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TITLE: ERRATIC ELECTRICITY POWER SUPPLY AND BUSINESS PERFORMANCE IN ZIMBABWE (2014 - 2019): CASE OF RIOZIM LIMITED

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DECLARATION

I JUSTICE CHIVANDIRE, do hereby declare that this dissertation is the result of my own investigation and research, except to the extent indicated in the Acknowledgements, References and by comments included in the body of the report, and that it has not been submitted in part or in full for any other degree to any other university.

Student Signature	**Date**
Supervisor's Signature	**Date**

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ABSTRACT

The motive for this study was to establish the impact of erratic power supply on business performance, focusing on RioZim Limited mining company in Zimbabwe. The study used Pooled Ordinary Least Squares Regression Analysis as a methodology, from a panel data of four (4) companies in the RioZim Group of companies between a period of 2014 to 2019. The companies were selected from a list of Chamber of Mines Zimbabwe mining companies in the big category to allow for generalisation. Secondary data were obtained from the public reports and internally generated reports. The results showed that power outage hours negatively impacted on business performance, while grid power consumption and alternative energy supply had a positive impact on business performance. The study recommends that government should increase power supply to the productive sector so as to reduce power outage hours and increase grid power consumption for improvement in business performance. The study also recommended that government should scrap duty on alternative energy sources, such as generators, to encourage investment in alternative energy for improvement of business performance. Lastly, related to alternative energy, mining firms should invest in alternative energy, as a power outage mitigation strategy, to improve business performance.

Key Words

Business Performance, Grid Power, Electricity, kWh, Output, Mining

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ABBREVIATIONS AND ACRONYMS

AES:	**Alternative Energy Supply**
AFDB :	**African Development Bank**
BSC:	**Balanced Score-Card**
CU:	**Capacity Utilisation**
GDP :	**Gross Domestic Product**
IPP :	**Independent Power Producer**
kWh:	**kilo-watt-hours**
MC:	**Maintenance Cost**
MEPD :	**Ministry of Energy and Power Development**
POH:	**Power Outage Hours**
SDG:	**Sustainable Development Goal**
SOE:	**State Owned Enterprise**
SWOT:	**Strength, Weakness Opportunity and Threats**
TNS:	**Tonnes**
UNDP :	**United Nations Development Program**
ZESA:	**Zimbabwe Electricity Supply Authority**
ZETDC:	**Zimbabwe Electricity Transmission and Distribution Authority Company**
ZPC :	**Zimbabwe Power Company**
ZSE :	**Zimbabwe Stock Exchange**

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Zimbabwe is experiencing acute power shortages and local firms are subjected to long hours of unscheduled power outages and load shedding. To alleviate this, some essential sectors to the economy like the mining sector are on 'ring fenced' tariff. "Ring fencing' is a contract that is entered by the power utility and the consumer within which a consumer pays a premium to have priority over other customers on power supplies. This ideally means that they will be exempt from load shedding and will have quicker turnaround time in case of faults. However, this is not always the case, as a result, many firms have invested in back-up power for internal generation by either solar, or diesel generators which invariably has an impact on the company's business performance (Ado & Josiah, 2015).

While there are different utilities or inputs to production that have an effect on business performance, like water, access to reliable power supply is important for the success of any business. Consistent power supply results in high productivity, client satisfaction, profitability and overall national economic growth. Unreliable supply of electricity imposes huge direct costs on the firm. These costs include, *inter alia*, equipment damages[1], raw materials spoilage, and loss of productive man-hours, forgone sales, reduced profits and management attention (Ado & Josiah, 2015). Other costs include opportunity costs of idle resources like labour, land and capital (Centolella, 2006). There are also indirect costs which include costs on other firms that are supplied by the impacted firm, usually called the spill over effect; costs on consumers if the impacted firm supplies a final good, as well as health and safety related expenses.

RIOZIM Limited is a publicly listed mining firm comprising of a group of mines namely, Cam and Motar, Renco, and Dalny gold mines as well as base metal processing at Empress Nickel refinery, and a diamond mine operating as Murowa Diamonds. RioZim has endured erratic power supplies since 2014 and the consequences of such have not been explicitly assessed. Therefore, this study

[1] Damages include, burnt electrical equipment such as electric motors and transformers, spoilage of work in progress

seeks to investigate the impact of erratic electricity power supply on business performance for RioZim Limited. The study will make use of cross-sectional data for the period 2014 to 2019 and will employ pooled ordinary least squares estimation technique.

1.2 BACKGROUND TO THE STUDY

Uninterrupted electrical power supplies are believed to have a positive impact on economic activities. This brings to the fore the importance of quantum and quality of electricity supply to the economic performance of firms. Lack of power leads to inhibited economic growth. The availability of reliable electric power would undeniably spur economic growth by bringing down the cost at which industries conduct their daily operations (Somefun, 2015).

Even at macro level, unreliable electricity power supply system poses severe challenges to the socio-economic and political structure of an economy. Some of these challenges manifest in the loss of welfare, pressure on governments by citizenry and industry, and loss of output among others (Oseni and Pollit, 2013).

Globally, the impact of erratic power supply is topical and effects are being felt. Seymour (2012) alludes to the fact that in the United States of America alone, industrial and digital business firms are losing US$45.7 billion per year due to power interruptions. Across all business sectors, an estimated US$104 billion to US$164 billion is lost due to interruptions with another US$15 billion to US$24 billion all due to power quality problems (*ibid).*

Power supply is a key factor in the life of plant and equipment. It impacts negatively on the manufacturing, productivity and growth. Critically, it affects the reliability and availability of equipment as they are controlled with many electronic components and parts assembled together and largely depends on the stability of power supply to them (Ibikunle & Adebayo, 2012). Power supply quality is therefore an important determinant of production.

The absence of reliable electricity or power supply and the recurrent power cuts cause severe economic damage. The cost of alternatives specifically for firms, mainly diesel generators, is at minimum four times the cost of a reliable grid power supply (Adam Smith International, 2014).
This direct cost has negative impact on the specific firm's performance. This can mean the time spent accessing alternatives, or the time is lost because some firms cannot carry on their relative activities in the night (Adam Smith International, 2014).

According to the International Monetary Fund (IMF) in the World Economic Outlook (WEO, 2014), nearly two-thirds of Africans , representing more than 620 million people, do not have access to electricity, and for those that do have access, they are facing high prices for an unreliable supply with frequent power outages. International Renewable Energy Agency (IRENA) puts the effects of scheduled blackouts and random power outages, on economic losses as varying annually from 1% to 5% of the Gross Domestic Product (GDPs) of the countries (IRENA, 2015). The United Nations Development Program (UNDP), through the Sustainable Development Goal Number 7 (SDGs – Number 7)[2] puts 1 in 7 people as lacking electricity in developing world (UNDP, 2020). Electricity access rate for African countries at just over 40 percent, the lowest in the world (AFDB, 2020). The deficit and access to energy also extends to industry and is attributed to a certain extend to the need for autonomy and going green by relying on clean energy sources like solar , wind and geothermal.

The Chamber of Mines (2019) reported that production for the first quarter of 2019 of all key minerals had recorded a decline of more than 10% compared to the same period in 2018 due to unreliable power. Mining operations require uninterrupted power because they operate round the clock. Across industry, be it manufacturing, mining or telecommunications are all facing the effects of erratic power supplies. According to Techzim (2019), telecommunications firms in Zimbabwe expressed that the operating environment was becoming untenable and uneconomical for them to guarantee quality service to its subscribers owing to power supplies unreliability. Zimbabwe faces load shedding of up to 16 hours on a daily basis as a result of a deficit in power generation (Makonese, 2016) and is worsening in the current to medium term. Coupled with power shortage in the region, the situation is expected to deteriorate in the outlook. It therefore means that businesses are forced to spend additional funds to procure backup energy for the effective and efficient running and survival of their businesses.

[2]SDG number 7 – Sustainable and Clean Energy

Zimbabwe's electricity sector, that is generation, transmission and distribution are controlled by Zimbabwe Electricity Supply Authority, a state owned enterprise (SOE) under the Ministry of Energy and Power Development (MEPD).Zimbabwe has an internal or domestic generation mix of thermal and hydro-electricity that is from coal and hydro (water) plants, as shown in Figure1. There are also Independent Power Producers (IPPs) who feed into the grid. The internal generation does not meet the national demand, so in order to augment the supply, ZESA imports power from the neighbouring countries. The local generation ability is constrained by lack of spares, maintenance, vandalism and antiquated equipment. Paradoxically, due to contractual obligations, ZESA exports a substantial amount of power to Namibia's' power utility NAMPOWER.

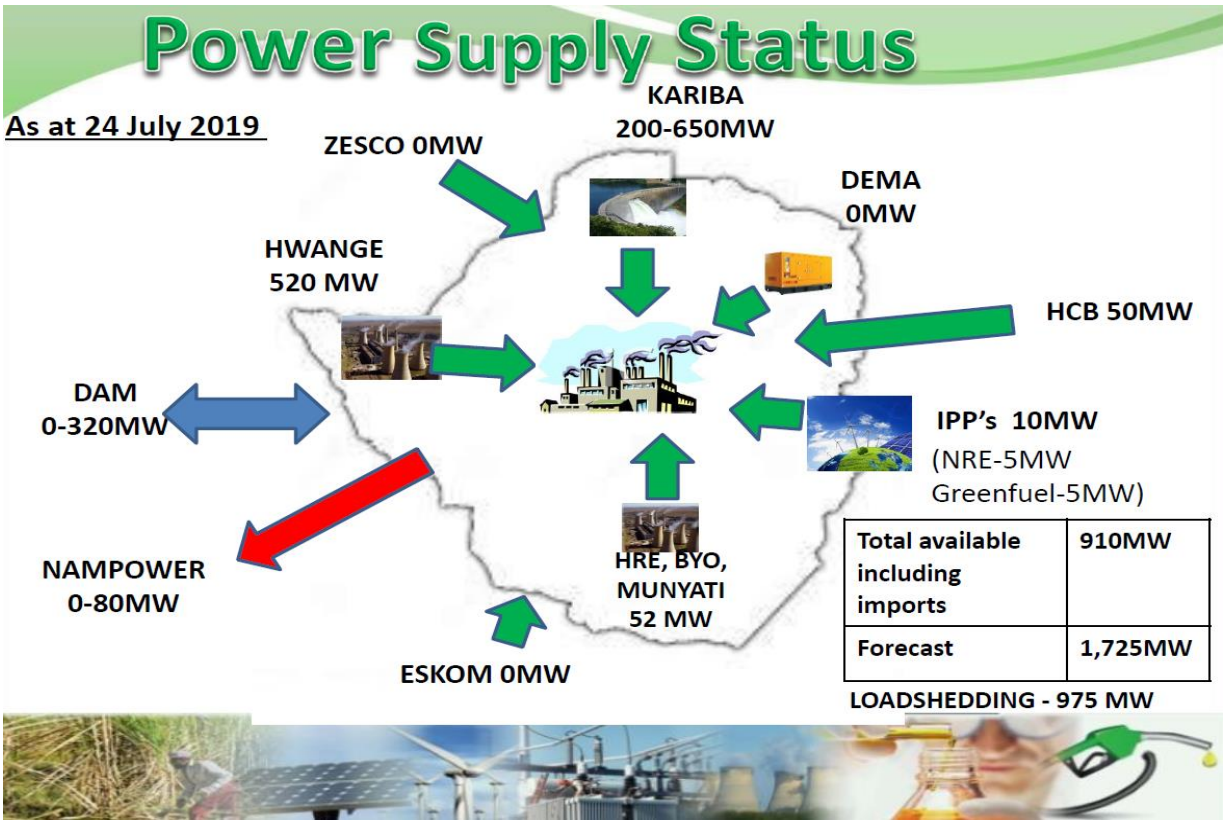

Figure 1: Power Supply Status

Source: https://www.czi.co.zw/resources/Regulating for Sustainable Energy Presented by Eng. Misheck Siyakatshana -ZERA

As shown in Figure 1, Zimbabwe has suffered a huge power deficit owing to depressed internal generation and minimum imports from traditional suppliers. In total, installed capacity is 2 270MW but available capacity has been about 430MW owing to breakdowns at Hwange, Munyati and Bulawayo thermal stations, Kariba has also been affected by low water levels in the Zambezi River (ZPC, 2019) caused by the drought. The drought resulted in reduced inflows into Lake Kariba, thereby causing water levels to drop to risky levels. This then prompted the Zambezi River Authority, which administers affairs of the dam, to cut water allocation for power generation at Kariba South, and North operated by Zambia, which shares the dam with Zimbabwe. This gap between generation and demand has resulted in load shedding that has impacted industry.

Zimbabwe will suffer longer and more frequent power shortages for the next 10 years (Rusvingo, 2014), The Ministry of Energy and Power Development project that by about 2022 is when the country will be able to generate enough electricity for domestic and industrial needs. The trend of in generation has continued to decline for the past 10 years as shown in Figure 2.

