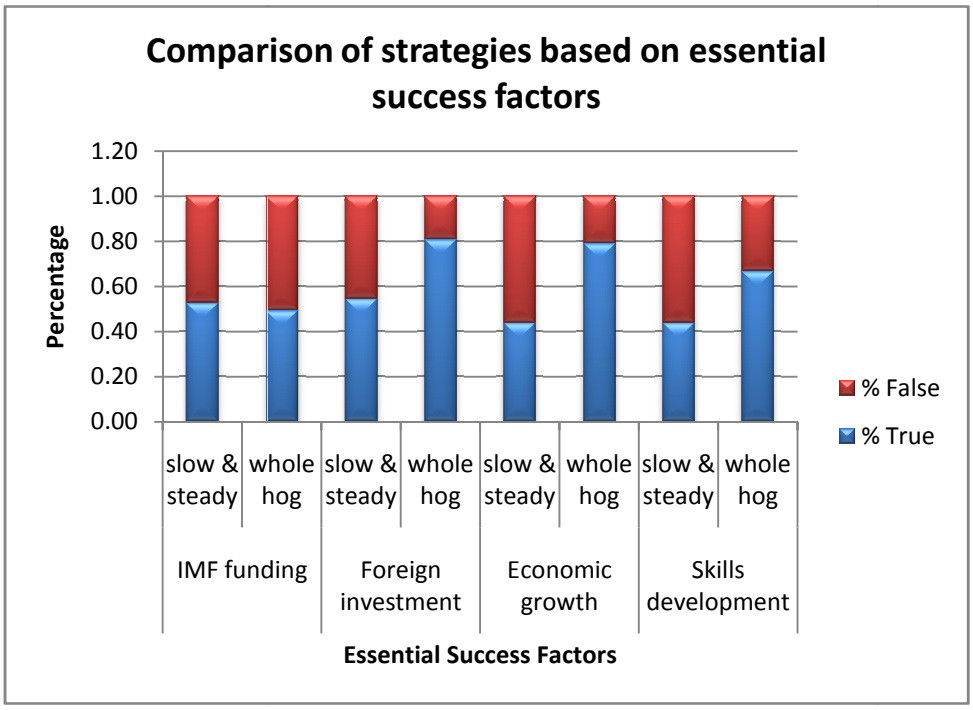
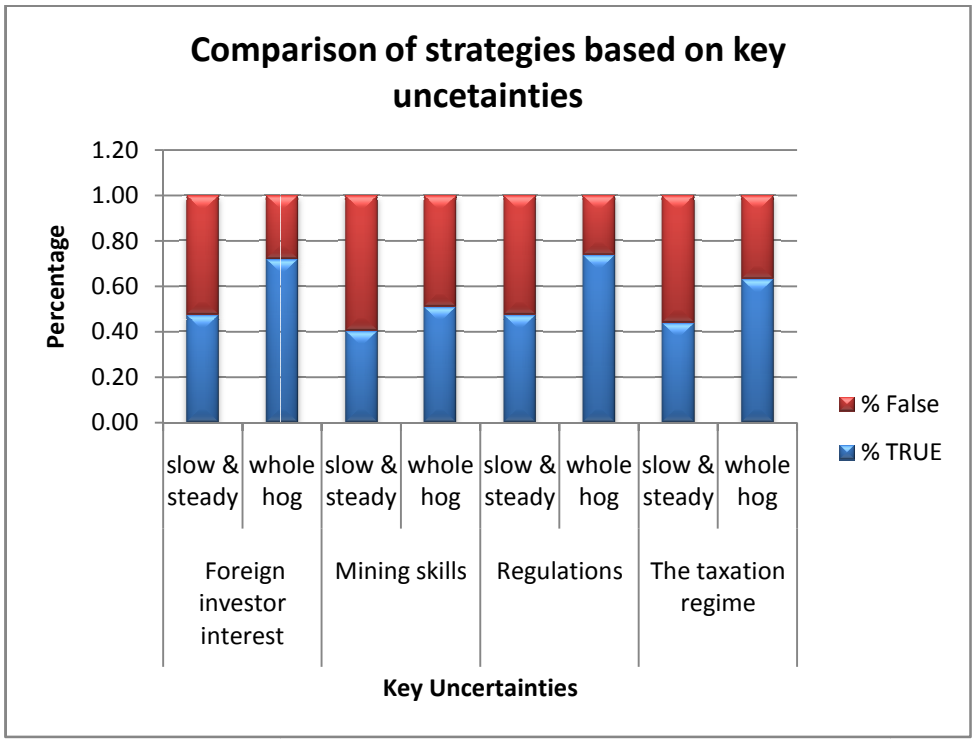


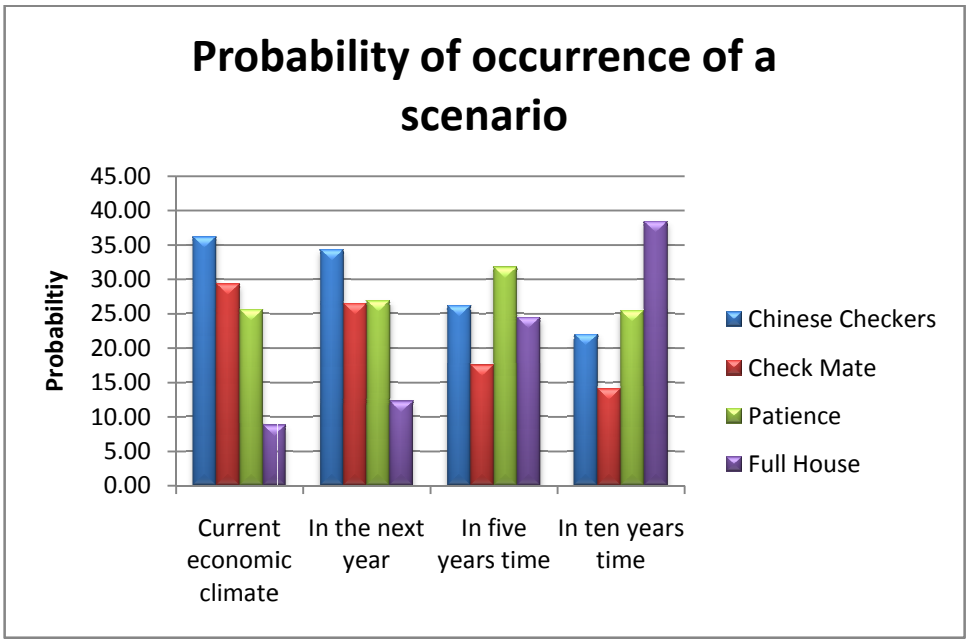
Figure 23 Graph of comparison of strategies based on key uncertainties



Question 6

Industry experts were asked to estimate the probability of occurrence of each scenario for the current economic climate, the next year, five years time, and ten years time. The averaged results are shown in the graph below. The probabilities of the occurrence of the scenarios Chinese Checkers and Check Mate decrease with the passing of time, while an increase in probability is observed for Full House. The Patience scenario has a relatively constant probability, which ranges between twenty five and thirty five percent, across all conditions.

