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THE IMPACT OF ELECTRICITY SUPPLY ON LABOUR PRODUCTIVITY IN THE WOODEN FITTINGS SECTOR: A CASE OF AFRICA CONSTRUCT IN ZIMBABWE

BY

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Abstract

The constant availability of electricity plays an important and dynamic role in both production and consumption of goods and services. Electricity supply plays a crucial role in the production and consumption of goods and services. This dissertation presents a case study conducted at Africa Construct, a firm in the wooden fittings industry sector in Zimbabwe, to investigate the impact of electricity supply on labor productivity. The primary aim was to assess the relationship between electricity supply and labor productivity, specifically focusing on the years 1991–2021 to estimate the impact of electricity shortages on firm productivity in Zimbabwe. Utilizing a combination of the Cobb Douglas Theory and the Real Business Cycle Theory, the study analyzed the variables of electricity supply, labor productivity, manufacturing employment, materials, and inflation rates. A sample of 156 individuals was drawn from the organization through the Simple Random Sampling Method, representing different departments. The collected data was then analyzed using the SPSS package to determine statistical proportions. The study adopted a mixed method research approach, combining the concepts of CVAR Co-integrated Vector Auto Regression as an estimation technique. The analysis revealed a positive long-term relationship between labor productivity, manufacturing employment, electricity supply, and inflation rates. However, no significant relationship was found between labor productivity and materials acquired. These findings suggest that electricity supply and manufacturing employment contribute to bringing labor productivity to equilibrium. It is recommended that policymakers focus on formulating and implementing policies aimed at promoting and expanding the electricity sector in Zimbabwe to boost the manufacturing sector and create more jobs in the country. Moreover, the study recommends the improvement of regulatory and investment frameworks for the power sector to attract private capital for new generation capacity, based on the positive relationship between electricity supply and labor productivity. These recommendations align with theoretical predictions and are supported by previous studies. Future research areas suggested include forecasting and interpolation using VARs with common trends, as well as studying the behavioral impact of power outages on developing countries. In conclusion, this dissertation sheds light on the critical role of electricity supply in the wooden fittings industry sector in Zimbabwe and provides valuable insights for policymakers and stakeholders to enhance labor productivity and economic growth.

Key Words: Labour Productivity, Electricity Supply, Zimbabwean Wooden Fittings, Vector Auto Regression

Declaration Page

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree

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Dedication

This dissertation is dedicated to my family, fellow entrepreneurial colleagues and the whole business community.

List of Acronyms and Abbreviations

ZETDC – Zimbabwe Electricity Distribution Company

ZPC – Zimbabwe Power Company

RBC – Real Business Cycle

OCED – Organization for Economic Co-operation and Development.

CVAR – Cointegrated Vector Auto Regression

ADF – Augmented Dickey Fuller

KPSS – Kwiatkowski-Phillips-Schmidt-Shin

PP – Phillips-Peron

VAR – Vector Auto Regression

VECM – Vector Error Correction Model

I (0) – Stationary

I (1) – Non-Stationary

Definition of Key words

Workforce productivity is the amount of goods and services that a group of workers produce in a given amount of time. It is one of several types of productivity that economists measure.

Labor productivity measures the hourly output of a country's economy. Specifically, it charts the amount of real gross domestic product (GDP) produced by an hour of labor. Growth in labor productivity depends on three main factors: saving and investment in physical capital, new technology, and human capital.

Productivity is concerned with the efficient utilization of resources in producing goods and services.

Production is concerned with the activities of producing goods and services.

Electricity Supply: This is a component that supplies power to at least one electric load. Typically, it converts one type of electrical power to another, but it may also convert a different form of energy – such as solar, mechanical, or chemical - into electrical energy. An electrical supply provides components with electric power. The term usually pertains to devices integrated within the component being powered. For example, computer power supplies convert AC current to DC current and are generally located at the rear of the computer case, along with at least one fan. An electric power supply is also known as a power supply unit, power brick or power adapter.

Load shedding: A last-resort measure which is implemented by a power supply utility whereby the strain placed on an electricity grid is reduced by means of temporarily halting the supply of electricity – purposely limiting electricity supply to users as a result of an over-demand thereof

Power outages: When the supply of power or electricity stops due to equipment failure

Entrepreneurial structure: Entrepreneurial structure is used in SMEs. This is when the major decisions are made by one or two key personnel. Usually in small businesses this will be the owner or the entrepreneur. Decisions are often made quickly by the entrepreneur who is experienced within the business. However, there is a workload issue for the decision makers as responsibility for many tasks will fall to them.

Interior Fixtures & Fittings: Fixtures are generally items which are attached, or 'fixed,' to the property, while fittings are items which aren't attached to the property, other than by a nail or a screw (such as a wooden boards, picture or mirror, for example). It's generally assumed that fixtures will be included in a property sale, unless otherwise stated, while fittings will not be included unless the seller expressly agrees to leave them behind.

Convergence analysis: Convergence determines how many elements are required in a model to ensure that the results of an analysis are not affected by changing the size of the mesh. System response (stress, deformation) will converge to a repeatable solution with decreasing element size.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

The aim of this research was to investigate and assess the impact of electricity supply on labour productivity in the Fittings Industry through a case study of Africa Construct - Zimbabwe Pvt. Ltd. The chapter will outline the background of the study, the research aim, research objectives and questions, study limitations and delimitations and research assumptions.

1.2 Statement of the Problem

A business depends on power each day to run its operations — this is not furtive. But when the power supply fails or goes out, unplanned downtime can occur — and that can cost a business thousands or even millions of dollars. According to Fisher-Vanden (2015), " Unreliable inputs to production, particularly those that are difficult to store, can significantly limit firms' productivity, in this case, power, leading them to react in a number of ways." (p. 199). Unanticipated and unexpected outages can lead to negative situations from which it may be difficult to recover. Making sure your business has a plan to eliminate interruption and downtown in the event of a power outage will help your business mitigate the potential losses and reduced productivity that can occur because of an outage.

Blimpo & Cosgrove-Davies (2019) reported that the power situation in the Southern region of Africa is being monitored by the World Bank as its effects on the economies of the countries in it are regarded as severe. The afflictions from the power supply are said to be one of the three major factors that will reduce growth in Southern Africa in 2015, and is expected to trickle down within the following years if affirmative action is not made by the responsible governing entities. Furthermore, the energy woes in within the region are said to be self-inflicted, as a result the countries would struggle to achieve a two percent growth.

The problem being faced in Zimbabwe is the inadequate and intermittent supply of electricity. Electricity being fed into industrial sector of Zimbabwe is discontinuous. This has a ripple effect in all the industries which we have in Zimbabwe (Mumvuma, 2018). This study has narrowed down to identify implications that may arise within the Interior Wooden Fittings.

Rafemoyo (2010) argues that SMEs appear to be more vulnerable than large businesses to shocks from the economic environment, mainly because of their lack of adequate human and capital resources, compounded by relatively severe financial constraints. However, their lighter structure sometimes allows them more flexibility to cope with those shocks. With Productivity being measurable in revenues, SME's are realizing lower revenues due to a discontinuous supply of electricity being provided on the national power grid.

Very Few studies such as Destek & Aslan, (2017), Bekun, Emir & Sarkodie, (2019) and Ziramba (2009) among others, have examined the relationship between electricity consumption and economic growth or industry production in the Southern African Region. "Looking at the existing literature, a lacuna exists in the available research as there seems to be no studies that focused on the impact of electricity supply on the manufacturing sector output in the Southern African Region", (Mpatane, 2015)

In Zimbabwe, power shortages are commonplace, but however empirical evidence on the impact of electricity shortages is still lacking. Looking at the existing literature, a void exists in the available researches as there seems to be no studies that have focused on the impact of electricity supply on productivity in the Wooden Fittings Industry of Zimbabwe.

Hence it is in this regard, that this study is attempting to empirically reveal the relationship between electricity supply and Zimbabwe`s labour productivity and assess whether it has a positive or negative impact on productivity and overall economy of the country. This Study seeks to add in providing literature to the diminutive number of researches that involve the study that test the relationship between electricity supply and productivity. There has never been any official local study that has been carried out and published to prove or test the significance of electricity supply of productivity in Zimbabwe, particularly for the local entrepreneur, who is in the Small to Medium Scale. There are little to no scholarly researches that have tried to look at the psychological and behavioral effects of electrical supply on labour productivity. This study is looking at filling that void, by providing an in-depth look and assessment on these behavioral effects.

Researches such as Oseni (2018) and Mpatane (2015) have highlighted on a difficulty in accessing documentation in regards to Electricity generation and manufacturing development in Africa. The researcher of this study has noted that majority of studies that have been done of this nature have been done for established enterprises in 2nd and 3rd World Countries, however little documentation has been done on local SME's. The data collected and analyzed is not reflective of the situations that occur in SME's. Hence in this regard the researcher has taken it up to try and do a study focused on an SMEs and fill this knowledge gap.

The goal is to see what percentage of significance electricity has in productivity. This is to help educate the local entrepreneur to see whether he/she can prioritize electricity supply among other factors that affect productivity. When an entrepreneur is coming up with a start-up he is faced with many factors to productivity. This document is looking at seeing what really the percentage of significance does electricity contribute to productivity.

1.3 Research Objectives

The specific objectives of this research are to:

1. Evaluate the extent of the impact of electricity supply on labor productivity in the wooden fittings sector at Africa Construct in Zimbabwe using statistical analysis techniques such as Correlation and Vector Auto Regression from 1991 to 2022.
2. Determine the percentage of significance of electricity supply on labour productivity by calculating the percentage of impact through statistical analysis in the wooden fittings sector of Africa Construct in Zimbabwe from 1991 to 2022.
3. Develop a practical engagement model that effectively illustrates the dynamic relationship between electricity supply and labour productivity within the wooden fittings sector at Africa Construct in Zimbabwe from 1991 to 2022.
4. To provide recommendations to policymakers and industry stakeholders for improving electricity supply reliability and enhancing labor productivity in Zimbabwe's wooden fittings sector.

1.4 Research Questions

1. What is the strength and direction of the correlation between electricity supply and labour productivity in the wooden fittings sector of Africa Construct in Zimbabwe from 1991 to 2022?
2. How does the relationship between electricity supply and labour productivity evolve over the period from 1991 to 2022 in the wooden fittings sector of Africa Construct in Zimbabwe?
3. To what extent does electricity supply significantly influence labour productivity in the wooden fittings sector of Africa Construct in Zimbabwe from 1991 to 2022?
4. How can a practical engagement model be developed to visually represent the relationship between electricity supply and labour productivity in the wooden fittings sector of Africa Construct in Zimbabwe from 1991 to 2022?
5. What key variables should be considered in constructing an engagement model to depict the relationship between electricity supply and labour productivity in the wooden fittings sector of Africa Construct in Zimbabwe from 1991 to 2022?
6. What recommendations can be proposed to policymakers, utility providers, and industry stakeholders to improve electricity supply reliability and enhance labor productivity within Zimbabwe's wooden fittings sector?

1.5 Assumptions/ Hypotheses

This study has two hypotheses which are as follows:

Null Hypothesis (H_0): There is no significant impact of electricity supply on labour productivity in the wooden fittings sector of Africa Construct in Zimbabwe.

Alternative Hypothesis (H_1): There is a significant positive impact of electricity supply on labour productivity in the wooden fittings sector of Africa Construct in Zimbabwe.

This hypothesis suggests that the availability and reliability of electricity supply have a substantial effect on the labour productivity within the wooden fittings sector of Africa Construct in Zimbabwe. The alternative hypothesis anticipates a positive relationship between electricity supply and labour productivity, while the null hypothesis assumes no significant impact.

1.6 Significance of the Study

It is very important to examine and find out how electricity supply affects labour productivity the Wooden Fittings Sector in Zimbabwe.

- This study contributed knowledge by giving policy makers a guide when formulating policies aimed at encouraging investors to use the available resources and means, in generating more electricity in Zimbabwe.
- The findings of this study contributed knowledge to the general public, policy makers, regulatory authorities and economic planners on the impact of electricity supply on manufacturing sector in Zimbabwe.
- This study is a benefit to policy makers and economic planners in terms of using its findings in formulating and implementing appropriate policy measures towards accelerating economic growth through the manufacturing sector
- The results that were obtained in this study also contributed to the available literature on the current situation of the Interior Fittings sector in Zimbabwe in particular the Carpentry Industry.

- The empirical findings and analysis benefited by adding to the knowledge for future researchers who are going to implement the results of this study for further research.
- This document assisted the local authorities to see what percentage electricity has among other factors and help them to see the percentage effect it has on ultimate economy and fund the local entrepreneur. Entrepreneurship is the biggest driver to Zimbabwe's economy. So, this study assisted the local authority to see, with actual figures, how they are letting down entrepreneurs by not continually supplying electricity. It also assisted the current local electricity suppliers how they are going to lose out on profit generation since SME's are likely going to favor other sources of electricity in the near future apart from the national grid.
- The researcher was particularly committed to sharing the results of the analysis with the Zimbabwean business community with whom the researcher works, in the hopes that the work will not just be an extraction of truths but will give them information with which they can better control their business entities, lives and resources.

1.7 Limitations of the Study

- Quantifying SME firm activity in a developing country was a challenge.

  The first reason for this was data unavailability. Most Small to Medium Enterprises have little documentation and in some cases no documentation at all. This is because of their entrepreneurial structure. Most SME's are in their initial stages of growth - are mostly concerned with making profits in-order to fund their progression and might not necessarily see a need to gather data.

The second reason also was that a significant proportion of entrepreneurial activity in developing countries takes place outside the formal sector and is not captured by enterprise surveys.

Another reason was lack of consistency across data sets in the use of different definitions of small, medium and large-scale in reference to firms.

These limitations were be mitigated by the inclusion and consideration of SME's as important players in raising a country's economy and allowing their trading information to be captured in enterprise surveys. These limitations were also be mitigated by getting secondary data from websites that collect SME's information gradually.

- Respondents to this study were the business owners, senior managers and the workforce that provide labour. All of these were representatives of the sample of the private firm. Some of the data that was collected was based on their perceptions and recall hence therefore open to a subjective bias. This limited the potential for authentic comparisons with other firms and against surveys in other countries that have been collected over different years. A way that was used to mitigate getting biased responses (information) was to encourage and educate the respondents to give out valid and truthful information whenever they were responding to the researcher.
- The qualitative information collected for the study relied on semi-structured online interviews that are going to be conducted. Although their open-ended nature provides qualitative insights, these may reflect differing interpretations of key words and expressions by both interviewer and informants. This was mitigated by giving prior research material to Respondents so that they familiarize themselves to crucial

keywords. These materials included detailed definitions and explanations of terms and full expansion of abbreviated words or terms.

- Some of the interviews carried out in this study were conducted in the local languages and hence incited language barrier. This was mitigated by introducing a translator during the course of the interviews. Another option that was used was the freely accessible online applications Google Translate or iTranslate Voice 3 which are easily available online. These were used by the Researcher to translate the local languages into English for easier communication.
- It was crucial to note that Interior Fittings /Wooden Fittings is a time-conscious business with working hours normally from 7AM to 6PM hence was especially difficult to gather observational data during the later hours of the day. This limitation was diminished by avoiding doing data collection at times after 6PM. The researcher adhered to a strict research time only from 7AM to 6PM only.
- Time is a limitation, and a study conducted over a certain interval of time is a snapshot dependent on conditions occurring during that time.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter discussed the overview of the company under study as well as giving an overview of Zimbabwe's Wooden Fittings sector. An overview of the contributions and documentation that other researchers have done in different parts of the world outlined the theoretical framework for the study. The chapter concluded by stating the relevance of the theoretical frame to the study. The literature review identified published literature, which falls into two broad categories: statistical analysis, and qualitative approaches.

This study investigated the phenomenon that many of the studies that have been carried out before have never tried to look at. These are the behavioral effects of electrical supply on labor. This study investigated this phenomenon through both statistical and qualitative approaches. The majority of the studies that have been carried out were done using data gathered from big established organizations in 2nd world countries. This information has somewhat a bias since it is not reflective of smaller to medium organizations. Zimbabwe, a 3rd World Country with its economy being made from many of these SME's, has to have a study that is practical according to its current situation .This study has intentionally narrowed down to study a very small enterprise in order to give a world view knowledge on how electricity affects small companies.

Most of the studies that have been carried out before have focused on electricity consumption and most of the results obtained have revealed positive relationship between electricity and manufactured output. These past Researchers have used different estimation techniques ranging from VAR, ARDL and Engle-Granger while some carried out surveys. This study however seeks to estimate using a hybrid of the Cobb Douglas Production function and Real Business Cycle (RBC) Theory and applying a Cointegrated VAR methodology.

2.2 Theoretical Framework

According to Grant & Osanloo (2014), Theoretical Framework is the 'blueprint' or guide for research. It is a framework based on an existing theory in the field of inquiry that is related and/or reflects the hypothesis of a study. It is a blueprint that is often 'borrowed' by the researcher to build his/her own house or research inquiry. It serves as the foundation upon which a research is constructed. The theoretical framework guides the researcher so that s/he would not deviate from the confines of the accepted theories to make his/her final contribution scholarly and academic (Sinclair, 2007).

In this section, the researcher discussed The Cobb-Douglas production function as a production theory. The researcher chose to use the indicated theory, to derive ("or borrow") constructs, principles, concepts, and tenants of a theory in order to underpin the knowledge base of the phenomenon to be investigated. The phenomenon being investigated/tested as part of our main study objective being to test the relationship between electricity supply and productivity, ascertain what percentage of significance electricity has in productivity and then to develop an engagement model between electricity supply and labour productivity based off the Cobb Douglas Function.

2.2.1 Cobb-Douglas production function

The following is the history behind the development of the Cobb Douglas Function. The Cobb-Douglas production function is frequently used to analyze the supply-side performance and measurement of a country's or a firm's productive potential. This functional form, however, includes the assumption of a constant share of labor in output. However a constant share of labor may be too restrictive for a small to medium enterprise or progressing third world country.

Mpatane (2015) states that the Cobb-Douglas production function is one of the widely used production functions in presenting how two or more inputs (capital and labour) can be used to produce a certain amount of output. Other Multitudes of authors have subscribed to this theory due to its robustness in quantifying output based on capital and labour. The function was introduced by Wicksteed (1894) and was put to test by Cobb and Douglas (1928) when modelling the growth a country's economy for the period 1899 to 1922. Cobb and Douglas (1928) wanted to find out the amount of labour and capital that are used to produce the volumes of goods and to determine the relationship between labour capital and productivity. Later on Gujarati and Porter (2009) further expanded the production function and proved that the theory had Constant Returns to Scale (CRS). A constant Returns to Scale happens when an increase in inputs (capital and labour) causes the same proportional increase in output. Constant Returns to Scale occur when increasing the number of inputs leads to an equivalent increase in the output. The two scientists also established that when using the production function and trying to test it in the short term at least one of the inputs (variables) was supposed to be fixed. In vice versa they also established that when one wants to use the production function to depict and do tests in the long run (long term) none of the inputs were supposed to be fixed. The main objective of these authors was to explain the business cycle by fluctuations in the rate of technological progress (Gujarati and Porter, 2009)

Capital and labour were found to be the key determinants of production output. Production was measured as the total monetary value of all goods produced in a year, labour as the total number of people per hours worked in a year and capital as the monetary value of all machinery, equipment and buildings. The function used by Cobb and Douglas (1928) was modelled as follows:

$$Y = AL^{a} + K^{\beta}$$

OR

$$F(L,K) = AL^{a} + K^{(1-a)}$$

Where:

- Y represented total production | GDP
- K was capital and
- L was labour.
- A represented the level/state of technology
- α and β represented the ratios of capital and labour to total output respectively.
- A, α and β are positive constants.
- The assumption was that 0<α <1 and β>1 so that the firm has decreasing marginal product of labour and capital.

