The impact of production inefficiencies on free cash flow at a producing gold mine, South Africa

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Declaration

“I declare that the Field Study hereby submitted for the Magister in Business Administration at the UFS Business School, University of the Free State, is my own independent work and that I have not previously submitted this work, either as a whole or in part, for a qualification at another university or at another faculty at this university.

I also hereby cede copyright of this work to the University of the Free State.”

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Donovan Pienaar

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Abstract

The South African mining industry is currently facing operational, political and economic challenges which threaten to render a large proportion of the operations unprofitable. Over the past few years, the gold and platinum sectors have faced the greatest challenges, and as a result have struggled to meet investor and market expectations.

Although a vast number of challenges exist beyond the control of mining companies, such as fluctuating and low commodity prices, volatile exchange rates, declining ore grades, labour relations issues and policy uncertainty, it should not be forgotten that there are factors over which the operations do have control. One such factor is production output and effective mine planning.

The current study focusses on one such deep-level gold mine which faces operational challenges, particularly in maintaining a stable production profile which meets monthly and annual targets. The aim of the study was to identify the main causes of production inefficiencies and operational delays and demonstrate how the production profile is impacted by these delays. The study utilised historical data which recorded the reasons for every single lost blast which had occurred over the past 5-year period spanning from 2013 – 2017. By conducting a Pareto analysis on the lost blast data, it was determined that only a small group of production delays (5 groups) accounted for the majority (~77%) of lost blasts and production delays. Furthermore, the majority of these losses and delays were as a result of human behaviour and ineffective scheduling of work to be done.

The study further measured the compliance to the mine's annual budget plan, which measured the percentage of areas planned to be mined, versus the actual area mined. The compliance investigation revealed that over the 5-year period, the monthly compliance to the budget plan, which focusses on a specific area planned to be mined, varied from 1.28% - 35.75%.

These figures are relevant as they have an impact on the amount of gold mined, as well as the economic operational life of the mine. Regression analysis on the same data set revealed that a moderate negative correlation existed between the

percentage compliance and the months of the year, indicating that although the compliance was low to begin with, it generally regressed as the year progressed.

Analysis of past production performances revealed that the mine struggles to meet its annual production targets. However, in spite of this, the mine has always remained cash flow positive over the 5-year period analysed. That being said, on a number of occasions the mine was not able to meet their annual free cash flow targets, where in other years, the free cash flow targets were surpassed by a considerable margin. Further analysis revealed that a favourable gold price was to thank for reaching financial targets and highlighted how dependent the operation was on a gold price higher than that budgeted for.

These facts are alarming, as the literature study indicated that investors are drawn to businesses which can deliver stable and profitable cash flows over an extended period of time, thus ensuring a favourable return on their investment. As it currently stands, the mine in question is one such operation which relies too heavily on outside influences (such as gold price) to meet their targets. It is recommended that the primary causes for production delays be taken seriously in an attempt to reduce such delays, which would improve the mine’s production profile, and in so doing, ensure a stable and positive cash flow for the operation.

Chapter 1 – Introduction

1.1 Introduction

The mining industry worldwide faces continuous challenges in its efforts to remain profitable, and to ensure long term sustainability and a return on investment for all stakeholders. The mining industry in South Africa is not exempt from these challenges, and as a result, has seen a steady decline in productivity over the past 10 years. Up until as recently as 2009, South Africa was listed as the world's top gold producer. However, rising production costs and declining production outputs have seen South Africa slip to 7th position by 2016 in terms of global gold production (Dick & Naidoo, 2016:2). Gold production in South Africa has been declining on an annual basis and has seen gold production figures drop from 252 tons in 2007, to 141 tons in 2016 (Chamber of Mines of South Africa, 2016:9).

As a result, mining companies are faced with continuous pressure to keep operations profitable and to ensure a positive free cash flow. Some of the major challenges faced by the South African mining industry, particularly the gold sector, include but are not limited to; increasing production costs, gold price volatility, fluctuating exchange rates, reduced labour productivity, declining production trends and declining ore grades (Neingo & Tholana, 2016:284-289).

Although there are a number of factors which mining houses have no control over, it is imperative that the operations have an understanding of their key operational value drivers, and how they can be influenced to change the value metrics. Arguably, the processes within the mining value chain over which an operation has the most control would be the scheduling of their drilling, blasting and transporting operations (Lane & Wylie, 2014:143).

Having a clear understanding of the major forces impacting costs, productivity and profitability, as well as the major forces which lead to production inefficiencies, would be beneficial to the operation in ensuring that it is run effectively (Lane & Wiley, 2014:144). Identifying key value drivers and quantifying the effect that production inefficiencies and compliance to the mining plan have on free cash flow, will enable

the operation to remain competitive and profitable in this challenging industry and economic climate.

For confidentiality purposes, the company in question will from here on be referred to as “the company”, and the particular mine under consideration will be referred to as “the mine”. The remainder of this chapter will provide some background to the mine, as well as to familiarise the reader with the problem statement, the focus of the study, as well as the analytical and data collection methods which will be used to draw conclusions from the study. Lastly, the layout of the study is discussed.

1.2 Background of the mine

At the time of conducting this research, the mine was one of 3 underground gold mining operations in South Africa operated and owned by AngloGold Ashanti. The mine has since been sold to a competitor South African gold mining company, with the transfer of assets completed by 1 March 2018. The mine is located in the Free State province, approximately 180km south-west of Johannesburg, and 16km south-east of Orkney (AngloGold Ashanti, 2017a:28). The mine employs roughly 4 500 people, and aims to produce an average of 9 800 kg of recovered gold annually, with a planned free cash flow generation ranging between R1.4 – R1.8 billion a year. The mine operates on a fixed production schedule, meaning that the operation has very little flexibility in terms of operating costs during periods of unfavourable commodity prices and currency exchange rates.

The mine in question was chosen for the particular study as the researcher is currently employed by the particular mine. The mine was also chosen for the selected study as it will serve as the flag ship operation for the mining company after the acquisition thereof. The mine will be responsible for a substantial amount of the company’s annual gold production and revenue generation. The mine faces considerable challenges in achieving its annual production targets. For the past number of years, the operation has suffered from considerable underperformance, and as a result, production targets have not been met (Figure 1) (The mine, 2017:3).

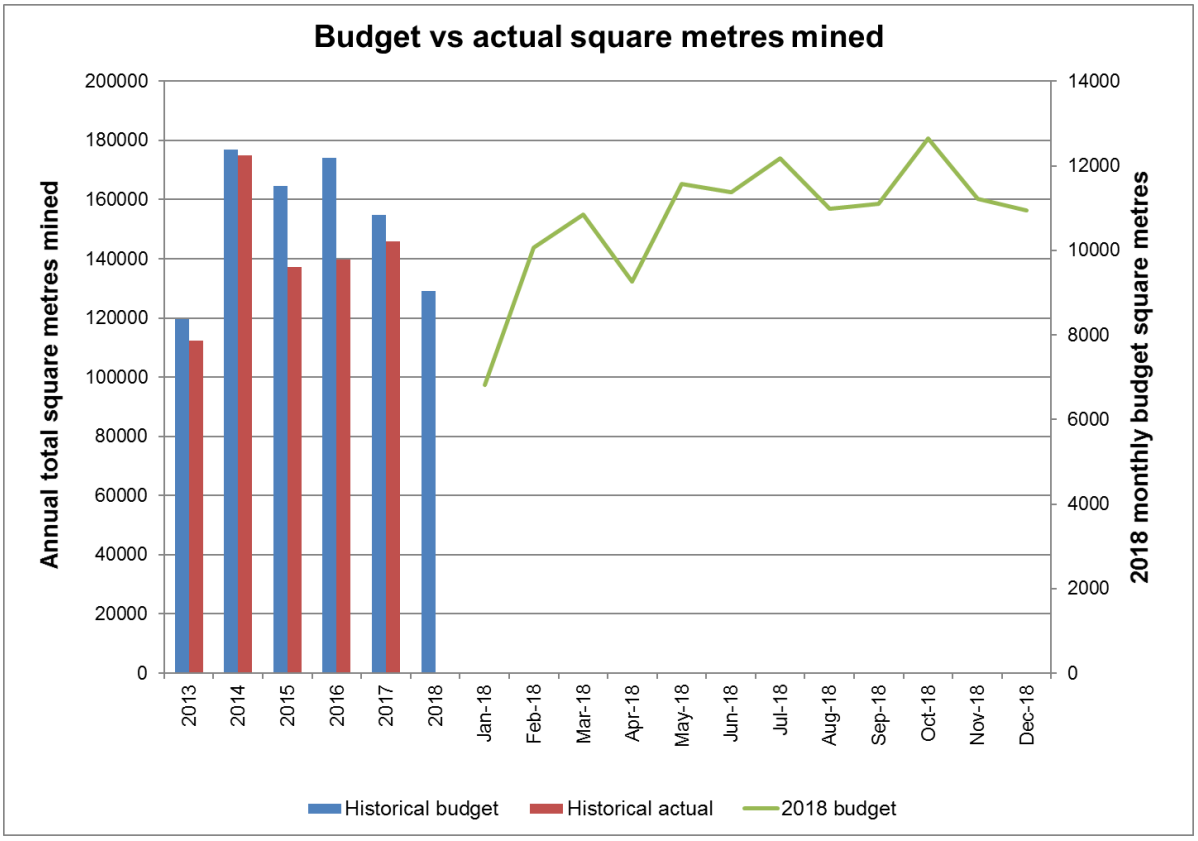


Figure 1: Planned vs actual area mined for the period 2013 – 2017, along with the 2018 monthly targets. Source: The mine (2017).

In recent years, the gold price has been favourable in the South African context due to a weaker ZAR/USD exchange rate (XE, 2017), and as a result, the Rand price per kilogram received has been well above budget (World Gold Council, 2017). This has enabled the mine to benefit from a higher than budgeted gold price, which has offset some of the free cash flow lost due to lower than planned gold production (Figure 2). A higher than budgeted gold price should not be relied upon to meet financial targets. A lower than budgeted gold price may ensue due to commodity price and currency exchange rate fluctuations, which may impact negatively on the free cash flow. This scenario is evident from the 2017 free cash flow (Figure 2), which depicts a loss in free cash flow as a result of a lower than forecast gold price. The 2017 budget gold price was planned at R569 068/kg with price assumptions of USD1200/Oz, and a ZAR/USD exchange rate of R14.25 (The mine, 2016). The average gold price received for 2017 was R524 200/kg (The mine, 2018b), which was driven primarily by a stronger ZAR/USD exchange rate.

It is important to note the additional R991 million revenue generated during 2016, as a result of a higher than planned gold price. This essentially offset the free cash flow lost due to lower than planned gold production. The opposite is true for 2017, where the average gold price received for the year was lower than the budgeted gold price. A lower than planned gold price, coupled with lower than planned gold production, resulted in the mine not meeting its 2017 free cash flow budget (Figure 2).

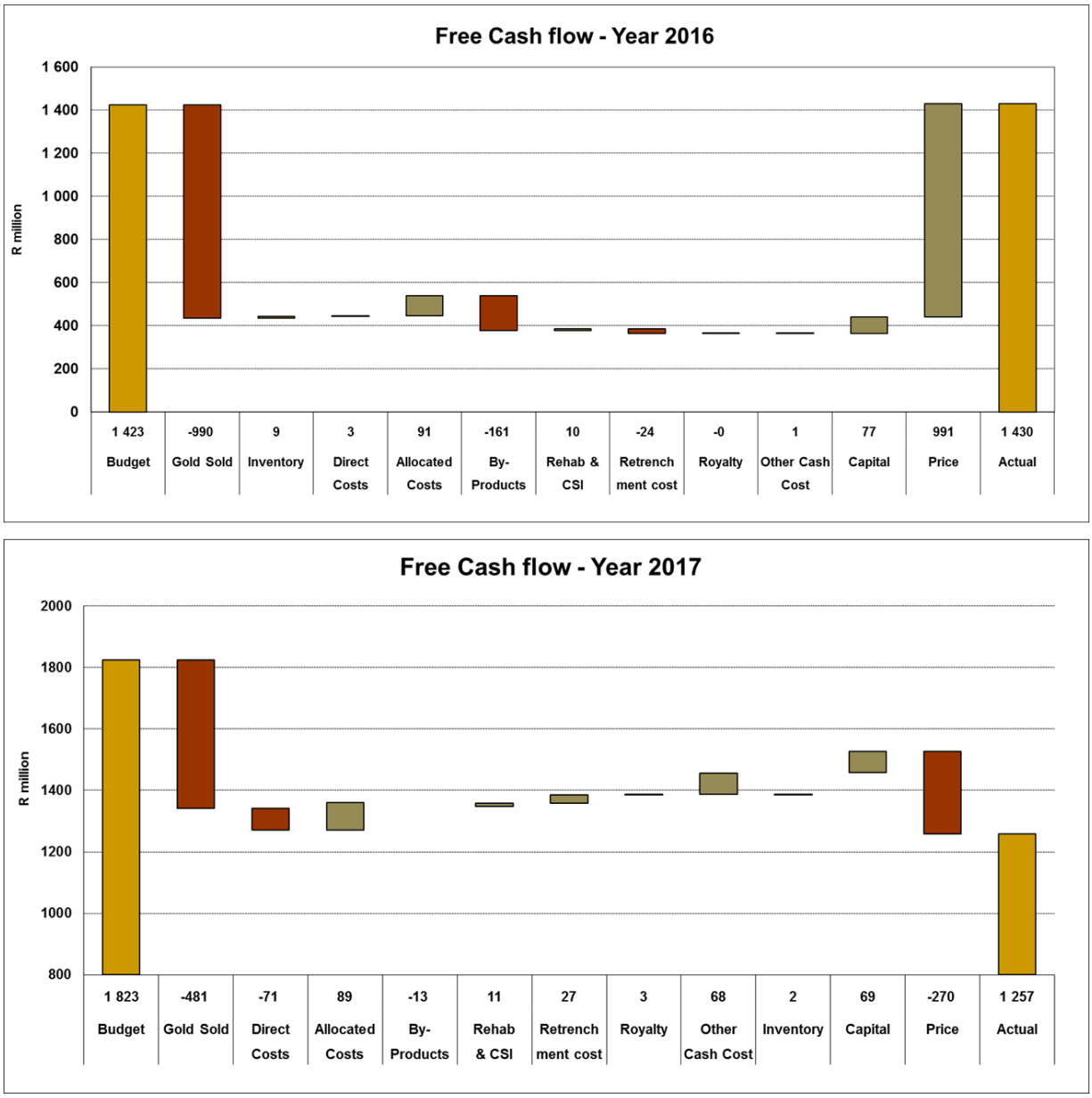


Figure 2: Comparison of budget vs actual free cash flow for 2016, as well as budget and actual free cash flow for 2017. Source: The mine (2018a).

The outlook for 2018 (Figure 3) seems likely to follow the same trend as that of 2017. It should be noted, however, that the graph is based on actual figures for January 2018, coupled with forecast figures for the remainder of the year, implying that the results can still vary considerably as the year progresses. The budgeted gold price of R542 544 per kg, and ZAR/USD exchange rate of R13.50 for 2018 (The mine, 2017) is significantly higher than the current gold price received of R520 341 per kg (average price received for January 2018), which is driven primarily by a stronger ZAR/USD exchange rate. The average USD/ZAR exchange rate for January 2018 was recorded as ZAR12.207 per USD (X-Rates, 2018).

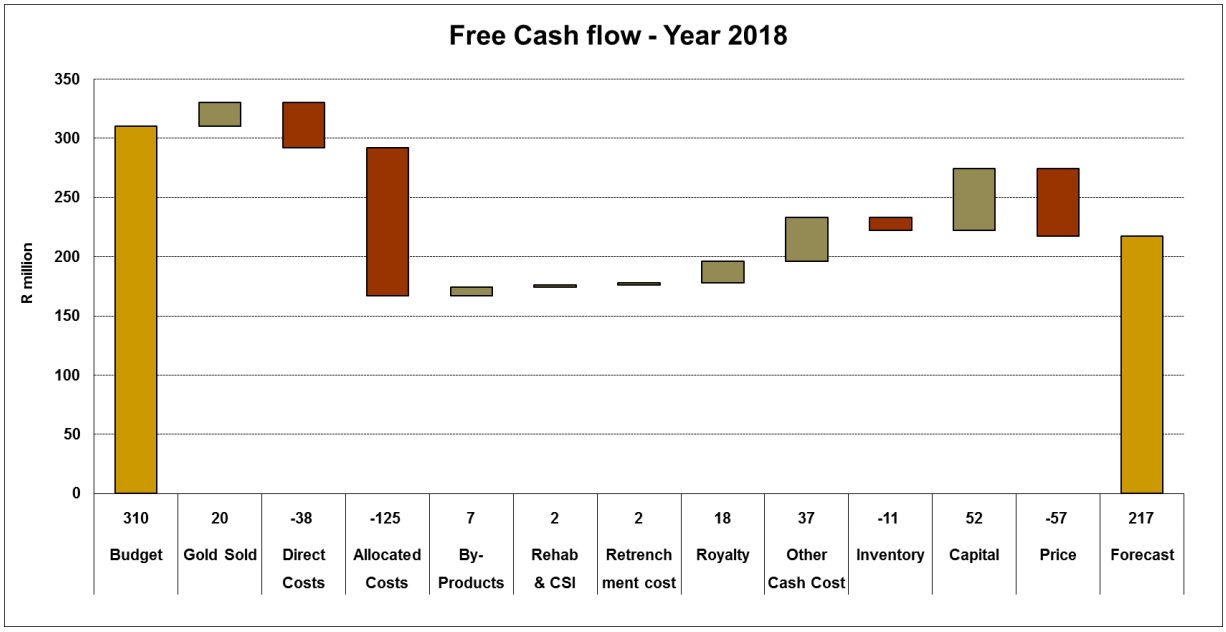


Figure 3: Forecast free cash flow for 2018, as at February 2018. Source: The mine (2018c).

The anticipated demand for minerals and energy is set to increase, coupled with increasing production costs and declining ore grades (Moran, Lodhia, Kunz and Huisingh, 2014:1). Therefore, it has become more vital than ever to ensure that production targets are met, mining schedules are adhered to, as well as ensuring that favourable market conditions are exploited to guarantee that additional free cash flow is generated. Similarly, in times of suppressed commodity prices such as those experienced in 2017 and forecast for 2018, it is imperative that the planned gold production targets are met, in order to minimise financial losses.

1.3 Problem statement and research questions

The global economic climate and depressed demand for commodities has necessitated the need for mining companies to move from a production-focused strategy to a cash preservation strategy, due to escalating operating costs and fluctuating commodity prices (Deloitte, 2014a:1,3; Deloitte, 2014b:2).

With a reduced focus on production, production targets are not being met on a daily or annual basis due to a wide range of contributing factors, creating a significant problem. Subsequently, gold targets are not being met, and a higher than planned gold price is relied upon to meet revenue targets.

The result is that the additional free cash flow obtainable from a higher than forecasted gold price is not being realised. Additionally, escalating production costs and lower than planned productivity may impact the company further by eroding cash flows, profit margins and the carrying value of an asset. These prevailing conditions have also made it harder for mining companies to attract both equity and debt financing, and have also contributed to a further decline in shareholder trust (Deloitte, 2014a:3).

During periods of a favourable, higher than forecasted gold price, the planned free cash flow lost due to production inefficiencies may be offset by a higher price received per kilogram of gold. In these instances, the increased revenue received should be exploited by still achieving production targets which would allow for significant financial over-performance.

During times of a suppressed gold price, the received price per kilogram may be substantially lower than what was originally forecasted. In this instance, production inefficiencies would not be offset by a higher than forecasted received gold price, and coupled with lower than planned gold production, could lead to significant revenue losses and a negative free cash flow for the operation. These pressing issues lead to the following research questions:

- What is the impact on free cash flow as a result of production inefficiencies at this particular mine?