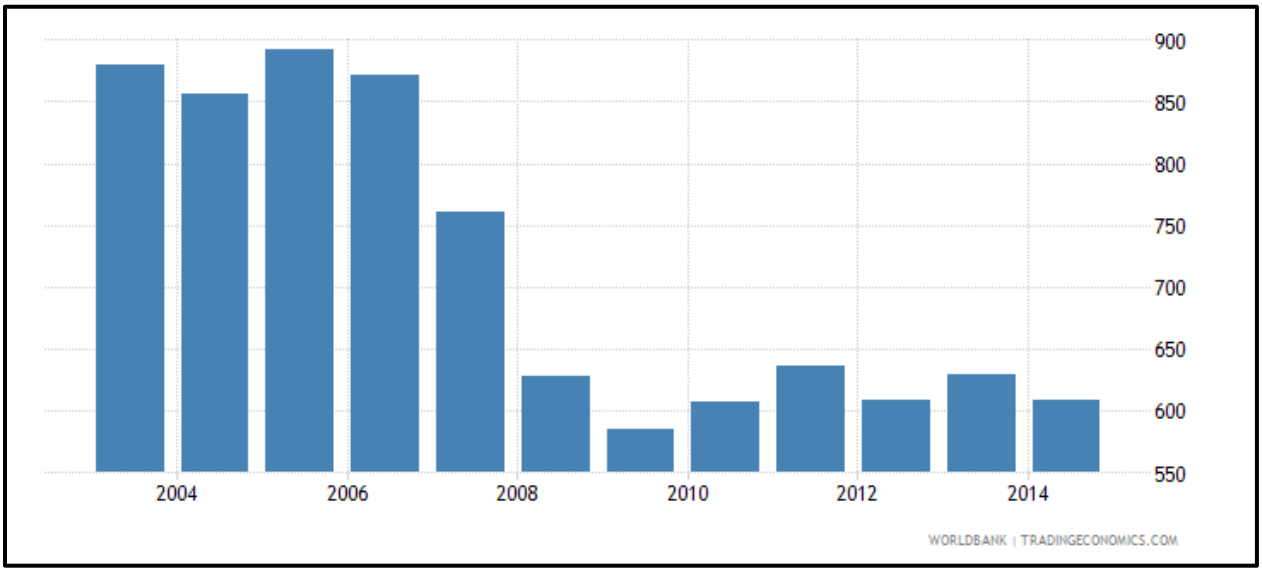

Figure 2: Electric power consumption (kWh per capita) in Zimbabwe

Source: World Bank

Figure 2 illustrates the decline in generation measured by a proxy of Electric power consumption per capita (kWh Per Capita)[3].The gradual decline in power generation, coupled with minimal power imports, has resulted in massive, in many cases unscheduled load shedding. Companies often resort to self-generation, which often is costly to run as compared to mains grid supply. For example, from Murowa Diamond's cost accounting, it costs US$0.09 per unit[4] compared to US$0.31 per unit of running on diesel generator.

Low electricity power system reliability results in faults owing to antiquated and obsolete infrastructure and general lack of maintenance. This in turn, results in unplanned power cuts resulting in unplanned equipment shutdown in industry. These unplanned shutdowns end up in breakdowns, spoilage of products, long and costly start-up processes which then impact negatively on business performance. The electricity interruptions or fluctuations have had varying effects on businesses including, but not limited to, instantaneous damage to semi-finished goods, associated costs incurred in repairing equipment and losses accrued from delayed or cancelled orders (Doe & Asamoah, 2014).

Unreliable electricity supply can be a threat to business performance in terms of productivity, investment growth, competitiveness which manifests itself poorly in the following key business performance indicators such as, plant availability, unit cost, maintenance cost, profitability and capacity utilization. Chamber of Mines Zimbabwe (2018), reported that the power situation remained the biggest challenge during the year 2018, under review with the mining industry subjected to unscheduled power outages. Zimbabwe is facing a debilitating power crisis, resulting in power cuts that last hours on end disrupting smooth flow of production and forces firms like RioZim to use expensive alternatives.

It is by no means that the power outages in Zimbabwe have had serious catastrophic effects on many areas of the general economy. In the health sector human lives have been lost due to life-support system failures. Hospitals and nursing homes have suffered losses, and companies have collapsed, all due to consistent power failures. Co-ordination facilities such as airports and aviation, and traffic

[3]kWh Per Capita - measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants.

[4]Unit is kWh , Source of Figures US$0.09 and US$0.31 is ZETDC Invoice and Murowa Cost Accounting Reports 2019

controls have also suffered. It is against this background that this study seeks to investigate the effects of erratic power supply on business performance for RioZim Limited.

1.2.1 Background to RioZim Limited

RioZim Limited was incorporated far back in 1956 as Rio Tinto Southern Rhodesia Ltd. RioZim then separated from Rio Tinto plc in 2004. It became a wholly owned Zimbabwean company that produces gold, coal, diamonds and toll refines nickel and copper. It operates four (4) mines in different geographical locations (Murowa Diamonds-Midlands, Renco Mine–Masvingo, Dalny as well as Cam and Motor mines in Mashonaland West Province) as show in the operations map in Figure 3.

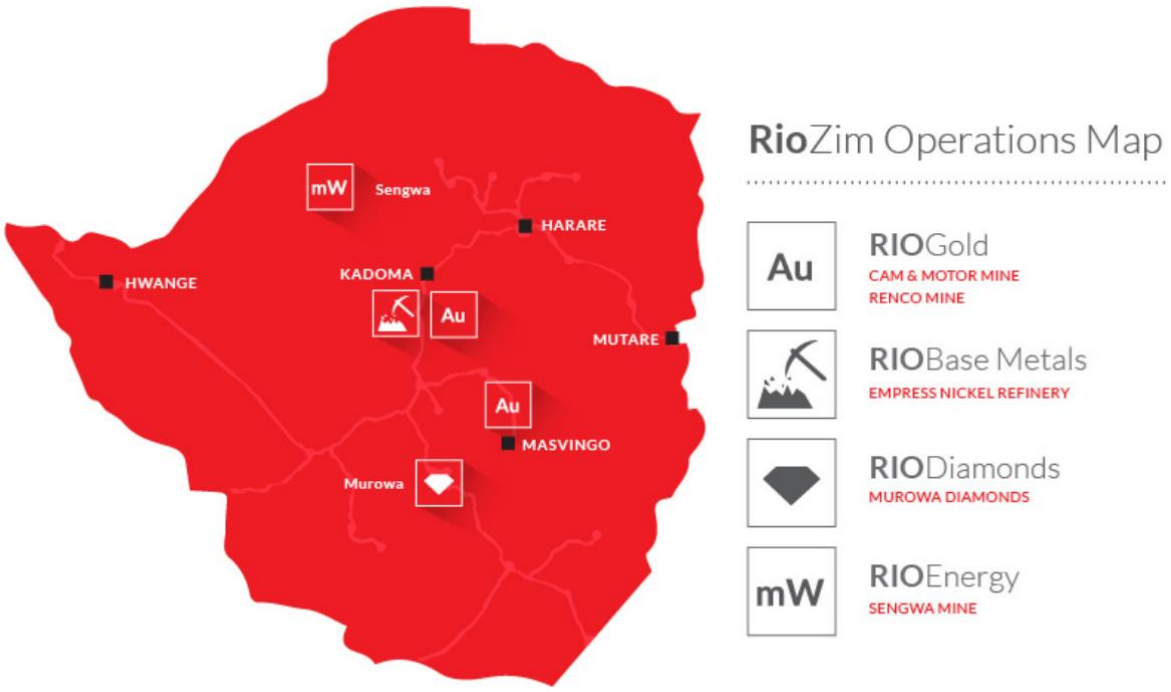

Figure 3: RioZim Limited Operations Map

Source: RioZim Limited Website – www.riozim.co.zw/?page_id=456

The firm is listed on the Zimbabwe Stock Exchange (ZSE). Since its separation from Rio Tinto plc, RioZim Limited has embarked on a number of transformational changes which included the launch of a new vision, mission and value statements as well as having some of its operations certified for

quality and adherence to world class standards in occupational health, safety and environmental management.

RioZim Limited has faced a number of operational challenges emanating from the obtaining macro-economic environment. The challenges include shortage of electricity power. Incessant power cuts have significantly affected production for RioZim Limited. As a direct result of these power cuts, the Group recorded a decrease in its production by 8% to 962kgs from 1 050kgs achieved in the comparative period in 2018 (RioZim, 2019). For the group, Dalny Mine and Murowa Diamond's business units experienced acute power cuts in the second quarter of 2019 which was exacerbated by the peak winter demand which only afforded an average of 4-6 hours of plant running time per day.
To mitigate the impact of power on business performance, RioZim Limited has invested power back-up diesel generators. It costs US$0.31/kWh to run a diesel generator compared to US$0.09/kWh running power utility supplies to run a mine of Murowa Diamonds' Scale[5]. This is impacting working capital, maintenance and expansion capital expenditure and the bottom line.*(ibid)*
Further to that, in trying reduce the negative impact of power challenges, RioZim is embarking on two major strategic energy projects; the Solar Power Project and the Sengwa Thermal Power Project in order to generate its own electricity. This will ensure uninterrupted power supply for the company and excess for national consumption. According to the Chief Executive Officer (CEO), the solar project is now on a feasibility study to start construction of a 178 megawatt solar power plants in a joint venture with the Chinese. According to RioZim (2019) the construction of solar power stations, to be built in different locations that will provide power to the group's mining operations namely Renco mine, Cam and Motor and Dalny Mine will help ameliorate the crippling power crisis battering the entire economy.

According to the RioZim Chairman, acute power outages pose significant risk to its energy intensive operations into the future. Even though the Company was paying for uninterrupted power supply in United States Dollars, the Group has continued to experience intermittent load shedding.

[5]Murowa Diamonds cost accounting for running a combined 2MVA & 1.6MVA back-up diesel generators at 80% loading

1.3 PROBLEM STATEMENT

Many mines in Zimbabwe are facing operational challenges partly attributed to unstable power supply. RioZim Limited has invested in self-generation using diesel generators while others have gone to the extent of looking at other alternatives like using solar energy. Mining is a heavy user of electricity and use of alternative power sources of supply like generators and solar is not sustainable due to high setup and running costs. In addition, alternative arrangements of having mining companies pay for power usage in foreign currency is costly and does not guarantee supply. Attempts to pay for power usage using foreign currency has failed to improve supply which negatively impacted on production (Chamber of Mines, 2019).

Further to that, some mines are willing to incur further costs by assisting the power utility by resources like spares, labour, and machinery, in case of faults. This would be in a bid to mitigate costs associated with prolonged power outages. This is the challenge that RioZim Limited together with other mines are confronted with.

Power outage costs have dire consequences on the operations of RioZim Limited. Firstly, power outages disrupt operations and result in increased unit costs when alternative energy sources are used. For example, it costs around US$0.31 per kWh to produce a kilowatt hour of energy when running diesel powered generators as opposed to US$0.09 per kWh when using grid power. The surge in the cost of energy will ultimately eat into profits thus adversely affecting mine operations. Other non-financial costs and risks that are associated with recurrent power interruptions include healthy and safety risk to employees as they will have to be constantly interacting with high to high and medium voltages which in normal circumstances does not need to be that frequent.

1.4 RESEARCH AIM AND OBJECTIVES

The main aim of this study was to investigate the impact of erratic electricity power supply on business performance in Zimbabwe, with a special focus on RioZim Limited for the period 2014 to 2019.

1.4.1 Specific Objectives

The objectives of the study are:

- To investigate the impact of Power outage time (hours) on output produced.
- To determine the impact of alternative energy (Diesel Generator) supply on output produced.
- To determine the impact of amount of Grid power consumed on output produced.

1.5 MAJOR RESEARCH QUESTION

What is the impact of erratic electricity power supply on business performance on a mining firm?

1.5.1 Specific Research Questions

- To what extent does power outage time (hours) impact on output of a mining business?
- How does alternative energy (Diesel Generator) supply impact on output of a mining business?
- How does the amount of Grid power consumed impact on output of a mining business?

1.6 HYPOTHESES

1.6.1 Overall Hypothesis

Erratic power supply negatively impacts business performance on mining business.

1.6.2 Specific Hypotheses

- Power outage time (hours) have a negative impact on output of a mining business.
- Alternative energy (Diesel generator) supplies have a positive impact on output of a mining business.
- Grid power consumed has a positive impact on output on a mining business.

1.7 JUSTIFICATION OF THE STUDY

There is a gap in terms of research on the full impact of erratic power supplies on business performance of mines in Zimbabwe. Studies have focused on other sectors of the economy like SMEs, and this has been mostly done in Western African countries like Ghana and Nigeria. An attempt on the study in Zimbabwe on focused on load shedding yet load shedding is only an element of erratic power supplies. Little has been studied on the impact of alternative energy supplies on business performance but yet it is a common adopted strategy in business.

1.7.1 Practical Contribution

The study will contribute to the body of literature on the impact of erratic power supply on business performance. In addition, the study may proffer policy prescriptions to mitigate against effects of erratic power supply, if study findings confirm so. It also seeks further to recommend to RioZim Limited and the mining sector at large what it can do to contribute optimally to the GDP.
The direct and indirect benefits of this study may be a positive to business performance which in turn translates to the achievement of the bottom line and a favourable working environment.

1.7.2 Theoretical Contribution

Most previous studies on the effects of erratic power supplies have focused on SMEs and load shedding. Load shedding is a part of a broader subject of erratic power supplies. The survival strategies focused on, India and western Africa. There is very little research in this topical area in the southern part of Africa let alone Zimbabwe yet it is where the issues of erratic power supply quality and quantity are most prevalent. This study will, benefit the academia and future researchers interested in the same area of power supply fidelity and its effect on business performance. This will therefore add to the body of knowledge on technology adoption frameworks.

It is the researcher's belief that gaps that would have been left by this research study can be explored by future studies.

1.7.3 Methodological Contribution

The investigation into the impact of erratic power supplies impact on business performance will be conducted through pooled ordinary least squares. The research strategy and methods will take into consideration the case study of RioZim with the aim of replicating and generalizing the results to the wider mining industry in Zimbabwe. Moreover this study methodology is associated with greater levels of validity due to the systematic selection of independent, and dependent variables.