- According to the function, if α + β = 1, the firm has constant returns to scale meaning that if K and L are each increased by for example 10%; Y will also increase by 10%.

The Cobb-Douglas production function was made under the following assumptions:

- Y^1 represent actual production Y
- Y^1 Approaches zero as either labour or capital approaches zero.
- The marginal productivity of labour is proportional to the amount of production per unit of labour
- The marginal productivity of capital is proportional to the amount of production per unit of capital.
- When Labour (L) increases the Marginal Product of Labour (MP_L) increases.
- When Capital (K) increases the Marginal Product of Capital (MP_K) increases.
- To Test or Use the Production Function in the Short term at least one of the inputs has to be fixed.
- To Test the Production Function in the Long term none of the inputs have to be fixed.

When performing the mathematical analysis, Cobb and Douglas presented their function as:

$$Y = bL^{\alpha} + K^{1-\alpha}$$

Where b is independent of labour and capital while α is constant.

When formulating this function, the assumptions were that:

- Capital values grew from year to year as the money value of goods produced,
- Cobb-Douglas production function was made under the assumption that production output dies out as either labour or capital vanishes.
- In real terms, a decrease in labour does not necessarily mean production will decrease as that decrease may be due to machinery that has been found to produce more goods than people. It has also been assumed that if either labour or capital is doubled, production output will also double. This could not be the case in real world. Capital may be doubled but not result in a double increase in output. There are other factors like electricity which is required for continuous operation of the machines. Because electricity supply is not consistent, load-shedding and brownouts may lead to insufficient use of these machines and as a result production output may not be as much as it was expected.
- The second assumption of the Cobb-Douglas production function is that the ratios of labour and capital to total output are constant. This assumption does not hold, mainly because labour and capital can be substituted for each other in the production of one good. There are goods that require more labour than machinery while others need more

machinery than labour. Because of the rapid change in technology, firms use advanced machines and equipment which are operated by two or three people for the production of their goods resulting in less labour required.

2.2.2 Real Business Cycle (RBC) Theory

Real business cycle theory was developed by a group of researchers in the 1990s. Kydland and Prescott (1996) were the first authors to contribute to RBC theory followed by Long and Plosser (2003). It was further expanded by Mankiw (2007). The main objective of these authors was to explain the business cycle by fluctuations in the rate of technological progress (Gujarati and Porter, 2009). In the basic version of RBC theory, the impulse initiating the business cycle is a shock to productivity which is propagated through the economy via its impact on capital accumulation and the resulting effect on productive capacity. According to this view, the employment fluctuations found during business cycle reflect voluntary movements along individual labour supply curves. This occurs when workers choose to enter the labour market or to work extra hours when real wages are unusually high due to a high level of productivity. On the other hand it could happen where labour supply is reduced when productivity and real wages are unusually low relative to their underlying growth trends. The real business cycle theory is modelled as:

$$P_t = K_t^a (A_t L_t)^{1-a}$$

Where;

- $0 < \alpha < 1$
- P is total output,

- K is the capital stock at the start of the period t,
- L is total labour input during that period measured in hours worked and the parameter.

At captures labour augmenting technical progress increasing the productivity of labour over time

As the term indicates, the real business cycle model is indeed real and contains no nominal values. The model can only be used to simulate fluctuations in the cyclical components of output and labour input. The RBC theory has a problem explaining the observed fluctuations in aggregate employment as the outcome of intertemporal substitution in labour. The theory assumes that workers voluntarily choose to work less when real wages are relatively low and vice versa. In real terms, not everyone will work less when real wages are low, some employees may choose to be more productive with the hope that they will get promotions or increase in wages.

2.3 Conceptual Framework

A conceptual framework is a structure which the researcher believes can best explain the natural progression of the phenomenon to be studied (Camp, 2001). It is linked with the concepts, empirical research and important theories used in promoting and systemizing the knowledge espoused by the researcher (Peshkin, 1993). It is the researcher's explanation of how the research problem would be explored. The conceptual framework presents an integrated way of looking at a problem under study (Liehr & Smith, 1999).

In a statistical perspective, the conceptual framework describes the relationship between the main concepts of a study. It is arranged in a logical structure to provide a picture or visual display of how ideas in a study relate to one another (Grant & Osanloo, 2014).

Researchers are at liberty to adopt existing frameworks, but have to modify it to suit the nature of the context of their research as well as the nature of their research questions (Fisher, 2007)

Miles and Huberman (1994, p.18) opine that conceptual frameworks can be ‘graphical or in a narrative form showing the key variables or constructs to be studied and the presumed relationships between them.’

The conceptual framework is going to offer the researcher the opportunity to construct his worldview on the phenomenon to be investigated.

The Researchers is going to adopt the existing framework but has modified it to suit the nature of the context of their research. The researchers is going to develop his conceptual frameworks from the theories that underpin this research

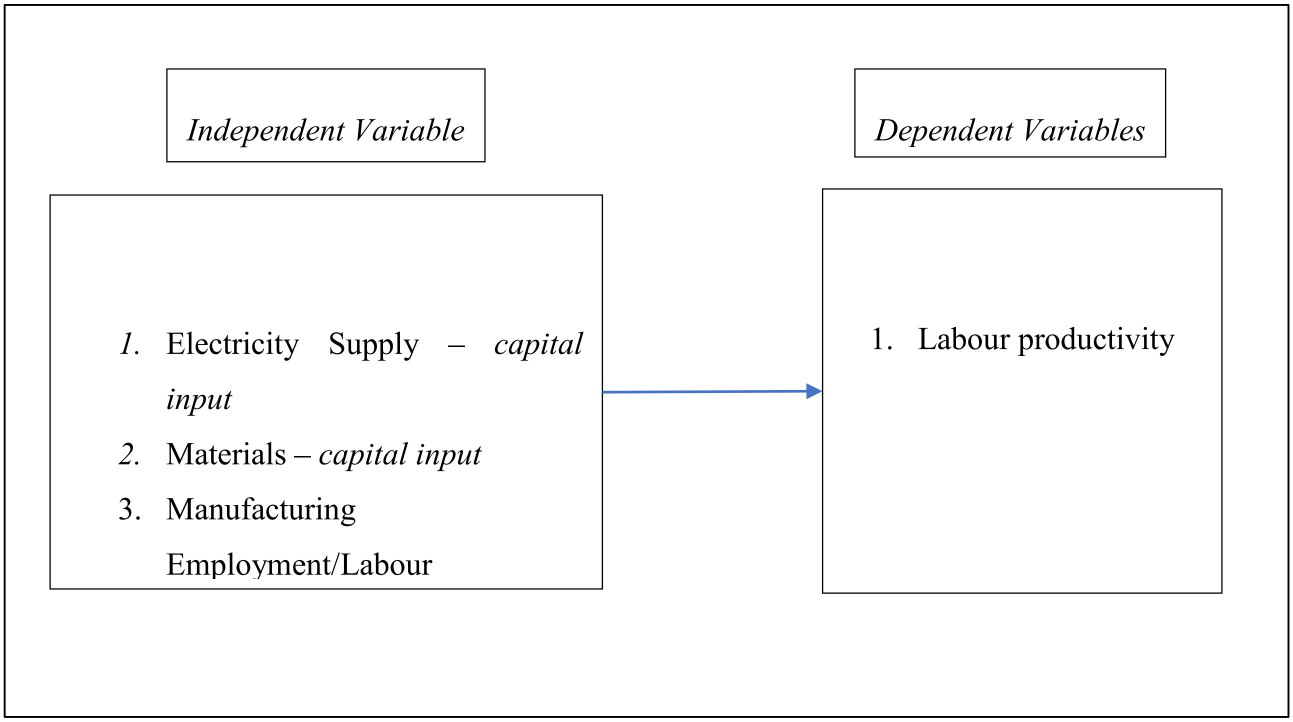

Figure 2.3.1 : Conceptual Framework

After the theoretic framework study has been conducted, the research findings accrued must corroborate, extend, or modify the existing theory that was borrowed for the study (Golder et al., 2022). The researcher may critique, develop and/or expand the theory that served as a guide for the study

2.4 Model Specification

The researcher came up with two model estimations: one, based on the Cobb Douglas Production Function and the other one based on a Multivariate framework by Ziramba (2009)

2.4.1 Model 1:

To determine the impact of electricity supply on labour productivity the researcher adopted a multivariate framework. Ziramba (2009), introduces this multivariate framework in his study. This study adopts and modifies the multivariate framework.

In his original study, Ziramba, models Industry production as a function of disaggregated electricity consumption and manufacturing employment. Ziramba (2009) included employment in a framework to allow for substitution possibilities between energy use and labour.

Therefore, in this study manufacturing employment = Labour + Energy Used

This study substitutes disaggregated energy consumption with electricity supply and includes manufacturing employment (i.e. energy use + labour).

Labour Productivity (in million Zimbabwean Dollar) is modelled as a function of manufacturing employment and electricity supply.

The common link between the model used in this study and the theoretical review is that labour is included as one of the explanatory variables.

The empirical model can be specified by the model below:

$$\boldsymbol{LP_t} = f(\,ME, \boldsymbol{ES}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

Where:

$\boldsymbol{LP_t}$= Labour Productivity ((in million Zimbabwean Dollars)

ME = Manufacturing employment = Labor + Energy Used

ES = Electricity supply (in gig watts-hour)

The effect of electricity supply and manufacturing employment on Labour Productivity is expected to be positive. In a linear form, equation 1 can be presented as:

$$\boldsymbol{LP_t} = \alpha + \beta_1 ME_t + \beta_{42} ES_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

α = Intercept

β_S = Slope Coefficients

μ = Error term

All the variables are converted to logarithms. This is done to obtain elasticity coefficients on the variables and minimizing the impact of outliers. The model is thus of the form:

$$\boldsymbol{lnLP_t} = \alpha + \beta_1\, lnME_t + \beta_2\, lnES_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

lnLP is a logarithm of Labour Productivity lnME is a logarithm of Manufacturing Employment

lnES is a logarithm of electricity supply from all producers in Zimbabwe in gigawatts hour

According to Nerlove (2020), the target variable is placed last in the ordering so that its impact on the dependent variable can be observed when performing the General Impulse response Function (GIRF). The variables that are not caused by other variables in the model are placed first in the list of ordering.

2.4.2 Model 2

To determine the impact of electricity supply on labour productivity the researcher adopted and modified the Cobb Douglas production function.

In This section, the Researcher presents a model of how electricity supply affected labour productivity. The daily production function is a Cobb-Douglas aggregate of capital, labor, electricity, and materials, with physical productivity A_{it}

T indexes points in time, which we refer to as "days." Every day, a plant uses capital K, labour L, electricity E, and materials M to produce output Q.

Q_{itT} denotes the output for plant *i* in year *t* on day T , and $Q_{it} \equiv \int_{T}^{0} QitT \;\; dT$ representing the yearly aggregate. The measure of "days" in a year is normalized to one. We do not model the possibility for inter-day substitution.

T indices = Time (in days)

K = Capital

L = Labour

E = Electricity Supply

M = Materials

Q = Output

P= market price

Q_{itT} = output for plant *i* in year *t,* on day *T*

$Q_{it} = \int_{T}^{0} QitT \; dT$ = annual aggregate

$$Q_{it} = A_{it}K_{itT}^{aK}\, L_{itT}^{aL}\, M_{itT}^{aM}\, E_{itT}^{aE} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

Since we observe revenues rather than physical quantities produced, we need to relate revenues to our production function in Equation (2). We assume that plants sell into a perfectly competitive output market with price p, and we define revenue productivity (TFPR) as

$\Omega_{it} = A_{it} \text{ x } p.$

This yields the following daily revenue-generating production function:

$$R_{itT} = \Omega_{it}\; K_{itT}^{aK}\, L_{itT}^{aL}\, M_{itT}^{aM}\, E_{itT}^{aE} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

2.5 Empirical Literature

2.5.1 Overview of Zimbabwe's Interior Fittings/Manufacturing sector

According to the Economic Forum Report, 2018, the wooden Fittings Sector under Carpentry manufacturing has a substantial direct employment creation potential and is central to the Zimbabwean export strategy. The sector has labour intensive tradable productions that generate revenues that have a significant positive impact on the balance of trade. The sector is mostly filled with small to medium sector companies (Mutukwa & Tanyanyiwa, 2021).

2.5.2 Overview of Zimbabwe's electricity sector

According to ZERA the countries energy consumption in Zimbabwe is one of the lowest in the world pumping out power as low as 7687 GWh in 2017 and 8505 GWh in 2018.

	2018 GWh	ZERA target	ZERA Variance (%)	2017 GWh	YTD Variance (%)
Distribution Sales (GWh)	8,505	8,760	-3%	7,687	10.6%

Figure 2.5.2.1: Energy Consumption in 2018

According to ZERA's publication in 2019, non-commercial energy sources, such as wood, animal wastes, and crop residues, are estimated to account for over half of the country's energy consumption. Zimbabwe has small reserves of oil and coal, and has very small natural gas resources and depends primarily on importation (ZERA, 2018).

According to ZERA (2018), year to date supply interruptions in 2018 were 110 against a target of 120. This resulted in a good performance of 8% above target. Interruptions recorded in 2017 were 125.

The yearly average duration of interruptions was 204 minutes against a target of 120 minutes in 2018 and this is attributable to delayed reaction to faults and a deficient infrastructure maintenance regime. For comparison in 2017 the number of minutes of Interruptions realized were 94 minutes. Transmission unserved Energy which was undelivered due to transmission system in 2018 resulted in 8.46 GWh being lost.

Electricity is the major source of power in Zimbabwe. It the country’s source of power that is used for most of the country's the economic activities (ZERA Annual Report, 2018). The bulk supply is produced at the Kariba Dam Hydroelectric Power Station 3850 GWh in 2017 and 5377.28 in 2018. At the Hwange Thermal Power Station which is the second highest was at (3202GWh) in 2017 and 3425.17 in 2018. This was a 7% Change; only three-fourth of which is considered to be available (ZERA, 2018).

Only 40% of the population has access to electricity with a per capita availability of 1360 GWh per annum. This is a result of the increased frequency in load-shedding as well as the general and common unavailability of electricity to households and Industry (World Bank, 2018).

According to the Chipango (2021), problems in the Zimbabwe electric power sector include, corruption in administration, high system losses, and delays in completion of new plants, low plant efficiencies, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance and low water levels at Kariba.

Zimbabwe's energy infrastructure is quite small, insufficient and poorly managed. Overall, the country's generation plants have been unable to meet system demand over the past decade. In generating and distributing electricity, the failure to adequately manage the load leads to extensive load shedding which results in severe disruption in the industrial production and other economic activities (World Bank, 2018)

Description	2018	2017	Target	Variance -2018/ Target (%)
Number of Interruptions	110	125	120	8%
Average duration of interruptions (minutes) - SAIDI	204	94.5	120	70%
Unserved Energy (MWh)	8.46	4.03	1.875	351%
Voltage excursions	298	288	168	77%

Figure 2.5.2.2 : Transmission Quality of Supply Parameters

According to Our_World_In_Data website, the countries' energy consumption per capita in Zimbabwe is one of the lowest in the world pumping out power as low as 513kWh in 2017, 506KWh in 2018 and 452 KWh in 2019.

2.5.3 Overview of Previous Studies

Miketa and Mulder (2005) conducted a study that examined the relationship between energy productivity and 10 manufacturing sectors in 56 developed and developing countries. The developed countries included 24 OECD countries from North America, the Pacific, and Western Europe, while the developing countries included 32 non-OECD countries. The manufacturing sectors were chosen based on the International Standards Industrial Classification (ISI), and the study covered the years 1971 to 1995, with a second period of study from 1995 to 2005.

Miketa and Mulder (2005) developed and employed a cross-country method. The study calculated average annual growth rates of energy productivity and conducted a convergence analysis in order to examine patterns of international energy productivity developments at sectorial level. Energy production was measured as output per final energy use. The outcomes obtained revealed that cross-country differences in energy tend to decline more especially with the less energy-intensive sectors except for the non-ferrous metal sector. Energy productivity growth was found to be higher in all manufacturing sectors particularly in countries that initially lagged behind in terms of energy productivity levels. Evidence of countries converging to different steady countries was observed while several others failed to catch-up.

Another study on the relationship between electricity supply and manufacturing output, is a study that was done by Yakubu, Manu and Bala (2015). The study examined the relationship between electricity supply and manufacturing output in Nigeria and employed autoregressive distributed lag (ARDL) as a research technique. Annual time series data covering the period 1971 to 2010 was used. A long run relationship between the variables was observed. Manufacturing output was found to be possibly depending on electricity supply both in the short run and long run but only significant in the long run.

The study done by Yakubu et al (2015) is more related to this study except for the methodology that was used. The results obtained are favorably comparable to the literature. In terms of methodology, Yakubu et al (2015) employed ARDL model while this study is going to use co-integrated VAR (Vector Auto regression). ARDL (Autoregressive Distributed Lag) model is said to be more efficient for small samples or limited observations especially in developing countries. Nigeria is a developing country but the sample size that was used by Yakub et al (2015) is not small (1971-2010) which makes the ARDL model to be unfit for their study. There exists a gap in terms of methodology used by Yakub et al (2015), and therefore this study seeks to close this gap by using co-integrated vector autoregressive (VAR) model.

Allcott, Collard-Wexler and O`Conell (2015) conducted a study estimating the effect of electricity shortages on Indian manufacturing using Cobb-Douglas production function model. A time series data from 1992 to 2010 on weather, power sector and manufacturing production was used. The results obtained showed that power shortages slowed down productivity in the manufacturing sector.
This resulted in revenue reduction of 5.6 to 8.6 percent for the average plant in a short run. The results have also shown that producer's surplus dropped 9.5 percent for the average plant, of which 3.9 percent was due to capital costs incurred for backup generators. It was also discovered that in the short run plants reduced their inputs in response to electricity shortages and that led to a decrease in total production. Alkott, Collard-Wexler and O`Conell (2015) focused on the shortage of electricity and how it affects manufactured output while this study focuses on how electricity supply affect manufactured output.

Aschauer (1989), studied the relationship between aggregate productivity and stock and flow of government spending variables in the US economy for the period 1949-85. In his estimations, using a general Cobb-Douglas production function, he treated government spending on public capital as one of the inputs in the production function and proxy for infrastructure variables, like electricity. After tests he came out with results which suggest that there is a strong positive relationship between output per unit of capital input, the private labour capital ratio, and the ratio of the public capital stock to the private capital stock. Mas et al. (1996) reports the regional dimension and temporal dimension of the impact of public capital on productivity gains. Using data for Spanish regions over the period 1964-91, they estimate a Cobb-Douglas production function by means of panel data techniques to control for unobserved state-specific characteristics. They establish that economic infrastructure has a significant positive effect on productivity, but social infrastructure does not. However, the problem with using composite indicators is that it becomes difficult to disentangle the productivity impact of a specific infrastructure indicator, like power.