- What is the current state of mining in South Africa, and what effects do mining companies suffer as a result of financial underperformance?
- What are the main contributing factors to production inefficiencies at the mine?
- Based on regression analysis, what level of confidence can be applied to the budget plan on a monthly and annual basis?

1.4. Research objectives

1.4.1 Primary objective

- To determine the impact of production inefficiencies on free cash flow at a producing gold mine in South Africa.

1.4.2 Secondary objectives

- To provide an overview of the state of the mining industry in South Africa.
- To provide some insight into how the market reacts to financial or production results and forecasts.
- To determine the main contributing factors of production delays and inefficiencies at the mine.
- To determine the level of confidence which can be applied to the budget production plan.
- To provide some recommendations on how to deal with the issues which are causing the majority of the lost blasts

1.5 Research methodology

1.5.1 Research design

Due to the nature of the problem being assessed, and the availability of historical data, a quantitative research design was selected for this field study. Creswell (2003:19-20) defines quantitative research as a type of research which explains phenomena by

collecting and interpreting numerical data which is analysed using statistical methods. Bryman and Bell (2014:31) further describe quantitative research as deductive, with a positivist approach, and having an objectivist conception of social reality.

A positivist approach contends that there is an objective reality to be studied and understood by making use of observable and measurable data. Thus, a positivist approach is employed for the purpose of this research study, considering that emphasis is placed on the use of numerical data, which allows for quantifiable observations through statistical analysis. This will allow the researcher to measure, describe and compare certain aspects related to the research questions posed (Gratton & Jones, 2004:15).

1.5.2 Data collection methods

Two data sets are required to attempt to answer the research questions which have been posed. Identifying the main causes of production delays and production inefficiencies would be addressed by utilising historical data. The historical data referred to records the various reasons for not achieving daily production targets. This data set would also be utilised to forecast production trends, which would enable the researcher to determine how much of an impact the production delays have had on the expected free cash flow obtainable from an operation over a given time period.

The second data set would be obtained by calculating the percentage compliance between the areas planned to be mined, versus the areas actually mined. This aspect of adhering to the planned areas to be mined has a significant influence on gold production, considering that each area planned to be mined has a specific estimated gold content which is used to forecast the gold production, and ultimately, the revenue generated.

1.5.3 Data analysis

The historical production delay data (lost blast analysis) will be analysed by means of various statistical methods. Due to the wide array of contributing factors, the primary analytical method to be used to identify the main causes of production delays will be a Pareto analysis. A Pareto analysis is a statistical method which is utilised to identify

the few vital errors in a process which result in the majority of the delays or process inefficiencies. This principle proposes that a small proportion of the vital errors or process inefficiencies (20%), are responsible for 80% of the overall impact (Sarkar, Mukhopadhyay & Ghosh, 2013:1-2). From here, the frequency of specific production delays will be used to attempt to forecast the production output for 2018. The forecast production output can then be used to forecast the free cash flow based on the prevailing market conditions (gold price, ZAR/USD). Thereafter, the deficit between the budget and forecasted free cash flow can be determined.

The data collected for the regression analysis will be utilised to determine what level of confidence can be applied to the production plan on both a monthly, as well as an annual basis. The regression analysis will attempt to show how much drift occurs over a 12-month period by determining what the percentage compliance to the initial budget plan was. The compliance will be expressed as a percentage of the actual square metres mined within a particular area, versus the planned area to be mined. The budget versus actual mining value (relates to specific amount of gold in the ore being mined) will also be considered, as this has a significant impact on the amount of gold produced.

1.5.4 Ethical considerations

The aim of this research study is to indicate the potential for losses in free cash flow sustained by the mine as a result of production inefficiencies. Preliminary financial and production forecasts could have a negative impact on the image of the operation, as well as the governing organisation, and could lead to further financial implications caused by a lack of confidence on the part of shareholders and investors. It is required that all financial and production data remains confidential, as well as the production and execution strategies.

Secondly, victimisation of individuals could follow from the results of the data analysis, particularly when continued poor production performance from a certain mining crew is identified. To prevent this, the names of individuals and their associated places of work, as well as their responsibilities, will be omitted from the report.

The ethical considerations to be followed by the researcher are:

- To obtain written permission from the relevant personnel to conduct the study.
- To not disclose the identity of individuals whom assisted with data collection for the study, or those individuals who assisted with providing data for the study.
- To ensure no harm came to any individual who assisted with the study.
- All results are to be kept confidential from the public realm. All the information and data used for the purpose of the study will be stored on a password-protected personal computer.
- The intended outcome and research objectives are to be communicated effectively to the management team of the mine prior to the commencement of the study.
- The results of the study will be communicated and shared with the management of the mine by means of a presentation and a confidential copy of the research dissertation.

1.6 Demarcation of field of study

1.6.1 Focus of the study

The historical data pertaining to the production inefficiencies and delays experienced by the mine will be obtained from the Business Improvement Department, situated on site. The percentage compliance to the budget plan will be calculated manually by the researcher, as this type of data is not regularly recorded.

The study aims to determine the impact of production inefficiencies and delays on free cash flow for the mine, and what level of confidence can be applied to the annual budget mining plan. The research fits into the structure of financial management. The goal of financial management can be defined as maximising the current value per share of the existing shares (Firer, Ross, Westerfield & Jordan., 2012:8).

The study was conducted on site at the mine in question and commenced on January 2018. All the data retrieved for the study was conducted on site.

1.7 Chapter layout of the study

Chapter 1: Research proposal

This chapter forms the foundation of the research. It will provide an overview of the research topic, as well as the methodology which was utilised for the study. This chapter will introduce the challenges currently being faced by the mining industry in both a global and South African context. Furthermore, Chapter 1 provides some background on the mine and introduces the research problem specific to this particular mine.

Chapter 2: The South African mining context

Chapter 2 will provide an overview of the South African mining industry, as well as current economic, labour and financial challenges currently faced by the industry.

Chapter 3: Effects of financial performance and market reaction

Chapter 3 aims to provide the reader with an understanding of how markets react to financial over- or underperformance of an organisation, and how earnings announcements and forecasts can act as drivers of share price. Chapter 3 also briefly outlines some of the key aspects which investors look for in a company, and how a company may act to maintain current investors and attract new ones.

Chapter 4: Research design and methodology

Chapter 4 will outline the research methodology utilised for the purpose of this particular study. This chapter focusses on the data sources, research design, analytical methods and data collection methods.

Chapter 5: Research results and discussion

Chapter 5 contains the results of the data analysis as well as a detailed discussion on the findings of the research.

Chapter 6: Recommendations and conclusion

Chapter 6 contains the conclusions drawn from the results previously discussed. Relevant recommendations pertaining to the findings of the study and research questions posed previously will also be made in this final chapter.

1.8 Conclusion

The study aims to determine the major causes of production delays and inefficiencies at the mine, and how these delays impact on free cash flow. The study will also serve to create awareness regarding the loss of free cash flow caused by production delays and by failing to exploit favourable market conditions. Lastly, based on the findings of the study, the researcher hopes to be able to provide recommendations regarding managerial and operational strategies which could be implemented to mitigate these risks by ensuring that the scheduled production plan is executed effectively, and that certain steps may be taken to prevent lost blasts in the future.

The literature review indicates that markets react strongly to financial announcements, particularly negative ones, and that earning announcements and forecasts are strong drivers of share price movements. This ultimately emphasises the importance of achieving the financial goals set out by the company in question.

Chapter 2 – The South African Mining Industry

2.1 Introduction

This chapter aims to provide an overview of the South African mining industry regarding production trends, economic contributions, employment levels, as well as the challenges the industry currently faces. The discussion will centre around the gold, platinum, coal and diamond sectors.

The mining industry in South Africa has been on a downward trend for the better part of the last 20 years. The number of listed companies on the JSE has dropped from 130 in 1994, to 53 listed companies in 2016. While the market capitalisation and bottom line of global mining companies has seen an upswing in recent times on the back of a recovery in commodity prices, South African mining companies have not shared in this fortune. Regulatory concerns and an economy in decline have caused concerns for local mining houses (Peyper, 2017:1).

Since 2013, the dollar prices of South African commodity exports have declined by 8.6% annually on average - up until 2016. Employment in the mining industry has also declined by an average of 4% yearly since 2013 (Chamber of Mines, 2017:3). Apart from declining profits and jobs in the industry, the overall contribution of the mining industry towards the South African GDP has also declined year on year from 2015 to 2016. In 2016, the mining industry contributed 7.3% towards the country's GDP, a decline of 4.7 % from 2015 (Chamber of Mines, 2017:3). Figure 4 shows how mining's contribution to South Africa's GDP has declined since 1980, falling from the second position to the 6th position.

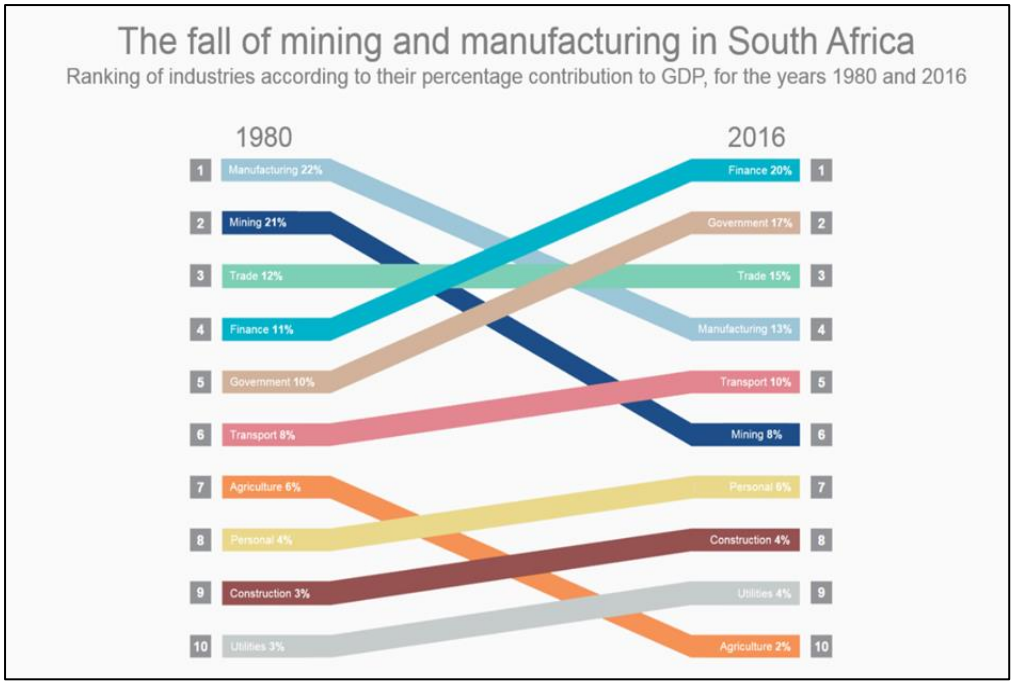


Figure 4: Decline in mining's contribution to SA's GDP. Source: Statistics SA (2017).

Notwithstanding extensive reserves, particularly of coal and platinum, many local and foreign investors have written off the mining sector in South Africa as a potential investment opportunity and destination. The impact of regulations, rising costs, falling productivity, industrial unrest, unreliable electricity supply and political uncertainty in South Africa are frequently cited as the reasons why other locations in Africa and globally are now more attractive destinations for direct investment in this sector. South Africa remains at risk of not getting the full benefit of global commodity demand as current uncertainties around the redrafted Mining Charter publication drag on and constrain much-needed investment in the mining sector (Omarjee, 2018:10).

The proposed Mining Charter 3 will have a significant impact on how businesses and operations within the mining industry are run. Some of the proposed amendments as contained in the Mining Charter 3 draft document include the following (Department of Mineral Resources, 2018:14-25);

Ownership: New mining rights to be held by entities with a shareholder representation of no less than 30% historically disadvantaged South Africans (HDSA). Shareholding blocks of no less than 8% to be allocated to host communities. A trickle dividend of 1% of earnings before interest, tax depreciation and amortisation (EBITDA) to be paid

to qualifying employees and host communities. Holders of existing rights who complied with the 2010 Mining Charter will have 5 years to increase HDSA shareholding to the new required level of 30%.

Procurement and enterprise development: Mining Charter 3 proposes that 80% of services should be procured from local companies, of which 60% must be BEE companies. A total of 70% of mining goods are to be acquired from BEE companies. Only SA based companies are to be used for analysis across the entire mining value chain (This places pressure on the credibility of analysis as no third-party laboratory can be used).

Employment equity: It will be required that 50% of executive directors must be black people, that 50% black people occupy senior management positions, with 60% black people at middle management level and 70% at junior management level. A minimum of 40% of core skills must be black people, with black people being fast-tracked into management roles.

Sustainable development: There is little mention of sustainable development and environmental compliance. The focus is placed on human capital development.

The proposed mining charter has resulted in a backlash from stakeholders, including unions and investors. The mining sector in South Africa is now being called “un-investable”, which is sure to place further strain on an industry which is already facing challenges in securing investment capital (Deloitte, 2018; Huffington Post, 2017:3).

There is a very real risk that if the Charter is implemented in its current form, investors will be forced to disinvest from South African mining. Given the significant policy and regulatory uncertainty created by this Charter, new investment into the mining sector is essentially on hold (ASISA, 2017:10).

Companies are now being forced to self-fund their expansion projects to ensure they remain competitive in the long term and also to ensure that their operations remain sustainable. South African mining companies re-invest, on average, up to 16% of their profits as a form of self-funding for capital projects and expansion (PWC, 2017:21). Investors have started placing a risk premium on South African mining companies, which has subsequently increased the cost of capital, making it more expensive to attract and obtain investor funding (Lane, Guzek and van Antwerpen, 2015:475). This

has placed further pressure on mining companies and their business units to ensure that they meet their required production and financial targets.

The mining industry in South Africa is a key export revenue generator and tax contributor (Lane, Guzek and van Antwerpen, 2015:473). The continued demise of the mining industry would have a significant negative impact on South Africa's economy as well as on tax revenue on which the government relies to fund social programmes.

Industry profits before tax over the five-year period ranging from 2012 to 2016 declined by 48%, and dividends paid to investors plunged by 52% (Peyper, 2017:3). Figure 5 depicts how the revenue generated within the South African mining industry was distributed, with the greatest proportion being allocated to employees in the form of salaries and fringe benefits. What is important, however, is that only 2% of profits generated within the mining industry were paid back to shareholders as dividends. The year 2017 marked the fifth year in a row which saw a decrease in dividend pay-out in the mining industry since 2011. The percentage dividend pay-out as a function of revenue has decreased from 11% in 2011, to 2% in 2017 (PWC, 2017:22).

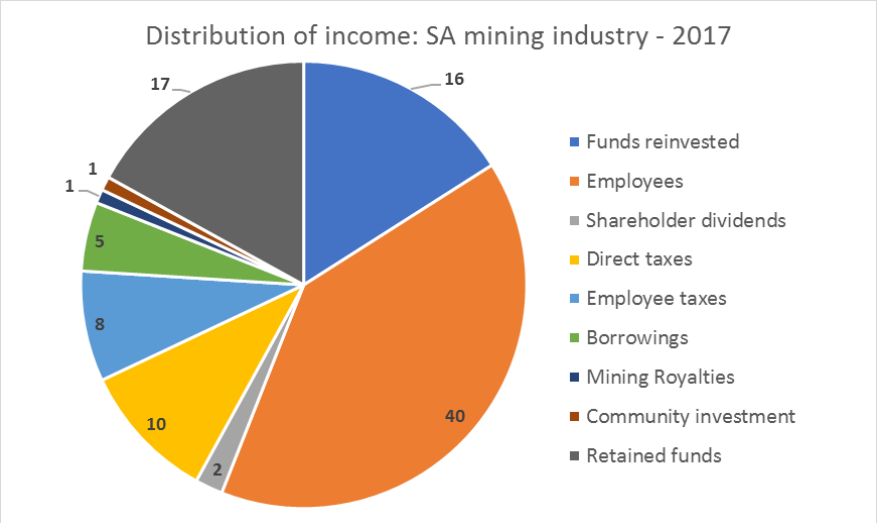


Figure 5: Distribution of income generated within the South African mining sector. Source: Adapted from PWC (2017:21).

Within hours of the gazetting of the new Mining Charter in June 2017, South Africa's mining companies listed on the JSE lost R51 billion of their value. This was in response

to the uncertainty of the stability of the SA mining industry, as well as uncertainty around what impact the proposed mining charter would have on the mining industry. The significant loss of R51 billion was primarily as a result of a sharp drop in the JSE mining index, which affected the share price of most JSE-listed mining companies (PWC, 2017:8). In addition, pension funds that hold mining stocks lost R2.7 billion of their value, affecting at least 60% of South Africans who hold shares in mining companies as part of their pension fund investments (Peyper, 2017:6).

Given the sharp decline in the share price of mining companies, which negatively affected the capital gains of shares purchased, coupled with the low dividend pay-outs, it becomes evident that the mining industry, and particularly the gold sector, may no longer be an attractive investment option. The challenge currently faced is determining how to increase the size of the pie to create more value for all the stakeholders in an environment of ever-increasing costs, reducing margins and increased volatility.

The South African mining industry is dominated by four main sectors in terms of revenue generated and persons employed. These four industries are: Platinum group elements (PGE), gold, coal and diamonds. Of these four major sectors within the South African mining industry, the coal and diamond sectors have remained relatively stable over the past number of years, both in terms of revenue streams and employee base. The precious metals sector, namely gold and platinum have struggled significantly in recent years, with revenue streams dwindling, as well as continued labour cuts and restructuring.

The section below provides some information on the four dominant sectors within the South African mining industry in an attempt to illustrate their size in terms of employment, their general production trends, as well as their importance in the South African mining context.

2.1.1 The gold sector

It is no secret that gold mining and its contribution to the mining industry in South Africa has declined significantly in recent years. Gold resources in South Africa are estimated to last for only another 39 years, based on current economic factors and extraction rates (Statistics SA, 2017:9). Precious metal mining companies are generally more

affected by economic factors compared to other resources' companies. This is generally due to the nature of the ore bodies being exploited, which are mined at great depths below the surface, resulting in the mining operations being extremely labour intensive and carrying high production costs. Gold mining companies are also increasingly at risk due to changes in gold price and currency movements, particularly in the South African context where stable commodity prices and exchange rates are relied upon to remain profitable (Mining Review, 2016).

Gold production in South Africa has been on the decline for the past fifteen years and has seen annual gold production fall from 337.3 tonnes in 2004, to 142.1 tonnes in 2016 (Figure 6). The decline in gold production has resulted in South Africa contributing a mere 4.4% to global gold production (Figure 7). This decline in gold production is due to a number of contributing factors, such as declining ore grades, declining reserves, increasing production costs and declining production efficiencies, to name but a few (Neingo & Tholana, 2016:284-289).