Figure 24 Probability of occurrence of a scenario



4.2. Analytical Hierarchy Process

The questionnaire results were combined using analytical hierarchy process (AHP) to determine the robustness of the strategies. The weight calculations of four of the key uncertainties are shown in the three steps below.

Step 1: Perform pair-wise comparison of the factors.

Pair-wise comparison

	Foreign investor interest	Mining skills	Regulations	The taxation regime
Foreign investor interest	1.0000	1.3795	0.9375	1.1071
Mining skills	0.7249	1.0000	0.6795	0.8025
Regulations	1.0667	1.4716	1.0000	1.1810
The taxation regime	0.9032	1.2461	0.8468	1.0000

Step 2: Determine the eigenvector.

According to [61] the eigenvector can be accurately approximated by squaring an n*x*m matrix if n is sufficiently small. The eigenvector is calculated as follows:

Equation 2 Eigenvector

$$Ei = \frac{\sum_{j=1}^{4} w_{ij}}{\sum_{i=1}^{4}\left(\sum_{j=1}^{4} w_{ij}\right)} \quad ; \forall i \in \{1, \dots, 4\}$$

where Ei is the eigenvector of the row i

w_{ij} is the weight of the factor in row i and column j

Matrix multiplication

	Foreign investor interest	Mining skills	Regulations	The taxation regime	Sum	eigenvector
Foreign investor interest	4.0000	5.5182	3.7499	4.4285	17.6965	0.2706
Mining skills	2.8995	4.0000	2.7182	3.2101	12.8278	0.1962
Regulations	4.2668	5.8863	4.0000	4.7239	18.8770	0.2887
The taxation regime	3.6130	4.9843	3.3870	4.0000	15.9843	0.2445
				Sum	65.3856	

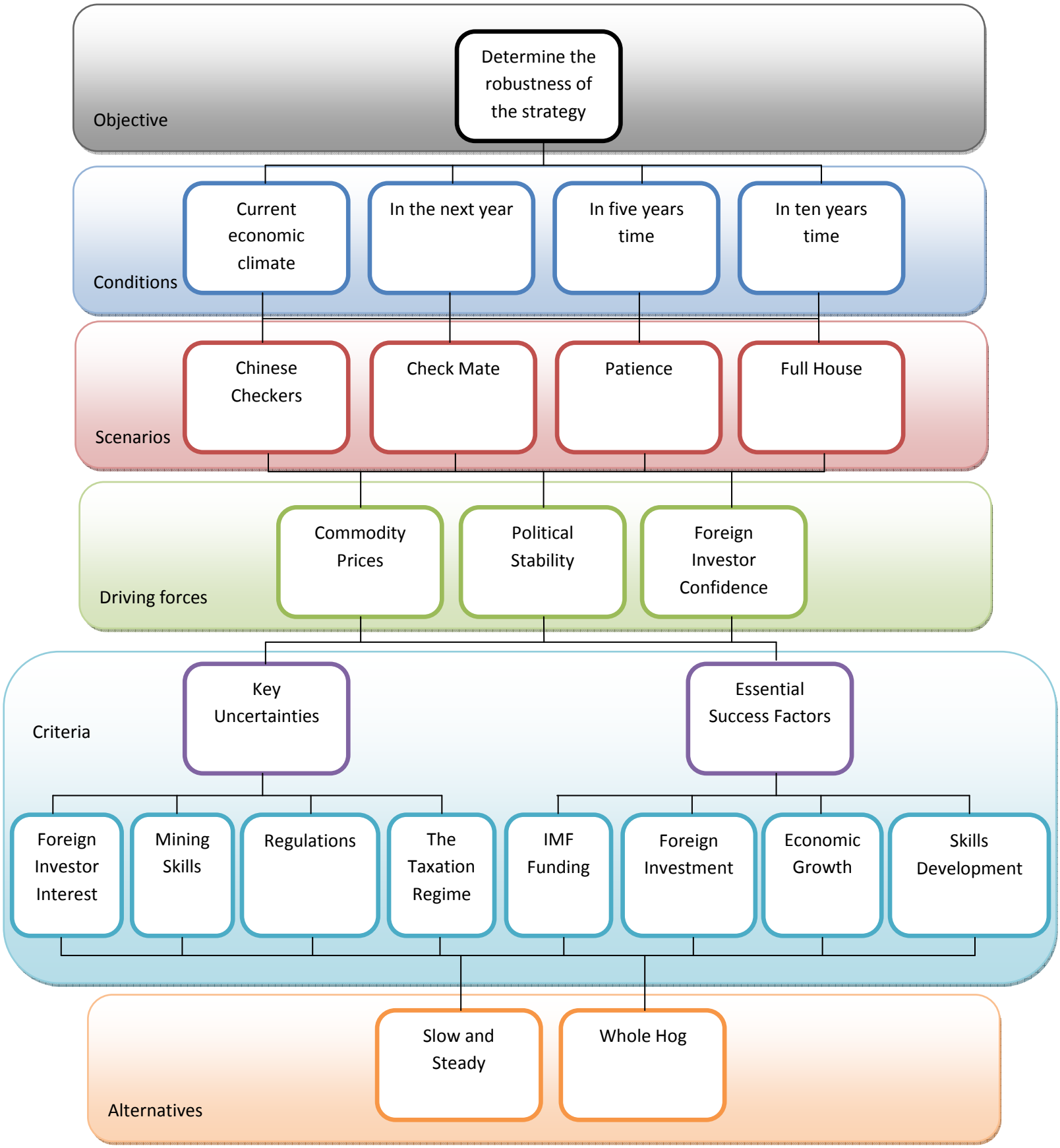
Step3: Repeat step 2 until the eigenvector values remain unchanged.

Matrix multiplication

	Foreign investor interest	Mining skills	Regulations	The taxation regime	Sum	Eigenvector
Foreign investor interest	64.0000	88.2909	59.9977	70.8558	283.1444	0.2706
Mining skills	46.3921	64.0000	43.4910	51.3617	205.2448	0.1962
Regulations	68.2692	94.1805	64.0000	75.5823	302.0321	0.2887
The taxation regime	57.8076	79.7481	54.1925	64.0000	255.7482	0.2445
				Sum	1046.1695	

The remaining calculations can be seen in Appendix G. The eigenvector values are used as the weights in the AHP, which is shown in the figure overleaf.

Figure 25 The Analytical Hierarchy



Starting at the top of the hierarchy the weights are multiplied out using matrix multiplication. The answer of each multiplication is used to calculate the weight of the factors in a lower level of the hierarchy. The first step is shown for illustrative purposes; the remaining calculations can be seen in Appendix H.