Use of deductive approach will establish a cause and effect relationship which can be tested through quantitative research strategy that produces credible and objective results for drawing informed conclusions. Experience gained from the research methodology will be useful for future studies.

1.8 SCOPE OF RESEARCH/DELIMITATION OF STUDY

The study focuses on RioZim Limited as a case study. The study will focus on secondary data to be collected from RioZim mining sites. The study will employ pooled ordinary least squares techniques as this approach is suitable to deal with time series of cross-sectional data.

1.9 DISSERTATION OUTLINE

The dissertation will consist of five (5) Chapters. Chapter one (1) comprises of the introduction of research study, study background, research problem, aim and objectives, research questions, hypothesis, significance of research and scope of research delimitations and limitations of research.

Chapter two (2) will constitute review of related literature .This will serve as the foundation of the research study and motivates own thought process and work of researcher. Chapter three (3) is the research methodology. This will highlight research design; where the study will be done, data collection techniques, population and sample size, tools for data collection, analytical techniques and ethical issues.

Chapter four (4) will focus on Data analysis, findings and discussion and Chapter five (5) then summarizes the research experience and level of achievement of research aim and objectives. Chapter

five (5) also contains the conclusion and recommendations generated thereof. There will also be suggestions of areas of further research.

1.10 CHAPTER ONE SUMMARY

Chapter One introduced the research topic and was structured as in the following description; the study background section highlighted the impact of erratic power supplies on business performance from a historical perspective. It is in the same chapter that the problem statement was highlighted, as illustrated by the obtaining situation regarding the impact of erratic power supply on business performance. The subsequent subtopics which are research objectives, research questions, the scope of research, the rationale or significance of the research and the hypothesis were deduced from the research problem. Finally there is a program in the form of dissertation outline. The researcher also went on to raise the justification of conducting the study by highlighting and identifying the research gap and then justified how the study will help fill in this gap.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This literature review section analyses existing contributions by other researchers and authors on how erratic power supply affects business performance. It is in chapter that the researcher will explore and review related literature on the dependent and independent variables associated with the research area. Further to that, this chapter will outline the theories underpinning this study. Related studies will also be reviewed and analysed in order to come up with a conceptual framework that shows the relationship between erratic power supply and business performance.

2.2 THEORIES UNDERPINNING THE STUDY

To fully understand and study the impact of power supply on business performance, the study is going to be anchored on two theories *viz*, Balanced Scorecard (BSC) Model and the SWOT Matrix Analysis. A discussion and critique of the individual theories followed by synthesis of the two theories will highlight the discussion**.**

2.2.1 Balanced Scorecard (BSC) Model

Developed in 1992 by R.S Kaplan and D.P Norton, the Balanced Scorecard framework is an integrated system that is used to measure and monitor business performance. The system looks and integrates four perspectives namely finance, internal processes, learning and growth as well as customers. The anchoring point of these perspectives is the business vision and strategy. According to Esposito (2007), the Balanced Scorecard focuses on future performance and at the same time measuring current performance.

The study on the impact of erratic power supplies on business performance can be approached from a Balanced Scorecard model. The model translates a company's strategy into specific measurable objectives and targets, both short and long term. It also identifies lagging and leading indicators and transforms strategy into action and establishes internal and external controls. All this culminates in

the ultimate perspective of financial performance which is central to the existence of a firm. This then creates a cause and effect relationship, which is key to business performance.

According to Gamal & Soemantri (2017), the Balanced Scorecard (BSC) model is used as a measurement tool in order to measure an organisation's performance in both public and sectors to achieve the key business strategies and objectives. They further give evidence that Balanced Scorecard (BSC) can be formally seen as a multidimensional approach to measure the management performance through examining relationship between the organisational strategies and operational performances.

It is in the same vein that the impact of erratic power supply on business performance as it applies to RioZim can be approached from Balanced Scorecard, from a performance assessment perspective. This will provide a framework to operational teams supported by objectives, targets, initiatives and corrective actions to be taken.

The Balanced Scorecard (BSC) is used widely as an advanced model of strategic orientation of organizations. It is in use in 54 per cent of the 1,230 well known global firms (Gamal & Soemantri, 2017). These global firms hinge their success on worker participation. Participation by all levels of employees especially the workers is key to organisational success. One of the main goals of Balanced Scorecard (BSC) is to create a participation and communication of the vision and strategic objectives of a company.

However, the Balanced Score Card (BSC) model is based on an assumed cause-and-effect relationship which may be problematic. Nørreklit, Kure and Trenca (2018), argued that there is a problem of covariation versus causality. For example, in the Balanced Score Card (BSC) model, Kaplan and Norton (1992) assume the presence of a cause-and-effect relationship between customer satisfaction and loyalty, and between loyalty and financial outcomes. In contrast, empirical findings portray a substantial amount of covariation between the factors; not causality. Put simply, some variables of power supply and business performance in this study might tend to go together but it may not be established that they cause each other.

In addition, to the problem of assumed cause-and–effect relationship, the BSC also has a problem of implementation. The BSC has been seen to disregard any form of implementation problems which is

not possible in the real world. Although implementation considerations are part of the model (Kaplan and Norton, 1996a), the downward cascading of managerial information is a much more challenging and questionable process than anticipated by the BSC model, which may likely lead to dysfunctional organizational behaviour and the subsequent loss of strategic control.

2.2.2 SWOT Matrix

Strategic planning is done by most organisations in today's business world. It is a way to help an organisation be more productive by helping guide the allocation of resources in order to achieve goals (Gürel &Emet, 2017). A business in existence ought to have systems that enable it to sustain its existence and competitive advantage. Business should continuously scan and appraise their environment using and summarise the issues with tools like PESTEL (Political Economic Social Technological Environment and Legal) and SWOT (Strength Weaknesses Opportunities and Threats) analysis framework.

Sabbaghi and Vaidyanathan (2004) argue that strengths define any internal assets like expertise, motivation, technology, finance and business model that will help to meet demands and to fight off threats. Weaknesses describe internal deficits such as lack of motivation, or more closely related to this study, lack of back-up generation facilities that hinder the organization from meeting its demands. Sabbaghi and Vaidyanathan, (2004), went on further to postulate opportunities as any external circumstances or trends that favour the demand for an organization's specific competence. These for example are what changes in economic, political, or technological factors. In this particular study, the rapid research, growth and availability of new technology in solar can be taken as an opportunity by electricity consumers, mines included. On the other hand, threats define any external circumstances will unfavourably influence an organisations performance, in this particular case erratic power supply is a threat to business performance.

SWOT analysis is suitable for the study of erratic power supply and business performance due to its holistic approach in nature. According to the System Approach philosophy, organizations are wholes. They are in constant interaction with their environments and consist of various sub-systems. In this sense, an organization exists in two environments, one being in itself and the other being outside Gürel and Emet (2017). It is essential to analyse these environments for strategic management

practices. SWOT Analysis fits other theories and strategic decision tools like the BSC and thus can be used for such a multi-dimensional study.

Whilst SWOT analysis can be useful for the study of erratic power supply and business performance, it cannot be used in isolation. Gürel & Emet (2017), King, (2004), suggest the need to employ additional analysis instead of SWOT or using it in conjunction with other techniques. Complimentary analysis techniques used to formulate SWOT based strategies can be viewed as Kaplan and Norton's Balanced Score Card. SWOT Analysis has a general perspective as an approach and present general solutions. SWOT Analysis was established in the times when the environmental conditions were static (King, 2004). For this reason, it is not a valid technique in today's volatile environment based on change and competition. Dynamic and structural alterations at the level of system, sub-system, and super system affect the strength and validity of entries in a SWOT Matrix. The main advantage of using SWOT analysis is that it is a popular method used by organizations for strategic management and marketing. According to Gürel and Emet (2017) it is a tried-and-true tool of strategic analysis, which makes benchmarking easier across industry.

2.2.3 Synthesis of the two Frameworks

Synthesising the SWOT matrix framework together with the balanced scorecard (BSC) makes a systematic, holistic and integrated strategic management system. An integrated approach of BSC and SWOT also allows qualitative indicators to be considered (Korableva & Kalimullina, 2016). This makes optimising of decision-making process by organisations. By first applying SWOT analysis and developing a set of strategies will serve as a basis and stepping stone towards the actual implementation of the balanced scorecard.

An assessment of the SWOT and Balanced Scorecard frameworks or models shows a link between the two in that both frameworks are anchored on a systematic way of monitoring, achieving and to a certain extent sustaining business performance. It is from SWOT analysis that strengths, weaknesses, opportunities and threats are identified and analysed. It is from the output of the SWOT analysis that Key Performance Indicators (KPIs) can be set and monitored as prescribed in the Balanced Scorecard

(BSC) model. Alignment of these KPIs to the business processes will in turn, result in good business performance.

2.3 RELATED LITERATURE AND STUDIES REVIEW

All business activities, especially industrial units, require constant and consistent flow of electricity. Literature on how unreliable electricity impacts business, despite firm size, location or management performance exists. The approach for this section is that, firstly, a systematic review of the literature on how erratic power supply and business performance interact with each other will be reviewed, and thereafter a thematic approach on the objectives and variables, is going to be examined.

The problems and challenges hampering operations of SMEs in developing countries is more prevalent in Sub-Saharan African countries and some parts of the Middle-East Forkuoh & Li (2015). Studies, by objectives have focused on Small to Medium Enterprises (SMEs) on their research studies on the impact of erratic power supplies on business performance as illustrated in the discussions below.

Research studies that assess the effect of power outages include those from West Africa, Nigeria in particular. Ado & Josiah (2015) as well as Frederick & Selase (2014), focused their research studies on the impact of electricity supply fluctuations on the operational performance of small scale business in Nigeria. They came to a conclusion that inadequate and unreliable supply of electricity impacts negatively on business performance. Nurudeen, Nafiu and Jibo (2018) studied the influence of unreliable power supply on economic contribution and performance of SMEs in Dekina Local government of Kogi State, Nigeria. They concluded that unreliable electricity supplies negatively affect the capacity utilization of the said firms.

Results from both Ado & Josiah (2015) as well as Nurudeen *et al.* (2018)'s studies found out that interrupted power supply negatively affects firm performance. However, these results cannot be generalised for RioZim mines due to heterogeneity issues that are primarily centred on differences in geographic location and nature of business.

Kamara (2017) also investigated how electricity supply influenced the performance of small and medium scale enterprises in Sierra Leone. He came to a conclusion that with stable power supply

there was an improvement in the business activities of small and medium scale enterprises which resulted in more jobs being created and competitiveness on the global market.

In a related research study, Braimah & Amponsah (2012) studied the causal and effect relationship between frequent and unpredictable electricity outages on the operations of small scale industries in Kumasi, Ghana. They came to a conclusion that uninterrupted electricity supply was vital for the effectiveness of small scale industries as they required constant supplies of electricity for their operations. In the same country, Nyanzu & Adarkwah (2016), investigated the effect of power supply on the performance of Small and Medium Size Enterprises whilst doing a comparative analysis between SMEs in different regions of the same country, Ghana. They came to a conclusion that there is a significant relationship between power supply and firm performance which converges with the conclusion of Braimah & Amponsah (2012).

In a broader perspective, Cole *et al.* (2018) looked at power disruptions in relation to firm performance in Sub-Saharan Africa with the main objective of looking at the marketing side of things in which they assessed the extent to which power outages affect the sales of manufacturing firms across Africa. They found out that power outages have a significant impact on firm sales for firms without generators but find no effect for firms with generators. The latter result differs from that of Ado and Josiah (2015) and Kamara (2017). There are possibilities that power outages may not adversely affect power generation in the presence of mitigatory measures.

In other studies, which generally show the impact of unreliable power supplies, Aliyu, Ramli and Saleh (2013), Kaseke & Hosking (2013) found a negative effect on the industrial sector and agricultural sectors and the ultimate effect on economic performance of a nation. The effects were the same across the sectors.

Several researchers have employed various methodologies to try and find the impact of erratic power supplies on business performance and to try and estimate the cost associated with power interruptions. For instance, Kwabala (2015) and Li & Forkuoh (2015) used both quantitative and qualitative approaches. In a study closely related to this research, Kwabala employed descriptive research design using a case study approach. Ado & Josiah (2015) used a quantitative approach applying a random

sampling technique from the population of the Small to Medium Enterprises (SMEs) and a structured questionnaire to obtain primary data.

In another study, Frederick & Selase (2014) deployed a mixed method approach to investigate the causal relationship between power fluctuations, profitability and competitiveness of SMEs for the gathering and analysis of data. Frederick and Selase used a multi-sampling method to obtain the study sample. They initially, applied purposive sampling technique to select all SMEs that used electricity as a key resource and then systematically sampled within the chosen group. They used descriptive analysis such as percentages, mean, frequency standard deviation to represent data and inferential analysis using regression analysis.

Nyanzu & Adarkwah (2016), approached the study from a quantitative approach perspective, situating the study into a positivist philosophy. Secondary data from the World Bank Enterprise Survey of 2013 of Ghana was used, and then they applied stratified random sampling for the enterprise surveys.

In terms of data analysis Ado & Josiah (2015) used simple bivariate regression analysis whilst Li & Forkuoh, (2015), used econometrics' structural equation model. Cole *et al*. (2018) used regression analysis whereas researchers Nyanzu & Adarkwah did the analysis using chi-square and t-test to do pattern analysis, additionally; they used ordinary least square regression analysis (OLS) from two approaches, the comparative analysis and the regression analysis. Frederick & Selase (2014), used a correlational analysis to analyse the data collected in the study on the effect of electric power fluctuations on the profitability and competitiveness of SMEs.