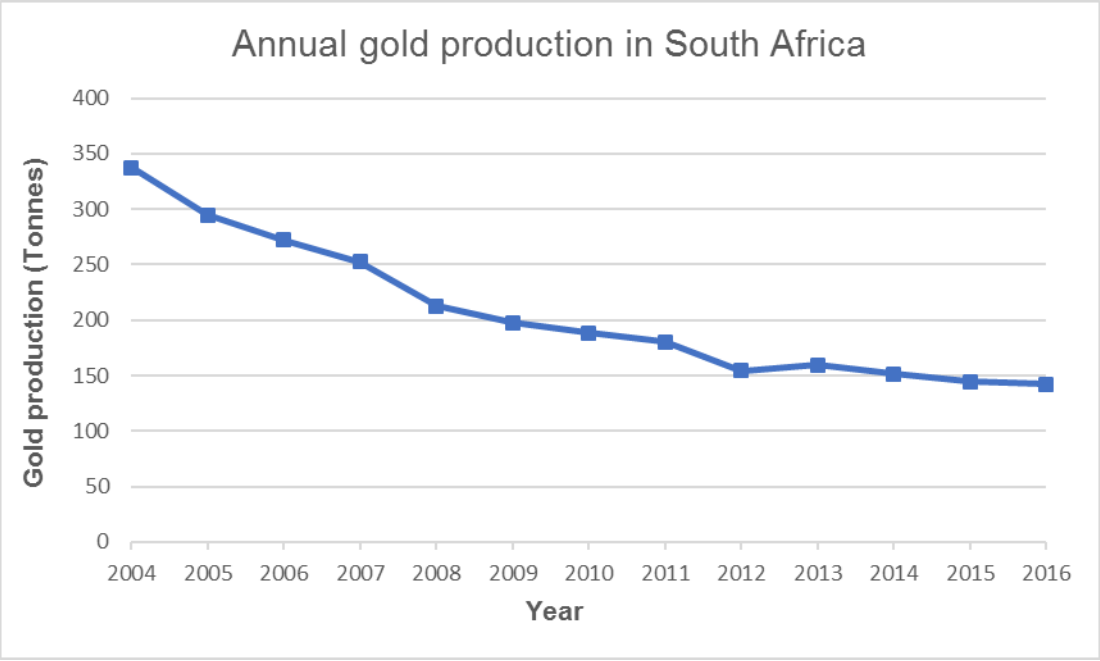


Figure 6: South African gold mining sector decline in annual gold production. Source: Adapted from Chamber of Mines (2017:17).

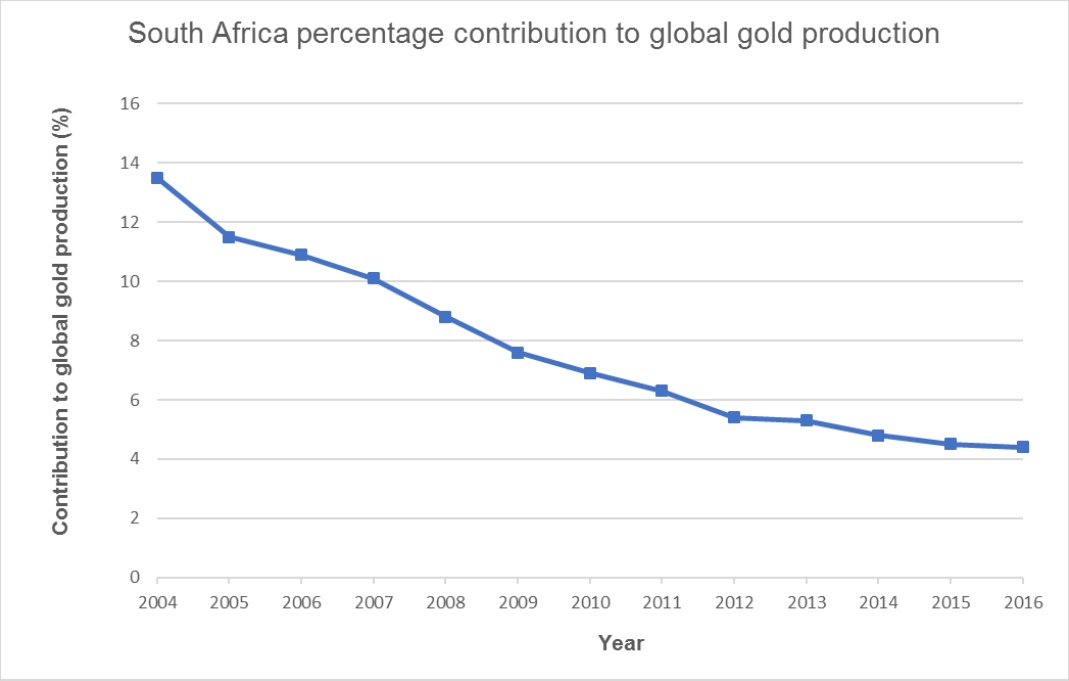


Figure 7: Continued decline of the South African gold mining sector's contribution to global output. Source: Adapted from Chamber of Mines (2017:17).

Gold mining companies suffered a R114 billion or 52% decrease in market capitalisation during 2017, losing almost all the gains made in the previous year. These decreases came on the back of a lower June 2017 Rand gold price. The recovery of the Rand meant that Rand price increases were not as impressive, and in fact resulted in further decreases for gold and platinum, putting South African deep-level gold and platinum miners under severe pressure (PWC, 2017:5). The loss in market capitalisation of gold mining companies comes as a direct result of a reduction in the share price of the companies in question (PWC, 2017:8). Declining share prices may be interpreted as a sign that investors are losing confidence in the gold sector as a favourable investment opportunity, partly because of declining revenue streams, decreased margins and uncertainty regarding a return on investment (ADX, 2014:8; Tease, 1993:51-53). A lack of investment confidence further threatens the sustainability of the gold mining sector.

Despite various cost-saving initiatives, which managed to keep overall operating costs within inflation increases, lower production of gold means higher unit costs. This translates into lower or negative profit margins in a flat or decreasing Rand price environment, which threatens the sustainability of a number of mines (PWC, 2017:12).

2.1.2 The PGE sector

The platinum group metals industry remains the biggest employer within the South African mining industry, accounting for 41% of employment within the industry (Statistics SA, 2017). South Africa also currently hosts 95.5% of global PGE resources (Chamber of Mines, 2017:9), with an estimated 335 years of PGE resources (Statistics SA, 2017:9). One cannot argue that the PGE sector in South Africa has a long and fruitful future ahead of it in terms of mining life, however, the sustainability and success of the PGE sector in South Africa relies on a number of factors other than available resources. These include aspects such as market economics, supply and demand, increasing production costs and labour challenges (Ryan, 2014:300).

As with gold mining, platinum mining is extremely labour intensive. With the added cost of beneficiation and production costs, platinum mining has become increasingly costly, with average production costs ranging between US$ 940 – US$ 1100 per ounce (Statista, 2018). At the same time, platinum prices have traded at low levels for the past two years, and were trading at US$ 903/oz as at 1 May 2018 (Trading Economics, 2018). It is clear that the production cost is higher than the price received, which results in numerous platinum mines being unprofitable. The Chamber of Mines' CEO Roger Baxter recently stated in a press release that 65% of South African platinum mines are unprofitable at this stage (Business, 2018:10).

The price of PGEs is primarily driven by supply and demand factors, and as it currently stands, supply of the PGE metals has exceeded demand. As a result, a surplus of platinum is currently being held in inventory, which has driven prices down significantly (Njini and Van der Walt, 2018:15).

The primary uses of platinum are in the automotive industry (43%), the jewellery industry (30%) as well as investment and other applications (27%) (Njini and Van der Walt, 2018). The future looks equally bleak for platinum demand, as reduced demand for diesel engines (a major source of pollution) and the rise of battery- and hydrogen-powered cars threatens to erode the demand for the metal used in the automotive industry (Van de Kaa, Scholten, Rezaei & Milchram, 2017:1,2; Matthey, 2018:2-8).

Although the platinum sector is battling to stay afloat in South Africa, their woes are not caused by drastic declines in production output, as is the case with gold. Figure 8 indicates that over the past number of years, platinum production in South Africa has

remained at fairly consistent levels, a fact which in itself may have crippled the industry due to oversupply, ultimately leading to low metal prices.

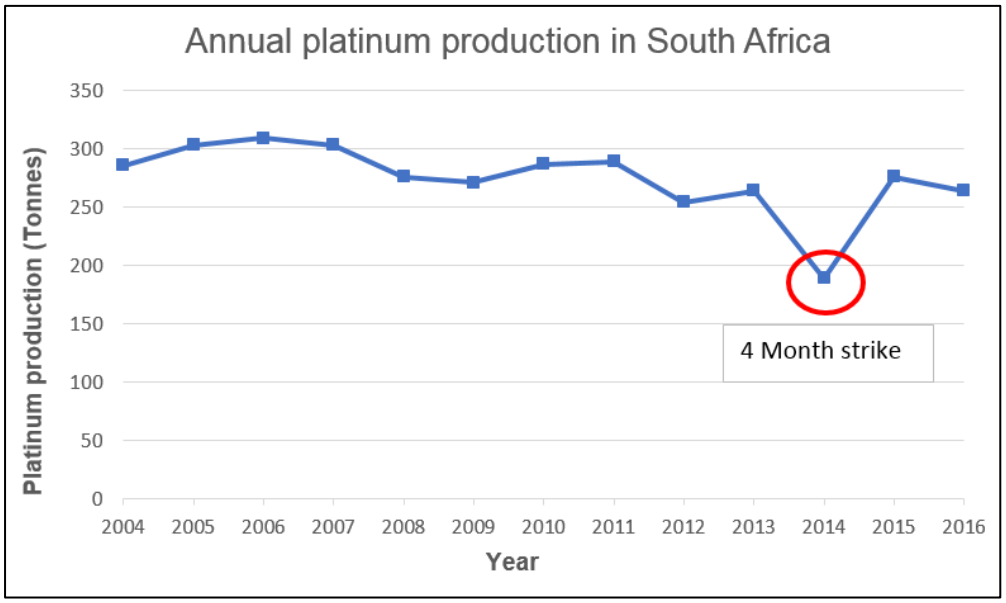


Figure 8: Annual South African platinum production. Source: Adapted from Chamber of Mines (2017:20).

2.1.3 The coal sector

The coal mining sector in South Africa is the third largest direct employer within the South African mining industry, accounting for 20% of employees within the industry (Statistics SA, 2017). South Africa also currently hosts 8% of global coal resources (Chamber of Mines, 2017:9), with an estimated 256 years of coal reserves available (Statistics SA, 2017:9). Unlike the gold and PGE sector, the employee base of the coal mining sector has remained stable over the past decade, with no major restructuring or job losses having occurred within the sector during this time (Chamber of Mines, 2017:11-17).

The coal mining sector in South Africa contributes the biggest monetary value of all the mining sectors, with total coal sales earning R111.95 billion in 2016, and gold and platinum earning R75.49 billion and R96.41 billion respectively. Export sales of coal accounted for 55% of total value by sales, making it a considerable export earner (Chamber of Mines, 2017: 4,24).

With local and global energy requirements set to increase, one can be certain that the local and export market for coal will remain stable, or continue to grow marginally at

best (IEA, 2017:4). This bodes well for the South African coal industry, which has seen stable production profiles for more than a decade (Figure 9).

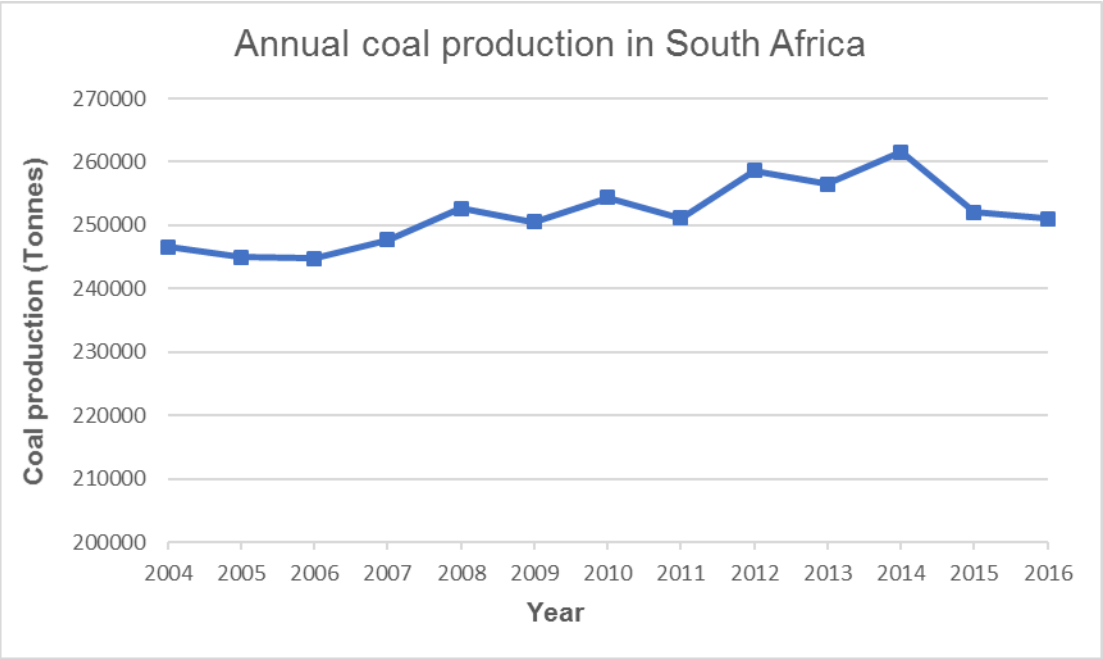


Figure 9: South Africa annual coal production. Source: Adapted from Chamber of Mines (2017:24).

The future of coal mining hinges on two aspects; the first being the rate of economic growth in developing countries, coupled with the acceptability of burning coal from an environmental perspective, and secondly, the development and implementation of nuclear and renewable energy sources. As it currently stands, coal as a source of energy is forecast to increase at moderate levels; however, oil as an energy source is predicted to increase its market share over coal (Mohring, 2001:19).

2.1.4 The diamond sector

The diamond mining sector in South Africa remains one of the most important contributors to global production. Although only 10% of the world's diamonds by weight are produced in South Africa, the diamond mining sector in South Africa accounts for a total of 60% of global diamond sales by value (Chamber of Mines, 2017:25). Total

diamond sales for 2016 amounted to R20.82 billion, with 60% of sales attributed to exports. The diamond mining sector in South Africa has seen stable production profiles over the past decade (Figure 10) and has maintained stable employee and production figures following the 2008 global financial crisis.

Figure 10: South Africa annual diamond production. Source: Adapted from Chamber of Mines (2017:26).

The diamond sector in South Africa is also one of the few sectors currently involved in active mine expansion. Companies such as Petra Diamonds and De Beers are both actively expanding their Cullinan and Venetia mines respectively in an attempt to increase production output from their mines (Breytenbach, 2015). It should be noted, however that these expansion projects are focused on currently-known deposits and near-mine expansion and are not as a result of new discoveries.

Global rough-diamond demand is projected to grow at an average annual rate of approximately 1% to 4% through to 2030, while supply is projected to grow from 0% to 1% per year over the same period (Linde, Kudryasheva, Geyler, Epstein and Fischler, 2017:47). The slow growth in supply is due to the fact that no new major discoveries have been made in recent years. Similarly, as a result of reduced margins,

slow economic growth and lack of investment, mining companies have cut back on exploration budgets in search of new discoveries (Steyn, 2017:19).

2.2 Current challenges

2.2.1 Labour unrest

It comes as no secret that South Africa's mining industry has been plagued by labour unrest and strike action for as long as minerals have been extracted from the ground. South Africa as a whole faces many challenges when it comes to labour relations, with continuous strike action taking place across an array of industries, and a recent upward trend in labour-related work stoppages (Figure 11). Strike action can have an adverse effect on investments. Ncube (2013:2) has shown that capital outflows increase greatly during periods of strikes, which reflects a loss in confidence among investors. This loss in confidence is generally brought on by reduced investment returns.

The mining industry is dependent on maintaining stable and profitable cash flows in order to ensure a return for their investors and to maintain investor confidence. However, strikes pose a threat to consistent cash flows, due to breaks in production outputs. When there is inconsistency on investment returns, the expectations of investors are not met, leading to them investing elsewhere (Chabalala, 2014:2).

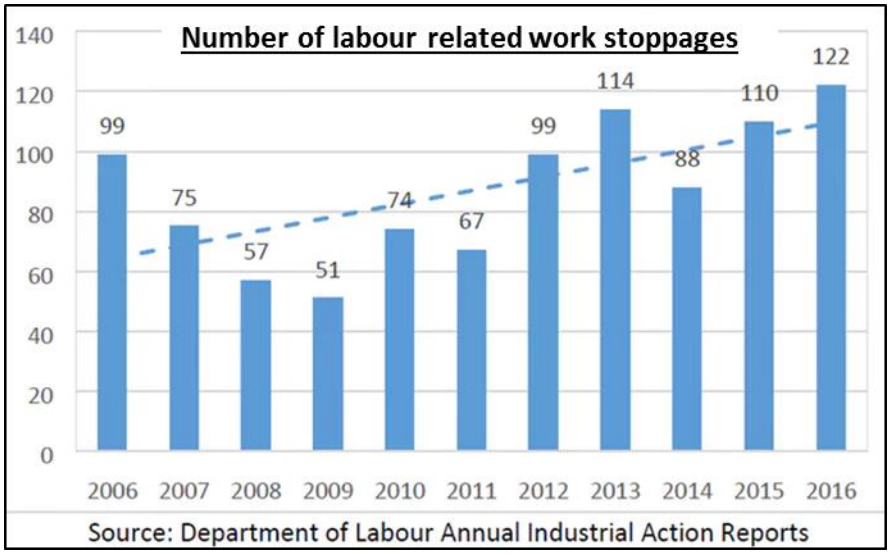


Figure 11: South Africa faces a high number of labour-related stoppages annually (Department of Labour, 2017).

2.2.2 Capital intensiveness

The long-lived mining booms of the past, which saw high commodity prices and high rates of return for investments, have become but a distant memory. The ever-changing economic climate and volatile commodity prices have made mining a risky investment, where returns are very sensitive to booms and busts. Unfortunately, mining is a capital-intensive industry, which requires continuous injections of capital, while also having high sunk costs. Capital that is invested in mining is at risk, and cannot readily be reclaimed or regathered (Runge, 2012:3).

Another issue that arises in terms of capital investment in the mining industry is the often long lag period that exists between the initial investment and the eventual output of the operation which is intended to deliver returns (Topp, Soames, Parham & Bloch, 2008:65). The uncertainty associated with future commodity prices, inflation and interest rates often deters investors from allocating capital to such projects because of the long lag period.

2.2.3 Exchange rates

The majority of South African mining operations export their products to the international market, and in so doing, receive foreign currencies as payment for their

goods. This means that the companies are dependent on favourable exchange rates as they receive their payment in South African Rand. In an attempt to combat the impact of globalisation, South Africa adopted a free-floating exchange rate system, which means that demand and supply in the foreign exchange rate market determines the value of the Rand. Previous studies have shown that a real depreciation in the Rand has a positive long run effect on mining exports (Ngondo & Khobai, 2018:1,7). This is because the price received per unit of product exported increases in Rand terms, which allows for increased profit margins, assuming that production costs per unit of product produced remain unchanged.

It therefore follows that a volatile and fluctuating exchange rate poses a threat to the mining industry, as sudden swings in currency exchange rates could drastically influence the profitability of an organisation, particularly in instances where the domestic currency appreciates relative to the exporting currency such as the US dollar.

2.3.4 Inflation and Interest rates

Inflation and interest rates are also two key variables that influence the mining industry as well as potential investment in the industry. High rates of inflation cause high rates of increases in the costs of goods and services. When this occurs, the cost of mining increases, which causes profit margins to decline. Increases in the rate of inflation bring with them lower rates of investment, as high rates of inflation reduce the real rate of return on investments (Onwe & Olarenwaju, 2014:190).

When mining companies seek to expand their operations, they often issue bonds or borrow money from financial institutions such as banks. When interest rates on loans are high, it directly increases the cost of capital which companies need to expand their operations. Therefore, when interest rates become too high, companies opt to hold off on incurring any form of debt, which may delay capital projects even further.

2.3 Chapter summary

From the data presented, it is clear that the South African mining industry faces considerable challenges in terms of global economic factors, as well as considerable policy uncertainty. The precious metals sector, which incorporates the gold and PGE

sector, has suffered the most in recent years and will continue to face hardship, given the current economic conditions and production costs.

The gold industry is particularly under threat, as is evident from the steady decline in production output. A stagnant gold price, coupled with unfavourable currency exchange rates, will place further strain on the gold sector. Limited investment and project expansion will also place further strain on the long-term sustainability of the sector.