Ali (2020). used a demand function to investigate the relationship between electricity consumption, output and price in the Malaysian manufacturing sector. The study employed annual time series data and covered the period 1978 to 2011. In the long run, electricity consumption, output and price were found to be co-integrated. Evidence of a positive relationship was found between electricity consumption and manufactured output. A long run, a unidirectional relationship from manufacturing output to electricity consumption was also obtained. Results obtained for the short run showed a unidirectional relationship running from electricity consumption to output. This indicates that in the short run, a decrease of energy usage in production might lead to a reduction in output growth.

Yurdakul & Kazan (2020) conducted a research in which they investigated the relationship between energy and production with evidence from the Turkey manufacturing sector. A multivariate framework was used in examining electricity consumption and value-added relation while also taking into account labour and fixed investment. Annual time series data from 1968 to 2002 was employed. A three cointegration vector was obtained between the variables showing evidence of a long run relationship among the variables. . Evidence of a unidirectional causality running from electricity consumption to manufacturing value added was found. The study also discovered manufacturing output positively responded to positive shocks electricity consumption through the use of generalized impulse response and variance decomposition.

In all the studies that have been discussed, a positive relationship between electricity and manufactured output was observed though the focus was more on the consumption side of electricity.

Among studies which focused on the impact of electricity on manufacturing sector is a study that was conducted by Scott, Darko, Lemma and Rud (2014). Scott et al (2014) examined how electricity insecurities affect businesses in low and middle income countries. The main aim was to assess and quantify the impact of electricity insecurities on firm productivity and competitiveness and how it affects their investment decisions for start-up and expansion. The results obtained by Scott et al (2014) revealed that electricity insecurity negatively affect total factor productivity and labour productivity of manufacturing SMEs. However this was not the case in all manufacturing SMEs as some had higher productivity. Variations in the findings between countries is associated with differences in geography, structure of the economy and business environment.

Moyo (2013) conducted a study on which the impact of the quality of power infrastructure on productivity in African manufacturing firms was examined. Data was sourced from the

World Bank enterprise surveys covering the period 2002-2005. Five Sub-Saharan African countries namely South Africa, Zambia, Uganda, Mauritius and Tanzania were used in this study. The firms were drawn from six International Standards Industrial Classification (ISI) industries in 28 towns and cities. Moyo (2013) employed the Cobb-Douglas production function to measure plant level total factor productivity (TFP) while estimates were done using Ordinary Least Square methods. Power infrastructure quality was measured by using the number of hours per day without electricity and the percentage of output lost due to outages. A cross-sectional model was estimated and the study also accounted for individual country and sector heterogeneity by using country and sector dummies.

The results obtained showed that the impact of power outages on productivity differed from one country or sector to another depending on the experiences on electricity problems that each country had. A high number of hours without electricity as well as high percentages of output lost due to power disruptions were expected to negatively affect productivity. Negative and significant results were obtained in Uganda, Zambia and Tanzania as well as in the food and agricultural sector implying that poor quality infrastructure negatively affect productivity in these countries.

2.6 Summary

The study discussed some of production theories including the Cobb-Douglas production function, Real Business Cycle Theory and the Constant Elasticity of Substitution (CES) production function. In addition to these theories, a number of studies on electricity and manufactured output were reviewed. Although most of these studies focused on electricity consumption, most of the results obtained revealed positive relationship between electricity and manufactured output.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used in the process of carrying out this study. The chapter laid out the study's design, and its research settings; while setting out the study population, sampling methods, data collection and analysis thereof. The chapter explained the ethical considerations that related to the study. The Researcher specified the model and the estimation technique used to determine the impact of electricity supply on productivity in the Zimbabwe's Interior Fittings sector's output. The chapter also identified the data to be used in the models.

3.2 The Research design

In order to satisfy the objectives of the dissertation, the researcher adopted both qualitative and quantitative research approaches to form a Mixed Methodology approach i.e. a hybrid approach. Mixed methods is the collection and "mixing" or integration of both quantitative and qualitative data in a study, (Creswell, 2004).

Justification for use of a qualitative research was because of the small sample that the researcher tested and got data from. The basic advantage of a Qualitative Research, which also constitutes its basic difference with quantitative research, is that it offered a complete description and analysis of a research subject, without limiting the scope of the research and the nature of participant's responses.

However some of the outcomes of the research were measurable and quantifiable hence it was not the best choice to adopt a qualitative research alone. Due to the type of numerical big data that was required for collection and data processing a Quantitative Research method that was also going to be adopted. Hence the two approaches combining to form a Mixed Method Research.

The research was considered as a case study research. In definition, a Case study research is a type of research study where a single phenomenon is explored in a natural setting through making use of a variety of methods in order to obtain in-depth knowledge, (Collis and Hussey, 2009). In fundamental nature, the case which was examined is the SME organization (i.e. Africa Construct–Zimbabwe).

This research study cascaded within the positivistic research paradigm and the interpretivist research paradigm. As a philosophy, positivism adheres to the view that only "factual" knowledge gained through observation, including measurement, is trustworthy. In a positivistic research, the role of the researcher is limited to data collection and interpretation in an objective way. In these types of studies research findings are usually observable and quantifiable (Collis and Husset, 2009).On the other hand, the term interpretivist involves researchers to interpret elements of the study, thus interpretivism integrates human interest into a study. Accordingly, "interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments". Development of interpretivist philosophy is based on the critique of positivism in social sciences. Accordingly, this philosophy emphasizes qualitative analysis over quantitative analysis (Cresswell, 2004).

“Interpretivist /interpretive research” is often used loosely and synonymously with “qualitative research”, although the two concepts are quite different. Interpretive research is a research paradigm that is based on the assumption that social reality is not singular or objective, but is rather shaped by human experiences and social contexts (ontology), and is therefore best studied within its socio-historic context by reconciling the subjective interpretations of its various participants (epistemology), (Easterby-Smith, Jaspersen, Thorpe & Valizade, 2021) .

Both quantitative data and qualitative data were collected from research subjects through means of questionnaires. The Researcher prepared questionnaires going to respondents comprising of 6 multiple choice questions, 3 yes/no questions, and 8 open-ended questions. All research subjects were approached online and questionnaires were distributed and disseminated to them through use of the Google Online questionnaires platform.

3.3 Population and Sampling

3.3.1 Target population

According to Creswell (2013) population is a group of individuals or participants with the specific attributes of interest and relevance.

The target population consisted of research candidates from the organisation. The population list is the total number of employees in the organisation. The population size was 258 people.

3.3.2 Sampling methods

Christofi et. al. (2021) state that sampling is a procedure through which a representative subset or portion of the complete population is chosen and analysed so that the researcher will have the ability to draw conclusions concerning the whole population. The Sampling technique to be used by the researcher is the Simple Random Sampling**.**

Easterby-Smith, Jaspersen, Thorpe & Valizade, (2021) state that Simple Random Sampling is a type of probability sampling in which the researcher randomly selects a subset of participants from a population. Each member of the population has an equal chance of being selected. Data is then collected from as large a percentage as possible of this random subset.

For randomly selecting the sample, The Sample Calculator that was used is the Rao-soft Sample Size Calculator from (Raosoft, 2023). In order to come up with a sample, the Researcher used the Simple Random formulae from Raosoft and came up with a sample size of 156.

$$n = \frac{N}{1 + Ne^2}$$

$$n = \frac{258}{1+258(0.05)^2} = 156$$

N = Population, n = sample size, e=error level of 0.05, Confidence level =0.95

The population was divided it into strata according to the different departments that are available in the organisation. The organisation had 7 departments namely Accounting, Human Resources, IT & Design, Research & Development, Workshop, Sales &

Marketing and lastly Transport & Logistics. The number of employees that was in each department is stated below;

Table 3.3.2.1: Population distribution

Department	Number of employees
IT Department	25
Accounting	24
Human Resources	95
Research & Development	22
Workshop	13
Transport & Logistics	34
Sales & Marketing	45
Total	**258**

In this study the strata referred to groups of similar people. The researcher stratified by department. A proportion was applied to determine which number of people where to be selected in each department or Strata.

After allocating the Proportion of department population against the entire population and plugging all parameters into the Rao-soft random calculator as well as the Excel Calculations sheets the following are results of samples from each department:

Table 3.3.2.2: Distribution of sample

	Count (Department Population)	Population Size ÷ Department Population	Proportion		Sample Size (Per Department)
IT Department	25	25/258	0.0969	0.0969 * 156	15
Accounting	24	24/258	0.0930	0.0930 * 156	15
Human Resources	95	95/258	0.3682	0.3682 * 156	57
Research & Development	22	22/258	0.08527	0.08527 * 156	13
Workshop	13	13/258	0.0504	0.0504 * 156	8
Transport, Logistics & Dispatch	34	34/258	0.1317	0.1317 * 156	21
Sales & Marketing	45	45/258	0.1744	0.1744 * 156	27

Department	**Number in sample**
IT Department	15
Accounting	15
Human Resources	57
Research & Development	13
Workshop	8
Transport, Logistics & Dispatch	21
Sales & Marketing	27
Total	**156**

Total sample size was 156.

3.4 Data Collection Instruments

3.4.1 Secondary data

Secondary data is the past data that was be used by the investigator, which had originally been gathered by some other person or organisation for some other purpose.

The researcher used secondary data obtained from the target Company's website, internal records, financial results, published studies, surveys and any other authoritative sources detailing their utilization and adoption of electrical power and all operations involving labour input.

3.4.2 Primary data

Primary data was the real- time data that was collected by the Researcher for the very first time from different sources of origin. The researcher gathered primary data from the company using the listed research instruments.

The Researcher used Questionnaires Direct Interviews and Personal Observation.

a) Questionnaires

Questionnaires were developed by the researcher for the sole purpose of gathering data from the participants. The type of Questionnaires that were used were Open-ended and Close-ended Questions in different sections.

The questionnaires comprised of sets of questions which had a section of close ended questions. This allowed quantitative data to be collected which was transformed into numerical data for analysis. The other section had open-ended questions. This allowed for the collection of qualitative data.

b) Interviews

The researcher hosted interviews and asked both open ended and close ended questions to the randomly selected sample. Although open-ended questions awarded participants the freedom to answer in their own words, it was difficult to code their responses in a way that made it easy for analysis.

The Research Instruments that were used were: Interview Schedules and Guides

c) Personal Observation

The researcher used of both Structured and unstructured observation of the employees during their natural working environment. This was the first-hand data collected on the ground. The Researcher watched and listened to the behaviour of the employees over time without manipulating or controlling the setting. The researcher recorded and documented all findings in ways that allowed some degree of analytical interpretations and discussion. As forms of Research Instruments, the Researcher made the use of:

- Observation forms
- Performance Checklists
- Time and Motion Logs
- Flow Charts
- Self-Check Lists

3.5 Pilot Study

Since the Questionnaire was an original document created for the first time by the researcher he carried out a pilot study in order to do a Reliability test of the Questionnaires.

3.6 Data Collection Procedure

The Researcher was given permission from the school to conduct distribution of research instruments within the organisation. Due to the current COVID-19 requirements the researcher abandoned the use of physical questionnaires and followed the use of Online Survey Questionnaires using Google Docs. The link to the online Questionnaires was circulated among the selected sample. The Questionnaire was set with an option of access and viewing at any time of the day.

The researcher administered and conducted online interviews with the selected sample. A set of open and close ended questions were asked by the researcher. The researcher scheduled adequate times in order to have an interview segment with each of the respondents. Each segment was 30 minutes long.

The Researcher got permission from the organisation to carry out real – time observations of participants. Dates were set aside when the researcher was present during working hours. The researcher monitored Respondents activities and recorded relevant information necessary to the study.

3.7 Analysis and Organization of Data

3.7.1 Data Analysis tools

Data processing instruments that were used by the researcher were E-Views, SPSS and EXCEL.

MS Excel was used to be collect and tabulate quantitative data from the participants. The data was analysed using E-Views and SPSS. This assisted in determining statistical proportions. Audio Recording were used to capture information from the respondents. The researcher went and put the qualitative data from the audio recordings as well as notes from interviews into different thematic areas in Microsoft Word format. For improved organisation of data, tables and graphs were utilised for further analysis of data.

Since the study is also quantitative in nature, the quantitative data was analyzed using descriptive analysis and descriptive statistics. This assisted in summarizing the data and finding important patterns in the data. Frequencies, means and percentages were gathered from the descriptive statistics. Data was subsequently analyzed together with the E-Views and SPSS package applications.

Summary statistics, measures of spread (range, variation, standard deviation and coefficient of variation), measures of central tendency (mean, mode or median) were used to present and analyze data gathered from this research.

3.8 Ethical Considerations

The following ethical considerations were taken into account for this research study (Collis and Hussey, 2009): voluntary participation, privacy and anonymity, knowledgeable consent, protection from harm, and confidentiality.

The researcher sought for permission to carry out the study from the university and obtained a confirmation letter from the university. The confirmation was used to verify to participants that the research had been approved by the relevant authority and that it was a legal procedure.

The researcher also sought consent for participating in the research, to use an audio recorder and to take notes via pen and paper during the interviews. Before going through with the procedure, the researcher went to explain to the respondents the purpose of the interviews and surveys, as being for academic purposes.

Names of respondents were treated with the utmost confidentiality and anonymity.

3.9 Summary

This chapter has detailed the way in which data was collected and analysed for the research on impact of electrical supply on labour productivity.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

In this Chapter the Researcher specified the model to be used and the estimation technique to be used to determine the impact of electricity supply on labour productivity. The chapter also identified the data to be used in the models.

The chapter also explained the research findings and it provides data analysis gathered through questionnaires.

The results of the unit root tests and the tabular analysis for the variables used in the model are presented in this chapter.

In order to establish the long run relationship among the variables, Johansen (1991, 1995) co-integration and NJ Granger test was conducted. This was followed by the estimation of the vector error correction model and diagnostic tests.

The next section of this chapter presents the findings while the last section concludes the chapter.

4.2 Data Presentation and Analysis

4.2.1 Data type and sources

The data was based on the following variables namely; Electricity Supply, Labour Productivity, Inflation rate, Manufacturing Employment & Materials. The data that was used in this study is obtained from ZERA, ZETDC, & ZESA, heglobaleconomy.com, ourworldindata.org, yearly books and other websites in comprehension with observable data. Financial Data was also gathered from the Company Headquarters.

4.2.2 Questionnaire Response Rate

The questionnaires were circulated within the organisation the in Harare. 156 people were targeted for response of however 86 questionnaires returned on time giving a response rate of 55%. Below is the table showing response rate for questionnaires. The reasons for that return was some of the respondents were not accessible during the Pandemic period.

Table 0.1: Questionnaire response rate

Response by Small to Medium enterprises	Frequency (number)	Per cent (valid)
Questionnaires returned	86	55%
Questionnaires not returned	70	45%
Total number of questionnaires	**156**	**100%**

4.2.3 Demographic Data and Gender Distribution

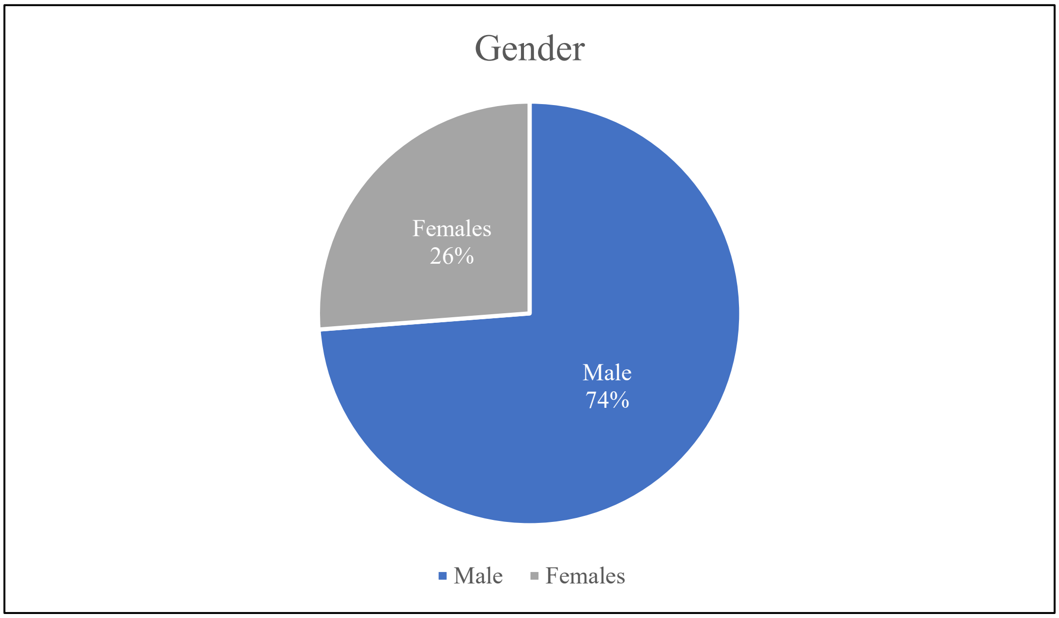

Figure 0.1: Gender distribution within the organisation

Figure 4.1 above shows that the majority of research participants in the organisation who were part of the study were females 26% compared to males 74%. This shows the gender dynamics and structure within the entrepreneurial organisation.

Table 0.2: Age Distribution

Variable **n=119**	**Category**	**Frequency**	**Percentage**
	18 – 30	23	27%
	31 – 40	35	41%
AGE	41 – 50	18	21%
	51 and above	9	11%
	Total	86	100.0%

Table 4.2 shows the age distribution of the study participants who were part of this study. The results shows that the majority of respondents 41% (35) of employees were between the ages of 31 – 40 followed with those between 18 – 30 years of age who constituted 27% of the study. A considerable 21% were between the ages of 41 – 50 whilst the remaining 11% constituted of the elderly who were above 50 years of age.

Table 0.3: Educational background of participants

Variable **n=86**	Category	Frequency	Percent
	O level	13	15%

Education	A level	9	11%
	Diploma	37	43%
	Degree	27	31%
	Total	86	100%

Table 4.3 shows the educational qualifications of the research participants. The results show that the majority of the respondents were educated with 43% indicating that they had a National or Higher National Diploma, followed by 31% who indicated that they had at least a degree only 15% indicated that they had an ordinary level qualification. A considerable 11% showed that they had reached advanced level. This shows that the majority of the research participants could comprehend and understand the research questions

4.2.4 Positions within the company

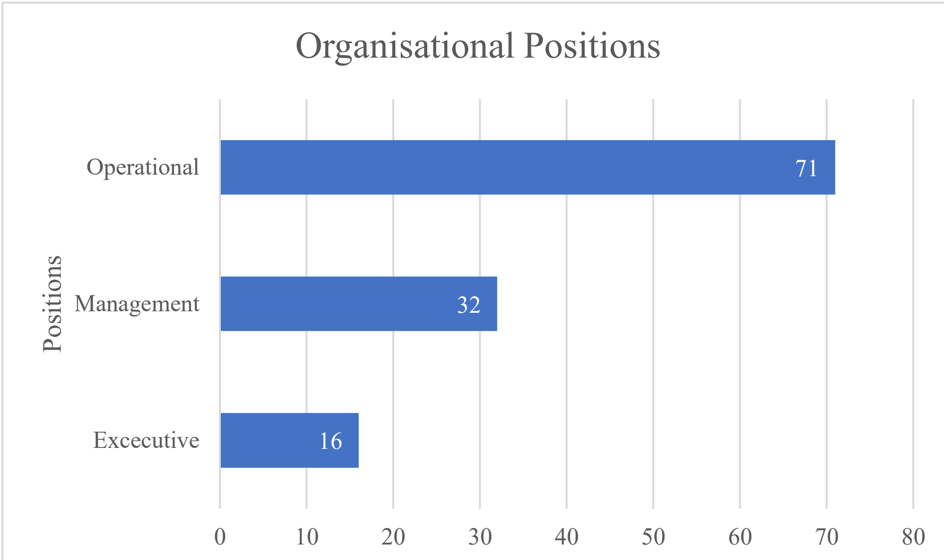

Figure 0.2: Positions within the company

Figure 4.2 above shows the position occupied by study respondents. The majority of the employees (71) indicated that they are part of the Operational Team of the business. Management had a total of (32).This indicated that they are managers and supervisors of the organisation. The Executive of the organisation comprised of 16 individuals.