Some researchers have used various techniques to estimate the cost associated with electricity power interruptions. For example, Castro *et al*. (2016; 2018) refer to input and production costs as increased by running generators. As the society gets more dependent on continuous electricity supply, the impacts of disruptions in the service yield significant economic losses for all customer segments (Kufeoglu & Lehtonen, 2016). For business, the impacts of disruptions come up indirectly or manifest as operating costs. These costs are an invisible tariff that the client pays to the power utility which

then impacts directly and indirectly on business performance as the impacted firm's products become less competitive and they lose market share and goodwill.

Some studies have been carried out in various parts of the world, and the effects have been found to be of varying magnitude depending on location. Arinaitwe (2006), George and Oseni, (2012) in separate studies compared results in developed and developing world. There was convergence in the results in that the impact was more severe in the developing world owing to lack of investment in energy infrastructure and weak government policies towards public infrastructure development.

George & Oseni (2012) and Kufeoglu & Lehtonen, (2016) agree that erratic power supplies impact negatively on business performance. They also point out the adverse ripple effect at the macro-economic level. At a firm's micro economic level, the effect is seen on higher per unit costs of production and subsequently reduced profitability of a firm.

Frederick & Selase (2014), bring out in their research an on-going analysis of the relationship between the energy sector and economic development. There is an inferred relationship between reliable energy supply and profitability and competitiveness of firms. The study also confers the mediating role played by the government through the prompt responding to measures that foster a conducive environment for provision of reliable power supplies.

Not only is there a relationship of reliable power supplies to competitiveness and profitability, a relationship also exists in the growth and development of a business enterprise. There is a convergence in studies that have shown the existence of a relationship between reliable electricity supply and economic development (George & Oseni; 2012; Frederick & Selase, 2014).

As demonstrated above, there is a general agreement among scholars that erratic power supplies have a negative impact on business performance regardless of the size of the firm or the nature of industry. However, there is need to establish if these result hold true for RioZim in order to ensure sustainable good business performance of the mining entity. There are other factors that positively or negatively impact business performance, of which these can be further areas of research.

Not only is power quality and availability a factor in business performance, it is also a factor in investment choices, business firms respond to unreliable supply of electricity in a variety of ways which include choice of business, choice of location, output reduction, factor substitution and self-generation, (Ado & Josiah, 2015).

This study aims to contribute to a strand of the literature that focuses on the effect of electrical energy reliability on firm performance. Despite the fact that much has been written on isolated studies mostly, in SMEs and manufacturing sector, more is yet to be revealed with regard to erratic power supply impact on business performance, with regards to the mining sector.

2.4 THEORETICAL REVIEW OF VARIABLES

The review of the variables will be guided by the objectives by way of focusing on each variable as it relates to the research area of erratic power supply and business performance, following a thematic fashion. The current study seeks to explain the cause and effect relationship between independent variables which are power outage time (hours), (a combination of grid faults and load shedding power cuts), grid energy consumption and alternative power supply (in form of the cost running a Diesel Generator) and the dependent variable being Business Performance. Business performance will be quantified using unit cost, profitability, capacity utilization and maintenance cost and production output measured in tonnes, metrics.

2.4.1 Business Performance

Business performance can be defined in terms of measures on firm growth rate. Ponikvar, Tajnikar and Pušnik (2009), speak of business performance in terms of the metrics of profitability, capacity utilisation, per unit costs, current assets, and solvency, as well as production out. These can also be applied as variables in this study. It can be further viewed in terms of revenue per employee, average costs, labour costs, capital costs, liquidity and productivity. Performance of a business is a function of technology, corporate governance, financing and availability of market for its finished products. Performance also relies on other utilities like electrical power supply and water. Electricity is a key enabler to productivity which translates to good business performance (Zinyama & Tinarwo, 2015).

A reliable supply of utilities like water and energy, like electricity, coal and fuel usually results in firms performing better than those that face unreliable utilities hence good business performance. Majanga, (2015) alludes that firms that face unstable utilities charge higher prices to the products making them expensive so as to enable them to recover their operating costs thereby decreasing their revenues.

2.4.1.1 Profitability

The *raison d'être* of any company is to earn money in the form of profit from its operations (Hirschey & Bentzen, 2016). This comes in the form of earning returns from the investments created within the business and assists in maintaining a healthy balance sheet. Business viability as a result of liquidity and profitability is crucial for firms to survive and increase growth over a long period (Kumar & Reddy, 2013). Cost is an input in determining profit by any business. Profit is only realizable if cost of production is less than revenue generated. Reliable electricity supply results in improvement and effectiveness of processes and resource efficiency through economies of scale, elimination of waste of energy and water, which eventually lead to growth in financial performance that is profitability (Ionascu *et al*, 2017).

To some degree of contrast some researchers are of the view that poor electricity supply generally may not always impact negatively on firms' output. Chissokho & Seck (2013), revealed a positive impact of electricity outages on some selected manufacturing firms in Senegal. The researchers attributed this trend to proper management of resources and over reliance on electricity during those periods

2.4.1.2 Capacity Utilisation

Capacity utilization can be defined as a ratio of the actual level of output to a sustainable maximum level of output, which is usually the capacity of a firm (Corrado & Mattey, 2002). In industry, electricity and other factors affect the level of capacity at which firms operate. This is because equipment will be idle when there is no power. Oseni & Pollitt (2013) posit that the poor state of electricity infrastructure hence erratic supplies has been a threat to firms' productivity, which then

results in firms having excess capacity. More often the assets and equipment will be idle waiting for electricity to be restored which then translates to low capacity utilisation. Arnold *et al.* (2008) and Escribano *et al.* (2009) also concede that unreliable electricity supply owing to bad infrastructure significantly reduced firms' total factor productivity. Capacity utilisation can be linked to business performance in that fixed costs are spread over the available capacity and any change in the capacity also results in changes in profit of a business entity.

2.4.1.3 Unit Cost

In business accounting, unit cost can be seen as total expenditure incurred by a firm along its value chain as it produces a good. Value chain includes producing, storing, and selling of one unit of a particular product or service. Power supply in the industry is key at every stage of the value chain and as such its reliability has a bearing on the costs associated with the production of such a product or service. Kamara, (2017) provides evidence that unreliable supply of electricity imposes huge costs on a firm. These costs include but are not limited to feedstock and raw material spoilage equipment damages and loss of productive man-hours with workers lying idle. These are direct costs which push up the cost per unit metric. Indirect cost, the firm will suffer loss of goodwill as it fails to satisfy its customers through disruption of production.

Kamara (2017) agrees with Ado & Josiah (2015) that as a strategy of limiting the costs of unreliable or inadequate power supply, companies tend to invest in back up facilities to generate own electricity. They both assert that self-generation of electricity is more costly to invest say for solar and to run with diesel generators and it generally costs more than the grid supplied electricity. In contrast, though depended on scale of operation and tariff regime, Allcott *et al*. (2016) found out some SMEs are reducing their operating cost by shifting production to off-peak hours where tariffs are low.

2.4.1.4 Maintenance Costs

Plant or equipment maintenance costs or expenses are the costs incurred to keep the plant or equipment in good condition and working order. Industry prefers to have scheduled maintenance which often is as a result of steady supply of inputs to a production unit (Igba *et al.,* 2014) Erratic

power supplies result in an unsteady production cycle which often results in unplanned equipment stoppages which may damage equipment.

Equipment damage costs are costs that are incurred to repair or replace both mechanical and electrical components of equipment that is damaged as a result of electrical power disturbance (Castro, Faias and Esteves, 2016). A wide variety of equipment damage occurs as a result of outages and voltage disturbances. This affects business performance in that the maintenance cost goes up as there is usually a high rate of parts replacement which is not budgeted for. Erratic power supplies lead to adhoc or corrective/ breakdown maintenance practices which are expensive as opposed to planned maintenance which is systematic and orderly.

2.4.1.5 Output Produced

Mining business performance can be measured using various financial and non-financial metrics which are under management's control. Specific to mining, McKinsey & Company,(2015) posit that these metrics include capital invested, labour utilisation , the quantum of production output measured in tonnes processed . Mining companies typically measure the output of the actual tonnes ore being mined, (Rehbach *et al.,* 2015).

Abeberese, (2017) measured Indian firms performance using output produced across various industries as a business performance proxy in his study of Electricity Cost and firm performance. The findings of this paper suggest that electricity constraints contribute to the observed negative growth pattern and firm output. RioZim Limited in its annual report uses both financial and production output as a measure of business performance.

2.4.2 Erratic Power Supply

Erratic or unreliable power supply has been the main potential contributor to the large productivity gap between developed and developing countries. By definition, Somefum (2015) views erratic electric power supply as a situation during which electric power supply is not stable, not regular in pattern, supply is unpredictable or better still said to be unreliable. Power supply can be viewed from

a system dependability perspective. System dependability or reliability in Electrical Power Systems may be broken down into two parts namely system adequacy and system security. System security is related to the response of the system no matter what disturbances it is subjected to or its resilience. System adequacy has to do with the ability to meeting load demand. A system that is adequate is free from load curtailment or shedding *(ibid).*

Electricity power supply reliability has grown into an important public policy issue due to the massive costs being borne by electricity consumers due to unreliable and inadequate electric power supply. Ensuring electricity power supply reliability has also occupied significant space in investment and operating decisions DOE, (2003).

Poor power supply quality impacts negatively business performance as business require a consistent input of quality power supply to realise economies of scale thereby bringing its costs of production low and thereby increasing its profit.

Firms have acknowledged the unreliability of the electricity power supply as one of their main obstacles to productivity, Cole et al. (2018).This has as a result seen an upsurge in the demand for relatively expensive back-up electricity generation to the degree that firm-owned electricity generators now characterize a significant share of the installed capacity in the productive sector in order to mitigate its negative impact *(ibid).*

2.4.2.1 Power Outage Time (Hours) (POH)

Power outage time, measured in hours is the time that a productive unit is not producing owing to a power cut. Power cuts are usually as a result of load shedding and grid faults. These shall be examined in detail as below.

2.4.2.1.1 Grid faults

Grid faults are usually as a result of technical distribution network failures, emanating from bad weather, or system component failures which result in loss or poor quality of power (ZESA, 2019). Power utilities should take actions designed to make the grid more robust and resilient to grid faults and failure of transmission and distribution equipment, for example wind resistant steel or concrete poles rather than wood poles. Most distribution network in Zimbabwe comprises of wooden poles

which are very susceptible to weather, fire and rodent attack which renders the network very unstable especially in the rainy season. Diboma & Tatietse (2013), provide evidence that unreliable supply of electricity emanating mainly from faults leads to an increase in business costs thereby limiting businesses' prosperity.

2.4.2.1.2 Load Shedding

Load shedding can be viewed as an organised form of electricity outages which are instituted when demand outstrips supply of electrical energy, which is different from faults, however in many occasions; it is random and sporadic, resulting in costly unplanned stoppages. This then impacts negatively on production processes and results in costly damage to equipment and work in progress (Eto, Divan & Brumsickle 2004). Fisher-Vanden *et al.* (2015) provide evidence that load shedding or increasing electricity scarcity raised the unit production cost for Chinese firms by 8% from 1999 to 2004.

2.4.3 Alternative Energy Supply

Businesses without back-up power generation can incur a lot of costs and loss in revenue each year due to downtime because of a power outage[6]. Firms that do not have access to sufficient electricity have lower output or sales compared to those with sufficient electricity, while firms that own or have access to standby generators do better than their counterparts without a generator. It is in that regard that firms resort to alternative power supply like the commercial off grid solar and biomass energy and back -up generators.

Business corporations react to unreliable supply of electricity in a variety of techniques which include choice of business, location, output reduction, factor substitution and self-generation Adenikinju, (2005). Self-generation has been the most widely embraced strategy. Firms invest in back up capacity to generate their own electricity during power outage Adenikinju, (2005).

[6] Evidence from DieselServiceandSupply.com, a company that deals in generators.

Work has been done on alternative or backup self-generation as it applies to business. Steinbuks & Foster (2010) hold that erratic power supply impacts firms in various sectors and as such firms invest in self-generation to mitigate the impact of power outages but Beenstock *et al*. (2012) was of the view that, investing in a backup generator does not always guarantee the complete mitigation of outages. A company may still have back-up and still suffer outage losses. These may take the form of restart costs or losses due to the inability of the backup method to generate and supply the total power load required by the firm. This has a bearing on the capacity utilisation of a firm as the capacity utilised during an outage is a big as the capacity of the available back-up energy.

Steinbuks & Foster (2010) further argue that firms tend to only invest in back-up power on critical plant equipment such as emergency lighting, pumping, and information technology (IT) equipment and complement it with cheaper energy from the national grid. Research has shown that the variable cost of self-generating electricity is approximately 3 to 4 times as costly as the costs of electricity supplied by the national grid due to diseconomies of scale in self-generation (Steinbuks & Foster, 2010).

The cost of servicing and fuel needed to operate the generators also means increased cost of production. Firms have passed on the cost to consumers resulting in their products and services being expensive. Others have absorbed the cost till they cannot afford it anymore. However, some businesses have laid workers off to remain in business. The impact of the erratic power supply is that the extra funds expanded on the alternative sources of power supply increase the cost of production thus raising the market costs of products and services. This makes the products to underperform in the market if there are similar products in the market that have been imported from countries where the power supply is regular. This is because regular power supply can reduce the cost of alternative back-up, and this cost reduction is expected to certainly influence the business performance of companies.