The PGE sector, although having maintained stable production levels over a number of years, and having vast amounts of minable resources available, faces its own set of challenges. None is more so than the prevailing and projected price of platinum. With a reduction in the need for platinum in the automotive industry as a result of technological advancements, the demand for this metal may continue to decline.

Faced with a global over-supply of the metal as it currently stands, a further reduction in demand may suppress the price of platinum even further. This will result in further platinum mine closures which will see the revenue stream from this sector decline even further. For investors and people or companies seeking reasonable returns on their investment, the platinum sector may not be the best choice as an investment option.

The coal and diamond sector, on the other hand, remain stable in terms of production output, employee base and revenue streams, with considerable opportunities for further growth and expansion based on global demand for both diamonds and coal. The biggest threat to the coal industry currently remains the growing interest and investment in renewable energy resources, which may result in a reduction in the demand for coal as an energy source. Diamonds, on the other hand, are set to perform well in the years to come, as analysts currently forecast a growing demand for the gemstone. This will see the demand for diamonds surpass the supply, ultimately leading to an increase in the price of diamonds.

It is evident that the mining industry in South Africa faces challenges unique to each sector, and that demand and supply, as well as economic factors such as commodity prices and exchange rates should be factored into consideration before making an investment in whichever sector of the mining industry. However, at present, the

precious metals sector remains a high-risk environment given the current economic conditions and operational challenges being faced.

Chapter 3 – Financial performance of mining companies

3.1 Introduction

This study is intended to demonstrate how a substantial loss in free cash flow can be incurred by a mine as a result of production inefficiencies, as well as demonstrating that only low levels of confidence can be applied to the current mine planning and execution procedures. Due to the nature of this study, there are not many literature reviews available relating to this specific topic. One avenue which can be approached, however, is the market effect which is felt by an organisation as a result of financial over- or underperformance.

The core function of any business is to generate a positive cash flow, to provide a return on investment for its shareholders and stakeholders, and to continuously attract new investors. The ability of a company to pay out cash dividends to its shareholders, and to increase the share price by obtaining additional outside investments into the company relies heavily on its ability to generate positive free cash flow.

This literature review focusses on the drivers of share price, and how investors are drawn to certain organisations. Furthermore, it also briefly touches on the effect that fluctuations in the gold price has on the future current value of an asset, and how the operational sustainability is influenced.

3.2 Definitions

Sustainability, in the broader sense of the term, generally means “the capacity to maintain” and is a key function to the success of any organisation. Although sustainability rests on three cornerstones; namely economic, environmental and social, this study incorporates primarily the economic aspect of sustainability. A sustainable business can be defined as one that creates profits for its shareholders, while complying with its environmental and social commitments (Gomes, Kniepp, Kruglianskas, da Rosa & Bichueti 2014:85).

Free cash flow is defined as the amount of cash that is left over after the operational costs, working capital and investment costs have been covered (Firer ***et al.***, 2012:31).

A portion of this left-over money is generally used to pay back any debt owed to lenders, distributed to shareholders in the form of cash dividends or retained as company profits (PWC, 2017:21).

3.3 Types of production schedules and the influence of gold price fluctuations

Although a number of factors contribute to the sustainability of an operation, recent studies have demonstrated that the economic and efficiency (productivity) dimensions were causal factors for the premature closing down of 75% of mining operations globally in recent years (Gomes et al. 2014:86). This is an alarming figure and demonstrates the effect that economic factors such as commodity prices, currency exchange rates and production efficiency can have on an operation.

Tufano (1998:1021, 1024) constructed a model whereby he demonstrated that firms who rely on fixed production models and schedules are more at risk when exposed to gold price "shocks" than firms who operate according to a flexible production schedule. Tufano demonstrates that large gold mining firms or operations are inherently sensitive to changes in the gold price. This is as a result of fixed financial costs, and the assumption that the operation only has a set number of minable gold ounces, with a finite operational capacity. The current future value of an operation is highly dependent on the prevailing gold price at the time, and as a result, the value of an asset may change while the number of minable gold ounces remains the same. An organisation or operation's sensitivity to changes in the gold price decreases as the gold price increases, primarily due to the additional revenue received from a higher than planned gold price.

3.4 Earnings announcements as a driver of share price

With the exception of certain organisations that are capable of self-funding their capital growth projects, the vast majority of mining houses are dependent on local and foreign investment to ensure sustainable growth. In recent years, investors and financial institutions have lost faith in the mining sector as a source of return on investment,

primarily because the mining industry has not been sufficiently profitable (Crowson 2002:15).

Larson and Madura (2003:119) have demonstrated that a company's share price is strongly influenced by public announcements related to expected (forecast) or actual earnings, as well as dividend announcements. They have also reported on the fact that the reaction to negative announcements regarding earnings and dividends is far more drastic than those related to positive announcements concerning earnings and dividend payments. This implies that negative news regarding earnings could have a much greater impact on an organisation than positive news would. Share price movements around earnings announcements have revealed much about growth expectations as well as the perceptions of management's credibility (Lev 2011:54).

Fluctuations in share prices are considered to be the rational response to changes in the expected present value of future cash flows (Chen and Fraser, 2010:1461), and as a result, expected future earnings are also based on forecast cash flows and revenue streams. The importance of being able to provide accurate market guidance with regards to expected earnings and free cash flow is vital in attempting to stabilise share prices and to ensure investor confidence remains high. Previous studies have shown that cash flow forecasts beyond two years have a significant influence on share price movements and investor confidence (Chen, Da & Zhao, 2013:21).

3.5 Maintaining and attracting investors

Investors are known for changing their investment preferences regularly, however, many of them are willing to invest with companies who regularly pay cash dividends (Lai, Lin, Hsu & Chang 2017:102). Companies who pay cash dividends are able to do so due to higher profitability and favourable free cash flow as well as constant, sustainable revenue streams. These factors result in higher company earnings, some of which are used for dividend payments. Higher company earnings and faster growth rates may lead investors to believe that a particular company will make a profit, which is an attractive investment prospect (Lai *et al*., 2017:102).

The payment of cash dividends, as well as a forecast increase in the dividend growth rate is not only associated with profit changes, but also has the added benefit of

increasing company share price, which brings further value to investors in terms of capital gains on share options. Free cash flow growth rates present a significantly positive association with future profitability, which can also act to strengthen company share price (Lai *et al*., 2017:104).

Often, growth opportunities represent a negative association with future profitability. This is as a result of the enormous amounts of capital expenditure required to fund growth projects. Investors are often hesitant to invest in such projects due to the inherent financial uncertainty associated with many mining projects, as well as the long payback period associated with new mining projects. The ability to self-fund capital projects, while still maintaining positive financial growth, would signal significant economic and financial sustainability, which would inevitably attract further investment and allow for company growth (Yoo and Kim, 2015:15985).

Fluctuations in company share price and investor confidence is inherently related to an organisation's ability to remain profitable and sustainable. A key driver of this is the ability to maintain a positive free cash flow and to ensure constant revenue streams throughout an organisation's lifetime. Publicly reported earnings and earnings projections are major drivers of investor activities which affects supply and demand of a stock, and in so doing influences the price thereof (Desjardins, 2015).

Dividend returns comprise only one form of return for investors in the mining industry. Generally, due to the long-term nature of mining investments, returns are more of a capital nature as mining companies need to reinvest their profits heavily in order to generate long-term sustainable mines and companies. If an investor is locked into only receiving dividends because they cannot realise their interest in the underlying asset, their returns are significantly limited. Their risk also increases as they are limited to a single or limited number of mining assets (PWC, 2017:27).

As indicated in Figure 12, the average distributions from mining companies to shareholders over the last 10 years, as a percentage of market capitalisation and total assets have been a mere 3.1% and 3.4% respectively. Even at the highest level of 5.7% and 6.1%, which included the impressive Kumba Iron Ore dividends for those years, the dividend returns are low. These low yields can be earned on a risk-free basis by investing in government bonds with much higher returns (PWC, 2017:27).

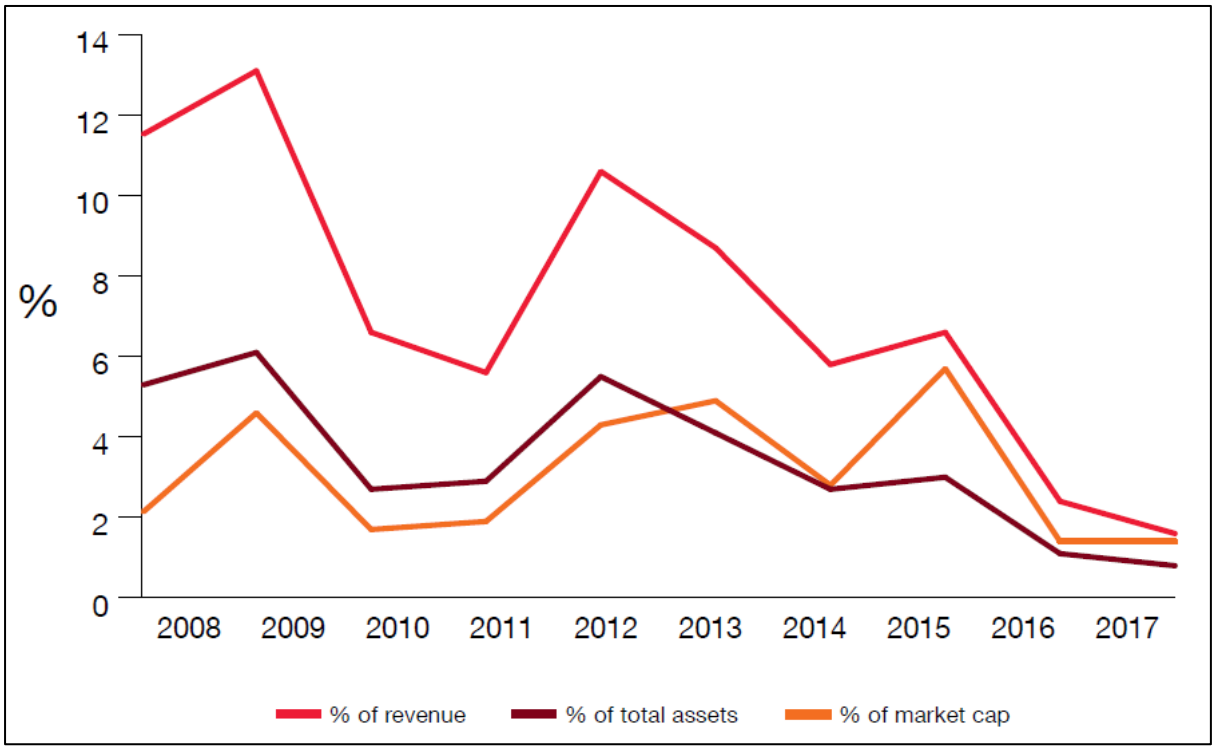


Figure 12: Payback to shareholders as a percentage of revenue, total assets and market cap. Source: PWC (2017:27).

3.6 Chapter summary

The information discussed above, although brief, highlights the importance of maintaining a stable and positive free cash flow stream. The ability to pay dividends to shareholders is fully reliant on an organisation's ability to achieve positive financial results. Apart from achieving positive financial results, companies should strive to achieve financial results which will afford them the opportunity to deliver dividend returns which constitute investment returns higher than those achievable on risk-free investments.

The mining industry is a risky environment, and as such, the rewards, or in this case return on investments, should be proportional to the amount of risk taken. As discussed in Chapter 2, the percentage of company profits paid out as dividends declined to a meagre 2% in 2016. Based on the low free cash flows generated by mining companies in South Africa as a result of decreased margins, one can assume

that the dividend payouts as a percentage of company profits are also not proportional to the risk taken. Lower forecast revenue streams and declining company profits are also sure to deter investment, which will further drive down share price and subsequently further erode investor value on a share capital basis.

Although this study does not focus on an entire organisation, the principles and key drivers most certainly filter down to the operational level. An organisation is dependent on all of its operations to perform optimally, and this is most certainly true in this instance. Although it is a single operation, the mine in question was responsible for delivering roughly 30% of AngloGold Ashanti's US$278 million free cash flow during the 2016 financial year (AngloGold Ashanti 2017b:9). Had they achieved their production targets, the mine would have been able to provide an additional ~US$70 million to the company's free cash flow.

This clearly demonstrates the direct impact on the company's free cash flow as a result of one operation not delivering on its production targets and relying too heavily on the gold price to meet its financial targets.

Chapter 4 – Research methodology

4.1 Introduction

The following chapter will introduce and describe the research methodology which was used for this study. Chapters 2 and 3 highlighted some of the challenges currently being faced within the South African mining industry, as well as the importance of being able to make accurate and reliable production and financial forecasts. The purpose of the chosen research methodology is to identify the major causes of production delays and inefficiencies, as well as to determine the level of confidence which can be applied to a particular budget plan. This is highly relevant due to the fact that this particular mine will serve as the primary gold producer and revenue generator for the company, which makes it critical to understand what may influence production output and revenue generation. This chapter will also explain the manner in which the data was obtained, as well as the particular statistical methods utilised to analyse the data for the purpose of drawing conclusions and making the necessary recommendations.

4.2 Research design

Numerous types of research designs may be appropriate, depending on the nature of the particular study being undertaken. Qualitative and quantitative research designs are the two primary methods utilised in research studies. Qualitative data is typically gathered from interviews, while quantitative data is typically gathered from questionnaires or other numerical data, and are usually analysed by means of different statistical methods (Walliman, 2011:71).

Due to the nature of the data being analysed for the purpose of this study, a quantitative research design was chosen, whereby numerical data of a historical nature will be analysed to determine various trends and compliance ratios. Quantitative research methods are meaningful in terms of answering questions pertaining to relationships within measurable variables, and aim to predict, explain and control certain trends and observations (Leedy, 1993). Emphasis is placed on the use

of numerical data, which allows for quantifiable observations through statistical analysis. This will allow the researcher to measure, describe and compare certain aspects related to the research questions posed (Gratton & Jones, 2004:15).

Quantitative research can utilise an array of research designs, which include historical, descriptive, correlation and comparative approaches to collecting and interpreting the data (Williman, 2011:10). This particular study will utilise a combination of designs, which will include components of historical data, descriptive data presentation and the determination of the correlation between certain variables.

A component of the study will utilise primary historical data, which will be used to determine what happened in the past, and then use that information to inform present and future trends. Historical data and trends incorporate the importance of past interactions and their effects on a system or process. From a descriptive perspective, the data being analysed can be used to predict what will happen again if the circumstances do not change. A correlation design will be used to examine the relationship between two variables, where a causal relationship is of primary interest. A causal relationship implies that a change in the one variable (the independent variable) affects another variable (dependent variable).

Bryman and Bell (2014:31) describe quantitative research as deductive, with a positivist approach, possessing an objectivist conception of social reality. The ontological assumption of this study is thus that reality is objective and singular apart from the researcher. A positivist approach is employed for the purpose of this research study, whereby the epistemological assumption is that the researcher is independent from that which is being researched (Sukamolson, 1996).

4.3 Data collection methods

This particular study will make use of historical data pertaining to production delays and compliance with the budget plan. This data will be obtained from the mine's historical database, which documents production delays, the agreed-upon budget plan for the mine, as well as the actual performance achieved for a particular time period. The purpose of this is to be able to identify the main causes of production delays and to identify trends over time to determine whether there is either a positive or negative

correlation between the budget plan and the actual mined area over time. The lost blast database is updated on a daily basis. When a particular mining area has not blasted on a particular day, the responsible miner will contact the Business Improvement Department and notify them of the lost blast, as well as the reason therefore. Figure 13 is an example of the top ten reasons provided for a lost blast, as reported by the relevant mining personnel over a 2-year period at the mine.

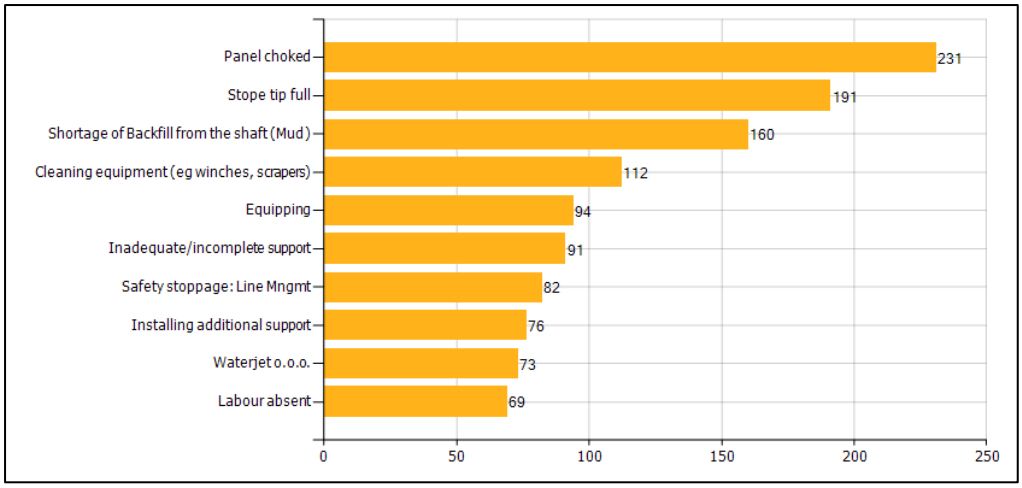


Figure 13: Top ten lost blast reasons reported over a two-year period at the mine. Data obtained from confidential on mine data base.

The second data set is obtained by determining what the percentage compliance was between the budget mining plan and the actual mining which took place. Compliance with the budget plan is critical, as the budget plan forms the basis of all financial and production forecasts for a particular year in question. The budgeted (also referred to as the forecast) gold production is determined by calculating the expected gold production from a particular area which is to be mined. Each area which is planned to be mined is unique in the sense that it contains a particular amount of gold, which is determined by the average gold grade of that area, as well as the surface area and volume of ore which is planned to be mined. It is evident that any form of deviation from the budget plan, however small, can greatly impact the gold production and revenue forecast.

Figure 14 is a simplified schematic example of a budget plan, indicating which areas are to be mined throughout the year, along with the forecasted gold production,

average gold grade, tonnes and revenue to be generated. Figure 15 depicts the actual mined areas, as well as the actual gold production, average gold grade, tonnes and revenue generated.

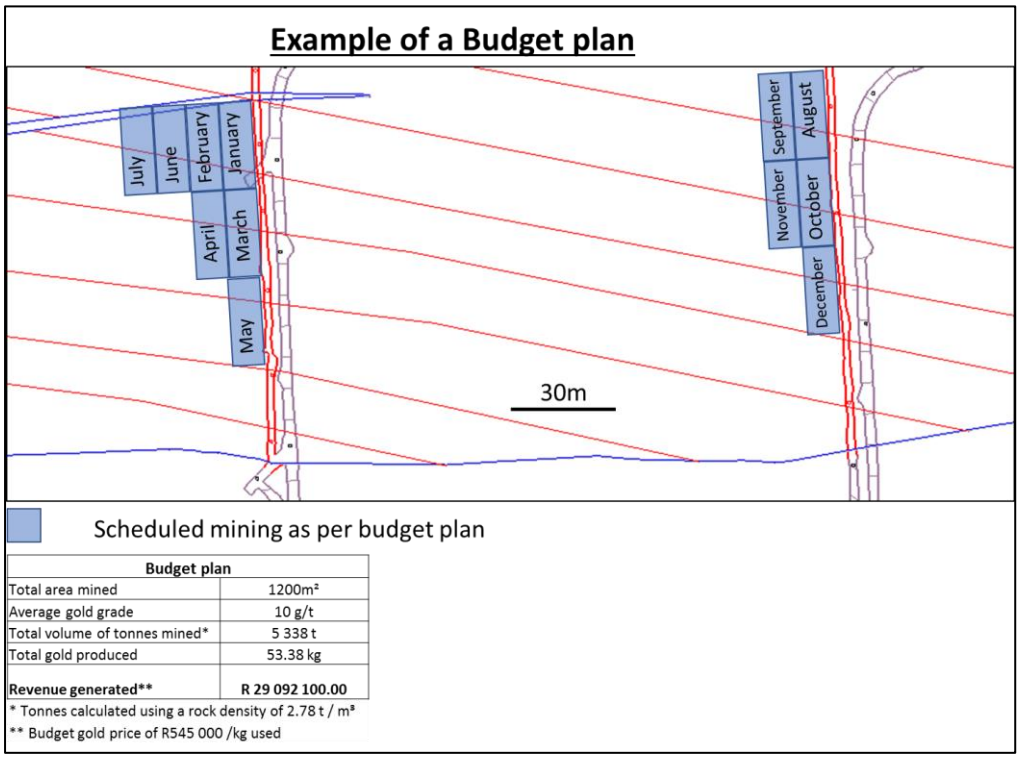


Figure 14: Schematic simplified example of a budget plan indicating the areas to be mined over a one-year period. Figure drawn by researcher for illustrative purposes only.