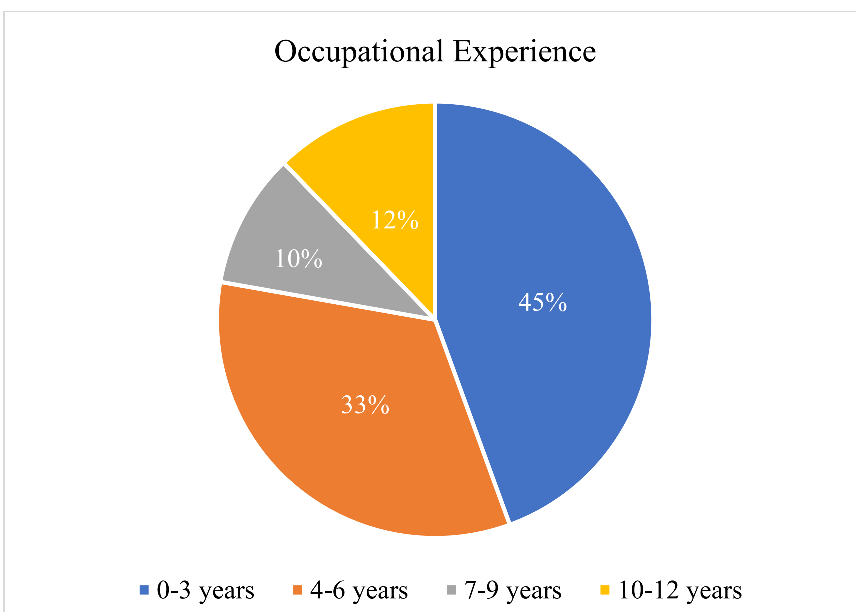

Figure 0.3: Prior experience before running a small business

Figure 4.3 shows that 45% of the respondents had 0-3 years' experience prior to starting their small businesses. 33% had between 4-6 years' experience while 10% had between 7-9 years of experience. A considerable 12% had experience ranging between 10-12 years.

4.2.5 Access to Reliable Electricity

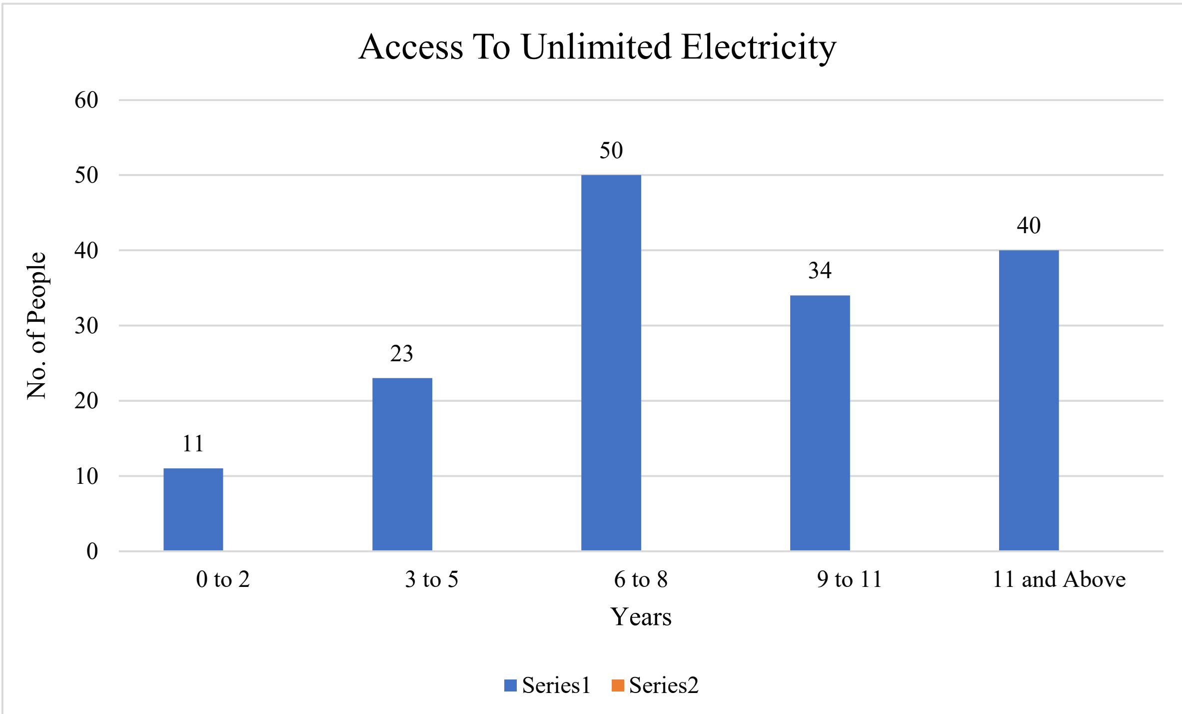

Figure 0.4: Access to reliable electricity

From the data collected from the Questionnaires it was gathered that majority of the people within the organization mentioned they last had Access to unlimited electricity 6 to 8 years ago.

It was also gathered that unlimited supply was last accessed in 2006.

The average employee in the organization has an average of 4-8 Hours on the job.

4.2.6 Manufacturing Employment of the Business

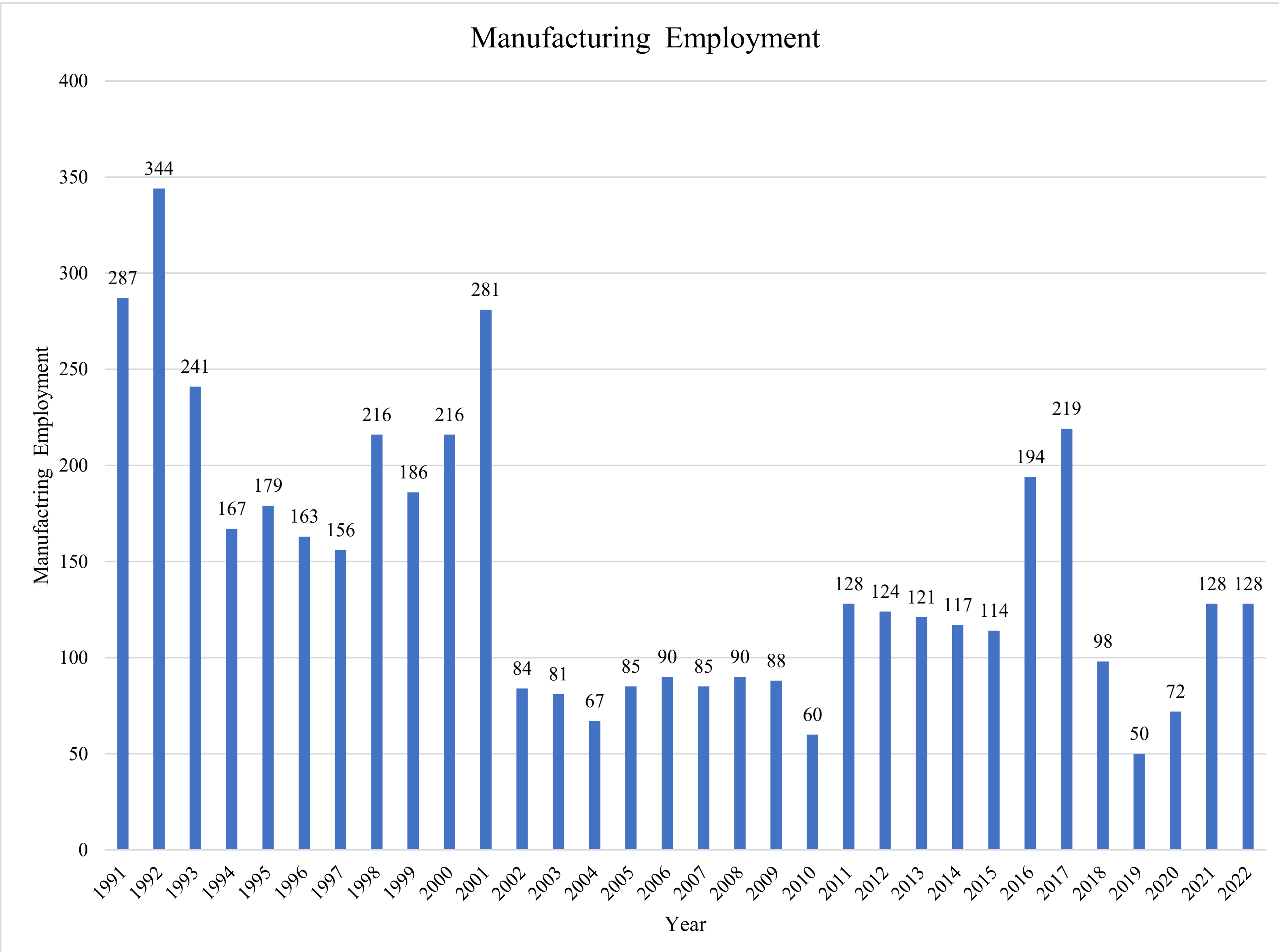

Figure 0.5: Years of operating as a business

The Figure above showed that the paid Manufacturing Employment of the organisation from 1991 to 2022. The information represents the employees who were part of the organisation operation with the past years from 1991 to 2022 each year .Manufacturing Employment comprises all persons of working age who are involved in the creation of new products either from raw materials or by assembling different components within the organisation.

4.2.7 Labour Productivity of the Business

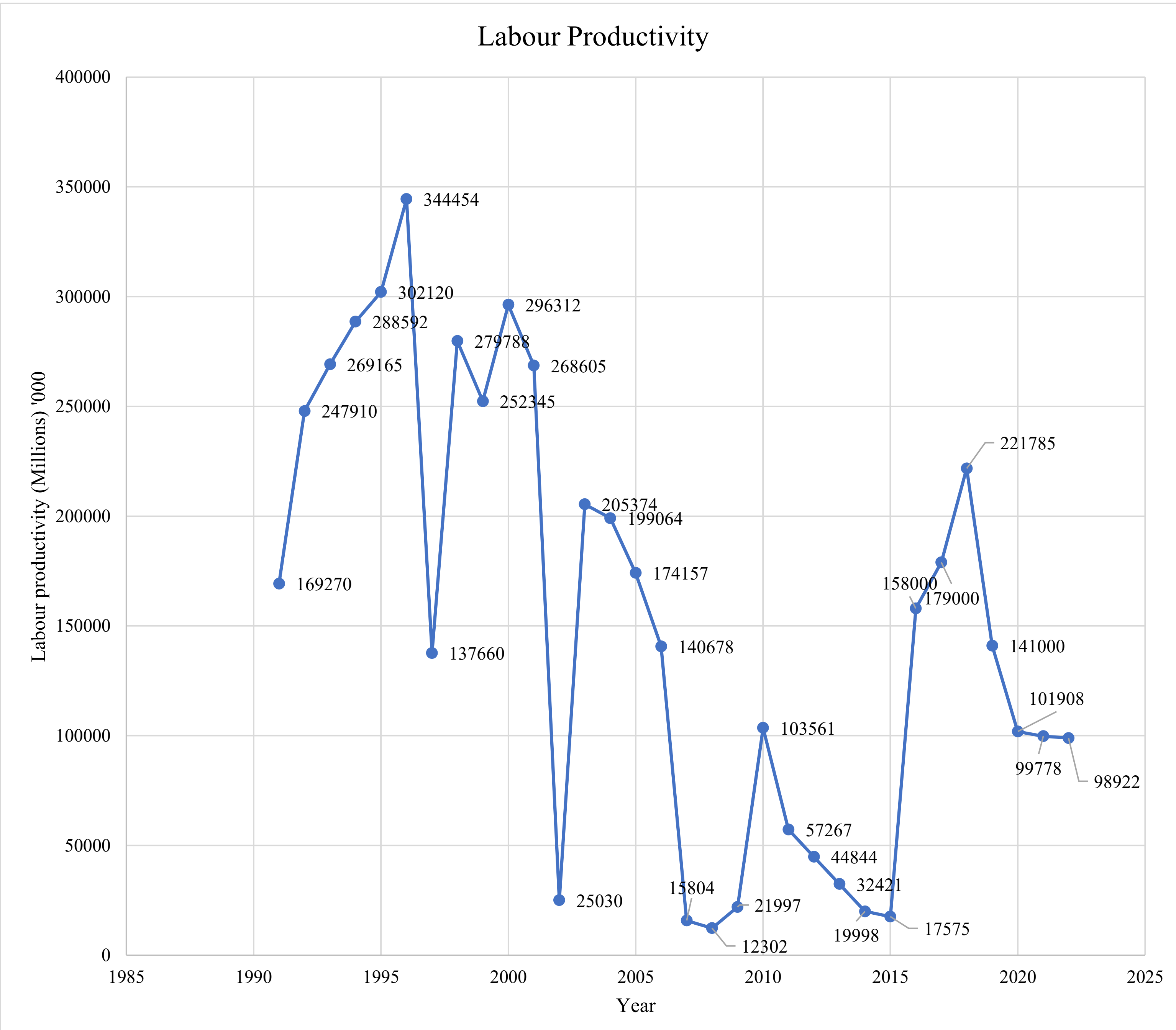

Figure 0.6: Labour productivity of the business

The Figure above showed the Labour Productivity of the organisation from the period 1991 to 2022. The highest amounts were recorded in 1996(ZWL$344,454,000) and the lowest amounts were recorded in 2008 (ZWL$12,302,000).

The trend shows that there was a steady rise from 1991 to 1996 with yearly moving average of ZWL$270,252,000. This could be because of the booming Industrial age during the time. The amounts took a slump in 1997 with a earning of ZWL$137,660,000. The trend fluctuated going up and down from 1996 to 2001.

There was a downward trend from 2003 (ZWL$205,374,000) to 2008 (ZWL$12,302,000). A possible cause of this could be the Economic depression that was witnessed in Zimbabwe during that period.

From 2008 to 2010 there was a very slight rise from ZWL$12,302,000 to ZWL$103,561,000.

From 2010 to 2015 there was a downward depression from ZWL$103,561,000 to ZWL$ 17,575.

There was an uptrend from 2015 (ZWL$ 17,575,000) to 2018 (ZWL$221,785,000)

There was a downtrend from 2018 (ZWL$ 221,785,000) to October – 2022 (ZWL$98,922,000)

NB: The amounts have been converted from USD to ZWL at a rate of 1:1000 for the purpose of this study only. This is for the entire study period from 1991 to 2022.

4.2.8 Electricity Supply in Zimbabwe

Figure and Graph Shows the Electrical supply of Zimbabwe since 1991 to 2022 according to According the current and historic data collected by HE Global economy (2022) and Our world in data (2022).

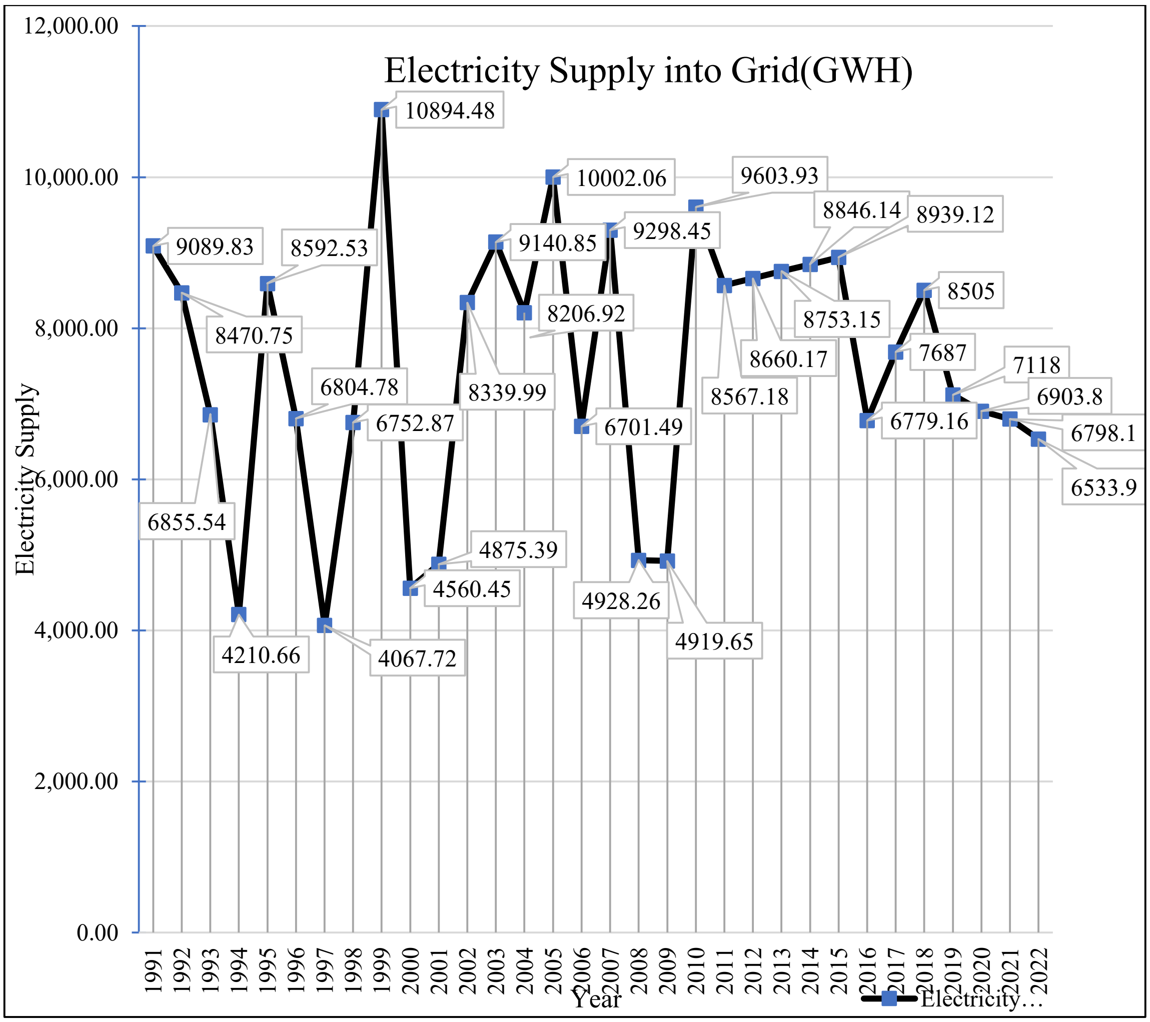

Figure 0.7 : Electricity supply chart

4.2.9 Inflation, consumer prices (CPI) (annual %) in Zimbabwe

Figure and Graph Shows the Inflation, consumer prices of Zimbabwe since 1991 to 2022 according to According the current and historic data collected by HE Global economy, (2022) and Our world in data, (2022).