	Current economic climate	In the next year	In five years time	In ten years time				
Chinese Checkers	0.3623	0.3433	0.2621	0.2200	*	0.0512	Current economic climate =	0.2459
Check Mate	0.2937	0.2649	0.1754	0.1412		0.0851	In the next year	0.1661
Patience	0.2561	0.2688	0.3177	0.2546		0.1926	In five years time	0.2680
Full House	0.0879	0.1230	0.2447	0.3842		0.6712	In ten years time	0.3200

The calculation above has determined the weights of each scenario with respect to the four conditions. The next step will use this answer to determine the weights of the driving forces with respect to the scenarios.

The final AHP result compares the two strategies with respect to the criteria and every higher level in the hierarchy. The result below has been normalised to one.

Slow and Steady	0.4964
Whole Hog	0.5036

According to industry experts, it appears that the strategies perform almost equally well; Whole Hog is 0.7117 percent more robust than Slow and Steady.

4.3. Robust Strategy Selection

As the AHP results are inconclusive an additional method has been used to analyse the robustness of the strategies. This method has been adapted from [37] to suit the questionnaire.

The performance of the strategies across all scenarios was determined by multiplying the average impact of the factors (from question 1 and 2) by the percent truth (from questions 4 and 5). The results are shown below:

Table 10 Strategy performance across all scenarios

		IMF funding	Foreign investment	Economic growth	Skills development	Foreign investor interest	Mining skills	Regulations	The taxation regime
slow & steady	Chinese Checkers	1.70	1.76	1.42	1.42	2.02	1.72	2.02	1.87
	Check Mate	6.20	6.41	5.17	5.17	4.32	3.68	4.32	4.00
	Patience	4.96	5.13	4.14	4.14	3.58	3.05	3.58	3.31
	Full House	6.25	6.46	5.21	5.21	4.75	4.05	4.75	4.40
whole hog	Chinese Checkers	1.59	2.61	2.55	2.15	3.07	2.17	3.14	2.69
	Check Mate	5.79	9.51	9.30	7.85	6.56	4.64	6.72	5.76
	Patience	4.63	7.61	7.44	6.29	5.43	3.84	5.56	4.77
	Full House	5.83	9.59	9.38	7.92	7.21	5.10	7.39	6.33

Questions 1 and 3 were used to determine the normalised impact and importance of the key uncertainties and essential success factors, respectively.

Table 11 Impact/ Importance of factors

	IMF funding	Foreign investment	Economic growth	Skills development	Foreign investor interest	Mining skills	Regulations	The taxation regime
Impact/Importance	0.20	0.32	0.23	0.26	0.28	0.23	0.26	0.23

The overall performance of a strategy for a scenario is calculated as follows:

(1.7 x 0.2) + (1.76 x 0.32) + (1.42 x 0.23) + (1.42 x 0.26) + (2.02 x 0.28) + (1.72 x 0.23) + (2.02 x 0.26) + (1.87 x 0.23) =6.56

The table below shows these results as well as the percentage of performance of each strategy in each scenario.

Table 12 Overall strategy performance

	slow & steady	whole hog	Sum	Percent: slow & steady	Percent: whole hog
Chinese Checkers	6.56	9.52	16.08	0.41	0.59
Check Mate	17.42	25.61	43.04	0.40	0.60
Patience	14.25	20.90	35.15	0.41	0.59
Full House	18.23	26.82	45.05	0.40	0.60

The probability of occurrence of a scenario (from question 6) was used to determine the degree of robustness of each strategy under different conditions [37]. The result is as follows:

Table 13 Degree of robustness

	slow & steady	whole hog
Current economic climate	40.62	59.38
In the next year	40.61	59.39
In five years time	40.58	59.42
In ten years time	40.56	59.44

This method results in a clearer outcome as Whole Hog is approximately 18 percent more robust, across all conditions, than Slow and Steady.

5. Discussion

5.1. Scenario planning as a strategic tool

In the context of the Zimbabwean mining sector, scenario planning has assisted in:

- Analysing Zimbabwe's position in the mining industry.
- Clarifying the areas of possible improvement.
- Establishing the key drivers of change in the mining sector.
- Clearly defining the possible futures that exist for Zimbabwe and its mining sector.
- Outlining decision makers' options.
- Formulating two strategies, one of which can be used to rebuild the mining sector.
- Alerting decision makers and industry experts to the possibilities in Zimbabwe's mining sector.

5.2. Questionnaire analysis

The questionnaire showed that:

- The key uncertainties in Zimbabwe's mining sector are:
    - Political stability.
    - Regulations.
    - Land Claims.
    - Foreign investor interest.

- Political stability and foreign investment are not important in the Chinese Checkers scenario, but these factors play a significant role in the Check Mate and Patience scenarios.

- Commodity prices, political stability, and foreign investment are crucial to the occurrence of the Full House scenario.

- The essential success factors for Zimbabwe are:
    - Security of tenure.
    - Foreign investment.
    - Free elections.
    - Skills development.

- Factors which have the greatest effect on the strategy Slow and Steady are:
    - IMF funding.
    - Foreign investment.
    - Changes in regulations.

- Factors which have the greatest effect on the strategy Whole Hog are:
    - Foreign investment.
    - Economic growth.
    - Changes in regulations.

- According to industry experts the probability of Chinese Checkers and Check Mate will decrease over the next ten years, while the probability of Full House will increase.

By drawing on the experience of industry experts the questionnaire has highlighted the area's on which the mining sector needs to focus its attention. The questionnaire

results indicate that, contrary to the World Economic Forum Global Competitiveness Report [14], the Zimbabwean mining sector has the potential to reach the Full House scenario and be economically competitive.

5.3. Choosing a strategy

AHP was used to evaluate which strategy would suit the mining sector's needs by analysing multiple objectives on multiple tiers. This method analysed the choice of strategy based on time, scenarios, driving forces, key uncertainties, and essential success factors.

Whole Hog had the highest ranking and according to the AHP method should be chosen as the preferable strategy for implementation. However, Whole Hog was only marginally higher ranked than Slow and Steady leading to two possible conclusions:

1. Both strategies will be effective in transforming the Zimbabwean mining sector into a successful contributor to economic growth.
2. It is unclear which strategy is more robust and further research is necessary.

As a result of these conflicting conclusions an alternative method was employed.

The robust strategy selection method evaluates the overall performance of a strategy across the scenarios given certain conditions (in this case, number of years). This method shows that Whole Hog is, on average, 18.82 percent more robust than Slow and Steady. This proves that conclusion two above is true. Both methods are in agreement that the Whole Hog method should be implemented.

5.4. Conclusion

Four scenarios, which describe the possible futures of Zimbabwe's mining industry, have been developed to assist in the formulation and selection of a robust strategy. The scenarios are:

- Chinese Checkers.
- Check Mate.
- Patience.
- Full House.