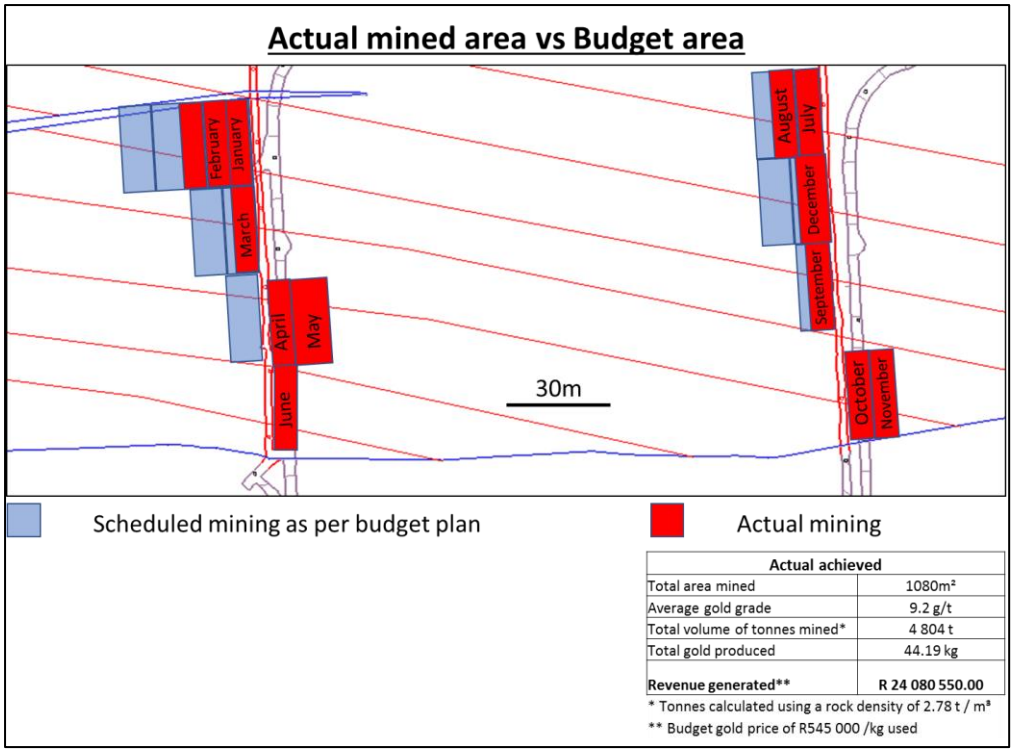


Figure 15: Schematic simplified example of the actual mining which took place over a one-year period compared to the budget plan. Figure drawn by researcher for illustrative purposes only.

Two notable observations will be investigated in this regard. The first is the "total area mined". The actual area mined was 1080m² for the year, compared to a budget of 1200m². The compliance with regards to total area mined for the year is high (90%), and the deficit can be attributed to production inefficiencies and production delays. The Pareto analysis (discussed in more detail in Section 4.4) aims to address this aspect to highlight what the major causes of production delays and inefficiencies are.

The second aspect to consider is evident from Figure 15, and focusses on the monthly and annual compliance to the specified area which is to be mined. It is clear from Figure 15 that the compliance to the budget plan is poor (roughly 50%), which may cause considerable variability and deviation from the budgeted figures which are used to forecast gold production and revenue generation.

By not mining in the designated planned areas, the average gold grade and volume mined is altered, which will result in a forecast different to that of the budget plan. Linear regression analysis will be utilised in this regard to attempt to determine whether a relationship exists between the budget plan and actual mining as a function of time. The correlation co-efficient between the budget plan and the actuals achieved

will be considered for both monthly and annual periods over a five-year period (2013 – 2017). Furthermore, an attempt will be made to determine what level of confidence one may be able to apply to the budget plan, based on the amount of variation which occurs as time progresses during the year. By determining what level of confidence can be applied to the budget plan on a monthly basis, or a different specified period, one would be able to establish at what point in the future the compliance to the budget plan starts to vary to such an extent that long-range forecasts are no longer reliable or accurate. By understanding the risk to the forecast, mitigating actions may be put in place.

4.4 Pareto analysis

When dealing with a set production schedule, as is implemented at the mine in question, it is crucial to ensure that every second of available productive time is utilised optimally. As mentioned previously, production delays and inefficiencies will greatly influence the gold production at the mine, and subsequently influence the revenue generated as well as the forecasts which are done continuously throughout the year.

A multitude of reasons for production delays and inefficiencies exist; however, a Pareto analysis will assist in determining which specific production delays are most prevalent. By focusing on the most dominant reasons for inefficiencies and delays, it may be possible to significantly reduce these delays and inefficiencies. This could be done by proactively addressing and eliminating those delays which are identified as a primary concern.

A root cause analysis is an analytical tool which is commonly used to perform a corrective and comprehensive system-based review of critical defects or bottle necks in a particular system (Joshi & Kadam, 2014:1). A root cause analysis aids in understanding the defects within a particular process which may otherwise be overlooked. A Pareto analysis is particularly useful to determine the most frequently occurring problems, and acts as a good departure point to prevent such problems in the future.

A Pareto analysis is typically adopted in situations which require analysis of pronounced imbalances (Ivančić, 2014:635). The Pareto principle adopts the concept

of the “vital few and the trivial many”, to explain and confirm the idea that a small number of causes are responsible for a large percentage of effects (Williams, 2007:50).

A key feature of a Pareto analysis, which greatly aids in a visual representation of the issue at hand, is the Pareto chart. A Pareto chart effectively depicts the frequency at which a certain problem occurs. From here, the identified problems (lost blast reasons) are arranged in a hierarchical order, starting with the problem that occurs the most. The frequencies of the identified problems are plotted on a cumulative graph, from where it is possible to determine the cumulative frequency percentage contribution of each unique lost blast reason (Ivančić, 2014:636).

It is important to note that the 80:20 principle is not a strict rule, but that the cumulative graph should be used to identify which categories have a higher frequency of occurrence than others (Ivančić, 2014:636). Figure 16 serves as an example of what a typical Pareto graph looks like and highlights how the distinction between the vital few and trivial many is made. It is clear from Figure 16 that a Pareto graph highlights the aspects of a particular problem that require immediate attention, and which may, if corrected, add the greatest amount of value in return.

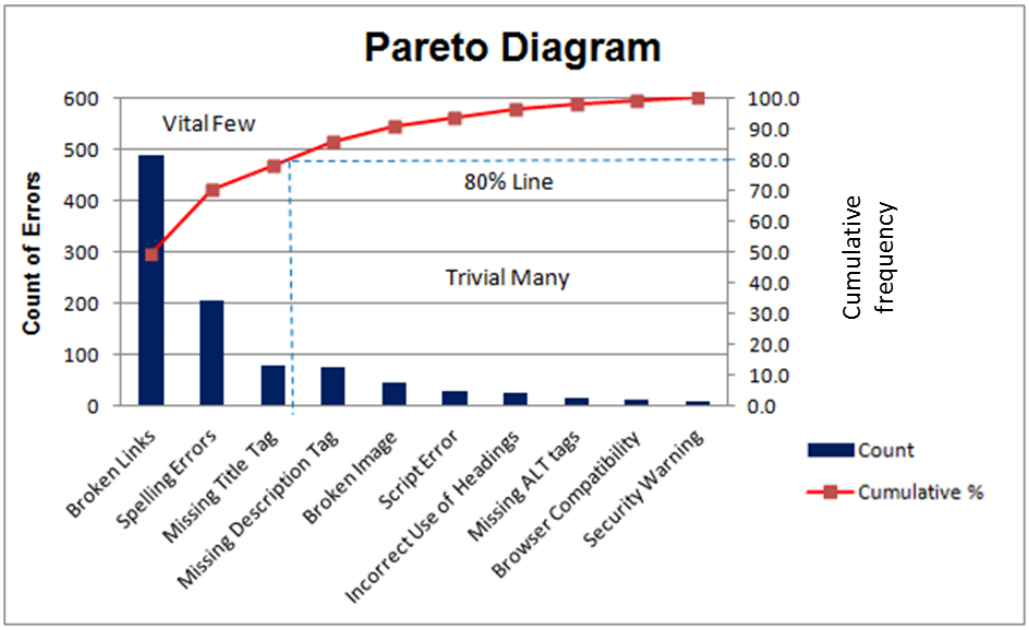


Figure 16: Example of a Pareto diagram indicating the cumulative percentage frequency of the vital few errors and how a small number of problems can collectively contribute to a significant number of inefficiencies. Source: Haughey, 2015 *(https://www.projectsmart.co.uk/pareto-analysis-step-by-step.php).*

When using a Pareto analysis to identify inefficiencies in a production environment, it is important to be able to make the distinction between effectiveness and efficiency. Effectiveness represents the extent to which planned activities and results are achieved, whereas efficiency refers to the relationship between the use of available resources and the achieved result (Ivančić, 2014:637). It is therefore crucial to ensure that the right things are done, rather than just focusing on doing things right.

Although use of a Pareto analysis has many benefits, it is important to note that a few weaknesses also exist. The Pareto principle is a static concept, which makes use of historical data and does not offer a live or dynamic view. Although it analyses different aspects of a problem and aids in identifying the main contributors to inefficiencies, it offers no potential solutions to the identified problems. Qualitative data cannot be integrated into the data set, which may result in the exclusion of valuable data. A Pareto analysis offers limited significance for small data sets (Ivančić, 2014:638-639).

The Pareto analysis ultimately aims to identify the major contributory factors to production delays and inefficiencies, from which point action plans and risk reduction strategies can be formulated (Ahmed & Ahmed, 2011:2). Adopting this principle allows the decision-making process to become more efficient, focusing on key activities, inefficiencies and value drivers (Ivančić, 2014:635).

4.5 Linear regression

When dealing with operations governed by a fixed production schedule, it is necessary to ensure the stability and reliability of the system or mining process. The reason for this is to be able to make accurate short and long-term forecasts related to production output and revenue generation. Compliance with the production plan is an essential component of this process, whereby the goal is to minimise variability to the plan, and also to be able to forecast production output with a high level of confidence.

One problem currently being faced at the mine, is the compliance with the budget plan on both a monthly and an annual basis. There are a multitude of reasons for not adhering to or achieving the budget plan, which range from production inefficiencies

(not achieving the required face advances due to lost blasts), to other reasons which may include unexpected crew moves and so forth.

As mentioned previously, not adhering to the budget plan introduces variability to the quantity of gold produced as well as the financial forecasts which are made regularly. Uncertainty regarding gold production and revenue generation can have a significant impact on the business, primarily in the form of investor confidence.

The purpose of the regression analysis is to determine whether a relationship exists between time (months of the year), and compliance with the budget plan. It is expected that in the short term, there should be reasonable compliance to the budget plan; however, as time passes (months), a decline in the compliance levels may be expected, due to various factors. The regression analysis further aims to highlight the decline in budget plan compliance as the year progresses, and to ultimately determine what level of confidence can be applied to the long-term gold production and revenue forecast as the year progresses.

Regression analysis is a statistical evaluation method which enables three things (Schneider, Hommel & Blettner, 2010:776):

Description: Regression analysis allows for the description of the statistical relationship between a dependent and an independent variable.

Estimation: Observation of the values of the independent variables allows for estimation of the dependent variable's value(s).

Prognostication: Risk factors that influence the outcome can be identified.

Various types of regression analysis exist, namely linear regression, logistic regression and cox regression. Due to the nature of the problem being assessed, linear regression was deemed to be the most appropriate analysis method.

Linear regression is used to study the relationship between a dependent variable (percentage compliance with budget plan), and an independent variable (months of the year). When conducting a regression analysis, it is critical to determine firstly whether the relationship between the variables may be linear or non-linear, as well as positive or negative (Figure 17). A simple scatter plot of the two variables often gives

a preliminary indication of the type of relationship which exists between the two variables being analysed (Schneider, Hommel & Blettner, 2010:777).

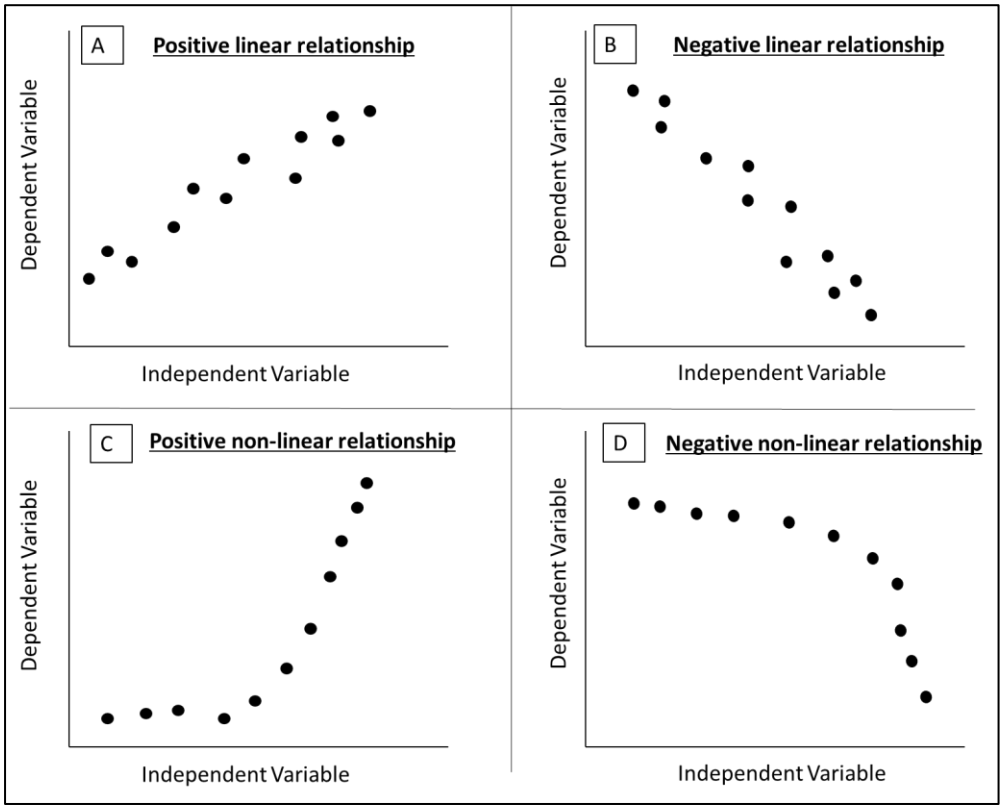


Figure 17: Simplified example of scatter plot patterns commonly observed when conducting regression analysis. A) Positive linear relationship, B) Negative linear relationship, C) Positive non-linear relationship, D) Negative non-linear relationship. Image compiled by researcher for illustrative purposes.

The dependent variable is described by a linear regression model, with a straight line that is defined by the following equation (Schneider *et al*., 2010:777; Pretorius, 2016:38):

$$y = b_0 + b_1 x \qquad \{1\}$$

Where;

y = The value of the dependent variable (% compliance with budget plan)

b_0 = the y-intercept of the line where x = 0

b_1 = the slope of the line (slope of regression)

x = the value of the independent variable (month of the year)

The parameters b_0 and b_1 of the regression line are estimated from historical values of the dependent variable y, and the independent variable x with the aid of statistical methods.

Once the values of b_0 and b_1 have been determined, the regression line will enable one to predict the value of the dependent variable y from that of the independent variable x. For example, after a linear regression has been performed, one may be able to predict or estimate the percentage compliance with the budget plan (y), based on the month of the year.

The regression coefficient (b_1) provides a measure of the contribution of the independent variable (x) towards explaining the value of the dependent variable y. If the independent variable (months of the year) is continuous, then the regression coefficient represents the change in the dependent variable per unit of change in the independent variable (Schneider *et al*., 2010:777).

It should be highlighted that the budget plan and the first month of the year, January, will always be used as a baseline to measure compliance with the budget plan, and that no adjustments to the mining plan throughout the year are considered in the regression analysis.

The correlation coefficient (r) is commonly used to determine the strength and direction of a relationship between two continuous variables, and may be interpreted in the following manner.

r = 1: Represents a perfect and monotone relationship between the two variables, meaning that for every unit of increase or decrease in the independent variable, the dependent variable will change by the equivalent amount.

r = 0: No linear or monotone relationship exists between the two variables in question. A change in one variable (independent variable) will have no influence on the value of the dependent variable.

r < 0: A negative relationship exists between the two variables. The value of the dependent variable (y) will tend to decrease as the value of the independent variable (x) increases.

r > 0: A positive relationship exists between the two variables. An increase in the value of the dependent variable (y) is commonly observed when there is an increase in the value of the independent variable (x).

Linear regression serves as a powerful statistical tool for predicting or estimating the value of a dependent variable as a function of an independent variable based on the regression line which is formulated from historical data. Linear regression analysis will prove to be useful in this regard as future compliance with the budget plan can be forecast, which in turn will enable the relevant personnel to forecast gold production and revenue with greater confidence.

4.6 Ethical considerations

The aim of this research study is to indicate the potential for losses in free cash flow sustained by the mine as a result of production inefficiencies. Preliminary financial and production forecasts could have a negative impact on the image of the operation, as well as the governing organisation, and could lead to further financial implications caused by a lack of confidence from shareholders and investors. It is required that all financial and production data remains confidential, as well as the mine's production and execution strategies.

Secondly, victimisation of individuals could follow from the results of the data analysis, particularly when continued poor production performance from a certain mining crew is identified. To prevent this, the names of individuals and their associated places of work, as well as their responsibilities, will be omitted from the report.

The ethical considerations to be followed by the researcher are:

- To obtain written permission from the relevant personnel to conduct the study.
- To not disclose the identity of individuals who assisted with data collection for the study, or those individuals who assisted with providing data for the study.
- To ensure no harm came to any individual who assisted with the study.

- All results are to be kept confidential from the public realm. All the information and data used for the purpose of the study will be stored on a password-protected personal computer.
- The intended outcome and research objectives are to be communicated effectively to the management team of the mine prior to the commencement of the study.
- The results of the study will be communicated and shared with the management of the mine by means of a presentation and a confidential copy of the research dissertation.

4.7 Conclusion

This chapter gave a broad overview of the methodology of the research study, and briefly summarised how the quantitative data which is required for this study will be obtained, and how the data will be analysed in order to answer the relevant research questions. The chapter further gave a general explanation of what a Pareto analysis and linear regression analysis involve, how these statistical evaluation methods are utilised to identify process inefficiencies, and how they may be used to predict future outcomes of a specific process.

Chapter 5 – Results

5.1 Introduction

The following chapter will introduce the results of the analysed data used for the Pareto analysis, as well as the linear regression analysis and all the additional analyses on both operational and financial performance. Chapter 4 described the methodology used to analyse the data, whereas the current chapter aims to explain the results of the data analysis. The results depicted serve as a tool to determine which factors contribute significantly to production delays, as well as the level of confidence which can be assumed for a particular budget plan. Understanding the drivers of major production delays is critical, as in many cases, these delays can be avoided or reduced if the correct work procedures and planning methods are employed. It is again stressed that understanding the causes for production delays and inefficiencies, as well as the factors which may impact free cash flow and revenue generation for this particular gold mine is critical, as the company is greatly dependant on its financial performance to meet their annual financial targets.