2.4.4 Grid Power Consumed[7]

Grid supply is electricity power as obtained from the supplies of a nations' power utility company, for example Zimbabwe has ZESA and South Africa has ESKOM. When there is a power cut, either

[7]Consumption of grid power is measured in Kilowatt-hours (kWh) units

through a fault or load shedding, the billing unit (meter) stops billing, in other words no consumption of grid power. To a firm that do not have back-up power it means that their resources immediately become idle and consequently, it will impact negatively on its business performance. It is estimated that the use of electricity compared to other forms of energy can raise productivity per worker by 50–200% for microenterprises (Oseni & Pollitt, 2013). This then follows that a firm that operates in a location with higher availability of grid electricity consumes more utility units compared to a firm located in an area prone to faults and load shedding.

According to Nyanzu & Adarkwah (2016), business performance can be linked to utility power consumed. Firms that experience power cuts end up having higher unit costs of production due to extra costs associated with alternative power generation and are less profitable than their counter parts who experience less power cuts. This brings competitive disadvantage to the firms affected.

2.5 THEORETICAL FRAMEWORK AND CONCEPTUAL FRAMEWORK

Miles and Huberman (1994), opine that conceptual framework can be graphical or in narrative form showing the key variables or constructs to be studied and the presumed relationship amongst them. The following figure illustrates the relationship between the independent variable (IV) which in this study is erratic or unreliable power supply to the dependent variable (DV), that is business performance in the form of a conceptual framework.

Conceptual Framework

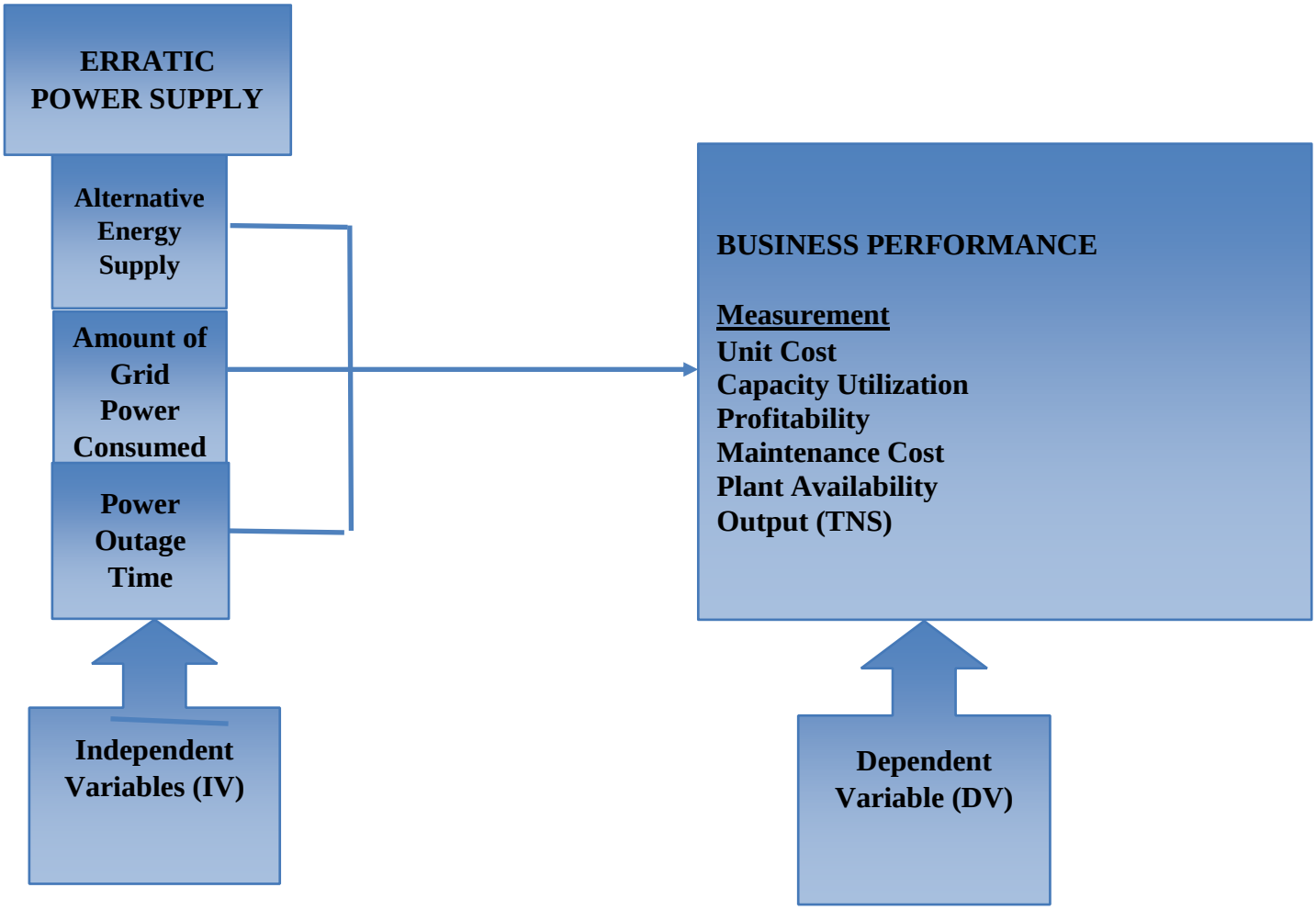

Figure 4: Conceptual Framework

Souce - Self Constructed

From the conceptual framework, the association between erratic power supply and business performance is established.

2.6 RESEARCH GAP

The research gap identified from the literature is that despite the fact that much has been written on isolated studies mostly, in SMEs and manufacturing sector, there is still a gap with regard to erratic power supply impact on business performance with regards to the mining sector. Further to that the

have been a narrow focus on load shedding as to explain erratic power supplies but erratic power supplies has various facets that include faults and the way in which firms respond to such disturbances.

There is also little that has been written or said about quantifying alternative energy supply. Its full impact on business performance is yet to be fully explored.

This research study is also different from other studies in one important aspect that is the scope. The scope of this study is the mining industry and a holdings, cluster or group of companies approach to issues as opposed to the common approach by other researchers who use a disaggregated analysis of different sectors and then generalising to other sectors.

The results of this study will be generalizable to the mining sectors.

The title of this research 'Erratic Power Supply and Business Performance in Zimbabwe for the Period 2014-2019. The Case of RioZim Limited', exploits study gaps identified from the existing literature. Some studies have been in developed economies and majority have been emerging economies, Africa in particular but the impact on business performance with reference to power supplies in the Zimbabwean mining sector has not been done.

2.7 SUMMARY

This Chapter outlined the relevant literature linking to the research under study ,starting with theories underpinning the study which gave a framework and foundation for the research study, insights on the theoretical reviews of the variables/concepts (independent, mediating and dependent variables) and finally an empirical review of erratic power supplies (independent variables) on business performance (dependent variable). The conceptual framework was developed indicating the linkages between independent, mediating and dependent variables. The subsequent chapter will concentrate on the methodology of the research study. Following from the reviewed literature, the study will adopt pooled ordinary least squares technique to analyse data from the four RioZim subsidiaries namely Murowa, Renco, Cam and Motor as well as Danly.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

Saunders et al. (2006), suggest that a research study can be put into two categories, either quantitative or qualitative. The selection on whether the research study should be qualitative or quantitative depending on the research problem at hand and the investigated type of data available in order to solve the problem. This research study was predominantly quantitative.

This chapter looked at the research methodology. Its structure was that it was comprised of a recap of research aim, objectives, questions, hypotheses. It also looked at the research philosophy, research design and the major data collection methods applicable to the research study. The chapter also dealt with the research instrument used and the study population together with the selection of respondents, the limitations of the study, credibility as well as the ethical considerations of the research study.

3.1.1 Recap Of Research Aim, Objectives, Questions And Hypotheses

3.1.1.1 Main Objective

The main aim of this study was to investigate the impact of erratic electricity power supply on business performance in Zimbabwe, with a special focus on RioZim Limited for the period 2014 to 2019.

3.1.1.2 Specific Objectives

The objectives of the study are:

- To investigate the impact of Power Outage time (hours) on output produced.
- To determine the impact of Alternative Energy (Diesel generator) supply on output produced.
- To determine the impact of amount of Grid Power consumed on output.

3.1.1.3 Major Research Question

What is the impact of erratic electricity power supply on business performance on a mining firm?

3.1.1.4 Specific Research Questions

- To what extent do Power Outage time (hours) impact on output of a mining business?
- How does Alternative Energy (Diesel generation) supply impact on output of a mining business?
- How does the amount of Grid Power consumed impact on output of a mining business?

3.1.1.5 Hypotheses

3.1.1.5.1 Overall Hypothesis

Erratic power supply negatively impacts business performance on mining business.

3.1.1.5.2 Specific Hypotheses

- Power outage time (hours) has a negative impact on output of a mining business.
- Alternative Energy (diesel generation) supplies have a positive impact on output of a mining business.
- Grid Power consumed has a positive impact on output of a mining business.

3.2 RESEARCH DESIGN

Research design is the plan of the proposed research study (Hollis, 2004). Saunders et al. (2007) suggest that research design governs the whole configuration and organisation of the research study. It also determines the type of evidence that is collected and interpreted in order to deliver acceptable answers to the research questions. Depending on the nature of research, there are three types; namely exploratory, explanatory and descriptive study, Hollis, (2004).

Exploratory studies seek new insights that are useful in digging deeper, clarifying with the aim of understanding of a problem or subject matter and then coming up with a theory. It is designed to provide insights about the relationship between variables that are not very clear and is usually used in a qualitative study and is not conclusive in nature. It is carried out by way of conducting in-depth interviews with unstructured questions and literature search.

Explanatory study seeks to confirm or disconfirm a theory to a certain research area. The variables are clearly defined and testing of a hypothesis is its main objective. The results are confirmatory and conclusive. It can also be called causal research in that it is carried out to identify the nature and extent of cause-and-effect relationships. It also focuses on an analysis of a situation or specific problem to explain the patterns of relationships between independent and dependent variables and it is quantitative in nature, Saunders et al. (2007).

A descriptive research study attempts to explore and explain while providing additional information about the topic. Its objective is to describe things by answering the questions" who, what, where, when, why, & how"? It seeks further to increase knowledge on a certain subject matter hence the reason why observations and surveys are employed to collect descriptive data.

It makes use of qualitative and quantitative research methodologies with the aim of describing things, events, practices and systems. The results maybe conclusive and confirmatory but more research might be needed.

3.2.1 Researchers' Choice and Justification

The research study adopted the explanatory research design for this dissertation based on the fact that it is a causal-effect research that helped to establish the impact of erratic power supply on business performance in the mining sector.

To achieve the proposed research objectives of erratic power supply and business performance for RioZim Limited, a quantitative research method was opted for because it is often the most efficient and cost-effective research method.

According to Saunders et al. (2007),explanatory research was a suitable way of assessing the impact of erratic power supply on business performance and is associated with greater levels of validity due to systematic selection of independent, mediating and dependent variables.

3.3 RESEARCH PHILOSOPHIES

Different philosophies influence researchers to study phenomena differently (Saunders, 2007). The beliefs that a researcher has about the nature of reality is ontology and the means to acquire the knowledge is epistemology (Saunders, 2007). These determine the research methodology.

3.3.1 Ontological Assumption

The research study is premised on the assumption that there is one truth on the impact of erratic power supply on business performance. Responses in the research are based on the available data and respondents' knowledge on the impact of erratic power supply on business performance through establishing cause-and-effect relationships and drawing conclusions.

3.3.2 Epistemological Assumption

The research study seeks to obtain objective information, in order to maintain objectivity, the researcher used existing data, kept a distance from respondents where applicable so as to allow them to express their views freely without influence of the researcher. Secondary data were used to obtain statistically useful information on the research topic. There was a low level of involvement of the researcher and a representative sample of respondents.

3.3.3 Axiological Assumption

It is the researcher's acknowledgment that the nature of this research uses secondary data and quantitative tools of analysis. The researcher's personal values of honesty, respect, transparency and

diligence as well as ethical conduct were reflected throughout this research study through to data analysis to establish trends, patterns and relationships.
Secondary data were used because of its advantage of a quick turnaround time of responses and cost-effectiveness.

3.4 RESEARCH PARADIGM

Research paradigm may take the following forms: positivism, interpretivism and pragmatism. (Saunders 2007). Research paradigms informed the researcher's beliefs and how they would guide and influence aspects of conducting the study.

3.4.1 Positivism

The study adopted and was located with a positivist research paradigm, hence it's anchoring within the quantitative research approach. A positivist research perspective aims to test and confirm hypothesis to enable to explain and predict the effect of one factor on another (Johnson & Onwuegbuzie, 2004). Saunders et al. (2009), writes that positivism plays the part of an objective analyst who makes independent interpretations on information and data that has been collected in an independent set up.

The nature of the research study and topic was suitable for using this approach because the constructs on the research are scientific hence can be measured effectively using quantitative methods. According to Saunders et al. (2009), positivism sticks to the premise and assumption that facts that are obtained through observation and measurement are reliable and trustworthy. The function of the researcher was secondary data collection through publicly available reports and internal reports for the companies involved which ensured minimum contact with the employees and interpretation of results with an objective approach. This meant that the results were quantifiable and suitable for statistical analysis. Statistical analysis was done to establish the cause-and-effect relationships between the variables.