Two strategies, Whole Hog and Slow and Steady, were developed with the aim of increasing the mining sector's contribution to economic growth. Slow and Steady is a long term strategy which advocates incremental policy changes, budgetary control, and petitioning for financial aid, while Whole Hog aims to attract foreign investment through a total policy overhaul and establishment of political stability.

A questionnaire was sent to industry experts to validate the scenarios and rate the effectiveness of the strategies. The questionnaire results were analysed using AHP and a robust strategy selection method. AHP ranked Whole Hog as 0.7117 percent more robust than Slow and Steady, while the robust strategy selection method concluded that Whole Hog was on average 18.82 percent more robust than Slow and Steady.

Although the project has focused on the mining sector, it has shown that Scenario Planning can be a useful tool for modelling a country holistically and should be used in the future to model other sectors in Zimbabwe.

5.5. Recommendations for further research

Further research could include:

- Scenario planning and strategy formulation for the agricultural, manufacturing, and tourism sectors since these sectors also contribute significantly to Zimbabwe's economy.
- Incorporating all twelve key uncertainties and eleven essential success factors into level four of the analytical hierarchy. This will allow a more thorough analysis of the strategies; however a different MADM technique may be required since the greater the number of factors included in AHP, the smaller the contribution of each factor.
- Analysing the questionnaire results based on the location of the industry expert to gauge whether the answers of respondents who are based in Zimbabwe differ significantly to those that are not.

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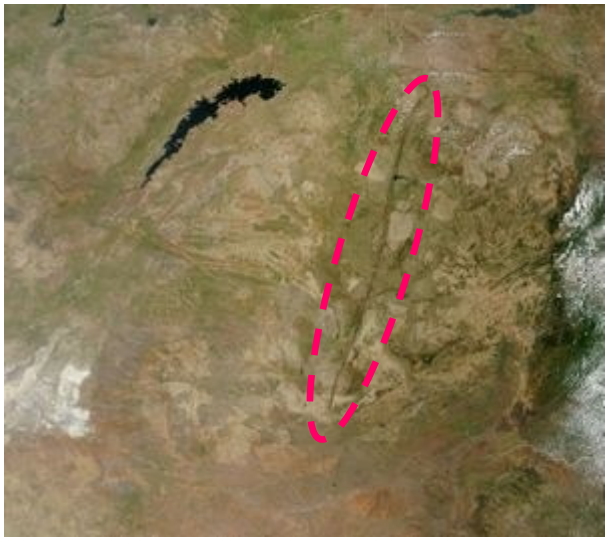
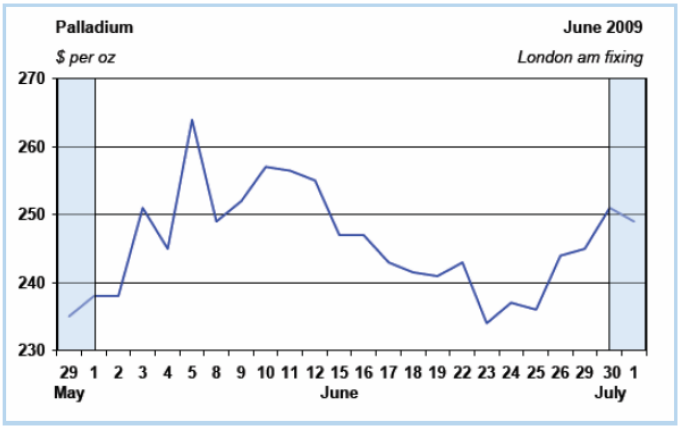
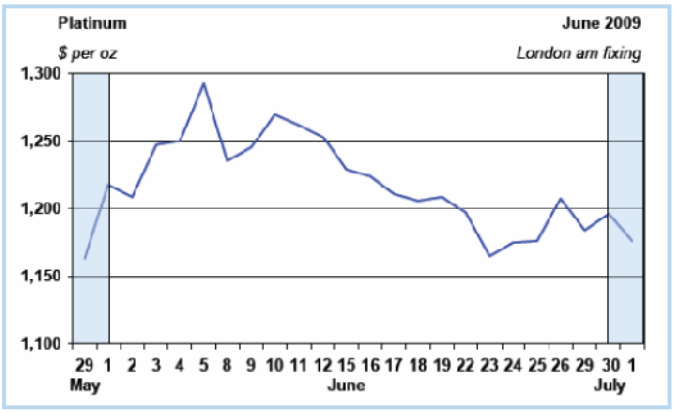
7. Appendices

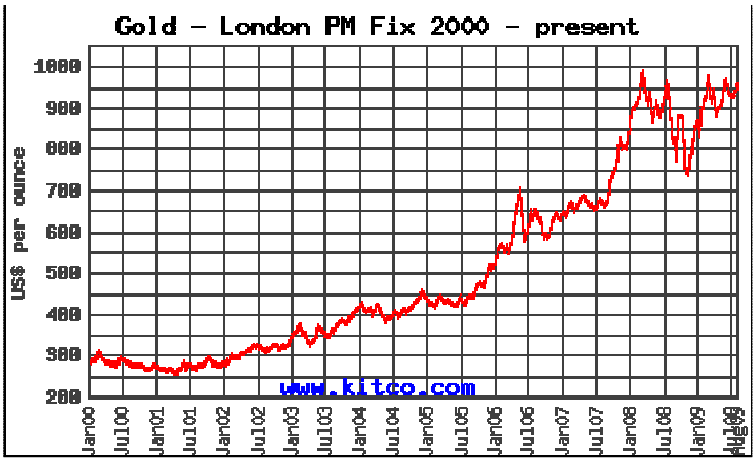
Appendix A: The Great Dyke [63]



Appendix B: PGM and Gold Prices [62]