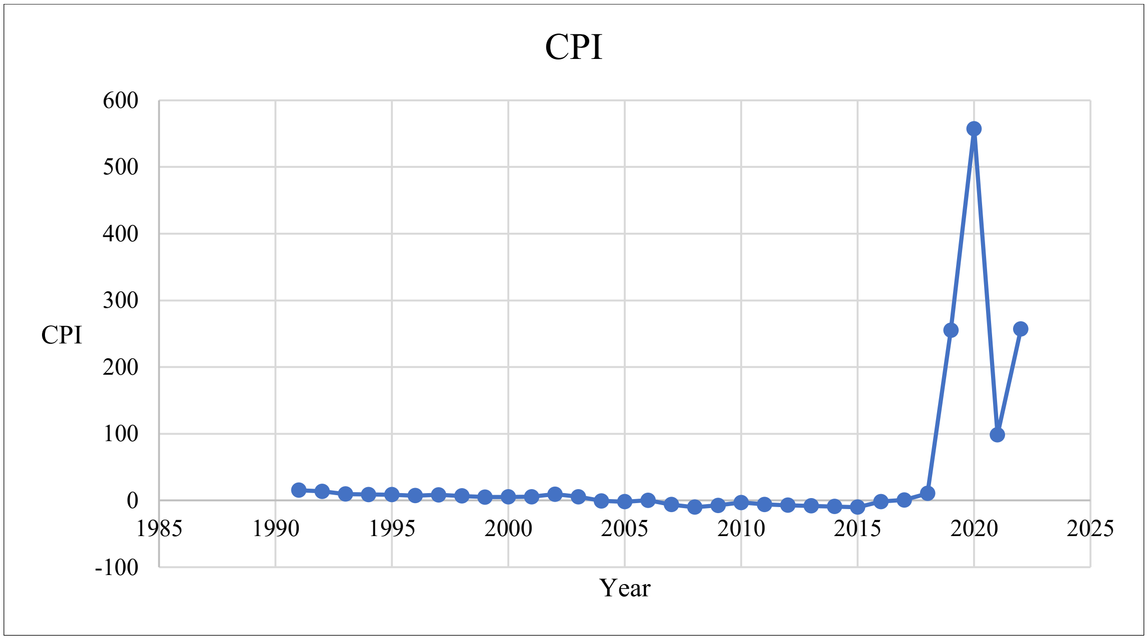

Figure 0.8 : CPI of Zimbabwe

Table 0.4 : CPI of Zimbabwe

Year	CPI%
1991	15.33
1992	13.87
1993	9.72
1994	8.94
1995	8.68
1996	7.35
1997	8.6
1998	6.88
1999	5.18
2000	5.34
2001	5.7
2002	9.49
2003	5.68

2004	-0.69
2005	-1.79
2006	0.24
2007	-6.18
2008	-10.1
2009	-7.22
2010	-3.02
2011	-6.01
2012	-7
2013	-7.99
2014	-8.98
2015	-9.97
2016	-1.54
2017	0.89
2018	10.62
2019	255.3
2020	557.2
2021	98.55
2022	256.9

The *Figure 4.8* above shows a constant, continuous and steady trend from 1991 to 2015. The values are fluctuating between (-9.97%) and (15.33 %.) The graph takes a steep upward peak from 2017 (0.89%) to 2020 (557.2%). The graph takes a sharp decline in 2021(98.55%) only to rise again in 2022(256.9%).

The highest value recorded within the graph is 557% in 2020. The Lowest value recorded within the graph is -9.97% in 2015.

4.2.10 Materials for Production within the Organisation

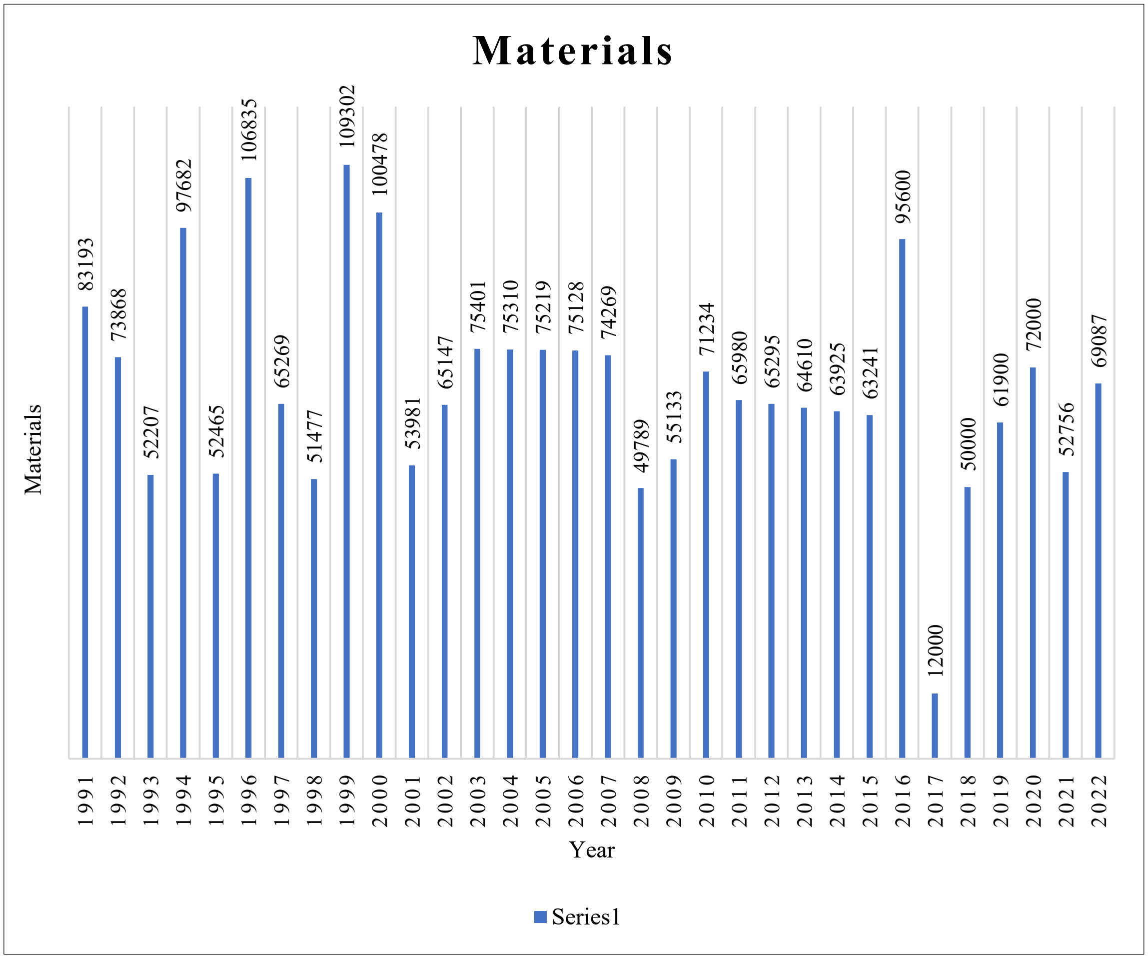

Figure 0.9 : Material acquired within the organisation 1991-2022

Table 0.5 : Materials acquired within the organization 1991-2022

Year	Materials
1991	83193
1992	73868
1993	52207
1994	97682
1995	52465
1996	106835

1997	65269
1998	51477
1999	109302
2000	100478
2001	53981
2002	65147
2003	75401
2004	75310
2005	75219
2006	75128
2007	74269
2008	49789
2009	55133
2010	71234
2011	65980
2012	65295
2013	64610
2014	63925
2015	63241
2016	95600
2017	12000
2018	50000
2019	61900
2020	72000
2021	52756
2022	69087

The *Figure 4*.9 above shows the Materials that were acquired for projects within the organisation. These are a factor which were considered as one of the independent variables within the equation.

The highest value recorded for materials acquired within the graph is ZWL$109,302 in 1991. The Lowest value recorded for materials acquired within the graph is ZWL$12,000 in 2015.

4.3 Mathematical model

In order to meet and be in line with our objectives of study and determine the impact of electricity supply on labour productivity in Zimbabwe, the study adopts the Cobb Douglas function and modifies the multivariate framework that was used by Ziramba (2009).

The model used in this study is based on the Cobb Douglas Production Function as modified by Ziramba (2009). The common link between the model used in this study and the theoretical review is that labour is included as one of the explanatory variables.

Industry production was modelled as a function of disaggregated electricity consumption and manufacturing employment. Ziramba (2009) included employment in a framework to allow for substitution possibilities between energy use and labour.

This study substitutes disaggregated energy consumption with electricity supply and includes manufacturing employment, materials, rate and inflation rate as explanatory variables in the model. Materials and inflation rate are included in the model so as to avoid under fitting a model or omitting relevant variables which according to Gujarati and Porter (2009) may result in biased results. Labour Productivity (in $ZWL million) is modelled as a function of manufacturing employment, inflation rate, materials and electricity supply.

This study analyses the interdependent relations between Electricity Supply, Labour, Capital, Materials and labour productivity. The observation encompasses seven-year period from 2016-2021. The data is presented on annual base. The software, used for empirics, are MS Excel and SPSS

All data series should be checked whether they are stationary. The factors are transformed into natural logarithms. This is done in order to avoid and remove spurious regressions.

The effect of electricity supply and manufacturing employment on Labour Productivity is expected to be positive. In a linear form, equation 1 can be presented as:

$$\boldsymbol{Y_{it}} = \alpha + \beta_k K_{it} + \beta_s I_{it}{}^{s} + \beta_u I_{it}{}^{u} + \beta_a a_{it} + \mu_t \dots\dots\dots\dots\dots\dots\dots (1)$$

$$\boldsymbol{LP_t} = \alpha + \beta_1 ME_t + \beta_2 ES_t + \beta_3 M_t + \beta_4 CPI_t + \mu_t \dots\dots\dots\dots\dots\dots\dots (2)$$

Where:

LP_t= Labour Productivity

ME = Manufacturing employment = Labor + Energy Used

ES = Electricity supply in giga-watts-hour

M = Materials

CPI= Inflation rate

α = Intercept

β_S = Slope Coefficients

μ = Error term

All the variables are converted to logarithms this is done to obtain elasticity coefficients on the variables and minimizing the impact of outliers. The model is thus of the form:

$$\boldsymbol{lnLP_t} = \alpha + \beta_1\, lnME_t + \beta_2\, lnES_t + \beta_3 lnM_t + \beta_4 lnCPI_t + \mu_t \dots\dots\dots\dots\dots\dots\dots (3)$$

Where:

lnLP is a logarithm of Labour Productivity

lnME is a logarithm of Manufacturing Employment

lnES is a logarithm of Electricity Supply from all producers in Zimbabwe in gigawatts hour

lnM is a logarithm of Materials

lnCPI is a logarithm of Interest Rate

All variables are expressed in logs. In the estimation, the total kilowatt hours of electricity consumed by the firm is used as the intermediate input in the control function step.

4.3.1 Estimation Technique Background

The study is going to follow and apply the following basic concepts of CVAR - Co-integrated Vector Auto Regression. This study uses Co-integrated Vector Auto Regression (CVAR) as an estimation technique.

The term autoregressive is due to the appearance of the lagged value of the dependent variable on the right-hand side, and the term vector is due to the fact that one is dealing with a vector of two or more variables.

In a CVAR (Co-integrated Vector Auto Regression (CVAR);

- All variables are Endogenous.
- All Variables are Predetermined and so the model itself is in reduced form.

Extraordinary alike and similar to simultaneous equation modelling where several endogenous variables are considered together. Each endogenous variable is explained by its lagged or past values and the lagged values of all other endogenous variables in the model. Usually there are no exogenous variables in the model.

According to Sims (1980) if there is a true simultaneity among a set of variables, they should all be treated on an equal footing; there should not be any priori distinction between endogenous and exogenous variables. VAR model is one of the most successful and easy to use for the analysis of the multivariate time series.

In this study we are going to apply the Unit Root Test Integrate Order. The Unit Root Test Integrate Order constitutes of Augmented Dickey-Fuller (ADF) and Philip-Perron (P.P) unit root.

ADF and P.P unit root or stationarity tests are implemented to examine whether the variables are stationarity or non-stationarity and test their order of integration. After testing for stationarity in the variables, the next step would be to test Cointegration. According to Granger (1987), Cointegration can be thought of as a pre-test to avoid spurious regression situations. Cointegration means that despite being individually non stationary, a linear combination of two or more time series can be stationary.

If the variables are stationary, the system cannot be modelled using variables in levels and a simple F-statistics will be sufficient to test the causal relationship between electricity supply and Labour Productivity.

If Cointegration is established amongst the variables the vector error correction model (VECM) will be used instead of VAR. The diagnostic tests will then be performed to assist in checking the appropriateness of the VAR model and they include heteroscedasticity, residual normality test and autocorrelation LM test among others. Finally the Generalized Impulse Response Function (GIRF) and the variance decomposition will be performed to check the robustness on the Cointegration results.

4.3.2 Estimation Technique

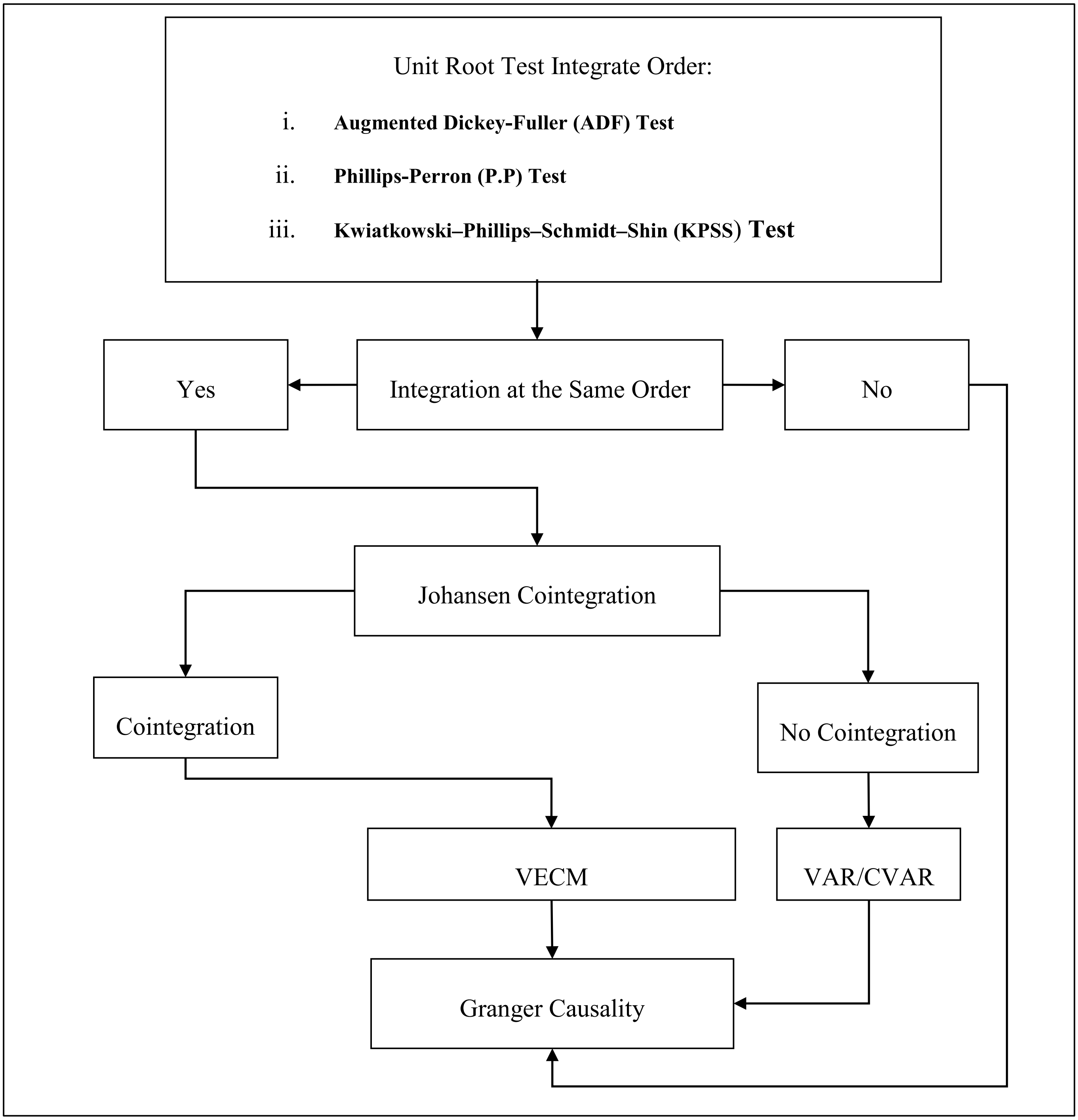

Figure 0.10: Algorithm showing Steps of Estimation Technique

The diagram represents the algorithm to follow when carrying out the Estimation technique. The diagram represents the methodology of the study

4.3.3 Steps to be taken

1. Unit Tests
2. Lag Order
3. Granger Causality tests
4. Correlation Matrix
5. Impulse Response

1. Unit root Tests

These are the tests which are regarded as the first step of the procedure. They are used to test for stationarity in a time series data. They are also used to find the order of integration. Researchers have been applying unit root test to test for **stationarity and non-stationarity in variables.**

Brooks (2008) outlines that a **stationary time series** is one with a constant mean, constant variance and constant auto-covariance for each given lag. The stationarity or otherwise of a series can strongly influence its behaviour and properties. A time series is said to be stationary if it does not change over time.

A time series which is not stationary is said to be a **non-stationary time series** (Gujarati and Porter, 2009). The mean and variance of a non-stationary series do not fluctuate around zero. Evidence of non-stationary variables can result in spurious regressions. In order to avoid the spurious regression problem that may arise from regressing a non-stationary series, the non-stationary series have to be transformed from non-stationary to stationary. The transformation method depends on whether the time series are difference stationary (DSP) or trend stationary (TSP). If a time series is non-stationary it must be differenced k times until it becomes stationary, and it will be said to be integrated of order k. Before performing any tests, all the variables must be tested for unit root and after that, estimating the parameters and testing for co-integration will follow.

The commonly used unit root tests are the **Augmented Dickey-Fuller (ADF)** test and **Phillips Perron test.**

According to, (Harivigneshwar C J, 2019), the **ADF Test** and **P.P** test are explained in detail below;

i. Augmented Dickey-Fuller (ADF) Test

The ADF test is used for checking the unit root. The existence of unit root indicates that the time series data is non-stationary.

The hypotheses for the test are:

1) Null Hypothesis – H_0: There is a unit root → series data is non-stationary
2) Alternate Hypothesis – H_0: There is a No unit root → the time series is stationary. i.e. there is constant steadiness, trend steadiness,

IF there is a **Unit Root** THEN **Series data is Non-Stationery.**

IF there is a No **Unit Root** THEN **Series data is Stationery.**

When using a P value:

If the p-value is less than a 5% significance level it means that we accept the Alternate Hypothesis and Reject the Null Hypothesis. (Yuanliang Song and HanHu, 2010)

When using T Statistics:

If T statistics is more negative than the critical value we Reject the Null Hypothesis of a unit root. In similar terms, when the T statistics is smaller than the critical value.

We fail to reject the Null Hypothesis when the T statistics is greater than the critical value.

ii. Phillips-Perron-Test

This is a more comprehensive theory of unit root non-stationarity. Phillips-Perron test examines the null hypothesis of a unit root in a univariate time series. If the series is non-stationary, it means that there is unit root. This test is somewhat similar to ADF but however the DF procedures are modified and generalised to allow for auto-correlated residuals.