5.2 Pareto analysis results

The mine utilises a recording database whereby each lost blast has to be logged and documented. Over the past 5 years, spanning the period from January 2013 to December 2017, a total of 6 674 lost blasts were recorded. These accounted for 13 829.6 kg of lost gold output out of a total planned production amount of 39 622 kg (34.9% of total) of gold. Clearly this figure is significant, and it is crucial to understand what the main drivers of these delays are.

Over the time period in question, a total of 112 different reasons for not blasting were recorded; however, these 112 individual reasons can be summarised into 15 main groups. These groups and their importance are discussed individually below, from the most relevant to least relevant in the interests of clarity (Table 1).

Table 1: Description and rank of the 15 groups identified for the lost blasts which occur regularly.

Lost blast reason	Description	Rank
Safety & Environment	Safety-related stoppages by any person who deems the working place unsafe and sub-standard. Stoppages are related to safety as well as environmental conditions related to temperature and ventilation. Made by mine employees, or an official from the Department of Mineral Resources (referred to as a section 54). Work place start-up and shut down procedures required to be carried out.	1
Support	Lost blasts which occur as a result of inadequate / substandard support installation, installation of additional support, installation of support incomplete and installation of back fill support.	2
Cleaning	Lost blasts which occur when a mining panel has not been cleaned properly, or when the cleaning took longer than planned as a result of big rocks, unsafe face shapes, unplanned winch moves, incomplete cleaning by the night shift crew, or when the mining panels are blocked due to excessive rock breakage.	3
Mining	Lost blasts related to seismic events, unscheduled cleaning operations, equipping of mining sites which are behind schedule, poor blasting practices leading to undesirable face shapes and lead-lag configurations, as well as unplanned changes of working places.	4
Labour	Lost blasts which occur as a result of mining crew members who attend training, crews which arrive at the working place late and are unable to complete their tasks, crew members who stay away from work without permission, mining crews who down tools and participate in protests, as well as crews who are moved to alternative working places.	5
Equipment failure	Lost blasts which occur as a result of various equipment failures, which includes but are not limited to fans, locomotives and other engineering-related equipment, failure and breakdown of cleaning equipment and other mining-related equipment.	6
Blasting	Lost blasts which occur as a result of the centralised blasting system malfunctioning. Also refers to explosives which did not detonate (misfire) as a result of substandard explosives preparation and installation. Partial blasts are also taken when the mining face shape configuration is not to standard.	7
Services	Lost blasts as a result of water and compressed air shortages from the underground workings. These shortages are different to shortages from the shaft. Also refers to ventilation and temperature constraints as a result of inadequate fan installations.	8
Logistics	Lost blasts which occur as a result of a shortage of underground transporting equipment, blockages and breakdowns in the ore delivery system, as well as transportation constraints as a result of derailments.	9
Geology / Rock engineering	Lost blasts as a result of poor / unsafe ground conditions, rock bursts in the working places, intersection of unexpected geological features, as well as falls of ground.	10
Backfill	Refers to shortages of material used for back fill (support) operations such as holding bags, as well as actual mud supplied from the metallurgical plant.	11
Material	Refers to shortages of materials such as explosives and other relevant equipment such as replacement drill rigs and timber used for support installation in the underground excavations.	12
Main Shaft	Lost blasts which occur as a result of power failures, back fill shortages (mud), water and compressed air supply shortages within the main shaft. It also incorporates delays in transporting men and material down the shaft on time.	13
Drilling	Lost blasts due to shortages of water or air supply and breakdowns to the drill rig used in the mining operations. These shortages are as a result of constrictions within the pipes used to service the drill rigs.	14
Trackless equipment	Lost blast due to mechanical failure of trackless mining equipment.	15

Table 2 and Figures 18, 19 and 20 clearly indicate that 5 out of the 15 identified groups account for roughly 80% of the lost blasts. It also follows that roughly 80% of the gold which was planned to be mined is also delayed or lost during that production period as a result of the same lost blast reasons.

Safety stoppages, environmental conditions, support-related issues, cleaning, mining and labour-related issues attributed a total of 77.02% over the period under investigation. It should be noted that stoppages related to the above-mentioned reasons are, in most instances, avoidable as they occur as a result of sub-standard working practices or poor work planning and work execution.

Table 2: Summary table of the lost blasts as per the main groupings. Gold content not mined as a result of lost blasts also shown.

Group	Number of lost blasts	% Frequency	Cumulative % Frequency		Gold content (kg)	% Frequency	Cumulative % Frequency		Square meters	% Frequency	Cumulative % Frequency
Safety & Env.	1784.00	26.73	26.73		3866.40	27.96	27.96		39 815	28.22	28.22
Support	1165.00	17.46	44.19		2335.20	16.89	44.84		23 816	16.88	45.10
Cleaning	907.00	13.59	57.78		1981.60	14.33	59.17		20 096	14.24	59.34
Mining	809.00	12.12	69.90		1472.80	10.65	69.82		14 884	10.55	69.89
Labour	475.00	7.12	77.02		975.20	7.05	76.87		10 364	7.35	77.24
Equipment failure	443.00	6.64	83.65		973.60	7.04	83.91		9 638	6.83	84.07
Blasting	301.00	4.51	88.16		608.00	4.40	88.31		6 113	4.33	88.40
Services	289.00	4.33	92.49		555.20	4.01	92.32		6 194	4.39	92.79
Logistics	124.00	1.86	94.35		334.40	2.42	94.74		2 775	1.97	94.76
Geology / RE	127.00	1.90	96.25		194.40	1.41	96.15		2 297	1.63	96.38
Backfill	89.00	1.33	97.59		248.00	1.79	97.94		2 037	1.44	97.83
Material	86.00	1.29	98.88		144.00	1.04	98.98		1 632	1.16	98.98
Main Shaft	61.00	0.91	99.79		105.60	0.76	99.75		1 112	0.79	99.77
Drilling	13.00	0.19	99.99		33.60	0.24	99.99		296	0.21	99.98
Trackless equip.	1.00	0.01	100.00		1.60	0.01	100.00		25	0.02	100.00
Total	**6 674**		**100**		**13 829.60**		**100**		**141 094.00**		**100**

Table 2 indicates that over the 5-year period analysed, safety and environmental stoppages alone account for over a quarter of the lost blast, as well as over a quarter of the lost gold production over the same time period. The stoppages were related to unsafe working conditions, accident investigations and substandard environmental conditions in the working places where the temperature and ventilation standards were

not adhered to. Lost blasts related to support installation, cleaning operations, mining practices and procedures, as well as equipment failures, account for an additional ~50% of the total lost blasts and lost gold production over the 5-year period in question.

What is notable is that labour-related issues accounted for ~7% of lost blasts, as well as lost gold production. Although some of the labour issues can be avoided with proper work planning and scheduling, the remainder may not be as easy to control, as these labour issues relate to behavioural difficulties on the part of the employees.

Figure 18 indicates the percentage contribution to lost blasts over the 5-year period analysed for each main group as discussed in Table 1. The cumulative percentage contribution of the lost blast groups is indicated by the red line, with the black lines marking where the cumulative total is close to 80%. From here, the top contributors to lost blasts can be identified, with the red shaded block indicating those groups which are responsible for ~80% of the total lost blasts.

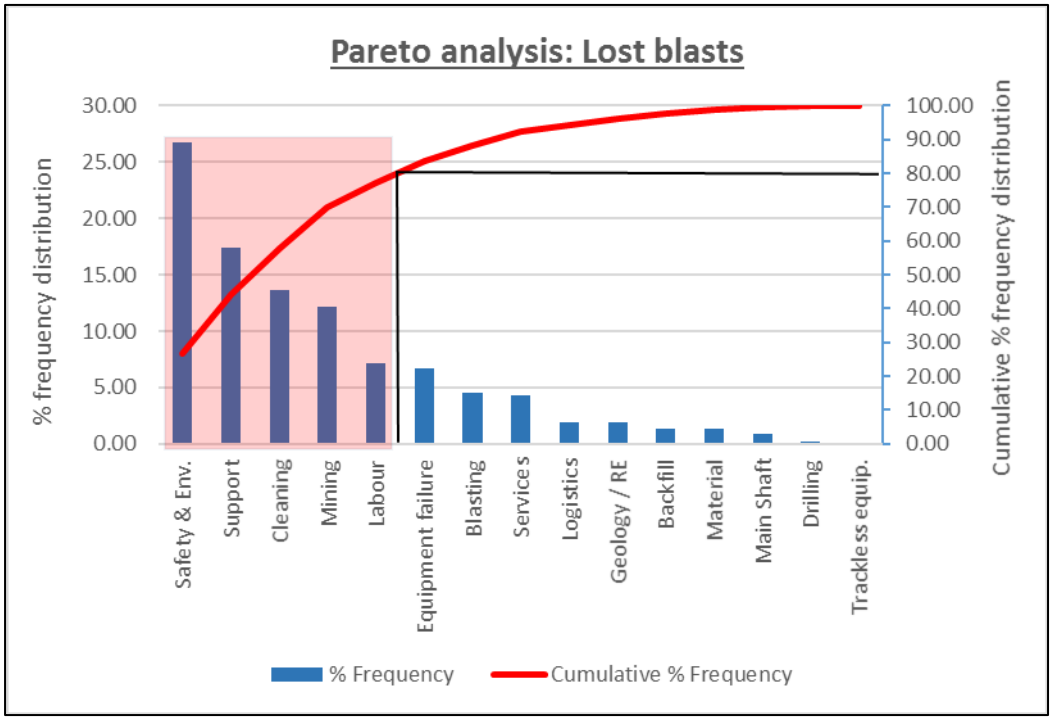


Figure 18: Pareto analysis indicating the primary contributing factors leading to lost blasts. Note that almost 80% of lost blasts are as a result of 5 out of the 15 groups.

Figure 19, on the other hand, shows the percentage of gold lost due to each lost blast group. The red line once again shows the cumulative percentage contribution of the

lost blast groups. As with Figure 18, the black line shows the cut-off point where the main contributors to lost gold production can be identified. As would be expected, the same 5 groups which contribute to lost blasts, are responsible for ~80% of lost gold production over the 5-year period analysed.

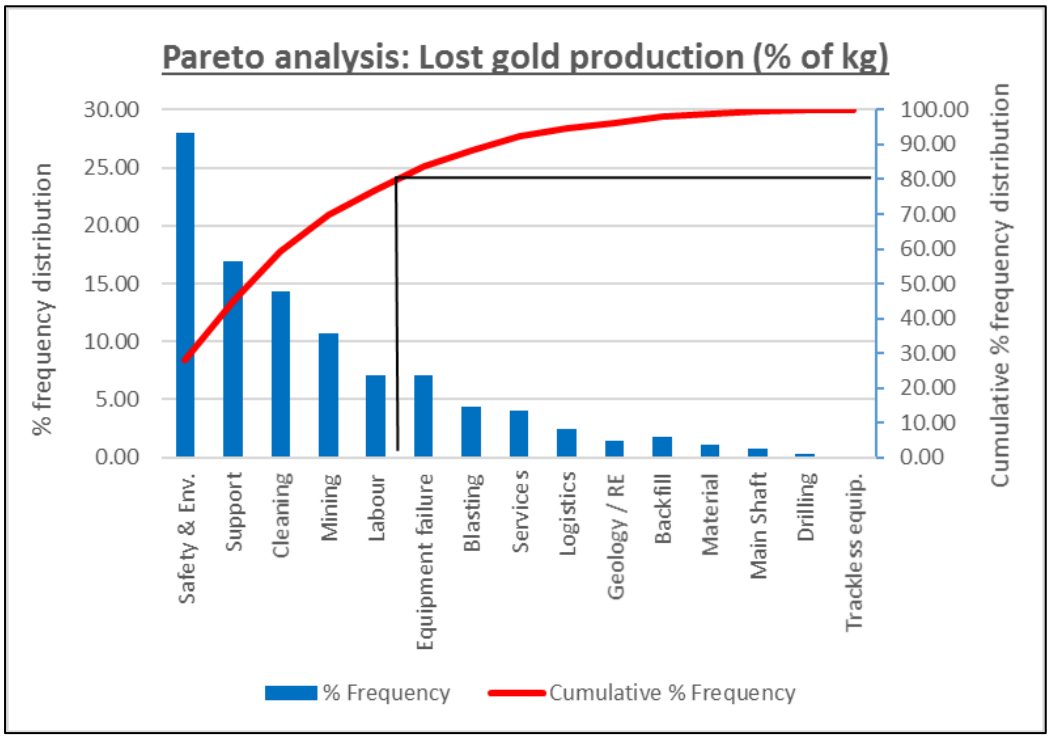


Figure 19: Pareto analysis indicating that roughly 80% of the planned gold production is delayed / lost as a result of the 5 main production delay groups identified above.

Figure 20 indicates the square metres planned to be mined which were not achieved due to the various lost blasts over the 5-year period analysed. As is expected, the top contributors for lost blasts would lead to the greatest number of square metres lost.

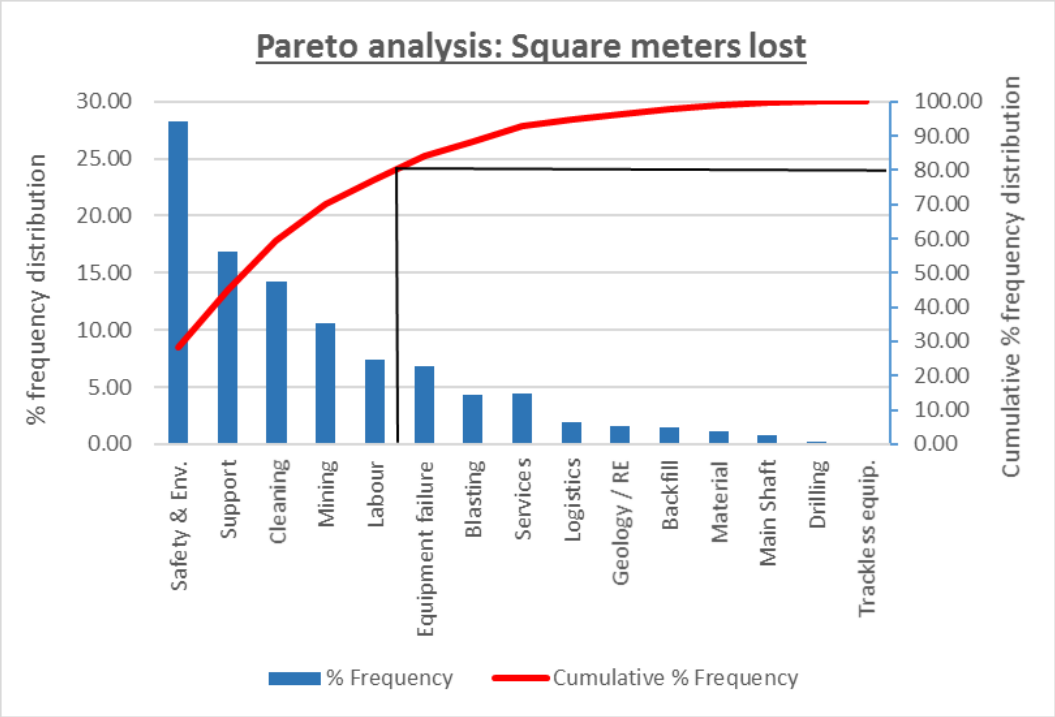


Figure 20: Pareto analysis indicating that roughly 80% of the total square metres planned to be mined were lost as a result of the 5 main production delay groups identified above.

The Pareto analysis conducted on the lost blasts proved to be valuable in the sense that it allowed for a large volume of historic data to be sorted and categorised into groups which could then be used to identify historical reasons for production inefficiencies. The analysis also aided in showing that only a handful of lost blast reasons accounted for the majority of the production delays and inefficiencies. The analysis also showed that in most instances, the lost blasts occurred due to human behaviour as well as inadequate scheduling and execution practices.

5.3 Regression analysis results

The regression analysis adopts the idea that at the start of the year, that which has actually been mined will comply closely with the budget plan, and that this compliance would decline gradually during the year as the actual mining deviates from the budget mining plan due to production delays and unforeseen circumstances which prohibit mining from taking place in the planned working areas. Figure 21 illustrates how the percentage compliance to the budget plan is calculated. The red areas represent the

planned mining areas for a particular time period, whereas the green areas represent the actual mined areas for that same time period. Only areas which overlap were used to calculate the compliance as a percentage of the total planned (budget) mining area.

Figure 21: Schematic illustration indicating how the mining compliance with the budget plan for a specific period is calculated.

Figure 22 indicates that the compliance with the budget plan on a monthly basis is rather poor throughout the year. The reason for this seems to be that very little attention is given to the agreed-upon budget plan once it has been signed off. The budget plan is completed 6 months prior to the start of its actual execution, by which time new short-term plans have been implemented, causing deviations from the budget plan. The highest monthly compliance was observed in February 2014 at 35.75%, and the lowest was observed in May 2014 at 1.28%. The average annual compliance ranged between 8.38% and 19.02%, against a target compliance of 100%, with the year 2015 having the lowest average compliance and 2017 the highest average compliance. Compliance rates this low indicate that the current planning and execution strategies are not aligned, and that considerable variability may be observed in terms of mining grade and gold production.