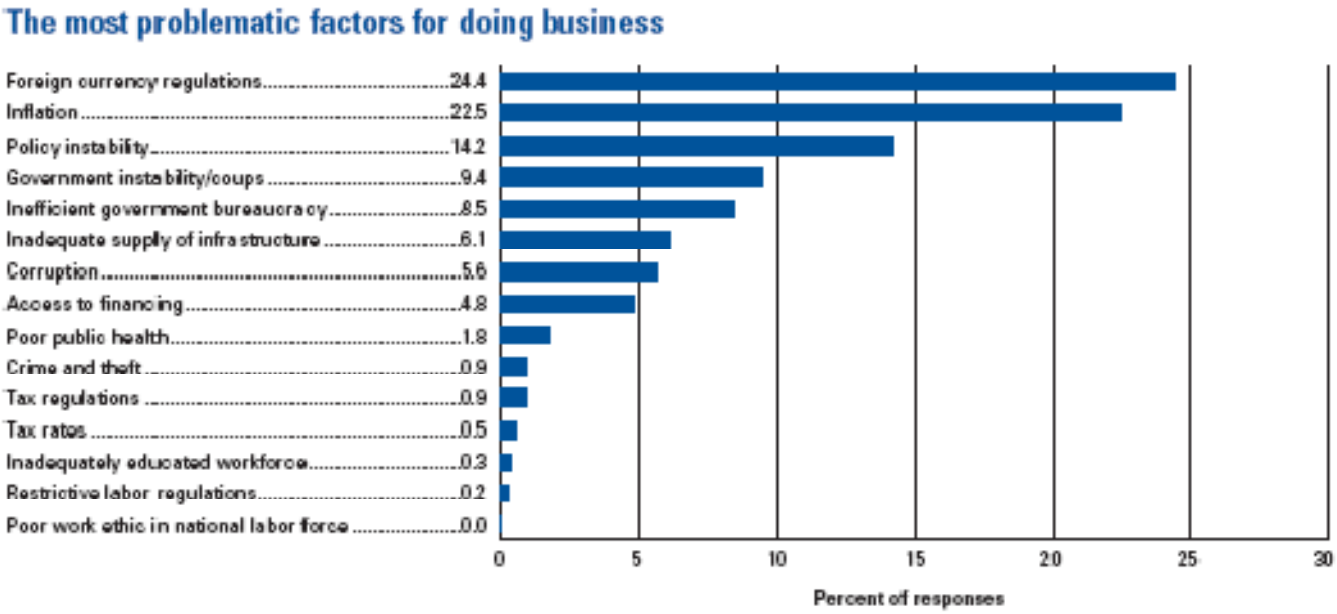




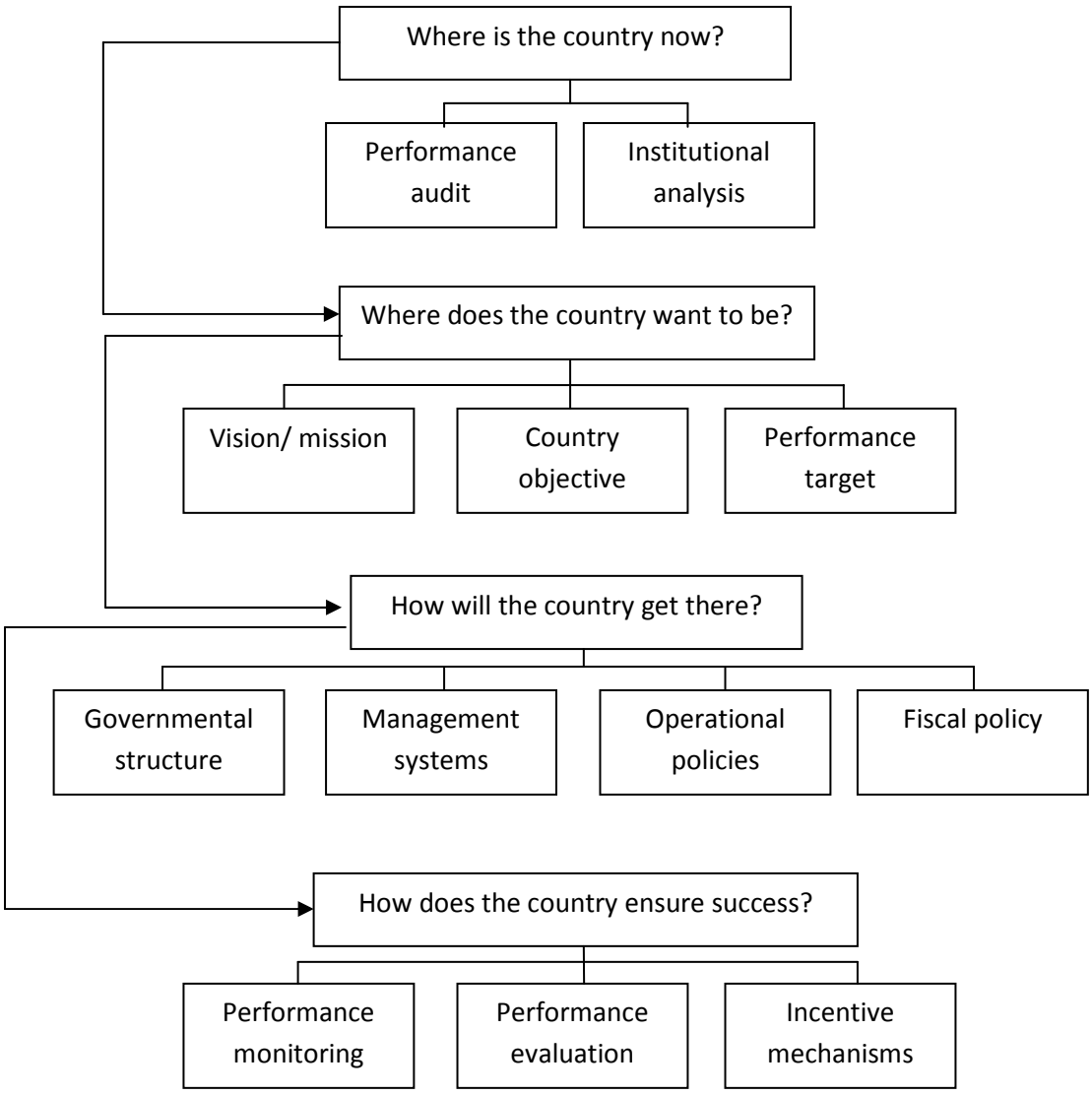


Appendix C: Zimbabwean Ease-of-doing-business Rank [44]

Ease of:	Doing Business 2009 rank	Doing Business 2008 rank	Change in rank
Doing Business	158	154	-4
Starting a business	164	170	+6
Dealing with construction permits	174	174	0
Employing workers	127	126	-1
Registering property	85	83	-2
Getting credit	84	79	-5
Protecting investors	113	110	-3
Paying taxes	157	144	-13
Trading across borders	162	158	-4
Enforcing contracts	77	73	-4
Closing a business	154	154	0



Appendix D: Strategic Planning Framework [15]



Appendix E: Questionnaire

1. Please score (between 1 and 5) the key uncertainties in Zimbabwe's mining industry according to impact and uncertainty

For Impact: 1=low impact and 5=high impact

For Uncertainty: 1=certain and 5=highly uncertain

Key Uncertainty	**Impact**	**Uncertainty**
Foreign investor interest		
Commodity prices		
Mineral wealth		
Production capacity		
Mining skills		
Political stability		
Production costs		
Electricity supply		
Regulations		
The taxation regime		
Land claims		
Security		

2. Please rate the of the effect of the key uncertainty on the scenario according to the following set {very high, high, normal, low, very low}

(A description of the scenarios can be seen at the end of this document)