Positivism is in sync with the ontological assumption. Ontological assumption seeks one truth from the cause-and-effect relationships that were established by this study. The researcher focused on facts, one truth, which is in line with ontological assumption. Positivism was based on the use of existing

theory which enabled the researcher to develop hypotheses that were tested by this research. The disadvantage of positivism was that it was based on and relied on experience as a major source of knowledge but however concepts of cause and effect were not based on experience. In addition, findings from a study anchored on a positivism paradigm could have lacked insight into in-depth matters since they are descriptive or explanatory in nature.

3.4.2 Interpretivism

Interpretivism is located in social sciences and is dependent on the individual's experiences, memories and expectations and thus is suitable for use in qualitative studies (Saunders, 2007). It is subjective and takes into account opinions, attitudes and feelings of respondents hence was not suitable for this study.

3.4.3 Pragmatism

Pragmatism is an integrated approach to positivism and interpretivism approaches. It disagrees with positivists' structured view. Positivists are of the view that only "factual" knowledge gained through observation and measurement, is trustworthy and there is little room for choice due to causal and effect relationship. Pragmatism also disagreed with interpretivists' totally relativist view which is highly contextual. It takes aspects from both positivist and interpretivist positions. Like positivists, realists or pragmatist argue that phenomena are objectively and scientifically studied and in line with interpretivists, pragmatics attach value to social reality. Pragmatism is associated with mixed methods.

3.5 RESEARCH APPROACH

Three common approaches to a research study exist, that is deductive, inductive and abductive. Deductive approach is objective and applies to scientific research; it explains how variables are related and makes some inference. It is used for quantitative research as it uses numeric data and tests hypothesis. It draws from general to specific conclusions can be drawn from available theory (Saunders, 2007). Conversely, inductive approach is subjective and more inclined to qualitative

research. A researcher starts with specific to broader generalization with the aim of wanting to develop a theory. The researcher wants to explore and use words to explain the concepts of how variables are related. Lastly, abductive approach is a combination of deductive and inductive research approaches whereby a theory is developed and tested. Interpretation of data will use both numeric and descriptive data.

3.5.1 Researchers' choice and Justification

This researcher will use a deductive approach to assess the impact of erratic power supply on business performance. According to Wilson (2010), a deductive approach is concerned with developing a hypothesis emanating from an existing theory and a research strategy is designed to test the hypothesis. Deductive approach usually is reasoning from the particular situation to the general inference, it is concerned with deducing conclusions from propositions hence is suitable for this quantitative study.

3.6 RESEARCH STRATEGY

Saunders, (2003) refers to a research strategy as a broad framework or plan that facilitates the researcher to respond to the research questions in an effective way and choose a suitable research methodology. From that reference ,the choice of a research strategy in research is determined by the research questions, objectives, extent of existing knowledge, amount of time and other resources and own research philosophy.

The research study aimed to examine the impact of erratic power supplies on business performance. The research strategy employed output processed in tonnes (TNS) to explain business performance and those that explain erratic power supplies which are power outage hours (POH), alternative energy supply (AES) and total grid power consumed (kWh). Figure 5 shows the conceptual framework that guided this study

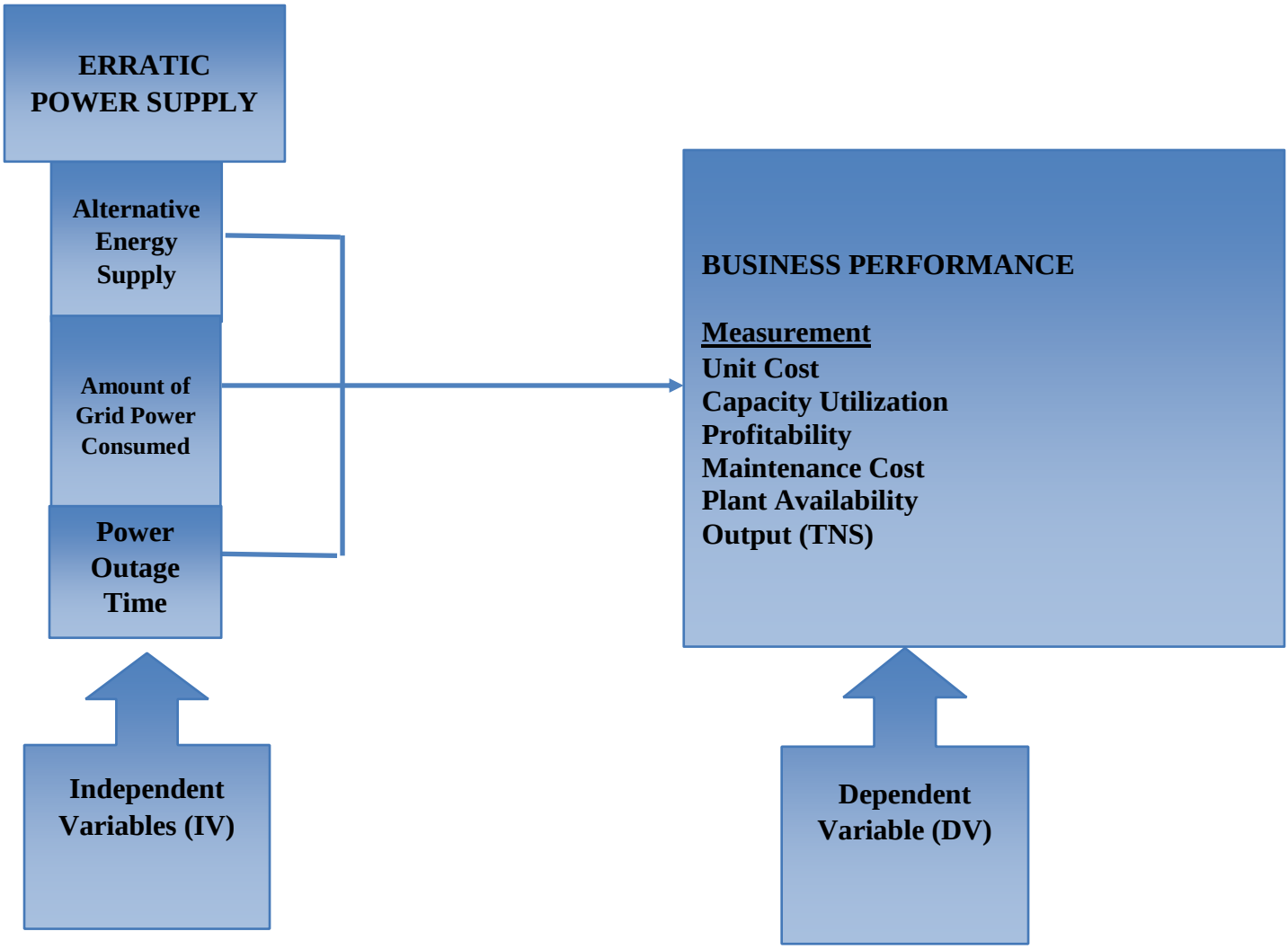

Figure 5: Conceptual Framework

Source (Self Constructed)

3.7 RESEARCH INSTRUMENT

Research instruments are tools for data collection. The researcher has to ensure that the instrument chosen is valid and reliable. Validity and reliability of any research project depends to a greater extent on the appropriateness of the instruments. For this research study, the researcher used public reports and internal reports for different business units under the RioZim Limited group.

3.7.1 Researchers Choice and Justification

The research will make use of secondary data , which is publicly available as well as internal audited management accounts. The research study used a quantitative approach and used a panel regression technique which is an econometric approach, to investigate the impact of erratic power supply on business performance. Similar quantitative studies based on econometric approaches by Adenikinju (2005), Arnold *et al*., 2008, Escribano *et al*., 2009, Oseni & Pollitt (2013) have used similar approaches.

A number of advantages and benefits for the choice of this approach emanated from the fact that the researcher is an employee of RioZim and has access to the use of publicly available audited internal and external data which has been granted use by management. Further to that the studies are part of the researchers work development program and have been sponsored by the company.

The disadvantage with this approach is that the format in which the data exist and definition of variables may differ from one firm to the other despite them being in the same group. The other limitation is that econometric being a historical and based on empirical data is hard to construct a predictive result.

3.8 POPULATION AND SAMPLING TECHNIQUES

3.8.1 Population

A population can be viewed as the total collection of elements about which the researcher wishes to explore (Cooper and Schindler, 2003). The target population for were all mines in Zimbabwe, registered under the Chamber of Mines, despite the type of mineral mined .The study population was RioZim Limited which is one of the biggest mining concerns in Zimbabwe. RioZim Limited was chosen for the study because of it being one of the largest mining houses in Zimbabwe and also because of the fact that the researcher is employed by the firm thereby making it easy to access data for use in the research. The sampling frame is defined by Saunders et al (2009) as a comprehensive list of members of the population, from which a sample is drawn. A business unit represents a

sampling unit. The sampling frame will therefore be the list of mines in Zimbabwe registered under the Chamber of Mines Class A – Big Companies.

The table below shows the mines registered under Chamber of Mines Zimbabwe in different categories

Table 3.1: Categories of Mining Companies registered under Chamber of Mines Zimbabwe

Source: Self Constructed

Class A – Big Companies	**Class B – Middle Size To Large Company**	**Class D – Mining Companies At Development Stage(Still Small)**	**Class G – Individually Owned Mines/ Not Companies**
1. Bilboes Holdings 2. Bindura Nickel Corp Premier B 3. Black box Investment 4. Duration gold 5. Freda Rebecca Mine 6. Great Dyke Investments 7. Hwange Colliery 8. Metallon gold 9. Mimosa Mining Company 10. MMCZ 11. Murowa Diamonds 12. New Dawn Mining 13. Rio Zim 14. Unki Mines 15. ZCDC 16. Zimasco 17. Zimplats 18. ZMDC	1. Pan African Mining 2. Thathile ex New dawn	1. Adlecraft 2. AEL Mining 3. Africa steel 4. Artisan trading 5. Best southern Drilling 6. Blanket mine 7. Canterbury Mine 8. Drilling resources 9. Golden reef mining 10. Rundale investments 11. Samrec vermiculite 12. Sandvik mining 13. Sinnofeerous 14. Tandamanzi 15. Venice Mine	1. G.Chandiwana 2. Newtron Mining

3.8.2 Sampling Methods

In research, regardless of the study being conducted there is need to collect data to answer the research questions and research objectives of the study (Saunders et al., 2009). Sampling is defined as the method which involves selecting a representative subsection of the observations from a population to establish the characteristics of the variables under scrutiny Wegner, (1999). There exist two sampling methods, namely probability and non-probability sampling methods. Probability sampling method is one in which every unit in the population has an equal chance of being selected in the sample, and this probability can be accurately determined.

Non-probability sampling on the other hand is whereby of selection cannot be accurately determined. It involves the selection of elements based on assumptions regarding the population of interest, which forms the criteria for selection.

3.8.3 Researchers Choice and Justification

This study used convenience sampling as depicted in the self-constructed Figure 6. The reseacher is employed by RioZim, hence the convenience and choice of sampling.

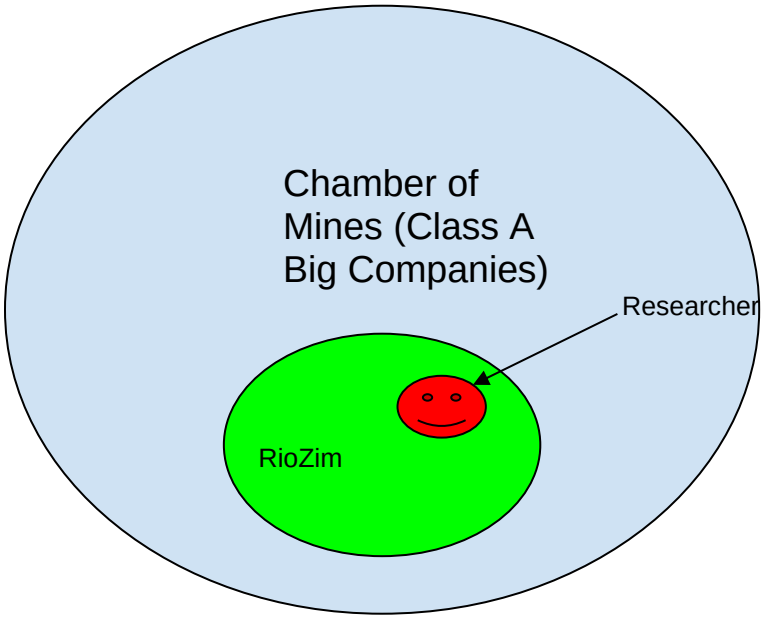

Figure 6: Convenience Sampling

Source - Self –Constructed.

The advantage to the researcher is that the sampling technique is fast due to the time constraints for the study. It is equally inexpensive, and the subjects are readily available. The source of variables data is internal and public data are readily available to the researcher as they are employees of the organisation under study.

The limitation about convenience sampling is sampling bias and that the sample may not be representative of the entire population thereby leading to limitation in generalization and inference making about the entire population but the effect is minimised as the mines are already classified according to contribution to the overall output and size of operation.

3.9 Sample Size

Sample size can be viewed as the number of individual elements of data collected in a survey. Reliability and accuracy of findings of a research study is dependent upon a sample size, the larger the sample size, the smaller the error to generalizing the population (Saunders et al., 2009).

For this study there are thirty-seven (37) mining companies listed under the Chamber of Mines Zimbabwe. Eighteen (18) under class A of Big Companies, two (2) under class B, middle size to large companies, fifteen (15) under class D Mining Companies at Development stage (still small) and two (2) lastly Class G, Individually owned mines, not companies according to Chamber of Mines classification.

Applying the convenience sampling method as described above, RioZim and Murowa Diamonds are selected from class A.