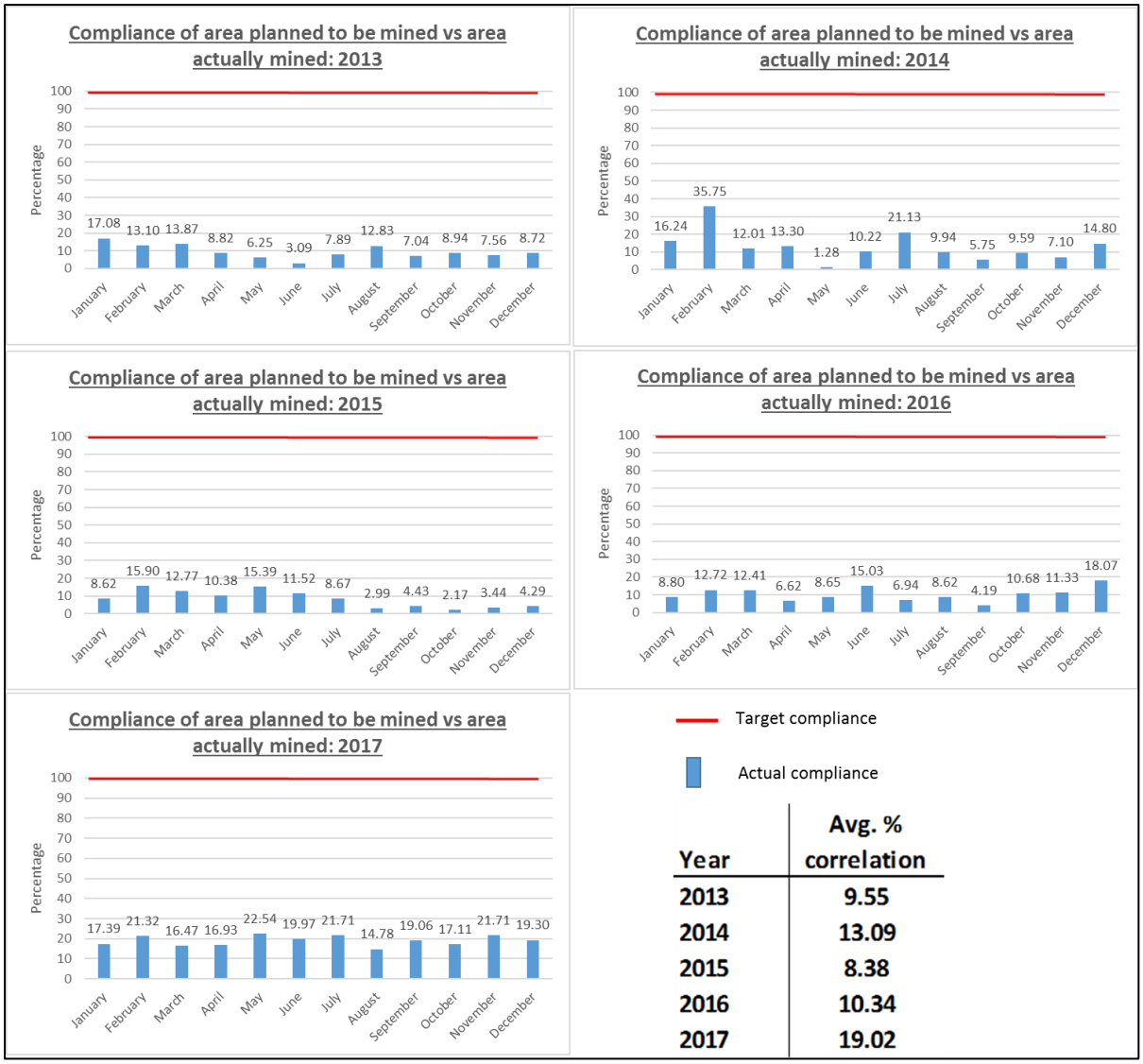


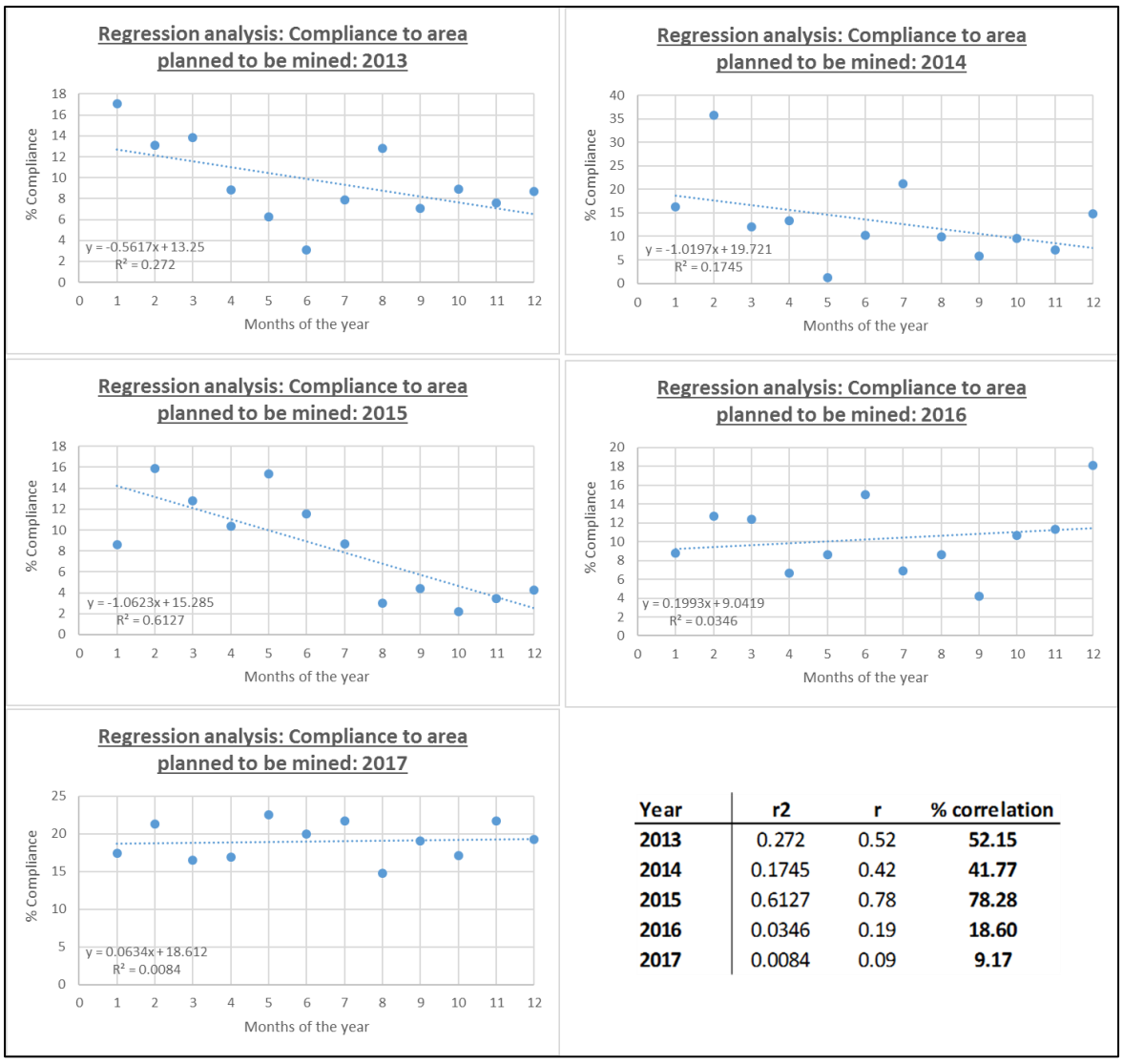
Figure 22: Bar graphs indicating the very poor monthly compliance with the budget plan over the 5-year period of interest.

The data used for the regression analysis was obtained by calculating the percentage compliance of the actual mined area to the budget plan, which outlined the area planned to be mined over a particular time period (see Chapter 4). This compliance was expressed as a percentage and was plot against the corresponding month of the year for each of the 5 years of interest. The assumption was that the percentage compliance would decline as the year progressed.

The results of the regression analysis (Figure 23) indicate that although the compliance is very low to begin with, and continues as such throughout the year, a moderate negative correlation still exists in certain cases. This implies that even

though the compliance with the budget plan is poor to begin with, it tends to regress as the year progresses. The years of 2013, 2014 and 2015 indicate moderate negative correlations, while 2016 and 2017 can be interpreted as having zero to slightly positive correlations, indicating that compliance throughout the year was stable, albeit at very low levels.

The greatest negative correlation was observed in 2015, where a negative correlation of 78.28% was observed, while 2017 saw the lowest correlation of 9.17%.



Year	r2	r	% correlation
2013	0.272	0.52	**52.15**
2014	0.1745	0.42	**41.77**
2015	0.6127	0.78	**78.28**
2016	0.0346	0.19	**18.60**
2017	0.0084	0.09	**9.17**

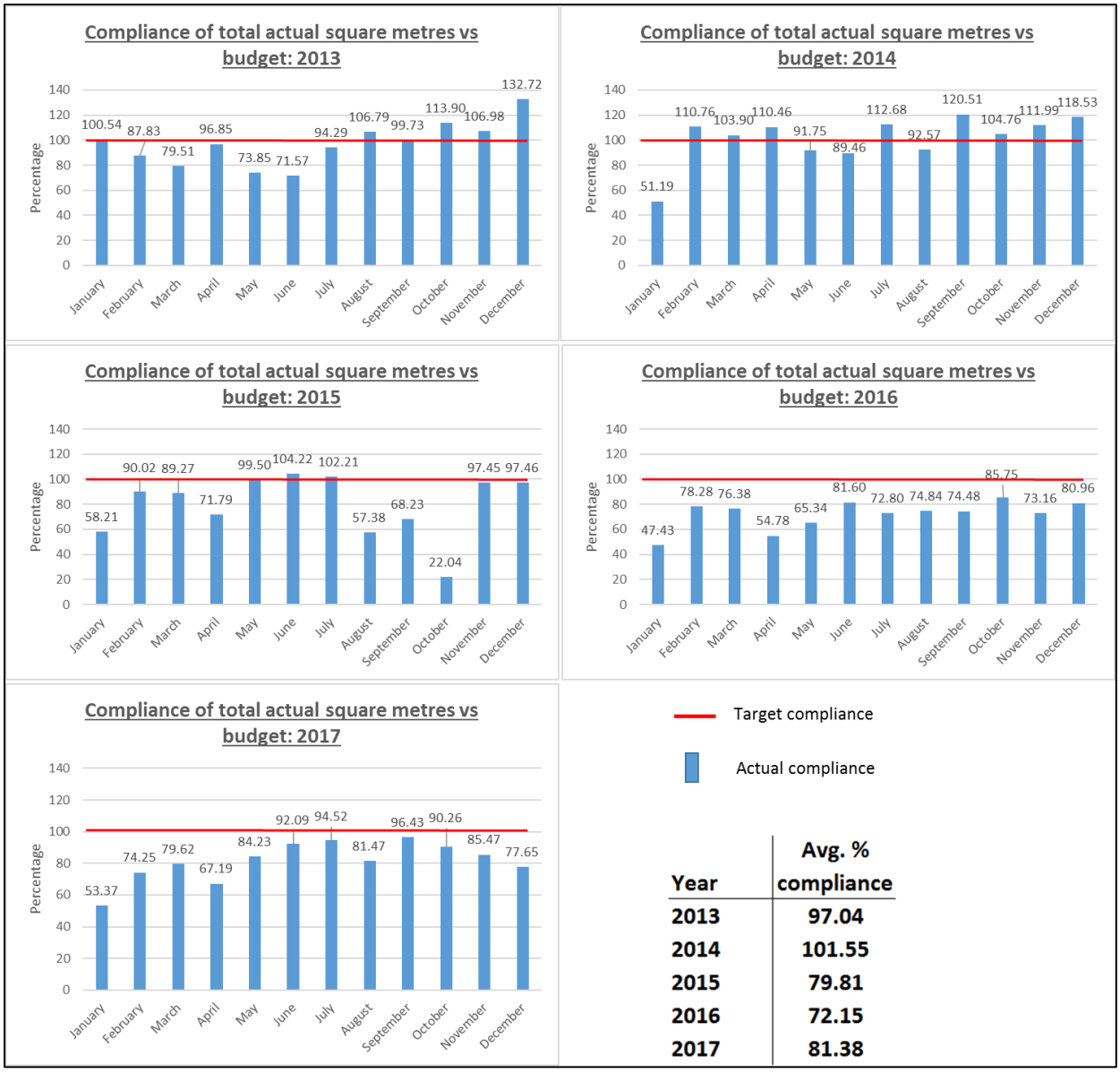
Figure 23: Results for the regression analysis over the 5-year period. Note the overall low compliance to begin with, with a gradual decline in compliance as the year progresses.

Regression analysis is a useful statistical tool for determining correlation coefficients and the causal relationship which exists between two variables. Apart from determining the strength of the correlation, it also assists in determining whether the relationship is of a positive or negative nature. In this case, the two variables of interest were the percentage compliance with the budget plan (dependent variable), and the months of the year (independent variable).

The regression analysis for this study proved useful in showing how the overall monthly compliance with the budget schedule is particularly low to begin with, and that in spite of this low compliance, it tended to regress moderately as the year progressed.

5.4 Total production compliance analysis results

Another crucial factor in reaching the planned production targets and gold output, is ensuring that the monthly and annual planned square metres of mining are achieved. It is therefore important to determine how variable the operation is in terms of monthly production regarding total square metres mined. The compliance with the budget plan in terms of total square metres mined is calculated by determining the total quantity of square metres mined (green blocks in Figure 21), regardless of location against the budget plan square metres, and expressed as a percentage. Figure 24 indicates that the production profile for the operation is generally not very stable, with significant month-on-month variability for all the years analysed.



Year	Avg. % compliance
2013	97.04
2014	101.55
2015	79.81
2016	72.15
2017	81.38

Figure 24: Monthly production compliance budget plan as a function of total square metres mined VS total square metres planned.

The highest compliance with the planned square metres was achieved in December 2013, with a compliance of 132.72%, indicating significant over-performance. This over-performance was as a result of a fairly soft target set for December 2013 leading up to an extended Christmas break. The lowest compliance was achieved in October 2015, where a compliance of 22.04% was achieved. This significant underperformance was as a result of 302 lost blasts recorded for the month, caused by an extended safety stoppage. The overall annual compliance with the budget plan

in terms of total square metres mined varied between 72.15% and 101.55%, with 2016 seeing the lowest overall compliance, and 2014 the highest.

As a general rule of thumb, in instances where the monthly compliance is below 70%, this was most often as a result of prolonged safety stoppages enforced by either the Department of Mineral Resources or the mine management.

5.5 Financial performance and gold price movement

One of the most critical variables when it comes to a mine's profitability is the gold price received per kilogram of gold sold. As part of the planning process, the corporate office determines a budget gold price for the year, which is used as the assumed gold price received per kilogram for a particular year. Based on this assumed gold price, the mine then devises their budget plan and determines how much gold would need to be produced in order to meet the financial targets set.

Unfortunately, the mining industry has no control over the gold price received, and from Figure 25 it is evident that the gold price in terms of Rand per kilogram is rather variable. The gold price received is dependent on two components, the US$ per ounce price, and the USD/ZAR exchange rate.

Table 3 below summarises the budget free cash flow (FCF) for each year analysed, compared to the actual FCF generated. Although the mine remained FCF positive over the 5-year period analysed, it is clear that on most occasions they missed their budget FCF target by a considerable margin, particularly in 2013, 2015 and 2017. The reason therefore can be observed in Table 4, which summarises the production performance, percentage of budget FCF achieved, the budget and actual gold price, as well as the total number of lost blasts for each year.

Table 3: Budget free cash flow (FCF) per year, compared to actual FCF generated.

Year	Budget FCF	Actual FCF	% Diff.
2013	R 558 525 664	R 182 347 225	-67.35
2014	R 602 418 278	R 1 012 352 164	68.04
2015	R 1 362 614 450	R 463 594 651	-65.98
2016	R 1 423 008 724	R 1 430 201 298	0.5
2017	R 1 823 277 371	R 1 256 917 320	-31.06

Table 4: Summary table of the key driving forces that influence FCF for each of the 5 years analysed.

	2013	2014	2015	2016	2017
% of production target achieved	97.04	101.55	79.81	72.15	81.38
% of budget FCF achieved	-67.35	+68.04	-65.98	+0.5	-31.06
Budget gold price R/kg	R 464 180	R 389 027	R 447 542	R 473 896	R 569 068
Received gold price R/kg	R 435 657	R 441 245	R 474 853	R 589 139	R 538 072
Lost blasts	988	1101	1946	1646	993
Red - Indicates actual was below budget Green - Indicates actual was above budget					

For 2013, the mine underperformed on their production targets, achieving only 97.04% of their planned square metres (Figure 25), as well as underperforming on their FCF targets. This underperformance was in light of a lower-than-budget received gold price in conjunction with poor production output. What is significant to note, is that in spite of the lower-than-budget gold price received for October, November and December 2013, the mine achieved an FCF greater than budget. This is due to the production over-performance in the same months (Figure 25), indicating the importance of over-performance during times of a lower-than-planned gold price.

In 2014, the mine saw a significant over-performance in terms of FCF, in spite of a high number of lost blasts for the year (Table 4). The mine achieved an FCF for the year which was 68.04% higher than the budget FCF. This financial over-performance was driven by steady production for the entire year (Figure 25), achieving a total production compliance of 101.55%, as well as a gold price which was consistently

higher than the planned gold price for the year (Figure 25). This scenario indicates how beneficial the achievement of production targets would be during times of higher-than-planned gold prices.

Despite a received gold price which was higher than the budget gold price for the entire 2015, the mine underperformed significantly in terms of FCF. The actual FCF achieved for the year was 65.98% below the budget FCF. The year 2015 is a clear indication of how a significant number of stoppages (Table 4) can have a very negative impact on FCF generation, despite the presence of favourable economic conditions such as gold price received.

In 2016, the mine achieved their FCF target, over-performing by 0.5% (Table 3). This was achieved in spite of a very poor production year, in which the mine achieved a production compliance of only 72.15% (Figure 24), which was driven by a very high number of lost blasts for the year (Table 4). The main driving force behind the success of the financial performance during this particular year is attributed to the gold price received, which was significantly higher than budget for the entire year. This scenario indicates how in certain instances the mine is reliant on a high gold price in order to achieve their financial targets.

2017 is another example of how under-performing on the compliance with budget square metres (81.38%), and a gold price lower than budget impacts the FCF generation. Production targets were not met, and coupled with a lower-than-budget gold price received, the mine once again under-performed significantly in terms of FCF generation (Table 3).

Year	Avg. Budget price	Avg. Received price
2013	R 464 180	R 435 657
2014	R 389 027	R 441 245
2015	R 447 542	R 474 853
2016	R 473 896	R 589 139
2017	R 569 068	R 538 072

Figure 25: Yearly budget gold price compared to monthly gold price received, as well as budget FCF compared with actual FCF generated monthly.

Figure 25 depicts the monthly budget FCF, alongside the actual FCF achieved, as well as the budget and actual monthly gold prices. What is evident from the data is how beneficial a higher-than-planned gold price is to achieve the budget FCF, particularly during months where the production performance is well below budget. What is also evident is how volatile the received gold price is, which once again emphasises how

crucial it is to maintain stable production output and to aim to over-perform on the production targets to ensure that the budget FCF is met on a monthly basis. The gold price is relied on far too often to offset the sub-par production performance. This is most evident for 2016, which saw the worst overall production performance for the 5 years analysed, and yet the FCF target for the year was still achieved.

5.6 Effect of non-compliance with budget plan

In terms of long-term business planning, it is vital that a budget plan is adhered to, particularly when considering the specific areas to be mined. The importance thereof is that each area planned to be mined during a particular time period contains a certain gold content, which has been estimated by means of various geostatistical techniques.

The gold production and financial forecasts are dependent on being able to accurately predict how much gold will be mined from a particular working place by considering the average mining value of the particular area, along with the planned production volumes from that same area. When the budget plan is not adhered to, the operation runs the risk of mining in areas which have a lower gold content than planned for over a specific time period.

The other alternative is that the operation may mine in areas where the gold content is significantly higher than planned, which may have an impact on the profitable life of the mine in the future. The reason for this is that during times of very low gold prices, and escalating production costs, the mine may be reliant on these high-grade areas to offset their production costs and low gold prices, by mining high-grade ore in order to remain cash flow positive. This concept is referred to as the “mining mix” and refers to the optimal ratio of high- and low-grade ore to be mined in order to ensure that the life of the mine is prolonged, whilst remaining cash flow positive.

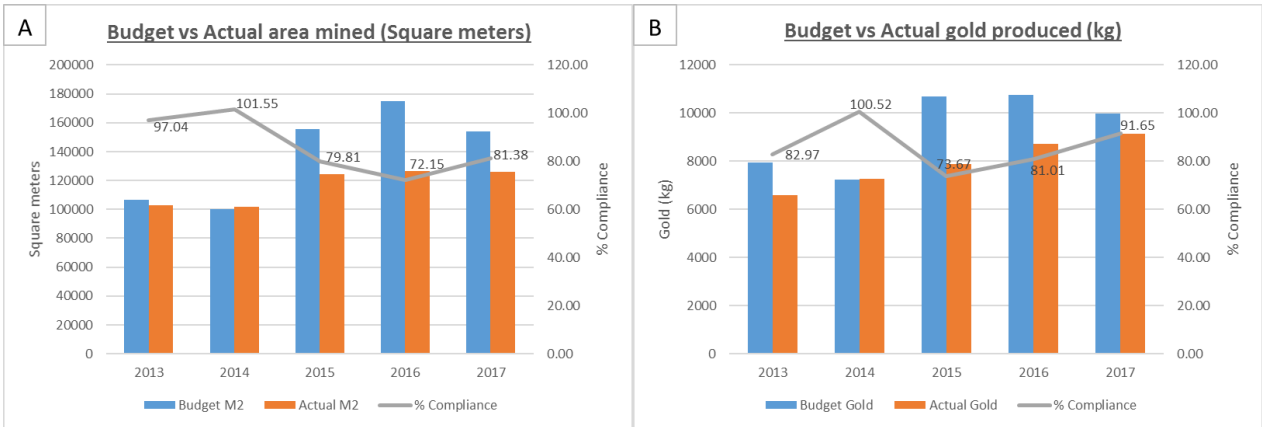


Figure 26: Comparison between the budget square metres and the mined square metres compliance A), and the budget gold produced vs the actual gold produced B).