The PP test considers less restriction on the distribution of the disturbance term. Phillips and Perron use nonparametric statistical methods to take care of the serial correlation in the error terms without adding lagged difference terms. The test often gives similar conclusions and suffers from most of the same limitations as the ADF test.

This test differs from the ADF test because it doesn't use lag first order. It uses the model:

$$yt = c + \delta t + \alpha y(t-1) + e(t)(1)$$

where;

y(t) is the current value of the variable.

y(t-1) is the past value of the variable.

c represents a constant.

e(t) is an error term.

The null hypothesis restricts the value to be one. The tests use modified Dickey-Fuller statistics to account for serial correlations.

For the dependable factors it is the following explanation:

$$\Delta ES_t = c + \delta_t + \alpha ES_{(t-1)} + i \sum_{i=1}^{k} \delta_i ES_{(t-1)} + e(t)(1)$$

$$\Delta ME_t = c + \delta_t + \alpha ME_{(t-1)} + i \sum_{i=1}^{k} \delta_i ME_{(t-1)} + e(t)(1)$$

2. **Johansen Procedure**

   Examining the order of integration

The order of integration must be examined in all the variables. When all the variables are integrated of the same order then we can proceed with the Cointegration test.

Johansen Cointegration is used for a system of equations. This means it has the ability to detect the presence of more than one co-integrating equation.

3. **Determination of Lag Order**

This is the step where we set the appropriate lag length of the model. We estimate the model and determine the rank of the lag length. The lag structure tests assist in determining the appropriate lags for the VAR.

Usually Vector Auto Regression Models often need lag order to be applied to it. AIC and BIC tests are used to check the fit of the models with respect to others. It is used to select the most parsimonious models:

$$AIC = 2\ln(L) + 2k \quad (2)$$

$$BIC = -2\ln(L) + k\ln(n) \quad (3)$$

Where;

L represents the value of log likelihood.

k is the number of parameters.

n is the number of observations.

4. **T-statistics**

The t statistic is used to select or reject the null hypothesis.t- statistic of ADF and Phillips Perron test are calculated. A value higher than 2 (or smaller than -2) shows that the coefficient is significant with a confidence interval of >95%.

A t-statistic more than 1.68 (or less than -1.68) specifies that the coefficient is significant with a confidence interval of >90%. (Walter Enders, 2018 Wiley)

The ADF test handles with T – statistics, defined by critical values. The more negative are the coefficients, the steadiness grows .The T – statistics is defined as:

$$\tau_{DF(ADF)} = \frac{\hat{\gamma}}{SE(\hat{\gamma})} \; ; (\gamma \; = \; \rho \quad 1)$$

5. **Mathematical Model for Vector Auto regression**

The 5th Stage is where we carry out the Mathematical model for Vector Auto-Regression. Vector Auto-Regression (VAR) is an algebraic tool in which each variable of the equation is treated symmetrically and $y(t)$ can be affected by the current and past realizations of the sequence. J. Jin and Y. Cheni. ,2013)

Chang-zheng & Hui-min (2011) state that Vector Auto regression model is a model which consist of multiple time series data where there is a unique equation present for each and every endogenous variable. The VAR equation is represented by a 5-th order VAR model which is presented below:

$$\begin{bmatrix} y1 \\ y2 \\ y3 \\ y4 \\ y5 \end{bmatrix} = y1(t-1)\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{bmatrix} + y2(t-1)\begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \end{bmatrix} + y3(t-1)\begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \end{bmatrix} + y4(t-1)\begin{bmatrix} d_1 \\ d_2 \\ d_3 \\ d_4 \\ d_5 \end{bmatrix} + y5(t-1)\begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \\ e_5 \end{bmatrix} + \begin{bmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \end{bmatrix}$$

Where;

- (y1, y2, y3, y4, y5): it is a (nx1) vector it is the current value of the variables.
- (c1, c2, c3, c4, c5): it is a (nx1) vector intercepts or constants.
- (ai, bi, ci, di, ei)(i = 1, 2,. . . 5) = (nx1) matrix, coefficient values of the equation.
- y1(t-1)....y5(t-1) represents the past value of the variable.

The coefficient value shows the change in the mean of the dependent variable when there is a one-unit shift in the independent variable while the other variables are held constant in the model.

6. Impulse response function

(Hui and Huifeng, 2013) state that Impulse response functions are used to examine the reactions among variables which are present in a VAR model. They help to trace out the responsiveness of the dependent variables in the VAR to shocks from each variable. They show the changes in the variables to shocks. The impulse response analysis reveals the outcomes of an external disturbance on the whole process. The adaption of the endogenous variables over time, after a shock, is differentiated with the time series data without a shock. An impulse-response function tells about the change of the variable over a particular period of time after a shock is given.

For each of the variables from each equation separately, a unit shock is applied to the error and the effects upon the VAR system over time are noted. If there are g variables in a system, a total of g2 impulse responses could be generated. In practice this is done by expressing the VAR model as a vector moving average model (VMA) (Brooks, 2008).

7. Granger causality

NJ Granger Cointegration is used for a single equation.

Granger causality basically checks for any correlation between the two variables [8]. The Granger causality tests for two variables (say C and J) if C is affected by both lagged values of C and J, then it is known as C Granger causes J.

Likewise, if J is affected by its lag and the lagged values of J, then we call it C Granger causes J. However, between C and J, if C Granger causes J and J Granger causes C, it is known as bi-directional causality. If only one relation exists, then it is the case of uni-directional causality. If both relations don’t exist, then the variables are said to be independent of each other.

8. Correlation matrix

A correlation coefficient gives the degree of association. It is denoted by r. It is also called as Pearson's correlation coefficient. It is a way to evaluate the linear association. A correlation matrix shows the correlation coefficients of the variables. Each variable is correlated with the values of others in the table. This shows which pairs having the highest correlation.

9. Residuals

A residual is a difference between the predicted value and the measured value in the VAR model. They show the accuracy of a mathematical function is, in representing a set of data, (Walter Enders,2018)

4.4 Discussion and Interpretation

4.4.1 Data Collected

All the variables and data collected was tabulated. Standard Deviations were formulated and were plugged together with our findings into E-Views for Data Analysis.

Table 0.6: Raw data findings

	Labour Productivity	Electricity Supply into Grid(GWH)	Manufacturing Employment	Materials	CPI%	Interruptions	Average Duration of Interruptions	
	ZWL '000	*According to. heglobaleconomy.com*			*According to. ourworldindata.org*			
	LP	**ES**	**ME**	**M**	**CPI**	***(I)***	***(A)***	***IxA***
1991	169270	9089.83	287	83193	**15.33**	-	-	-
1992	269165	8470.75	85	73868	**13.87**	-	-	-
1993	288592	6855.54	241	52207	**9.72**	-	-	-
1994	247910	4210.66	167	97682	**8.94**	-	-	-
1995	302120	8592.53	179	52465	**8.68**	-	-	-
1996	344454	6804.78	77	106835	**7.35**	-	-	-
1997	137660	4067.72	156	65269	**8.60**	-	-	-
1998	279788	6752.87	216	51477	**6.88**	-	-	-
1999	252345	10894.48	186	109302	**5.18**	-	-	-
2000	296312	4560.45	216	100478	**5.34**	-	-	-
2001	268605	4875.39	281	53981	**5.70**	-	-	-
2002	25030	8339.99	84	65147	**9.49**	-	-	-
2003	205374	9140.85	81	75401	**5.68**	-	-	-
2004	174157	8206.92	67	75310	**-0.69**	-	-	-
2005	199064	10002.06	85	75219	**-1.79**	-	-	-
2006	140678	6701.49	90	75128	**0.24**	-	-	-
2007	15804	9298.45	85	74269	**-6.18**	-	-	-
2008	12302	4928.26	90	49789	**-10.07**	-	-	-
2009	21997	4919.65	88	55133	**-7.22**	-	-	-
2010	103561	9603.93	60	71234	**-3.02**	-	-	-

2011	57267	8567.18	128	65980	**-6.01**	-	-	-
2012	44844	8660.17	124	65295	**-7.00**	-	-	-
2013	32421	8753.15	121	64610	**-7.99**	-	-	-
2014	19998	8846.14	117	63925	**-8.98**	-	-	-
2015	17575	8939.12	114	63241	**-9.97**	-	-	-
2016	300000	6779.16	347	95600	-1.54	171	94.5	11812.5
2017	279000	7687	339	12000	0.89	125	80	10000
2018	321785	8505	98	50000	10.62	110	280	30800
2019	141000	7118	50	61900	255.3	167	204	34068
2020	101908	6903.8	72	72000	557.2	114	210	23940
2021	98922	6798.1	128	52756	98.55	0	0	0
2022	99778	6533.9	128	69087	256.9	0	0	0

4.4.2 Large Observations

Table 0.7: Findings and observations

	Labour Productivity	Electricity Supply into Grid(GWH)	Manufacturing Employment	Materials	CPI%
	LP	ES	ME	M	CPI
1991	169270	9089.83	287	83193	15.33
1992	269165	8470.75	85	73868	13.87
1993	288592	6855.54	241	52207	9.72
1994	247910	4210.66	167	97682	8.94
1995	302120	8592.53	179	52465	8.68
1996	344454	6804.78	77	106835	7.35
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1999	252345	10894.48	186	109302	5.18
2000	296312	4560.45	216	100478	5.34
2001	268605	4875.39	281	53981	5.70
2002	25030	8339.99	84	65147	9.49
2003	205374	9140.85	81	75401	5.68
2004	174157	8206.92	67	75310	-0.69
2005	199064	10002.06	85	75219	-1.79
2006	140678	6701.49	90	75128	0.24
2007	15804	9298.45	85	74269	-6.18
2008	12302	4928.26	90	49789	-10.07
2009	21997	4919.65	88	55133	-7.22
2010	103561	9603.93	60	71234	-3.02

2011	57267	8567.18	128	65980	-6.01
2012	44844	8660.17	124	65295	-7.00
2013	32421	8753.15	121	64610	-7.99
2014	19998	8846.14	117	63925	-8.98
2015	17575	8939.12	114	63241	-9.97
2016	300000	6779.16	347	95600	-1.54
2017	279000	7687	339	12000	0.89
2018	321785	8505	98	50000	10.62
2019	141000	7118	50	61900	255.3
2020	101908	6903.8	72	72000	557.2
2021	98922	6798.1	128	52756	98.55
2022	99778	6533.9	128	69087	256.9

4.3.3 Table of Logs

Table 0.8 : Logs of findings and observations

	Labour Productivity	Electricity Supply into Grid(GWH)	Manufacturing Employment	Materials	CPI%
	lnLP	lnES	lnME	lnM	CPI
1991	12.0392493	9.114911035	5.659663867	11.32892348	15.33
1992	12.5030816	9.044374098	4.437069391	11.2100384	13.87
1993	12.57276947	8.832812798	5.486219972	10.86296943	9.72
1994	12.42082188	8.345373808	5.117687614	11.48946964	8.94
1995	12.61857981	9.058648311	5.187105454	10.86790615	8.68
1996	12.74971484	8.825380141	4.340959893	11.57903929	7.35

1997	11.83254429	8.310837424	5.05156144	11.08626747	8.60
1998	12.54178689	8.817722866	5.375212849	10.84889434	6.88
1999	12.43855101	9.296011465	5.227725442	11.60187164	5.18
2000	12.59916859	8.425176986	5.374689945	11.51769525	5.34
2001	12.50099876	8.491955593	5.638221151	10.89639129	5.70
2002	10.12783553	9.028816755	4.435491212	11.08439721	9.49
2003	12.23258751	9.120509019	4.389057435	11.23056958	5.68
2004	12.06771088	9.012732683	4.199060167	11.22936195	-0.69
2005	12.2013806	9.210546689	4.445405664	11.22815287	-1.79
2006	11.85422887	8.810084868	4.49980967	11.22694231	0.24
2007	9.668041884	9.137603438	4.442651256	11.21544398	-6.18
2008	9.417483009	8.502741313	4.49980967	10.81554936	-10.07
2009	9.998658463	8.500991674	4.472353925	10.9175001	-7.22
2010	11.54791516	9.1699272	4.090394549	11.17372551	3.02
2011	10.95548248	9.055693958	4.848670613	11.09710051	-6.01
2012	10.7109469	9.066489207	4.821875298	11.08666837	-7.00
2013	10.38656196	9.077169162	4.79434218	11.07612624	-7.99
2014	9.903384527	9.08773626	4.766029473	11.0654718	-8.98
2015	9.774225244	9.098192861	4.736891742	11.05470261	-9.97
2016	12.61153775	8.821608479	5.84932478	11.4679281	-1.54
2017	12.53896706	8.947285869	5.826000107	9.392661929	0.89
2018	12.6816389	9.048409505	4.584967479	10.81977828	10.62
2019	11.85651517	8.870382066	3.912023005	11.03327546	255.3
2020	11.53182572	8.839827264	4.276666119	11.1844214	557.2
2021	11.50208694	8.82439844	4.852030264	10.87343279	98.55
2022	11.510703	8.784759287	4.852030264	11.14312186	256.9

Table 1 shows the large observations that were found as statistics during data capturing. It represents the amounts of the respective variables with which tests were carried out on.

Table 2 shows the logarithms of each respective amount. In order to carry out the tests, the figures were converted into logarithms for subsequent error terms that we would come across during calculations.

4.4.3 Unit root/stationarity test results

The first step in the procedure was to test the stationarity of time series. Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test and test were applied to find the order of integration. These tests showed how many times a variable needs to be differenced to become stationary. The null hypothesis of the unit root was rejected if the test statistic was more negative than the critical value. This meant that the series did not have a unit root.

4.4.3.1 ADF (Augmented Dickey Fuller): Results

Table 0.9 : Augmented Dick Fuller results

At Level	Variable	LNLP	LNES	CPI	LNM	LNME
With Constant	t-Statistic	-2.6526	-5.0966	-2.7744	-5.9596	-3.8291
	Prob.	**0.0937**	**0.0002**	**0.0736**	**0.0000**	**0.0066**
		*	***	*	***	***
With Constant & Trend	t-Statistic	-2.8686	-5.2130	-3.3088	-8.0686	-3.7274
	Prob.	**0.1857**	**0.0010**	**0.0835**	**0.0000**	**0.0353**
		n0	***	*	***	**

Without Constant & Trend	t-Statistic	-0.3781	-0.3713	-2.5104	-0.3083	-0.7366
	Prob.	**0.5398**	**0.5425**	**0.0139**	**0.5663**	**0.3892**
		n0	n0	**	n0	n0
At First Difference	Variable	d(LNLP)	d(LNES)	d(CPI)	d(LNM)	d(LNME)
With Constant	t-Statistic	-12.2693	-12.3437	-10.4163	-32.5652	-15.3486
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0001**	**0.0000**
		***	***	***	***	***
With Constant & Trend	t-Statistic	-13.6416	-11.9265	-20.1334	-31.8131	-14.7039
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***	***
Without Constant & Trend	t-Statistic	-11.1343	-12.7279	-9.5879	-29.6880	-16.0345
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***	***

4.4.3.2 PP (Phillip Pheron): Results

Table 0.10: Phillip Pheron results

At Level		LNLP	LNES	CPI	LNM	LNME
With Constant	t-Statistic	-2.6526	-5.0966	-2.7744	-5.9596	-3.8291
	Prob.	**0.0937**	**0.0002**	**0.0736**	**0.0000**	**0.0066**
		*	***	*	***	***
With Constant & Trend	t-Statistic	-2.8686	-5.2130	-3.3088	-8.0686	-3.7274
	Prob.	**0.1857**	**0.0010**	**0.0835**	**0.0000**	**0.0353**
		n0	***	*	***	**
Without Constant & Trend	t-Statistic	-0.3781	-0.3713	-2.5104	-0.3083	-0.7366

	Prob.	**0.5398**	**0.5425**	**0.0139**	**0.5663**	**0.3892**
		n0	**n0**	**	**n0**	**n0**
At First Difference		d(LNLP)	d(LNES)	d(CPI)	d(LNM)	d(LNME)
With Constant	t-Statistic	-12.2693	-12.3437	-10.4163	-32.5652	-15.3486
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0001**	**0.0000**
		***	***	***	***	***
With Constant & Trend	t-Statistic	-13.6416	-11.9265	-20.1334	-31.8131	-14.7039
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***	***
Without Constant & Trend	t-Statistic	-11.1343	-12.7279	-9.5879	-29.6880	-16.0345
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***	***

Key/Notes
a: (*) = Significant at the 10%; (**) = Significant at the 5%; (***) = Significant at the 1% and (no) = Not Significant
b: Lag Length based on SIC
c: Probability based on MacKinnon (1996) one-sided p-values.
d. ***Ln***. represents logarithms of variables
I(0) = Stationary
I(1) = Non - Stationary

The unit root/stationary tests presented in the tables above show that the variables are – I (1). This means that they are non-stationary in levels but become stationary – I (0) after being differenced once. This is true for both PP and ADF test.

After being differenced once, the variables become stationary as they fluctuate around the zero mean indicating stationarity therefore necessary to conclude that all the series are first difference stationary I (1), which means that the variables are integrated of the same order, so we move forward to Cointegration test.

4.4.4 NJ Granger

This is the Estimated Equation

Dependent Variable: LNLP
Method: Least Squares
Date: 08/19/22 Time: 13:50
Sample: 1991 2022
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNES	0.128769	0.725114	0.177584	0.8604
CPI	0.001502	0.001688	0.890205	0.3812
LNM	0.444001	0.499103	0.889598	0.3815
LNME	0.954346	0.392640	2.430586	0.0220
C	0.890071	9.561652	0.093088	0.9265

R-squared	0.188532	Mean dependent var	11.62178
Adjusted R-squared	0.068314	S.D. dependent var	1.058840
S.E. of regression	1.022033	Akaike info criterion	3.024066
Sum squared resid	28.20290	Schwarz criterion	3.253087
Log likelihood	-43.38506	Hannan-Quinn criter.	3.099980
F-statistic	1.568255	Durbin-Watson stat	0.990802
Prob(F-statistic)	0.211254		

Figure 0.11: Estimated Equation

After plugging in values the above Estimation Equation was established.

We open the variables as an equation starting with the Dependant Variables.

This is the Estimation of the Equation using NLS (Least Squares).

Above in Figure is the Estimated Model. We use the Model to Generate the Residual term.

4.4.5 ECM (Error Correction Model)

	Last updated: 08/19/22 - 13:57			
	Residuals from equation with dependent variable LNLP			
	Modified: 1991 2022 // makeresids ecm			
1991	-0.478911			
1992	1.215762			
1993	0.471785			
1994	0.457315			
1995	0.773339			
1996	1.428277			
1997	0.116126			
1998	0.559196			
1999	0.203356			
2000	0.372993			
2001	0.290038			
2002	-1.093609			
2003	0.984481			
2004	1.024915			
2005	0.900200			
2006	0.550177			
2007	-1.608881			
2008	-1.648830			
2009	-1.090789			
2010	0.607704			
2011	-0.646090			
2012	-0.860322			
2013	-1.153635			
2014	-1.604933			
2015	-1.701360			
2016	-0.086220			
2017	0.765055			
2018	1.430819			
2019	0.808419			
2020	-0.381044			
2021	-0.130694			
2022	-0.474636			

Table 0.11: Represented ECM – Residual from Equation

This is ECM(Error Correction Model).

This is the generated residual series. The residual series is named ECM. The results we get from the residual series are tested for unit root.

We tested the residual using ADF to test for unit root at level.

If the test is Stationary at Level we conclude that there is Cointegration.