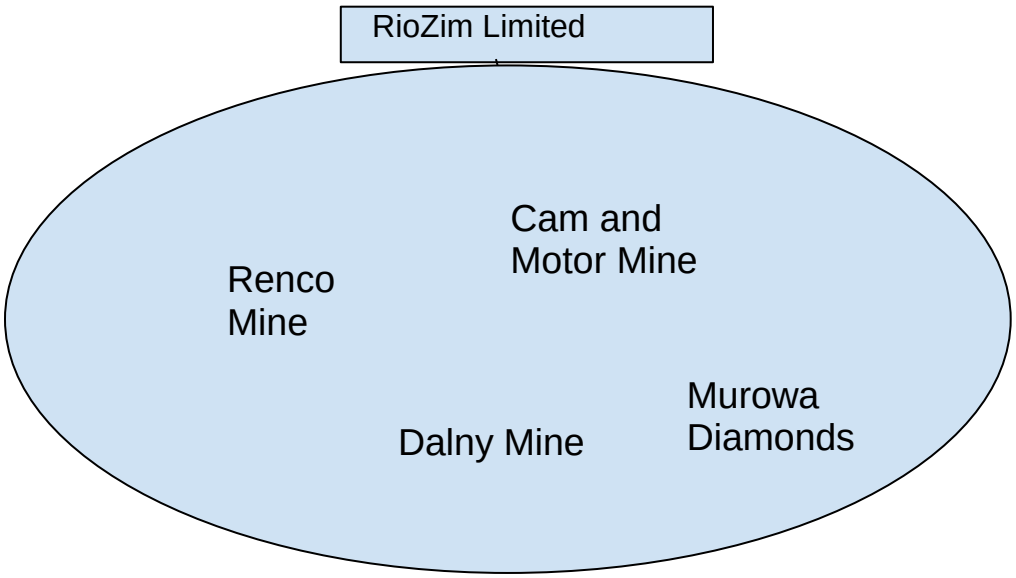

Figure 7: Sample Size

Source - Self Constructed

Applying the sampling method, the size obtained is four (4) companies. For the purposes of this study, it is considered adequate.

3.9.1 Data Source and Sample Period

In order to analyse the full impact of the independent variable (IV) to the dependent variable (DV), the period of 2014 to 2019 is chosen. It is in this period that has seen the power utility suffering a huge power deficit due depressed hydro-generation at Kariba owing to the drought, frequent breakdowns at thermal power stations and unreliable imports as a result of acute foreign currency shortage.

It is also in this period that the distribution network has been very unreliable due to lack of maintenance due to working capital constraints on the part of ZETDC. The study used secondary data in the form of publicly available reports and audited financial statements and well as internally generated reports. The sources were considered legitimate, reliable and comprehensive to ensure the replicability and validity of the study.

3.10 DATA PROCESSING ANALYSIS

This research study used STATA 16, a statistical product and services solutions package, and other appropriate statistical techniques for data processing and analysis in line with quantitative studies. The analysis was done based on descriptive statistics and the output of the pooled ordinary least squares regression to develop evidence for the conclusion and recommendation thereof for this study.

3.10.1Panel Data

The data was characterised by both time series and cross section dimensions. Time series was annual firm variable from 2014 to 2019. Cross section dimension was the four (4) companies in the RioZim Limited group of companies. According to Brooks (2014), the advantage of using panel regression techniques is that the effects that cannot be observed in pure cross –section and time series can be measured and relationships between variables over time can be reliably examined over time.
From examined literature, which have business performance as a dependent variable Escribano *et al*. (2009), Arnold *et al*. (2008), Adenikinju (2005) and Oboyo (2017) used panel regression techniques to conduct casual and effect studies on impact of power and separately, capital structure on business performance of firms. This brings validity to the approach.

3.10.2 Pooled Ordinary Least Squares Regression Analysis

Pooled ordinary least squares estimation technique was applied to panel data. Panel data have the dimensions of both time series and cross-sections. The data was characterised by time series dimension in that the period under consideration was given as from 2014 to 2019 and the cross section dimension in that it cuts across four (4) mines in different geographical locations (Murowa Diamonds-Midlands, Renco Mine-Masvingo, Dalny as well as Cam and Motor mines in Mashonaland West Province). Effects that cannot be observed under pure time-series and pure time series can be measured using panel regression techniques. The relationships between variables over time series can be reliably observed even for smaller samples Brooks (2014).

3.10.3 Model Choice and justification

From the reviewed literature, Arnold *et a*l., 2008, Frederick & Selase, (2014), Ado & Josiah (2015), Kwabala (2015), Kamara, (2017), Ionascu *et al*, 2017 settled for financial metric variables which include profitability, maintenance cost, per unit cost as a measure of business performance. In order to contribute to the body of knowledge and making use of the available data, this researcher is going to use non –financial proxy of business performance of output produced measured in tonnes.

From the reviewed literature, discussed above and highlighted in 3.6 above under 'Researchers choice and justification' and the 'Conceptual framework' and Specific Hypotheses in of the study, coupled with the discussion discussion in 3.8.1the following model can be specified.

$$TNS_{it} = \alpha_i + \beta_1 * POH_{it} + \beta_2 * kWh_{it} + \beta_3 * AES_{it} + \grave{\varepsilon}_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

Where

- α_i is the constant intercepting term for each company (i)
- $\grave{\varepsilon}_{it}$ is the error constant
- β_i is the coefficient of the explanatory variable
- TNS_{it} is the dependent variable representing tonnes of output produced for company (i) in time (t)
- POH_{it} is the independent erratic power supply variable representing Power Outage Hours for company (i) in time (t)
- kWh_{it} is the independent power supply variable representing total grid power consumed for company (i) in time (t)
- AES_{it} is the independent erratic power supply variable representing Alternative Energy Supply (measured in USD$ for cost of fuel) for company (i) in time (t)

3.10.4 Modelling Approach

The pooled OLS regression was used to investigate the impact of erratic power supply on business performance. This methodological approach assumes that explanatory variables have individual heterogeneity and are uncorrelated. This ensures that the results will be unbiased.

3.11 RELIABILITY AND VALIDITY

Reliability refers to the consistency of results over time period whilst validity ensures what was intended to be measured was measures or in other words it refers to the strength of the conclusions that are drawn from the results obtained from the study i.e. whether findings are really about what they appear to be about (Saunders et al, 2009).

The use of public and internal data for the study ensured that it can be replicated. Detailed literature review ensure that the most suitable and appropriate models were chosen and correct inferences made when the results were interpreted.

There are threats to validity and reliability and they can be compromised at each stage of the research process which include sampling, data collection and analysis. These risks were considered and the following countermeasures were taken to ensure valid and reliable outcomes;

- The sample was taken from the list classified as **Class A – Big Companies ,** in which an element or elements will be able to be generalised and represent the mining sector
- Verifiable audited public and internal data of the companies was used
- Validation of data was done to eliminate errors of capturing and omission

3.12 ETHICAL CONSIDERATIONS

Ethical considerations of research include informed consent, privacy and confidentiality, protection against harm, and protection against identity (Saunders et al; 2012).

Together with the researcher's axiological beliefs the following ethical considerations will be implemented.

Informed consent - the secondary data used was obtained from information available in the public domain which do not require consent for use. At the start of data gathering, the researcher sought approval from the different mines' management in case of internal data. It was obtained by express permission from the companies involved.

Privacy and Confidentiality - For data used and obtained, if additional insight was sought and provided by individuals, their identity and privacy was respected. The respective business unit

managers who assisted with data were further assured of confidentiality of the information provided and that the research findings were to be used for academic purposes only.

Due care was taken during the entire time of the study so as not to cause harm to individuals, companies and the environment.

3.13 RESEARCH LIMITATIONS

In conducting the research project, the researcher encountered some challenges. The study focused on isolated mines in certain geographical locations and the applicability of erratic power supply on some geographical locations is different. Quantification of indirect costs was a challenge due to logistical issues.

3.14 CHAPTER SUMMARY

This chapter explained the methodological approach adopted to achieve the set objectives. The aim of the research study was to establish the impact of erratic power supply on business performance, in the case of RIOZIM Limited. Further to that, it also looked into the research design of the study by examining the research philosophy and paradigms, research approaches, research instrument , data processing and analysis, target population and sampling methods, reliability and validity ,ethical consideration as well as research limitations. The next chapter will discuss the analysis of the results obtained from data analysis.

CHAPTER 4: DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1 INTRODUCTION

This chapter focuses on the empirical analysis of data to establish how erratic power supply impacts on firm performance. Panel data for RioZim was used where the cross-section component incorporate four RioZim subsidiaries namely, Murowa Diamonds mine , Renco mine , Cam and Motor mine as well as Dalny mine, while the time series component covered the period 2014 to 2019. Statistical package STATA version 16 was used to analyse the data.. The dependent variable used to capture business performance of RioZim Limited was output produced (in tonnes). The explanatory variables included power outage hours (POH), total power consumed (kWh) and alternative energy supply (AES). The data used was secondary data obtained from publicly available company reports, such as annual reports, as well as internally generated documents.

This chapter looked at descriptive statistics where the distribution of data was undertaken. This was followed by the application of panel data techniques to the data. Lastly, interpretation of results was done to address the objectives raised in Chapter One as well as giving a basis for recommendations to address the problem under study.

4.2 DESCRIPTIVE ANALYSIS

The study analysed panel data for four subsidiaries of RioZim over a five year period from 2014 to 2019. The descriptive statistics for the data used are presented in Table 4.1.

Table 4.1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
TNS	24	363804.6	247824.7	108017.2	1019000
POH	24	647.4913	379.0627	125	1411.2
Kwh	24	2.12e+07	1.30e+07	5461300	4.56e+07
AES	24	110896.4	69650.16	10000	219503.3

.

Source: STATA 16 output - Author's computations from RioZim annual reports

From Table 4.1, the dependant variable, tonnes produced (TNS), has a minimum value of about 108,000 tonnes and a maximum value of 1.01 million tonnes. The average output over the study period is 363,804. The standard deviation is quite high at 247,824 which shows high variability in output produced because of various exogenous factors in the economy. While there are many factors that can explain this phenomenon, this study seeks to isolate the impact of erratic power supply on business performance (as measured by output).

Power outage hours (POH) is one of the independent variables with a minimum value of 125 hours and a maximum of 1411.2 hours. The mean period of power outages is 647.5 hours with a standard deviation of 379 hours. This high mean accompanied by a high standard deviation suggests that power outages are quite prevalent and also high enough not to ignore. If power outages are frequent, due to load shedding and grid faults, the effects on the mining enterprise could be dire. Power outages are believed to affect operations in a number of ways that include, but not limited to, output, profitability, capacity utilisation and equipment. High power outage hours coerce the entity to invest in alternative power sources so as to mitigate against disruption in operations induced by load shedding and grid faults. It is one of the objectives of this study to establish the impact of power outage hours on output produced in RioZim.

Total power consumed (kWh), is included as an independent variable to establish the link between power consumed and output produced. This variable captures the power provided by the public utility ZESA. The minimum power consumed by RioZim in a year was 5.4 million kilowatt hours while the maximum was 45.6 million kilowatt hours. The mean power consumed was 21.2 million kilowatt hours with a standard deviation of 13 million kilowatt hours. These statistics show that there is high volatility in power distribution by ZESA. Whilst the energy deficit should be met by imports, the nation has very limited foreign currency to meet the energy gap. This forces the public utility to engage in load shedding as they try to ‘equitably’ distribute the scarce power. Apart from load shedding contributing to the observed high volatility of, grid faults also contribute to the same. A small standard deviation would imply that there is minimum disruption of operations as the maximum, minimum and mean value of power consumed will be very close to each other. Given the

very high volatility of power supply, this study seeks to investigate the impact of total power consumed (kWh) on business performance.

The last independent variable is alternative energy supply (AES) which measures the cost of fuel used to run generators during periods of power outages. The minimum cost incurred in a year was US$10,000 with a maximum of US$219,503.50. The mean cost of using alternative energy was US$110,896.40 with a standard deviation of US$69,650.16. An average spent of US$110,896.40 per annum is very high by any standard and clearly shows that power supply in the country is well below reasonable. As such, RioZim Limited has to resort to alternative sources of energy to keep operations abreast. Certain mining operations like Gold production are very delicate that unplanned machine stoppages may have serious maintenance costs accruing owing to equipment breakdowns. Hence the need for generators and associated equipment to play a role of uninterrupted power supply to delicate units within the mine. The cost of alternative energy (US$0.31 per kWh) is much greater than conventional power from ZESA (US$0.09 per kWh) ,RioZim, (2019). The choice by the mine to continue operations in light of relatively higher operational costs speaks to the desire of the firm to remain afloat. Closing down operations may be a difficult decision to make but if the situation gets worse, shut down may be an option. Such a move will have dire consequences on employment levels, export earnings and taxation to government. It is, thus, one of the objectives of this study to establish how the cost of alternative energy supply affects output.

4.3 REGRESSION RESULTS

The study used panel data for RioZim' s four subsidiaries over the period 2014 to 2019. Given that it was panel data the random effects, fixed effects and pooled regression were considered and the best model was arrived at after employment of the Hausman test (Brook, 2014). Based on the results, the best model selected was the pooled ordinary least squares approach. Neither the random effects nor fixed effects models were significant at the 5 percent level (See Appendix B). Table 3 shows the pooled OLS results obtained using STATA 16.