	Commodity Prices	Political Stability	Foreign Investor Confidence
Chinese Checkers			
Check Mate			
Patience			
Full House			

3. Essential success factors are those factors without which Zimbabwe's mining sector cannot succeed.
Please rate the essential success factors according to importance where 1=unimportant and 5=very important

Essential Success Factor	Importance score
IMF funding	
Free elections	
Lifting of sanctions	
Improved tax laws	
Foreign investment	
Free press	
Security of tenure	
Environmental protection laws	
Sound fiscal policy	
Economic growth	
Skills development	

4. Please indicate whether the essential success factor will be met by the given strategy, by ticking the relevant block
(A description of the strategies can be seen in at the end of this document)

	Essential Success Factors			
Strategy	IMF funding	Foreign investment	Economic growth	Skills development
Slow and Steady	☐	☐	☐	☐
Whole Hog	☐	☐	☐	☐

5. Please indicate whether the strategy will effectively combat the key uncertainty by ticking the relevant block
(A description of the strategies can be seen at the end of this document)

	Key Uncertainties			
Strategy	Foreign investor interest	Mining skills	Regulations	The taxation regime
Slow and Steady	☐	☐	☐	☐
Whole Hog	☐	☐	☐	☐

6. Please estimate the probability of occurrence of each scenario for each condition as a percentage (for example 60 percent).

	Probability of Occurrence			
Condition	**Chinese Checkers**	**Check Mate**	**Patience**	**Full House**
Current economic climate				
In the next year				
In five years time				
In ten years time				

Appendix F: Industry Experts

The views expressed in the questionnaire are solely the opinion of the respondent and in no way reflect the views of the companies for which they work.

Industry Expert	Qualifications	Company
Adam Wooldridge	BSc Hons Geology & Geophysics	New Resolution Geophysics
Andre du Toit	Geologist (Bsc Hons)- 22years Zimbabwe mining industry	Zimplats
Anonymous	B.Sc Hons (Geology) / B.Com (Economics)	BHPBilliton
Anton Grobler	B.Sc (Hons) Earth Sciences	Impala Platinum
Barry Drew	B.Comm/ MBA/ Mining Tax Diploma	Recently retired from Anglocoal
Bob Crisp	C.Eng., M.I.Mech.E., QBE	RGC Consultants cc
Bruce Walters	B Sc (Hons) Geology	Retired
Charl Zietsman	Bsc Hons Geology	Wesizwe Platinum
Christiaan Ndoro	Bsc	The MSA Group
Coniace Madamombe	MSc, BSc Hons Geology	The Mineral Corporation
D Nieuwoudt	BSC.Hons	Xstrata Alloys
David Conradie	M.Eng. (Industrial) Cum Laude	Sasol Mining
David Hedges	BSc(Hons) Mat Sci	Columbus Stainless (Pty) Ltd
Dorian Wrigley	BSc Eng, MSc Eng, CFA Candidate, Graduate Diploma in Utility Management	Umbono
Edgar Muthego	BSc Hons Geology	Impala Platinum Limited
Frank Rauschning	B Sc Mining, PR Eng	Impala Platinum Limited
Dr Frieder J Reichhardt	MSc and PhD in Geology	MSA Geoservices
G Njowa	MSc	Venmyn Rand
Gordon Chunnett	BSc Hons, Head of Geology	Anglo Platinum

Henk de Hoop	MSc Mining Engineering, CFA	Rand Merchant Bank
Ian Haddon	BSc, BSc Hons, PhD	The MSA Group
Ian R Saunders	Bsc (Chem) Eng, PGDBA, FSAIMM, previous president of the Chamber of Mines	New Dawn Mining Corp.
I.L.Monareng	Geology diploma	Impala Platinum Limited
J Wahl	MEng	Sasol Synfuels
John Paul Hunt	MSc Economic Geology	Norilsk Nickel Africa
Keith Minty	Chief Operating Officer, B.Sc. Mining Engineering, Financial Analysis	Thani Dubai Mining Ltd. - Dubai, U.A.E.
Keith Scott	NDIP Geology, BSc. Hons. Geology	The MSA Group
Keith Sims	BSc. Hons	Rio Tinto
Kudakwashe Chipatiso	BSc, MSc (Geology) UZ	Rock & Stock Investments
Les Gardner	MEng	Impala Platinum Limited
M John Mokgopa	Hons. B.Sc Geology	Lonmin
Manie Blignaut	Bsc Hons, GDE, Dr Sci Nat	Wesizwe Platinum Ltd
Mark stowell	Chartered accountant	Mawson west
Matt Mullins	BSc (Hons) Geology	BHPBilliton
Michael Valenta	BSc (Eng) Metallurgy	Metallicon Process Consulting (Pty) Ltd
M C J de Wit	PhD geology	BRC DiamondCore
Mike Scott	BSc(Hons)Geol, MSc(Min. Eng.)	MinEx Projects (Pty) Ltd
Mike Venter	BSc (Hons)	The MSA Group
Neil Gardyne	Bsc (Hons) Geology - CEO	Decorum Capital - NAMF Fund managers
Nic Barcza	BSc MSc PhD (Metallurgical Engineering)	Mintek/Executive Consultant
Nico Denner	B.Sc Hons Geology, MBA	Gemecs (Pty) Ltd
PM Rice	MEng (Mining)	Anglo American
Peter Camden Smith	M.Sc, M.B.L.,G.D.Eng	Self employed
Richard Montjoie	B.Sc. Hons. Geology	Umbono Financial Services

	Pr.Sci.Nat	
Roger Scott	MSc Mineral Economics	Freeport McMoRan
Ronald Voordouw	PhD geology	Council for Geoscience
Roy Pitchford	Chatered Accountant, Director of Companies, previous president of the Chamber of Mines	Director of Several Companies
Kazek Trofimczyk	BSc Hons - Geophysics	Anglo American
Karin Barnard	Geology Honours	Anglo Platinum (Bafokeng Rasimone Platinum Mine)
Schalk Liebenberg	BSc Hons: Geology, Graduate Dipl Mining Engineering	BHPBilliton
Sipho Majola	BSc (Honours)	Xstrata Alloys (Pty) Ltd
Samson Malenga	Bsc Honours Geology	Anglo Platinum Ltd
Stephan Blom	Bing Industrial Eng.	Sasol Mining
Steve Duma	BSc Hons Geology	Implats
Theodore HC Pegram	BSc (Hons) Geology, GDE (Mining)	Anglo Platinum Limited
Vinay Somera	BSc, Bcom (hons), MBA	Implats
Wayne Pettit	B.Sc Hons Geophysics, 21 years in global mineral exploration	n/a