4.4.6 Augmented Dickey Fuller Tests (ADF) Tests and Phillip-Theron Tests

Augmented Dickey-Fuller Unit Root Test on ECM

Null Hypothesis: ECM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.107760	0.0363
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 08/19/22 Time: 14:23
Sample (adjusted): 1992 2022
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.499595	0.160757	-3.107760	0.0042
C	0.007787	0.152720	0.050990	0.9597

R-squared	0.249835	Mean dependent var	0.000138
Adjusted R-squared	0.223967	S.D. dependent var	0.965116
S.E. of regression	0.850197	Akaike info criterion	2.575644
Sum squared resid	20.96223	Schwarz criterion	2.668160
Log likelihood	-37.92249	Hannan-Quinn criter.	2.605802
F-statistic	9.658169	Durbin-Watson stat	1.694815
Prob(F-statistic)	0.004195		

Figure 0.12: Results of ADF Test

Phillips-Perron Unit Root Test on ECM

Null Hypothesis: ECM has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.049467	0.0413
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.676201
HAC corrected variance (Bartlett kernel)	0.630286

Phillips-Perron Test Equation
Dependent Variable: D(ECM)
Method: Least Squares
Date: 08/19/22 Time: 14:22
Sample (adjusted): 1992 2022
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.499595	0.160757	-3.107760	0.0042
C	0.007787	0.152720	0.050990	0.9597

R-squared	0.249835	Mean dependent var	0.000138
Adjusted R-squared	0.223967	S.D. dependent var	0.965116
S.E. of regression	0.850197	Akaike info criterion	2.575644
Sum squared resid	20.96223	Schwarz criterion	2.668160
Log likelihood	-37.92249	Hannan-Quinn criter.	2.605802
F-statistic	9.658169	Durbin-Watson stat	1.694815
Prob(F-statistic)	0.004195		

Figure 0.13: Results of P.P. Test

Results from Test

- After carrying out the test it was acknowledged and concluded that *At Level,* **ADF**, is significant at 5%. This means that we are rejecting the Null Hypothesis that the Error term has a Unit Root at 5%.
- We tested using ADF at 7 lags.
- The test was Stationary at Level so we conclude that there is Cointegration between Labour Productivity and its Respective Independent Variables of this Analysis.
- Our **ECM (Error Correction Model)** is Stationary.
- We tested using **P.P.** and we get the same Result.

Since we have confirmed that there is Co-integration between Labour Productivity and its Independent Variables we can now go ahead and interpret that the coefficients of the model in line with Long Run.

The Model is a long Run Model and is not a Spurious Result.

We can totally depend on this process because R-Squared is less than Durban Watson Statistics, which is a simple rule of thumb to note and detect that there is no Spurious Regression

We can confirm that that there is Co-Intergration between the variables.

4.4.7 Jahansen Cointegration Test

```
                        Johansen Cointegration Test
==============================================================================
Date: 08/19/22   Time: 16:04
Sample (adjusted): 1994 2022
Included observations: 29 after adjustments
Trend assumption: Linear deterministic trend
Series: LNLP LNES CPI LNM LNME
```

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.923849	110.0896	69.81889	0.0000
At most 1	0.424352	35.41345	47.85613	0.4264
At most 2	0.371395	19.39795	29.79707	0.4646
At most 3	0.173538	5.934621	15.49471	0.7033
At most 4	0.013943	0.407191	3.841466	0.5234

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.923849	74.67614	33.87687	0.0000
At most 1	0.424352	16.01549	27.58434	0.6645
At most 2	0.371395	13.46333	21.13162	0.4105
At most 3	0.173538	5.527430	14.26460	0.6743
At most 4	0.013943	0.407191	3.841466	0.5234

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LNLP	LNES	CPI	LNM	LNME
-0.128025	0.391229	0.044921	-4.741936	0.666221
1.134236	5.866985	-0.009751	0.952444	-0.109132
-0.943103	2.611773	-0.003774	2.515505	3.768915
-0.994908	4.857346	0.061187	2.632956	-0.425843
1.013003	1.119610	-0.132262	-5.314557	-0.825463

Unrestricted Adjustment Coefficients (alpha):

D(LNLP)	0.078430	-0.475525	0.247723	0.139812	-0.038845
D(LNES)	-0.030079	-0.112243	-0.068967	-0.058959	0.003761
D(CPI)	67.08945	4.320247	-6.629975	0.495392	2.243596
D(LNM)	0.143196	0.004933	-0.112100	0.004937	-0.027750
D(LNME)	-0.122202	-0.087956	-0.046669	0.121973	-0.001854

1 Cointegrating Equation(sLog likelihood -182.2854

Normalized cointegrating coefficients (standard error in parentheses)

LNLP	LNES	CPI	LNM	LNME
1.000000	-3.055881	-0.350877	37.03916	-5.203833
	(4.42523)	(0.06219)	(3.72723)	(1.83473)

Adjustment coefficients (standard error in parentheses)

D(LNLP)	-0.010041
	(0.02977)
D(LNES)	0.003851
	(0.00783)
D(CPI)	-8.589124

```
            (0.92933)

 D(LNM)     -0.018333

            (0.00936)

 D(LNME)     0.015645

            (0.01036)

==============================================================================


2 Cointegrating Equation(sLog likelihood -174.2776

==============================================================================

Normalized cointegrating coefficients (standard error in parentheses)

    LNLP         LNES          CPI          LNM         LNME

   1.000000     0.000000    -0.223762     23.59552    -3.306981

                            (0.04015)    (2.29644)    (1.15631)

   0.000000     1.000000     0.041597    -4.399269     0.620722

                            (0.00824)    (0.47135)    (0.23734)


Adjustment coefficients (standard error in parentheses)

   D(LNLP)     -0.549398    -2.759211

               (0.23052)    (1.18749)

   D(LNES)     -0.123459    -0.670294

               (0.06253)    (0.32212)

   D(CPI)      -3.688942     51.59417

               (8.19893)    (42.2360)

   D(LNM)      -0.012737     0.084967

               (0.08348)    (0.43004)

   D(LNME)     -0.084118    -0.563844

               (0.08909)    (0.45895)

==============================================================================


3 Cointegrating Equation(sLog likelihood -167.5459

==============================================================================

Normalized cointegrating coefficients (standard error in parentheses)
```

LNLP	LNES	CPI	LNM	LNME
1.000000	0.000000	0.000000	-1.488230	-2.635173
			(1.48212)	(0.72599)
0.000000	1.000000	0.000000	0.263745	0.495834
			(0.32375)	(0.15858)
0.000000	0.000000	1.000000	-112.1002	3.002335
			(11.4524)	(5.60976)

Adjustment coefficients (standard error in parentheses)

D(LNLP)	-0.783026	-2.112216	0.007225
	(0.28548)	(1.24053)	(0.00889)
D(LNES)	-0.058416	-0.850419	3.57E-06
	(0.07724)	(0.33563)	(0.00241)
D(CPI)	2.563808	34.27818	2.996623
	(10.3656)	(45.0421)	(0.32288)
D(LNM)	0.092985	-0.207812	0.006807
	(0.10053)	(0.43683)	(0.00313)
D(LNME)	-0.040104	-0.685732	-0.004456
	(0.11435)	(0.49687)	(0.00356)

==

4 Cointegrating Equation(sLog likelihood -164.7822

==

Normalized cointegrating coefficients (standard error in parentheses)

LNLP	LNES	CPI	LNM	LNME
1.000000	0.000000	0.000000	0.000000	-3.882268
				(1.01289)
0.000000	1.000000	0.000000	0.000000	0.716845
				(0.20917)
0.000000	0.000000	1.000000	0.000000	-90.93448
				(34.7190)
0.000000	0.000000	0.000000	1.000000	-0.837972

				(0.29781)

Adjustment coefficients (standard error in parentheses)

D(LNLP)	-0.922127	-1.433100	0.015779	0.166448
	(0.33858)	(1.53013)	(0.01454)	(1.14911)
D(LNES)	0.000243	-1.136801	-0.003604	-0.292993
	(0.08949)	(0.40443)	(0.00384)	(0.30372)
D(CPI)	2.070939	36.68447	3.026934	-329.3925
	(12.4864)	(56.4285)	(0.53633)	(42.3773)
D(LNM)	0.088073	-0.183832	0.007110	-0.943315
	(0.12109)	(0.54725)	(0.00520)	(0.41098)
D(LNME)	-0.161456	-0.093269	0.003007	0.699455
	(0.12725)	(0.57508)	(0.00547)	(0.43188)

==

Johansen Cointegration test results

The Johansen Test shows that the results for both the Trace and Maximum Eigenvalue tests reject the null hypothesis in favour of at least one Cointegration vectors. These results are significant at 5 percent level. It could therefore be concluded that there is one co-integrating relationships in this model. In this test, a long-run relationship has been established between Labour Productivity and its explanatory variables. The short-run and long-run dynamics of the model can be established in a vector error correction model.

Dependent Variable: D(LNLP)
Method: Least Squares
Date: 08/21/22 Time: 05:44
Sample (adjusted): 1992 2022
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPI)	0.000455	0.001452	0.313298	0.7566
D(LNES)	0.110794	0.448384	0.247097	0.8068
D(LNM)	0.442259	0.302142	1.463746	0.1552
D(LNME)	0.582738	0.305099	1.909997	0.0672
ECM(-1)	-0.483700	0.167656	-2.885079	0.0078

R-squared	0.332727	Mean dependent var	-0.017050
Adjusted R-squared	0.230069	S.D. dependent var	0.985184
S.E. of regression	0.864457	Akaike info criterion	2.693259
Sum squared resid	19.42941	Schwarz criterion	2.924547
Log likelihood	-36.74551	Hannan-Quinn criter.	2.768653
Durbin-Watson stat	1.775236		

Figure 0.14 : Results for Johansen Cointegration Test

4.4.8 VECM (Vector Error Correction Estimates)

```
                         Vector Error Correction Estimates
================================================================================
 Vector Error Correction Estimates
 Date: 08/21/22   Time: 06:00
 Sample (adjusted): 1994 2022
 Included observations: 29 after adjustments
 Standard errors in ( ) & t-statistics in [ ]
================================================================================
 Cointegrating Eq:     CointEq1
================================================================================
      LNLP(-1)         1.000000


       CPI(-1)        -0.350877
                       (0.06219)
                      [-5.64221]


      LNES(-1)        -3.055881
                       (4.42523)
                      [-0.69056]


       LNM(-1)         37.03916
                       (3.72723)
                      [ 9.93746]


      LNME(-1)        -5.203833
                       (1.83473)
                      [-2.83629]


         C            -358.0354
================================================================================
```

Error Correction:	D(LNLP)	D(CPI)	D(LNES)	D(LNM)	D(LNME)
CointEq1	-0.010041	-8.589124	0.003851	-0.018333	0.015645
	(0.02977)	(0.92933)	(0.00783)	(0.00936)	(0.01036)
	[-0.33724]	[-9.24224]	[0.49171]	[-1.95770]	[1.51026]
D(LNLP(-1))	-0.208515	-2.413432	0.094244	-0.083347	-0.045443
	(0.27141)	(8.47141)	(0.07139)	(0.08536)	(0.09443)
	[-0.76827]	[-0.28489]	[1.32013]	[-0.97639]	[-0.48124]
D(LNLP(-2))	-0.204139	4.403318	0.014784	-0.021559	-0.021169
	(0.27046)	(8.44187)	(0.07114)	(0.08506)	(0.09410)
	[-0.75478]	[0.52160]	[0.20781]	[-0.25344]	[-0.22496]
D(CPI(-1))	-0.003069	-3.032727	0.001033	-0.005108	0.004514
	(0.00810)	(0.25276)	(0.00213)	(0.00255)	(0.00282)
	[-0.37897]	[-11.9982]	[0.48482]	[-2.00547]	[1.60213]
D(CPI(-2))	-0.005807	-5.058015	0.002018	-0.008945	0.008998
	(0.01578)	(0.49266)	(0.00415)	(0.00496)	(0.00549)
	[-0.36788]	[-10.2668]	[0.48611]	[-1.80193]	[1.63850]
D(LNES(-1))	0.352888	-40.52933	-0.591359	0.422893	0.023979
	(0.73268)	(22.8691)	(0.19272)	(0.23044)	(0.25492)
	[0.48164]	[-1.77223]	[-3.06847]	[1.83516]	[0.09407]
D(LNES(-2))	0.250828	-32.75564	-0.656355	0.155129	0.313538
	(0.82722)	(25.8198)	(0.21759)	(0.26017)	(0.28781)
	[0.30322]	[-1.26862]	[-3.01652]	[0.59626]	[1.08940]
D(LNM(-1))	0.137961	271.5048	-0.115896	-0.445454	0.177122
	(1.00508)	(31.3712)	(0.26437)	(0.31611)	(0.34969)

	[0.13726]	[8.65459]	[-0.43839]	[-1.40917]	[0.50651]
D(LNM(-2))	0.190055	128.1134	0.023119	-0.237315	0.332593
	(0.65188)	(20.3471)	(0.17147)	(0.20503)	(0.22680)
	[0.29155]	[6.29640]	[0.13483]	[-1.15749]	[1.46643]
D(LNME(-1))	0.062652	-32.60665	-0.199478	-0.209478	-0.050288
	(0.70027)	(21.8572)	(0.18419)	(0.22024)	(0.24364)
	[0.08947]	[-1.49180]	[-1.08298]	[-0.95112]	[-0.20640]
D(LNME(-2))	0.084346	-24.36803	0.099724	-0.211728	0.100515
	(0.56227)	(17.5501)	(0.14790)	(0.17684)	(0.19563)
	[0.15001]	[-1.38849]	[0.67428]	[-1.19727]	[0.51381]
C	0.080794	114.3575	-0.043202	0.179688	-0.192732
	(0.40443)	(12.6233)	(0.10638)	(0.12720)	(0.14071)
	[0.19977]	[9.05921]	[-0.40612]	[1.41266]	[-1.36971]

==

R-squared	0.076316	0.932499	0.530567	0.725024	0.571919
Adj. R-squared	-0.521361	0.888822	0.226817	0.547099	0.294926
Sum sq. resids	26.66466	25977.70	1.844846	2.637636	3.227753
S.E. equation	1.252401	39.09092	0.329424	0.393897	0.435738
F-statistic	0.127688	21.34994	1.746719	4.074874	2.064741
Log likelihood	-39.93184	-139.7158	-1.203170	-6.386731	-9.314329
Akaike AIC	3.581506	10.46316	0.910563	1.268050	1.469954
Schwarz SC	4.147284	11.02894	1.476341	1.833828	2.035731
Mean dependent	-0.036623	8.523536	-0.001657	0.009660	-0.021869
S.D. dependent	1.015377	117.2377	0.374640	0.585304	0.518930

==

Determinant resid covariance (dof	2.864606
Determinant resid covariance	0.198299
Log likelihood	-182.2854

```
 Akaike information criterion      17.05416

 Schwarz criterion                 20.11879

==========================================================================
```

Key:
Standard errors = ( )
T-statistics in = [ ]

Vector Error Correction Mode results

Since the existence of the long run relationship was established between Labour Productivity, manufacturing employment, inflation rate, materials and electricity supply, the next step was to establish the short-run and long-run relationship dynamics using the Vector Error Correction Model.

VECM restricts the long run behaviour of the endogenous variables to converge to their co-integrating relationships while permitting for short run adjustment dynamics. VECM is necessary because it is an appropriate model in measuring the correction from disequilibrium of previous periods. A negative and significant coefficient of the VECM indicates that any short-run fluctuations between the variables will give rise to a stable long run relationship between them.

The findings in the table above presents the long-run causality between variables used in the study.

The Co-integrating equation (*CointEq1*), presents the long run relationship between labour productivity and the explanatory variables (lnCPI, lnME, and lnES).

The coefficients with negative numbers indicate a positive long run relationship between the dependant variable and its explanatory variables. Constant has no T-Statistic.

Under the Cointegration Equation ($CointEq1$), a positive long run relationship is revealed between Labour Productivity and its explanatory variables Manufacturing Employment, Inflation Rate and Electricity Supply. As for Materials the relationship is negative. This is shown because the Coefficient on Materials (*lnM*) is positive.

The results imply that interest rate, electricity supply and manufacturing employment and play a role in bringing Labour Productivity to equilibrium, while Materials on the other hand, does not play any role in bringing Labour Productivity to equilibrium.

The significant error correction term between zero and negative two indicates a stable long run equilibrium. In this study, the error term is -0.010041, which implies that Cointegration relationship is stable. The speed of adjustment is 1.004 percent. This is a speed at which Labour Productivity returns to equilibrium after a shock in independent variables like electricity supply and manufacturing employment. It shows that 1.004 percent of the gap between labour productivity and its equilibrium value is eliminated in the short run. VECM was conducted at one lag length order with one co-integrating vectors and the deterministic trend assumption of the test was (allow for linear deterministic trend in data) at trend 3, Intercept and trend in CE-no intercept in VAR.

All the results of tests are shown in table of findings above.

4.4.9 Diagnostic tests results

To assess if the model used in this study reasonably fit the data, the diagnostic tests were performed and they include testing for normality, heteroscedasticity and serial correlation. Conducting diagnostic tests is very crucial in the analysis since it reveals whether there exists a problem in the estimation of a model or not. If a problem is detected it means that the model is not efficient and this can also mean that the results are biased. For this study, the diagnostic tests carried out showed that the model is reasonably well specified.

As indicated in the table below:

- The residuals are normally distributed with a probability of 0.335860 of the Jarque-Bera. This is reassigned to 34 percent.
- The residuals are not serially correlated as indicated by LM-Stat probability Chi Square of 0.8666. This is reassigned to 87 percent.
- The data has homoscedasticity. It has also been observed that there is no heteroscedasticity as shown by a joint Chi-square probability. This is good for regression

Table 0.12: Diagnostic tests results

Test	Null Hypothesis	Probability	Results
Normality Test / Jarque-Bera (JB)	There is a normal distribution	0.335860	– We Accept Null hypothesis. – The Disturbances in the dataset are Normally Distributed. – This is because Prob. > 0.05.
Langrage Multiplier (LM)	No serial correlation	0.8666	– Accept Null hypothesis – There is no evidence of serial correlation. – This is because Prob. > 0.05 – We achieved this result by adding one period lag of the dependent variable.
White (CH-sq.)	No conditional heteroscedasticity	Prob. Chi-Square(14) = 0.2079 Prob. Chi-Square(14) =0.9580	– We Accept Null hypothesis. – The data has homoscedasticity. – This is Because Prob.>0.05

Table 0.13: Diagnostic Tests Results

4.5 Summary

The purpose of this chapter was to analyse the relationship between labour productivity and its explanatory variables being electricity supply, manufacturing employment, materials and inflation rate.

The first procedure was to test for stationarity in the variables and the series were found to be all I (1). This means they were all Non Stationary.

The Johansen Cointegration test showed that there was one co-integrating vector which was between labour productivity and its explanatory variables.

The variables that have a positive long run relationship with labour productivity were Electricity Supply, Manufacturing Employment and Inflation rate.

The error term was negative and significant as expected.

The results obtained for VECM revealed that about 1.004 percent of the variations in labour productivity from its equilibrium level is corrected within a year. The diagnostic tests revealed that our model is normally distributed; there is no serial correlation and no heteroscedasticity.

The results are favourably comparable to those in the literature and they are also supported by the previous studies.