Figure 26 is a summary diagram of the production compliance with the budget plan, along with the compliance in terms of gold produced. If the mining took place in the areas where it was originally planned, the compliance of the gold produced would have been the same as the compliance of the area mined; however, this is not the case.

The gold produced in 2013 was 82.97% of the budget amount; however, the compliance to square metres mined was higher, at 97.04%. The reason therefore is that the areas which were actually mined during 2013 had an overall lower mining value than originally budgeted for, which saw a mining value compliance of 94.71% (Figure 27). The significance thereof is that the gold production would have been higher if mining had occurred in the planned areas, which would have reduced the FCF deficit. The same trend was observed in 2015.

On the other hand, 2014, 2016 and 2017 saw gold production compliance higher than the square metre compliance, which was assisted in all three cases by a higher- than-planned mining grade for the year. The benefit of mining in areas with a higher grade, is that the gold production deficit caused by production delays is reduced, thereby improving free cash flow. However, as mentioned previously, the downside is that it may reduce the profitable life of the mine in the long term.

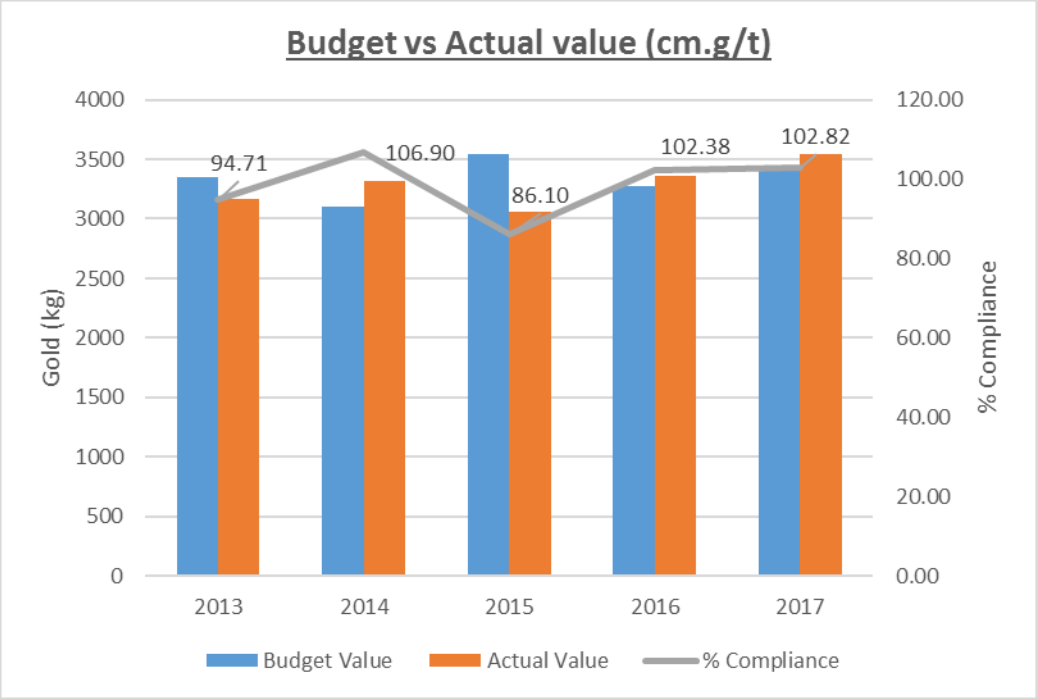


Figure 27: Compliance of actual average mining value compared to average budget mining value per year.

Figure 27 indicates to what extent the average actual mining value for the year deviated from the planned average mining value. Deviating from the planned average mining value would add further complications in terms of forecasting gold production and FCF. If the actual mining value cannot be relied upon to align with the planned mining value, this is a clear indication that mining operations are not taking place within the planned areas.

Mining in areas with a lower-than-planned value would add further pressure in terms of gold production, whereas mining in areas with higher values than planned could reduce the profitable life of the mine, because the correct ratio of low-grade to high-grade ore is not being mined.

5.7 Conclusion

The data which was analysed indicated that the majority of lost blasts which occur during a particular year can be attributed to 5 main groups, namely, safety and environmental-related issues, support related issues, cleaning operations, mining-related issues and labour issues. The five above mentioned groups account for close to 80% of all lost blasts, of which safety-related stoppages account for ~27% of these lost blasts.

The regression analysis indicated that the compliance with the budget mining areas was poor throughout the year, and that hardly any confidence can be applied to the budget plan in terms of specific mining areas and their accompanying mining value. The regression analysis further indicated that in certain instances, there is a moderate linear correlation between the months of the year and the compliance with budget plan for a specific site. This negative correlation was observed in spite of the overall low compliance to begin with.

The compliance with the budget in terms of total square metres mined was also variable throughout the year, which can be attributed to the various lost blasts which occurred on a monthly basis. In general, the monthly square metre compliance was below the target of 100%, which impacted on the amount of gold produced.

It was observed that the operation is heavily dependent on a higher-than-budget gold price in order to meet their FCF targets, and that during periods of a lower-than-planned gold price, FCF targets were not met as a result of gold price and lower-than-budget production compliance. It was also observed that in cases where the gold price was significantly higher than budget, the operation did not exploit the gold price to enhance their FCF by ensuring that production targets were met, and that lost blasts were minimised.

It was also noted that due to the poor compliance with the budget areas to be mined, the average mining value of the areas which were mined was lower than the budget mining value. This further impacted on gold production, which negatively impacted the FCF generation. On the other hand, certain years saw a higher-than-budget average mining value, which assisted in offsetting the sub-par production volumes, which in turn assisted in improving FCF.

Chapter 6 – Conclusion and recommendations

6.1 Introduction

Given the challenges the mining industry currently faces from a cost-control perspective, in terms of maintaining consistent production levels, as well as volatile and fluctuating commodity prices and currency exchange rates, it is critical to understand which aspects of the operation contribute to production inefficiencies and reduced cash flows.

The results presented in Chapter 5 have shown that the mine in question faces many challenges; particularly in terms of production output and efficient planning and execution. In the past, the mine has relied too heavily on a favourable gold price to meet their annual financial targets. The data presented in Chapter 5 has also shown that only a small number of specific issues account for the majority of the production delays, which based on the nature of the production delays, could be reduced significantly if correct planning and work compliance procedures were to be followed.

This final chapter will attempt to summarise the major empirical findings of the study, as well as provide an overview of the major findings which can be drawn from the literature review. Several limitations regarding the current study will also be put forward. Lastly, a few recommendations are provided, based on the outcome of the study, which will conclude the chapter and the study.

6.2 Limitations of the study

The study utilised historical data which had been recorded over a 5-year period, detailing the reasons for every lost blast which occurred over the period of interest. Although there are thousands of data points which were used for the data analysis, one limitation may be the accuracy and credibility thereof. Although the data is believed to be accurate and representative, it has occurred in the past that the wrong reason for a lost blast was reported in an attempt to avoid penalties or disciplinary action. That being said, the number of times that a lost blast may have been

misrepresented by the person reporting it would be negligible, therefore it would have no major impact on the outcome of the study and the conclusions drawn.

A further limitation to the study is that although the historical analysis of the lost blast data provided insight into the major causes for production delays, it would be unreasonable to assume that the same number of lost blasts would occur year-on-year. Therefore, one would not be able to say with certainty that a certain “discount” should be applied to the planned production figures based on historical trends. What the analysis of the data did was to point out the areas of concern which require attention and immediate action, which may prove to be difficult to rectify, as in most of the cases, the stoppages were as a direct result of human behaviour.

Fixing and modifying human behaviour will prove far more difficult than simply modifying a process or a system, which may prove to be another limitation of the study’s findings.

The final limitation to the study stems from the inherent variable nature of the gold price and currency exchange rates. Even though the study indicated that production output was below target in most cases, the mine still managed to stay FCF positive in all 5 years, even exceeding the FCF budget in some cases. This shows that production output is not always a true reflection of financial performance. Long-term financial forecasting should thus be reviewed and adjusted constantly as the production profile changes and the gold price fluctuates.

6.3 Major Literature Findings

Due to the nature of the current study, it proved difficult to acquire literature and previous studies similar to the one in question. An alternative approach was followed, which gave an overview of the South African mining industry, which focused on production profiles, employment figures and the sustainability of the four main sectors within the South African mining industry.

The investigation revealed that the precious metals sector, namely the gold and platinum sectors, currently faces significant challenges when it comes to ensuring a

sustainable future. Both sectors face challenges related to productivity, escalating production costs and continued labour-related issues. The investigation further revealed that the mining industry, particularly in South Africa, is a capital-intensive industry, requiring large amounts of sunk capital with significant lag periods. With these investments comes a significant risk, which fewer and fewer investors are willing to take, due to the low and ever-decreasing investment returns.

The lack of investor appetite for the mining industry has forced mining companies to secure capital funds by means of loans to remain on track with their capital projects and expansion plans. The acquired debt has placed further financial pressure on these organisations, which reduces their margins and places them even more at risk than they would already have been.

The current rates of inflation and interest within South Africa are of such a nature that investment would still be profitable; however, uncertainty regarding mining policies has undermined any remaining sliver of confidence which investors may have had in the mining industry.

Literature has revealed, however, that investor confidence can be rebuilt over time if organisations are capable of demonstrating that they can deliver consistent and stable financial results of a positive nature. Studies have shown that earnings announcements and cash flow forecasts are a strong driver of share price, and that the ability of a company to remain profitable and ensure a return for its investors in the long term has a positive effect on attracting investment.

From the literature study, it is evident that the South African mining industry will continue to face significant challenges in terms of attracting investors, particularly due to the various challenges the industry as a whole currently faces. In terms of the mine itself, the most evident challenge currently being faced is the ability to deliver stable production profiles and accurate cash flow forecasts.

6.4 Major empirical findings

The study utilised empirical data to draw conclusions regarding the major production delays, the compliance with the budget plan, as well as the level of confidence which can be applied to the budget plan. The data which was used was obtained from the mine's historical database.

The first set of data was obtained from the historical lost blast database, which was used for the Pareto analysis to determine what the major causes for production delays and inefficiencies were. The second data set, used for the regression analysis and compliance analysis, was obtained from the mine's budget plan and actual recorded production figures.

The Pareto analysis clearly indicated that most of the production delays (roughly 80%) are caused by a small number of contributing factors. These factors, in order of importance, are:

1) Safety and environmental issues
2) Support-related issues
3) Cleaning-related issues
4) Mining-related issues
5) Labour issues

What is notable from the main contributing factors identified, is that in most instances the delays and subsequent lost blasts could have been reduced or avoided altogether if proper planning and work management practices had been implemented. The five main areas of concern, listed above and discussed in more detail in Chapter 5, are all avoidable to a certain degree. Safety and environmental stoppages could be avoided if work is executed according to the prescribed safety and environmental standards and procedures.

Similarly, issues related to support installation, delays caused by cleaning inefficiencies, mining-related issues and labour-related issues could all be avoided if the required work and equipment maintenance was executed according to predetermined work and maintenance schedules.

Although there are schedules in place to govern what work needs to be done by when and by whom, there is little control over the actual execution of the schedule. In many

cases the schedules serve only as a guideline, which is often re-adjusted to cater for delays and inefficiencies.

The purpose of the regression analysis was to measure the percentage compliance with the budget plan in terms of actual area mined versus what was planned to be mined. Measuring this compliance is significant, considering that gold production and essentially cash flow is heavily dependent on which areas are mined due to the differences in gold content for each working place. Sticking to the budget plan is also critical, as all future work to be completed and scheduled for the year ahead should be done according to the mining budget plan.

The results as presented in Chapter 5 indicate that overall compliance with the budget plan on a monthly basis is very poor, and that the budget plan in terms of specific areas to be mined is hardly ever met. This implies that the monthly, three-monthly and yearly planning cycles mean very little and can be regarded as a pointless exercise, considering that the mining plan is never executed accordingly. As a result of the poor compliance with the budget plan, one can only place very low levels of confidence in the execution of the agreed-upon budget plan.

Non-compliance with the budget plan not only causes inefficiencies in the work planning and execution strategy, but it also casts doubt over the gold production and essentially the cash flow of the operation. A good example of how non-compliance to the budget plan impacts on production can be seen by reverting to the number of lost blasts which occur as a result of mining issues (12.12%). Such issues include working places which have not been properly equipped for mining, or a sudden change in the place to be mined, all of which result in lost blasts and a different gold volume than originally planned.

Deviating from the budget plan will result in a different average mining value to that which was planned, and the effects thereof are evident, particularly in 2013 and 2015, where the actual average mining value was lower than the planned budget mining value. The combined impact of lower-than-planned production volumes, as well as lower-than-planned mining values contributes significantly to the FCF of the operation, as well as the operational life of the mine. When the mining value is lower than planned, production volumes would have to be increased to ensure the correct amount of gold is mined and produced, a task which is already difficult considering the constant

production delays and inefficiencies. On the other hand, when higher-value areas are mined, it could impact the operational life of the mine. The sustainable life of an operation lies in the ability of management and effective planning procedures to ensure the average mining value is of such a nature that the right amount of gold is produced to ensure constant positive FCF over as long a period as possible. When too much high-grade material is mined in the short term, the average mining grade of the operation will decline in the long run, resulting in the operation becoming unprofitable, and in doing so, large amounts of gold may remain underground which can no longer be mined at a profit.

The impact on FCF as a result of production inefficiencies has proven to be significant in the past, as has been shown by the results presented in Chapter 5. The variance in actual FCF achieved versus budget FCF has been highly erratic. Actual FCF achieved has ranged from -67.35% to +68.98%, versus the budget FCF over the 5-year period which was analysed.

What is evident from the data presented in Chapter 5, is that the mine has been highly dependent on favourable gold prices to meet its budget FCF targets. 2014 was the only year in which the mine achieved its planned production volumes. However, the mine achieved its budget FCF targets in 2014 and again in 2016, with significant financial over-performance in 2014, driven by a combination of a received gold price which was consistently higher than budgeted, and by meeting planned production volumes. The financial performance in 2014 and 2016 clearly indicates how reliant the mine is on commodity prices to meet its budget FCF, and also how beneficial high gold prices could be to FCF when production targets are met, as was the case in 2014.

In all the other years studied (2013, 2015 and 2017) the financial targets were not met, due to a combination of poor production outputs, as well as lower-than-budgeted gold prices in certain instances. These financial underperformances are evident of how great the impact to FCF is when planned production volumes are not achieved, and how susceptible the operation is to production inefficiencies, particularly during times when exchange rates and the gold price are not favourable.

One may argue that the inability to meet the desired production and financial targets consistently would be a cause for concern, particularly in an industry which is highly dependent on investor capital to expand operations. Investors seek out opportunities

which will deliver consistent returns over both the short and long term. However, the mining industry, and particularly the gold sector, has failed to deliver any consistent results which would boost investor confidence. The mine which formed the focus of this study is no exception to this, and the argument remains that some form of intervention is required to stabilise production outputs to a level where the dependence on the gold price to meet financial targets is minimised.

6.5 Recommendations

It is clear that the impact on FCF as a result of production inefficiencies is significant, and that such threats to the operation of the mine should be mitigated at all costs. As mentioned previously, the majority of the lost blasts are avoidable. It is therefore recommended that the primary reasons for production delays be scrutinised more thoroughly to determine what human intervention, or lack thereof, contributes most to the production delays. After this, effective action plans to reduce these issues can be constructed.

In most cases, stoppages which result from unsafe working conditions or non-compliance to standards and procedures are as a direct result of human behaviour, where an individual was either unaware of the prescribed standard, or deliberately chose to not comply with the standard.

Employees are required to complete an annual induction training programme upon their return from annual leave. This could serve as the perfect platform to retrain individual employees on their specific areas of work, and the accompanying standards relevant to their job function, rather than simply providing a generalised induction which does not cover job-specific material.

Employees are required to sign and acknowledge that they have completed the induction, which in this case would serve as proof that the employee has been re-trained on the standards and procedures most relevant to him and his working environment. By doing this, employees may be less likely to deviate from standards and procedures, which may ultimately result in fewer stoppages and fewer lost blasts.

Focus should be placed on executing the agreed-upon budget plan at all costs, particularly when it comes to specific areas to be mined. The budget plan is finalised

6 months prior to it being implemented in the new financial year, and as such, all efforts should be made to ensure that the areas identified for mining are equipped ahead of time to ensure that the scheduled mining can take place as planned.

As it currently stands, mining employees are paid according to the volume of ore they mine and deliver, regardless of the quality of the ore delivered. The quality in this case refers to the grade of the ore, which ultimately relates to the amount of gold produced. One way of ensuring that the budget plan is adhered to, is to constantly compare the monthly mine planning to the original budget plan. As it stood in the past, no reference was made to the budget plan during the monthly planning sessions, nor was any effort made to align the monthly mining plan to the agreed-upon budget plan. Any compliance on a monthly basis with the budget plan was merely coincidental. It has been observed however that during the latter parts of 2017, and for the whole of 2018, a more concerted effort has been made to align monthly planning schedules and working places to the signed of budget plan.

It may be beneficial in this case to hold the mining employee who delivers the monthly mining plan accountable to the annual budget plan, and to structure their key performance indicators (KPIs) in such a way that they would focus on ensuring the monthly mining plan is aligned with the budget plan.

The operation should also structure their planning in such a way that additional workplaces are ready and waiting, should a particular working place be lost for whatever reason. By ensuring that there is a backup place to work, the affected mining crew can be transferred to the new working place with minimal preparation being required before mining can commence. This will result in fewer production delays and fewer losses in production.

It is advised that mine management also communicate these issues to the rest of the employees, as in most cases, the mine employees are not aware of how big an impact the production inefficiencies and lost blasts have on the gold production and FCF of the operation. By making everyone aware of the main causes of lost blasts, an action plan and a step-wise approach to reducing production delays can be constructed, whereby everyone from the top to the bottom can play a role in ensuring the correct work schedule is followed and executed. Awareness around the average mining grade and the effect it has on gold production and FCF should also be a priority. In many

cases, the mining personnel focus solely on delivering the required volume of ore; however, very little focus is placed on delivering the required volume at the correct gold grades. This occurrence is evident where the actual mining grade was lower than the planned mining grade, which again relates back to compliance with the budget plan.

Only once the entire operation is made aware of the leading causes of production delays, as well as the key value drivers such as grade, can effective action plans be put in place to restore the operation to a stable and profitable production environment. Once stability has returned to the operation, and the mine shows that it can consistently deliver upon its financial targets, investment to expand the operation is sure to follow.

The study has conclusively shown that a small group of problem areas encountered by the mine and the production personnel account for the majority of production delays and lost blasts. The study has also demonstrated that the compliance with the budget plan is poor, and that the current work planning and execution strategies are not effective in allowing any great deal of confidence to be applied to the budget plan and the subsequent financial forecasts. The study has also demonstrated that financial results are not always a true reflection of production results, and that a favourable gold price over-inflates the success and performance of the operation.

Focus needs to be placed on stabilising the production profile, and on working on modifying those aspects of human behaviour which cause production delays, in an attempt to reduce the dependence of financial success on a favourable gold price.

Only once the mine demonstrates the ability to meet its financial targets regardless of a favourable or unfavourable gold price will they again instil a sense of confidence among the employees and potential investors. It is critical that the leaders of the mine focus on the primary reasons for lost blasts, as identified, and that they attempt to address these issues going forward to prevent or reduce a reoccurrence of past issues which resulted in reduced FCF. Similarly, it is critical that focus be placed on executing the agreed upon mining plan so that accurate and reliable gold production and cash flow forecasts can be made.

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