Appendix G: AHP calculations

Level 1: Conditions

Pair-wise comparison

	Current economic climate	In the next year	In five years time	In ten years time
Current economic climate	1.00	0.50	0.25	0.10
In the next year	2.00	1.00	0.33	0.14
In five years time	4.00	3.00	1.00	0.20
In ten years time	10.00	7.00	5.00	1.00

matrix multiplication

	Current economic climate	In the next year	In five years time	In ten years time	Sum	Eigenvector
Current economic climate	4.0000	2.4500	1.1667	0.3214	7.9381	0.0501
In the next year	6.7619	4.0000	1.8810	0.5524	13.1952	0.0832
In five years time	16.0000	9.4000	4.0000	1.2286	30.6286	0.1931
In ten years time	54.0000	34.0000	14.8333	4.0000	106.8333	0.6736
				Sum	158.5952	

Level 2: Scenarios

Pair-wise comparison:
Current economic climate

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1.0000	1.2335	1.4143	4.1217
Check Mate	0.8106	1.0000	1.1465	3.3413
Patience	0.7070	0.8721	1.0000	2.9141
Full House	0.2426	0.2992	0.3431	1.0000

Matrix multiplication:
Current economic climate

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	4.9343	5.6575	16.4870	31.0788	0.3623
Check Mate	3.2426	4.0000	4.5863	13.3653	25.1942	0.2937
Patience	2.8281	3.4886	4.0000	11.6567	21.9734	0.2561
Full House	0.9705	1.1971	1.3726	4.0000	7.5402	0.0879
				Sum	85.7867	

Pair-wise comparison: In the next year

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1	1.296026	1.277415	2.79172611
Check Mate	0.771589	1	0.98564	2.15406562
Patience	0.782831	1.01457	1	2.18544936
Full House	0.358201	0.464238	0.457572	1

Matrix multiplication: In the next year

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	5.1841	5.1097	11.1669	25.4607	0.3433
Check Mate	3.0864	4.0000	3.9426	8.6163	19.6452	0.2649
Patience	3.1313	4.0583	4.0000	8.7418	19.9314	0.2688
Full House	1.4328	1.8570	1.8303	4.0000	9.1200	0.1230
				Sum	74.1573	

Pair-wise comparison: In five years time

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1.0000	1.494	0.824959	1.07096774
Check Mate	0.669344	1.0000	0.552181	0.71684588
Patience	1.212182	1.811	1.0000	1.29820789
Full House	0.933735	1.395	0.770293	1.0000

Matrix multiplication: In five years time

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	5.9760	3.2998	4.2839	17.5597	0.2621
Check Mate	2.6774	4.0000	2.2087	2.8674	11.7535	0.1754
Patience	4.8487	7.2440	4.0000	5.1928	21.2856	0.3177
Full House	3.7349	5.5800	3.0812	4.0000	16.3961	0.2447
				Sum	66.9949	

Pair-wise comparison: In ten years time

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1.0000	1.557764	0.864232	0.57260274
Check Mate	0.641946	1.0000	0.55479	0.36757991
Patience	1.157097	1.802484	1.0000	0.66255708
Full House	1.746411	2.720497	1.509304	1.0000

Matrix multiplication: In ten years time

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	6.2311	3.4569	2.2904	15.9784	0.2200
Check Mate	2.5678	4.0000	2.2192	1.4703	10.2573	0.1412
Patience	4.6284	7.2099	4.0000	2.6502	18.4886	0.2546
Full House	6.9856	10.8820	6.0372	4.0000	27.9048	0.3842
				Sum	72.6291	

Level 3: Driving forces

Commodity Prices

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1.0000	1.6707	1.6707	1.0000
Check Mate	0.5985	1.0000	1.0000	0.5985
Patience	0.5985	1.0000	1.0000	0.5985
Full House	1.0000	1.6707	1.6707	1.0000

Commodity Prices

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	6.6830	6.6830	4.0000	21.3660	0.3128
Check Mate	2.3941	4.0000	4.0000	2.3941	12.7883	0.1872
Patience	2.3941	4.0000	4.0000	2.3941	12.7883	0.1872
Full House	4.0000	6.6830	6.6830	4.0000	21.3660	0.3128
				Sum	68.3085	

Political Stability

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1.0000	0.2724	0.3412	0.2708
Check Mate	3.6709	1.0000	1.2524	0.9942
Patience	2.9312	0.7985	1.0000	0.7938
Full House	3.6924	1.0059	1.2597	1.0000

Political Stability

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	1.0896	1.3647	1.0833	7.5376	0.0885
Check Mate	14.6837	4.0000	5.0095	3.9767	27.6700	0.3250
Patience	11.7246	3.1939	4.0000	3.1753	22.0938	0.2595
Full House	14.7698	4.0234	5.0389	4.0000	27.8321	0.3269
				Sum	85.1335	

Foreign Investor Confidence

	Chinese Checkers	Check Mate	Patience	Full House
Chinese Checkers	1.0000	0.2766	0.3447	0.2736
Check Mate	3.6148	1.0000	1.2460	0.9891
Patience	2.9012	0.8026	1.0000	0.7938
Full House	3.6547	1.0110	1.2597	1.0000

Foreign Investor Confidence

	Chinese Checkers	Check Mate	Patience	Full House	Sum	eigenvector
Chinese Checkers	4.0000	1.1066	1.3787	1.0945	7.5798	0.0895
Check Mate	14.4591	4.0000	4.9839	3.9563	27.3993	0.3236
Patience	11.6048	3.2104	4.0000	3.1753	21.9904	0.2597
Full House	14.6188	4.0442	5.0389	4.0000	27.7019	0.3272
				Sum	84.6714	

Level 4: Criteria

For key uncertainties:

Pair-wise comparison

	Foreign investor interest	Commodity prices	Political stability
Foreign investor interest	1.0000	1.3319	0.8060
Commodity prices	0.7508	1.0000	0.6051
Political stability	1.2408	1.6526	1.0000

matrix multiplication

	Foreign investor interest	Commodity prices	Political stability	sum	eigenvector
Foreign investor interest	3.0000	3.9957	2.4179	9.4135	0.3343
Commodity prices	2.2524	3.0000	1.8154	7.0678	0.2510
Political stability	3.7223	4.9577	3.0000	11.6800	0.4148
			Sum	28.1613	

Pair-wise comparison

	Foreign investor interest	Mining skills	Regulations	The taxation regime
Foreign investor interest	1.0000	1.3795	0.9375	1.1071
Mining skills	0.7249	1.0000	0.6795	0.8025
Regulations	1.0667	1.4716	1.0000	1.1810
The taxation regime	0.9032	1.2461	0.8468	1.0000

matrix multiplication

	Foreign investor interest	Mining skills	Regulations	The taxation regime	Sum	eigenvector
Foreign investor interest	4.0000	5.5182	3.7499	4.4285	17.6965	0.2706
Mining skills	2.8995	4.0000	2.7182	3.2101	12.8278	0.1962
Regulations	4.2668	5.8863	4.0000	4.7239	18.8770	0.2887
The taxation regime	3.6130	4.9843	3.3870	4.0000	15.9843	0.2445
				Sum	65.3856	