Table 4.2: Pooled Regression Results

TNS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
POH	-731.3388	189.9439	-3.85	0.001	-1127.555	-335.1226
Kwh	.0084408	.0047843	1.76	0.093	-.0015392	.0184207
AES	6.472038	1.423918	4.55	0.000	3.501797	9.442278
_cons	-59266.65	175428.1	-0.34	0.739	-425203.2	306669.9

Source: STATA 16 output

The model was subjected to a battery of tests to assess its suitability. The F-statistic is 10.35 with a probability value of 0.0003 (See Appendix A). This means that the overall model is significant at the 1 percent level of significance. The explanatory power of the model, as given by R-squared is 0.6081 (See Appendix A). This means that 60.81 percent of variation in the dependent variable (TNS) is explained by variations in the dependent variables (POH, kWh and AES. This meant that the pooled OLS results obtained were valid for reliable interpretation. The parsimonious model is expressed as follows:

TNS = -59,266.65 – 731.3388*POH + 0.0084408*kWh + 6.472038*AES

4.4 DISCUSSION OF RESULTS

From Table 4.1, the coefficient of power outage hours (POH) negatively impacts on output produced for RioZim and is statistically significant at the 1 percent level. This means that for every hour increase in power outages, combined output falls by 731 tonnes. This result is consistent with the hypothesis in Chapter One that power outages negatively affect business performance. This means that load shedding coupled with grid faults are substantially hurting the operations of RioZim Limited. In line, with the Balance Score Card and SWOT models, the organisation should strategize

for future existence through mitigation of current threats and challenges. In line with the Balance Scorecard (BSC), RioZim should translate its strategy into specific measurable objectives and targets, both short and long term in order to circumvent the negative impact of power outage time. These results are consistent with Ado and Josiah (2015) as well as Nurudeen *et al.* (2018) who also found a similar result. However, in contrast Allcott *et al*. (2016) found out some firms, though small to medium enterprises (SMEs) are reducing their operating cost by shifting production to off-peak hours where tariffs are low.

In other contrasting findings Chissokho & Seck (2013) obtained quite different findings. In their study, outages were found to have a positive and significant effect on the productivity of firms. The submitted explanation for the contradictory finding is that outages motivated better management practices, which mitigated the negative effects of electricity power supply cuts.

For grid power consumed (kWh) the coefficient is positive and significant at the 10 percent level. An increase in grid power by 1 kWh increases the combined output by 0.008tonnes. This result is consistent with hypothesis in Chapter One that an increase in grid power consumed positively affects business performance. If the supply of electricity was reliable and adequate, RioZim Limited would avoid the cost of maintenance and diesel fuel as a result of operating on generators. As such, the more grid power that RioZim accesses, the more output is produced. This benefit of increased output is realised from the non-interruption of operations. Continuity in any business operation is very important for purposes of improving business performance. In addition, the up time of machines will not be disturbed by shocks in the power supply thus maintaining consistency in quantity and quality of output produced. This high up time will also translate into lower maintenance costs since machine operations will be insulated from abrupt power outages. Thus, increased grid power consumption improves RioZim's business performance. The SWOT analysis framework dovetails with the result in that if power supply is uninterrupted RioZim should take that as an opportunity to improve business performance, as shown from the result. Oseni and Pollitt (2013), as well as Nyanzu and Adarkwah (2016) also found that grid power consumed positively impacts on business performance.

For alternative energy supply (AES), the coefficient is positive and statistically significant at the 1 percent level. This result is consistent with the hypothesis in Chapter One that alternative energy

supply has a positive impact on business performance. If grid power is not available, a mining entity should operate using the available alternative energy supply to avoid interruption of operations. Use of alternative energy will keep up time of machines at a high level thus resulting in increased mining output. In addition, alternative power supply will keep production disruptions at low levels thus minimising on power outage induced maintenance costs. This result is in line with Beenstock *et al.* (2012) and Cole *et al.* (2018) that alternative power supply has a positive impact on business performance.

4.5 CONCLUSION

This chapter the presented an analysis of the research's findings, analysis and discussion of the study and presented the results in detail. The presentation of the findings of the study was in the form of tables and figures which enabled the salient issues from the study to be presented openly and succinctly.

Results from this study reveal that, RioZim limited, suffer from unreliable power (both load shedding and grid faults), and this unreliable power has had adverse effects on its output leading to depressed business performance. The main area affected by unstable power was output produced measured in tonnes as a result of downtime incurred when there is a power cut. The use of diesel generators was also found to mitigate to impact of the losses in output as evidenced by the results of a positive impact on the tonnes produced.

This study found out that there was a negative impact of erratic power supply on business performance measured by the output produced of a mining company. Whilst there were other financial indicators of business performance, this study focussed on non-financial proxy of business performance, that is the tonnes produced.

The study established that the independent variables i.e. grid power consumed (kWh), alternative energy supply (AES) and power outage (POH) time measured in do have an effect on business performance measured by output. The next chapter presents the conclusions and recommendations of this study based on the findings explained in this chapter.

CHAPTER 5 - CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the conclusion of the study focusing on the outcome and discussion of the findings in the previous chapter. The chapter provides a summary of the study, practical recommendations for managerial action as well as highlighting suggestions for future research.

5.2 CONCLUSION

The study sought to investigate the impact of erratic power supply on business performance and came up with the following conclusions;

- Power outage hours have a negative impact on business performance (output measured in tonnes).
- Grid power consumption has a positive impact on business performance.
- Alternative energy supply has a positive impact on business performance.

To briefly summarise the results, the study found out that frequent and unexpected power outages embody a significant load on mining firms. Back-up power or for this study Alternative Energy Supply and main grid consumption, both have a positive impact on the output of a company.

5.3 ANSWER TO RESEARCH QUESTIONS

The study set out to answer questions pertaining to the impact of erratic power supply on business performance. The research questions, generated from the topic, show that power outage hours (load shedding and grid faults) negatively affects business performance (output) while grid power consumed and alternative energy supply positively affect mining output.

5.4 HYPOTHESIS TESTING AND INTERPRETATION

Table 5.1: Summary of Hypothesis Test results

Hypotheses	**Result**
Power outage time (hours) has a negative impact on output of a mining business	Accept
Alternative energy (diesel generation) supplies have a positive impact on output of a mining business	Accept
Grid Power consumed has a positive impact on business productivity on a mining business.	Accept

Source: Self Constructed

The relationship between Power Outage time and business performance was tested using regression analysis and the findings showed that this factor was statistically significant and negatively affecting business performance at RioZim Limited.

In the same vein the relationship between Alternative Energy Supply use and business performance was also tested using regression analysis and the findings showed that this factor was statistically significant and positively impacting business performance at RioZim Limited.

The third factor Grid Power measured in kWh, consumed was also statistically significant demonstrating that it had a positive influence on business performance.

The hypotheses for this study were accepted whereby Power Outage Time measured in Hours (POH) had a negative impact on the dependent variable, that is, Business Performance measured by the Production Output in Tonnes (TNS) produced of a mining business. Independent variables, Alternative Energy (diesel generation) supplies (AES) had a positive impact on the dependent variable and Grid Power (kWh) consumed had a positive impact on the dependent variable, that is, Business Performance measured by the Production Output in Tonnes (TNS).

5.5 CONTRIBUTION

The main objective of this study was to investigate the impact of erratic power supply on business performance and came up with information (model) that can be used to make business decisions.
The recommendations generated thereof offer advice to RioZim Limited and other mining companies on the with an understanding on the full impact of erratic on business performance at an organisation in a developing economy in Africa across industry.

The practical contribution of the study was to effectively manage business in the wake of erratic power supplies and reduce their negative impact on business performance. It also provides management with advice on investment strategies in alternative energy as well as tactics on how to respond to erratic power supplies for the betterment of business performance.

The theoretical contribution was that the study contributes to the body of knowledge that can be used as reference by future researchers interested in the same area of study of erratic power and its effect on business performance.

5.6 POLICY RECOMMENDATIONS

Findings from this study have a great significance for policy formulation. Given that power outage time (POH) has a negative impact on business performance, and that grid power consumption (kWh) positively affects output, the study recommends that the Ministry of Energy and Power Development, through regulatory bodies like Zimbabwe Energy Regulatory Authority (ZERA) responsible for the energy sector, must intervene to reduce power outage hours in the mining industry thereby reducing or eliminating load shedding (power outage). This can be achieved by promoting renewable energy products for domestic consumers (households) through tax breaks and duty relaxation at domestic consumption level so as to free energy to the productive sector, thereby reducing load shedding in mining areas. These interventions will result in reduced (or elimination) of power outage hours, which will in turn result in increased grid power consumption. Once there is minimal or no interruption of mining operations, this will lead to the improvement of business performance (mining output).

In addition to renewable energy policy proposition above, one of the recommendations is the adoption of energy conservative policies such as strategies to encourage move from the use of energy inefficient electric gadgets and devices like incandescent bulbs, energy inefficient electric motors in industry, traditional element stoves, refrigerators and air conditioners, computers and televisions, to the use of energy efficient Light Emitting Diode (LED) bulbs, energy efficient electric motors, modern refrigerators, computers and LED televisions.

Whilst the Zimbabwe Electricity Supply Authority was recently given a tax waiver (ZPC, 2019) on grid and generation maintenance spares, this has to be regularised into a statutory instrument (SI) by the responsible Ministry. This will dovetail well into the findings of this study, as this will reduce Power Outage Time (Hours), which was found out to have a negative impact of production output.

The results of this study established that alternative energy supply has a positive impact on mining performance (output). In light of this finding, the study recommends that mining firms should invest in alternative energy sources such as generators and solar power, and gas among other forms of alternative energy, is a power outage mitigation strategy. Solar and natural gas can have a huge impact on energy demand and can be implemented at local government level. In other countries, housing plans cannot be approved without provision for renewable energy, which is gas and solar. In addition,

government should scrap duty on the importation of generators so as to encourage investment in these power outage mitigation strategies. Mining firms are very critical to the macro-economy as they are a very important source of foreign currency generation through mineral export earnings. The implication of such interventions will result in increased investment in alternative energy supply which mitigates against power interruptions thus improving mining firm performance. In addition, improved mining performance will translate into improved foreign currency generation via improved mineral exports.

5.7 MANAGERIAL RECOMMENDATIONS

Findings have shown that the grid power consumed has positive impact on business performance. It is imperative that management of RioZim Limited and other companies in Zimbabwe should maximise the utilization of grid power when it is available. They can be able to achieve this by shifting their non-productive activities like plant and equipment maintenance to days that coincide with power outages, whether planned or otherwise so as to capitalise on the price differential between the use of generator (US$0.09 against US$ 0.31 per unit). They should engage and maintain a relationship with ZESA so that accurate information on load-shedding and grid maintenance can be communicated in time and so that they synchronise their production activities and minimise unplanned power cuts. Unscheduled power cuts are detrimental to production output as more often equipment is damaged.

In the same line, the findings have also shown that the use of Alternative Energy Supply (AES), in this particular case has a positive impact on business output. Even though the initial capital outlay is huge, Managers of mining companies can also maximise their resources that is manpower, plant and equipment, which would otherwise be idle when there is no power thereby improving on their average fixed cost since rent and other fixed costs will remain constant.

Mining companies must come up with systems that enable them to accurately capture data on power availability and reliability. This will enable firms to analyse trends so as to make predictions and make informed investment decisions, strategies and tactics in the wake of volatility in power supply. Technology, in the form of gadgetry like intelligent and smart metering and power analysers are available on the market to capture data.

5.9 Research limitations

The limitations of the research study were the non-centralisation of data in the RioZim Limited group of companies such more time was required to gather data. Time constraints were an issue in trying to establish balance of work and research study data collection and analysis. The study focused on isolated mines in different geographical locations and the applicability of erratic power supply on some geographical locations is different. Quantification of alternative energy supply as well as other indirect costs was a challenge due different understanding and appreciation across business units. Given time, financial and data constraints the research was limited to RioZim group of companies whereas a broader sample would have produced interesting results.

5.10 Areas of further research

The study focused on the impact of erratic power supply and business performance, using a non-financial metric proxy of business performance, production output, measured in tonnes. Future research can consider financial metrics. This study was also primarily focusing on the mining industry, future research also should consider a study across industry.

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APPENDIX

APPENDIX A: Pooled OLS Regression Output

```
. regress TNS POH Kwh AES
```

Source	SS	df	MS	Number of obs	=	24
				F(3, 20)	=	10.35
Model	8.5904e+11	3	2.8635e+11	Prob > F	=	0.0003
Residual	5.5356e+11	20	2.7678e+10	R-squared	=	0.6081
				Adj R-squared	=	0.5493
Total	1.4126e+12	23	6.1417e+10	Root MSE	=	1.7e+05

TNS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
POH	-731.3388	189.9439	-3.85	0.001	-1127.555	-335.1226
Kwh	.0084408	.0047843	1.76	0.093	-.0015392	.0184207
AES	6.472038	1.423918	4.55	0.000	3.501797	9.442278
_cons	-59266.65	175428.1	-0.34	0.739	-425203.2	306669.9

APPENDIX B: Hausman Test for Fixed or Random Effects

```
. hausman fixed

Note: the rank of the differenced variance matrix (2) does not equal the number of coefficients being tested (3); be sure this is what you
      expect, or there may be problems computing the test.  Examine the output of your estimators for anything unexpected and possibly
      consider scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed          .          Difference          S.E.
-------------+------------------------------------------------------------
         POH |    .0000743     .0000591       .0000152        .0001514
         Kwh |   -6.90e-10     1.36e-09      -2.05e-09        8.90e-09
         AES |   -1.08e-07     5.29e-08      -1.61e-07        1.16e-06
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.07
                Prob>chi2 =      0.9634
```