For essential success factors:

Pair-wise comparison

	foreign investor confidence	political stability
foreign investor confidence	1.0000	0.9618
political stability	1.0397	1.0000

matrix multiplication

	foreign investor confidence	political stability	Sum	eigenvector
foreign investor confidence	2.0000	1.9236	3.9236	0.4903
political stability	2.0795	2.0000	4.0795	0.5097
		Sum	8.0030	

Pair-wise comparison

	IMF funding	Foreign investment	Economic growth	Skills development
IMF funding	1.0000	0.6255	0.8564	0.7731
Foreign investment	1.5988	1.0000	1.3692	1.2361
Economic growth	1.1677	0.7303	1.0000	0.9028
Skills development	1.2934	0.8090	1.1077	1.0000

matrix multiplication

	IMF funding	Foreign investment	Economic growth	Skills development	Sum	eigenvector
IMF funding	4.0000	2.5019	3.4256	3.0926	13.0201	0.1976
Foreign investment	6.3952	4.0000	5.4769	4.9444	20.8166	0.3160
Economic growth	4.6707	2.9213	4.0000	3.6111	15.2031	0.2308
Skills development	5.1737	3.2360	4.4308	4.0000	16.8404	0.2556
				Sum	65.8802	

Level 5: Alternatives

Slow and steady: pair-wise comparison

	IMF funding	Foreign investment	Economic growth	Skills development
IMF funding	1.0000	0.9677	1.2000	1.2000
Foreign investment	1.0333	1.0000	1.2400	1.2400
Economic growth	0.8333	0.8065	1.0000	1.0000
Skills development	0.8333	0.8065	1.0000	1.0000

matrix multiplication

Slow and steady

	IMF funding	Foreign investment	Economic growth	Skills development	Sum	Eigenvector
IMF funding	4.0000	3.8710	4.8000	4.8000	17.4710	0.2703
Foreign investment	4.1333	4.0000	4.9600	4.9600	18.0533	0.2793
Economic growth	3.3333	3.2258	4.0000	4.0000	14.5591	0.2252
Skills development	3.3333	3.2258	4.0000	4.0000	14.5591	0.2252
				Sum	64.6426	

Whole Hog: pair-wise comparison

	IMF funding	Foreign investment	Economic growth	Skills development
IMF funding	1.0000	0.6087	0.6222	0.7368
Foreign investment	1.6429	1.0000	1.0222	1.2105
Economic growth	1.6071	0.9783	1.0000	1.1842
Skills development	1.3571	0.8261	0.8444	1.0000

Matrix multiplication

Whole Hog

	IMF funding	Foreign investment	Economic growth	Skills development	Sum	Eigenvector
IMF funding	4.0000	2.4348	2.4889	2.9474	11.8710	0.1783
Foreign investment	6.5714	4.0000	4.0889	4.8421	19.5024	0.2930
Economic growth	6.4286	3.9130	4.0000	4.7368	19.0785	0.2866
Skills development	5.4286	3.3043	3.3778	4.0000	16.1107	0.2420
				Sum	66.5626	

The weights have been put into the AHP overleaf.

The most robust strategy

Current economic climate	In the next year	In five years time	In ten years time
0.0512	0.0851	0.1926	0.6712

Chinese Checkers				Check Mate				Patience				Full House			
0.3623	0.3433	0.2621	0.2200	0.2937	0.2649	0.1754	0.1412	0.2561	0.2688	0.3177	0.2546	0.0879	0.1230	0.2447	0.3842

Commodity Prices			
0.3128	0.1872	0.1872	0.3128

Political Stability			
0.0885	0.3250	0.2595	0.3269

Foreign Investor Confidence			
0.0895	0.3236	0.2597	0.3272

Key Uncertainties		0.5
0.2510	0.4148	0.3343

Essential Success Factors		0.5
0	0.5097	0.4903

	Foreign investor interest	Mining skills	Regulations	The taxation regime	IMF funding	Foreign investment	Economic growth	Skills development
Slow and Steady	0.2647	0.2255	0.2647	0.2451	0.2703	0.2793	0.2252	0.2252
Whole Hog	0.2770	0.1959	0.2838	0.2432	0.1783	0.2930	0.2866	0.2420

Appendix H: Finding the solution

	Current economic climate	In the next year	In five years time	In ten years time					
Chinese Checkers	0.3623	0.3433	0.2621	0.2200	*	0.0512	Current economic climate	=	0.2459
Check Mate	0.2937	0.2649	0.1754	0.1412		0.0851	In the next year		0.1661
Patience	0.2561	0.2688	0.3177	0.2546		0.1926	In five years time		0.2680
Full House	0.0879	0.1230	0.2447	0.3842		0.6712	In ten years time		0.3200

	Chinese Checkers	Check Mate	Patience	Full House					
Commodity prices	0.3128	0.1872	0.1872	0.3128	*	0.2459	Chinese Checkers	=	0.2583
Political stability	0.0885	0.3250	0.2595	0.3269		0.1661	Check Mate		0.2499
Foreign investor confidence	0.0895	0.3236	0.2597	0.3272		0.2680	Patience		0.2501
						0.3200	Full House		

	Commodity prices	Political stability	Foreign investor confidence					
Key Uncertainties	0.2510	0.4148	0.3343	*	0.2583	Commodity prices	=	0.2521
Essential success factors	0.0000	0.5097	0.4903		0.2499	Political stability		0.2500
					0.2501	Foreign investor confidence		

Key Uncertainties	Essential success factors				
Foreign investor interest	0.2706	0.0000	*	0.2521	Key Uncertainties = 0.0682
Mining skills	0.1962	0.0000		0.2500	Essential success factors 0.0495
Regulations	0.2887	0.0000			0.0728
The taxation regime	0.2445	0.0000			0.0616
IMF funding	0.0000	0.1976			0.0494
Foreign investment	0.0000	0.3160			0.0790
Economic growth	0.0000	0.2308			0.0577
Skills development	0.0000	0.2556			0.0639

	Foreign investor interest	Mining skills	Regulations	The taxation regime	IMF funding	Foreign investment	Economic growth	Skills development	
Slow and Steady	0.2647	0.2255	0.2647	0.2451	0.2703	0.2793	0.2252	0.2252	*
Whole Hog	0.2770	0.1959	0.2838	0.2432	0.1783	0.2930	0.2866	0.2420	

				Normalized
0.0682	Foreign investor interest	= 0.1264	=	0.4964
0.0495	Mining skills	0.1282		0.5036
0.0728	Regulations			
0.0616	The taxation regime			
0.0494	IMF funding			
0.0790	Foreign investment			
0.0577	Economic growth			
0.0639	Skills development			