Overally the chapter specified the model that was used to determine the impact of electricity supply on Labour productivity. The variables which were used in the tests were electricity supply, materials, Labour Productivity, inflation rate, and manufacturing employment. The model used the Augmented Dickey-Fuller test, Phillips-Perron test for unit root. Johansen (1991, 1995) co-integration technique based on VAR is employed in this study to determine the long-run relationship between labour productivity and its explanatory variables. Diagnostic tests were done. The residuals were normally distributed, they had no heteroscedasticity and were not serial correlated.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provided answers to questions which were raised in chapter one of this study. This Chapter provides the summary and conclusions for this research based on a reflection of the discussions from the previous chapters. It will also provide implications of this study and as well as suggest areas for further research with regards to this study area.

5.2 Summary

The first chapter provided the basic introduction to the study which laid out the primary aims and objectives of investigating and assessing the impact of electricity supply on labour productivity. The Statement of the Problem revealed that businesses relied on electrical supply and that a discontinuous supply of it can lead to downtime and losses. It is revealed also that there are a very few scholarly reports on this topic hence the need of this study to fill this gap/void. The specific Research objectives of the study assisted in the formulation of the various Research Questions which were enquired throughout the documentation. A Hypothesis of the study was developed and two hypotheses where presented and stated, whilst awaiting to be tested. Limitations that could possibly hinder the progress of the Study were also laid out and recommendations to curb these restrictions were given.

The Second Chapter discussed production theories of Cobb-Douglas production function, Real Business Cycle Theory and the Constant Elasticity of Substitution (CES) production function. In addition to these theories, a number of studies on electricity and manufactured output were reviewed. The variables to be used in this research were established and these were Electricity Supply, Labour productivity, Manufacturing Employment, Materials & Inflation Rates. An estimation model was established with these variables. A Cointegrated VAR methodology was implemented to test the impact of electricity supply on Zimbabwe's labour productivity.

The third chapter detailed the way in which data was collected and analyzed for the research on impact of electrical supply on labour productivity.

The Forth Chapter established that the variables that have a positive long run relationship with labour productivity were Electricity Supply, Manufacturing Employment and Inflation rate. The diagnostic tests revealed that our model is normally distributed; there is no serial correlation and no heteroscedasticity. The results are favourably comparable to those in the literature and they are also supported by the previous studies.

5.3 Conclusions

The relationship between electricity supply and labour productivity has long been debated, but mostly focused on the consumption of electricity by the Fittings & manufacturing sector. It is against this particular background that it was necessary to determine and document the impact of electricity supply on the Fittings & Manufacturing sector in Zimbabwe.

The study has the following specific objectives:

1. Develop an engagement model between electricity supply and labour productivity.
2. Test the relationship between electricity supply and labour productivity using Correlation and Vector Auto regression.
3. Ascertain what percentage of significance electricity has in productivity.

(1) As part of its objectives this study wanted to develop an engagement model between electricity supply and labour productivity.

The study discussed some of production theories including the Cobb-Douglas production Function and Real Business Cycle Theory. In addition to these theories, a number of studies on electricity supply and labour productivity in the Fittings & manufacturing sector were reviewed. Even though most of these studies focused on electricity consumption, most of the results obtained revealed positive relationship between electricity and labour productivity. The model was formulated between the dependent variable labour productivity (LP) and electrical Supply (ES) and including the other subsequent explanatory independent variables namely Inflation Rate (CPI), manufacturing employment (ME) and Materials M). This model was later implemented in Chapter 4 during actual calculations. This objective was fully met and completed.

(2) As part of its objectives this study wanted to test the relationship between electricity supply and labour productivity by using Correlation and VAR methodology. This was fully achieved in Chapter 4.

Other researchers used different estimation techniques ranging from VAR, ARDL and Engle-Granger while some carried out surveys.

After an extensive review of the literature on electricity and labour productivity, an empirical model that links labour productivity to its explanatory variables was specified.

The variables that were identified as (LP) labour productivity's explanatory variables included: Inflation Rate (CPI), manufacturing employment (ME) and electricity supply (ES). The study relied on Johansen co-integration and VECM to determine the impact of electricity supply on labour productivity.

Stationarity in the variables was tested by using ADF and PP test and the variables were found to be integrated of the same order and they all became stationary at first difference I(1).

Johansen Cointegration showed evidence of one co-integrating vector. A positive long run relationship was found between labour productivity and manufacturing employment, electricity supply and inflation rate. Evidence of these results is consistent with a priori expectation.

(3) The study also needed to ascertain what percentage of significance electricity has in productivity. Cointegration allowed for the estimation of VECM. The correction error term of -0.010041 which indicates a stable long run equilibrium was obtained. The speed of adjustment showed that 1.004 percent of the gap between labour productivity and its equilibrium value (i.e. Electrical Supply) is eliminated in the short run. The model passed the entire diagnostic tests and the residuals were found to be normally distributed, with homoscedasticity and were not serially correlated.

The collective results have shown that Zimbabwe's Fittings & manufacturing sector output can be enhanced by increasing electricity supply. These results are favourably comparable to those in the literature.

5.4 Implications

(Mapako & Gwatipedza, 2016), Zimbabwe's fittings & manufacturing sector has been experiencing a decline in its output due to shortages of electricity which led to load-shedding and brownouts. The empirical results of this study have found a long run positive relationship between electricity supply and labour productivity. The policy implication of this positive relationship is that an expansion of electricity sector will lead to an increase in labour productivity. Policy makers in Zimbabwe should continue to formulate and implement policies that are aimed at promoting and expanding a self-powering and sustainable electricity sector. The Electricity Act 4/2002 and the ENERGY REGULATORY AUTHORITY ACT (Act 3/2011), which is aimed at maintaining the power infrastructure and building new power stations is an example of the policies that can be used to expand the electricity sector. This will not only boost the Fittings & manufacturing sector but will also create more jobs in the country.

Expansion in generation is expected to increase in Zimbabwe since the government finally approved the National Renewable Energy Policy and recommitted to the National Biofuels Policy in August 2020, following many years of indecision. The two critical and long-awaited policies could catalyze renewable energy investments and diversify the country's energy mix. Through the policies, the private sector is anticipated to play a leading and complementary role in electricity production. (Tonderayi Mukeredzi, 2020)

5.5 Recommendations

The study has the following specific objectives:

1. Develop an engagement model between electricity supply and labour productivity.

The model revealed a significant relationship between electricity supply and productivity with inflation rate, manufacturing employment and materials. The study recommended that the factors which affect productivity should be closely monitored so that action can be taken if the values fall.

It was also recommended that measures be taken by all companies to ensure that they have a stable electricity supply through acquiring alternative power sources.

Another Recommendation would be look to into sustainable Renewable sources of Electricity. Zimbabwe is electrical energy dependent, but the alternative provided by renewable sources would contribute to economic progress in the future only if the cost of establishing this energy as well as its accessibility and cost is competitive with traditional energy directions. • ZESA and its governing bodies should Encourage the use of renewable sources of electricity e.g., Solar Energy in order to give a balance on Power use to avoid over dependence on Electricity through the national grid only. The Government should increase its coal production and has decided “to rehabilitate Hwange power station.

2. Test the relationship between electricity supply and labour productivity using Correlation and Vector Auto regression.

The tests revealed a positive association between electricity supply and labour productivity. The study recommends that policymakers create a valuable framework for individuals to privately generate electricity and feed into the national grid to alleviate shortages. Harnessing private resources would cover for the government’s current inability to fund new power stations infrastructure.

The study also recommended manufacturing companies to take a collaborative approach to dealing with power challenges and install shared backup power systems as this would be cheaper than each one having their own. This approach would give more companies backup power options at lower cost. This could also reduce carbon emissions per individual, into the atmosphere and help reduce global warming

A monitoring committee should be established to constantly monitor the Electrical Programme of Zimbabwe. A resource mobilization strategy should be put in place for the Electrical Supply Programmes, and this should be clearly stated in the Electricity Act. The Zimbabwean Government should have a strong hand at fighting corruption and incompetence within the governing body that is responsible for Electricity Procurement for example trying to avoid the case of Intratek Company fiasco. Intratek is an IPP which was awarded a tender in 2015 through the Zimbabwe Power Company (ZPC) to supply electricity through a 100 megawatts Gwanda solar farm project but it never delivered. (Newsday, 2022).

3. Ascertain what percentage of significance electricity has in productivity.

The tests revealed that electricity has high significance in manufacturing companies' productivity. The study recommended that companies should recognize availability of electricity as a nonnegotiable and put the installation of backup power as a high priority. The study also recommended that companies should designate an individual or department which looks at the supply of electricity in the production plants and ensures that uninterrupted power of the required power is available.

5.6 Suggestions for Further Research

Areas of Future research that were suggested would be Forecasting and Interpolation using VARs with common trends.

Another area would be to study on the Behavioural Impact of Power Outages on Developing Countries.

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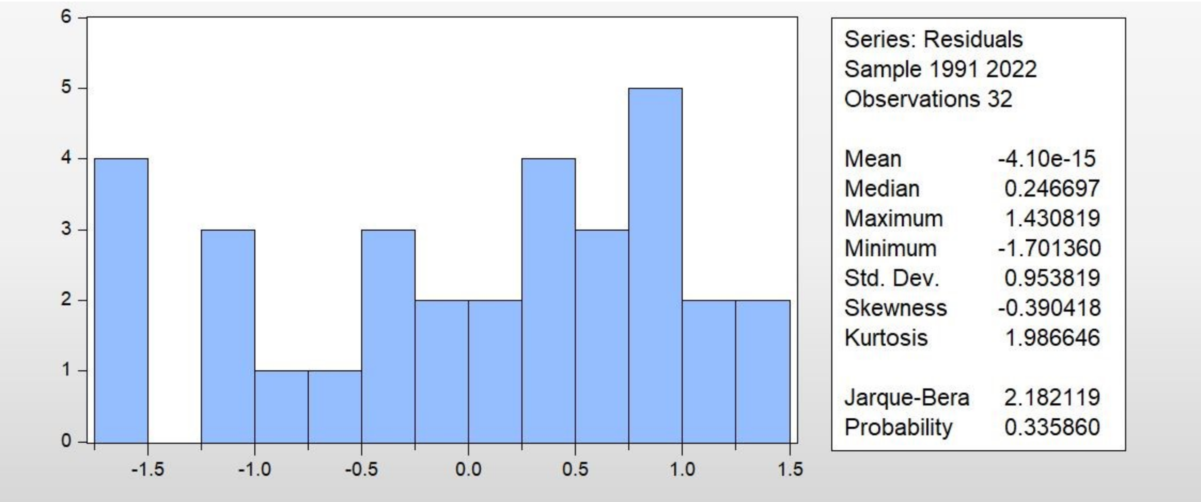
APPENDICES

APPENDIX 1: Diagnostic Tests Results

1. Normality Test



2. Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.107190	Prob. F(2,23)	0.8988
Obs*R-squared	0.286277	Prob. Chi-Square(2)	0.8666

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 10/15/22 Time: 14:23

Sample: 1992 2022

Included observations: 31

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNES	-0.050296	0.682491	-0.073695	0.9419
CPI	7.33E-06	0.001551	0.004729	0.9963
LNM	0.040154	0.461792	0.086953	0.9315
LNME	0.022231	0.395556	0.056202	0.9557
LNLP(-1)	-0.061626	0.303675	-0.202935	0.8410
C	0.610890	9.966748	0.061293	0.9517
RESID(-1)	0.126563	0.370330	0.341757	0.7356
RESID(-2)	-0.031356	0.270017	-0.116127	0.9086

R-squared	0.009235	Mean dependent var	-1.90E-15
Adjusted R-squared	-0.292302	S.D. dependent var	0.794740
S.E. of regression	0.903456	Akaike info criterion	2.852458
Sum squared resid	18.77337	Schwarz criterion	3.222520
Log likelihood	-36.21311	Hannan-Quinn criter.	2.973089
F-statistic	0.030626	Durbin-Watson stat	1.959535
Prob(F-statistic)	0.999956		

3. Heteroskedasticity Test

Heteroskedasticity Test: White

F-statistic	1.556220	Prob. F(14,17)	0.1916
Obs*R-squared	17.97471	Prob. Chi-Square(14)	0.2079
Scaled explained SS	6.312786	Prob. Chi-Square(14)	0.9580

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 10/15/22 Time: 15:00

Sample: 1991 2022

Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.52682	327.3461	0.047432	0.9627
LNES^2	-4.216063	3.436216	-1.226949	0.2366
LNES*CPI	-0.078371	0.089680	-0.873892	0.3944
LNES*LNM	1.102898	3.045996	0.362081	0.7218
LNES*LNME	0.292687	2.440070	0.119950	0.9059
LNES	60.93980	55.51055	1.097806	0.2876
CPI^2	-1.14E-05	2.25E-05	-0.504515	0.6204
CPI*LNM	0.053441	0.047744	1.119314	0.2786
CPI*LNME	-0.012796	0.009573	-1.336706	0.1989
CPI	0.153505	1.051703	0.145958	0.8857
LNM^2	0.914336	1.157651	0.789820	0.4405
LNM*LNME	2.087616	1.688035	1.236713	0.2330
LNM	-41.35115	52.29326	-0.790755	0.4400
LNME^2	-0.833532	1.126209	-0.740122	0.4693
LNME	-18.65044	28.67326	-0.650447	0.5241

R-squared	0.561710	Mean dependent var	0.881341
Adjusted R-squared	0.200765	S.D. dependent var	0.889444
S.E. of regression	0.795163	Akaike info criterion	2.684438
Sum squared resid	10.74883	Schwarz criterion	3.371501
Log likelihood	-27.95100	Hannan-Quinn criter.	2.912180
F-statistic	1.556220	Durbin-Watson stat	1.576130

Prob(F-statistic)	0.191646

APPENDIX 2:

4. AUREC Approval letter

AFRICA UNIVERSITY
A United Methodist-Related Institution
Investing in Africa's future

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 website: www.africau.edu

Ref: AU2117/21 11 June, 2021

TERRANCE CHIRARA
C/O CBPLG
Africa University
Box 1320
Mutare

RE: THE IMPACT OF ELECTRICITY SUPPLY ON LABOUR PRODUCTIVITY IN THE WOODEN FITTINGS SECTOR. A CASE OF AFRICA CONSTRUCT - ZIMBABWE

Thank you for the above titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal
b) Data collection instruments
c) Informed consent guide

- **APPROVAL NUMBER** AUREC 2117/21
  This number should be used on all correspondences, consent forms, and appropriate documents.
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** June 11, 2021
- **EXPIRATION DATE** June 11, 2022
- **TYPE OF MEETING** Expedited
  After the expiration date this research may only continue upon renewal. For purposes of renewal, a progress report on a standard AUREC form should be submitted a month before expiration date.
- **SERIOUS ADVERSE EVENTS** All serious problems having to do with subject safety must be reported to AUREC within 3 working days on standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

AFRICA UNIVERSITY
RESEARCH ETHICS COMMITTEE (AUREC)
APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

Yours Faithfully

Mchinzou

MARY CHINZOU – A/AUREC ADMINISTRATORFOR CHAIRPERSON, AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE

5. AUREC Approval letter

COLLEGE OF BUSINESS, PEACE, LEADERSHIP AND GOVERNANCE

29/04/2021

Africa University Research Ethics Committee

Ref: Approval for AUREC Proposal Submission

TERRANCE CHIRARA has worked on the proposal and I can confirm that it is ready for review by your esteemed committee.

Respectfully submitted,

T. Nemaunga	
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Supervisor's Name	Supervisor's Signature
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H.O.D's Name	H.O.D's Signature

6. INFORMED CONSENT GUIDE

My name is Terrance Chirara a final year EMBA student from AU. I am carrying out a study on assessing the Impacts of Electricity Supply on Labour Productivity in the Wooden Fittings Sector. A Case of Africa Construct Zimbabwe. I am kindly asking you to participate in this study by answering and filling in the Questioner that has been handed to you.
What you should know about the study:

Purpose of the study:
The purpose of the study is assessing the Impacts of Electricity Supply on Labour Productivity. You were selected for the study because you have knowledge on the supply of electricity to the Industry of Zimbabwe and how it is affecting your company.

Procedures and duration
If you decide to participate you will assist with information about the current power supply issues of Zimbabwe and how it has affected your company. It is expected that this will take about an hour during an interview and discussion.

Risks and discomforts
The Researcher might ask to see company performance documents of the company over the past two years for comparative reasons

Benefits and/or compensation
The Benefits to the your organisation is that it will add to the documentation and will assist to see the company's knowledge about the effects of power supply has on the growth of the company

Confidentiality
All information that is obtained in the study and shared by the participant and that can be identified with the participant will not be disclosed without their permission. Names and any other identification will not be asked for in the questionnaires.

Voluntary participation
Participation in this study is voluntary. If participant decides not to participate in this study, their decision will not affect their future relationship with.......... (Participant's organisation or other authority) If they chose to participate, they are free to withdraw their consent and to discontinue participation without penalty.

Offer to answer questions
Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

Authorisation
If you have decided to participate in this study please sign this form in the space provide below as an indication that you have read and understood the information provided above and have agreed to participate.

Terrance Chirara	**29/04/2021**
--	--------------------------------
Name of Research Participant (please print)	Date

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Signature of Research Participant or legally authorised representative

If you have any questions concerning this study or consent form beyond those answered by the researcher including questions about the research, your rights as a research participant, or if you feel that you have been treated unfairly and would like to talk to someone other than the researcher, please feel free to contact the Africa University Research Ethics Committee on telephone (020) 60075 or 60026 extension 1156 email aurec@africau.edu

Name of Researcher: Terrance Chirara

7. Letter of Permission from Company

Office 2, Kugona Center, Helensvale
Borrowdale, Harare

(+263) 777 827 469

africaconstructinfo@gmail.com
admin@africaconstruct.co.zw

AFRICA CONSTRUCT

18 May 2021

To Whom It May Concern

This letter serves as a courteous note that the Student Researcher, **Terrance Chirara** from Africa University, has been given permission to carry out his research in our organisation.

We have given him access to our resources which will allow him to carry out his research within the company.

Yours Sincerely,

Munashe Saramusi
Chief Executive Officer
Africa Construct

THE DIRECTOR
AFRICA CONSTRUCT
18 MAY 2021
STAND No. 21757
RUWA INDUSTRIAL AREA, RUWA
ZIMBABWE

8. Research Instruments: Questionnaires

QUESTIONNAIRE

My name is Terrance Chirara - a post graduate student studying towards an Executive Master's in Business Administration. I am conducting a research study titled 'Assessing the Impacts of Electricity Supply on Labour Productivity in the Wooden Fittings Sector. A Case of **Africa Construct** - Zimbabwe'. I am kindly asking for assistance by way of completing a questionnaire to make this project a success. Please note that the views that you will provide will be used for academic purposes only and shall be treated with confidentiality.

Instructions

1. Please do not write your name on this questionnaire.

2. Please respond by ticking [✓], ☒ or ■ the appropriate box/es where applicable and write in full in the spaces provided where specified.

3. Please click here to indicate your informed consent to participate in this study ☒

KEY

City	Code
Harare	HR
Bulawayo	BL
Chinhoyi	CH
Marondera	MR

Department	Code
IT Department	IT
Accounting	AC
Human Resources	HR
Research & Development	RD
Workshop	WS
Transport, Logistics & Dispatch	TL
Sales & Marketing	SM

Geocode	City		Department		Employee. No.		Age		Entry. No.		Year			

SECTION A: Demographics

1. Gender

Male	
Female	

2. Age

Below 30 Years	31 – 40 Years	41 – 50 Years	51+ Years

3. Which department are you in?

Information Technology ☐

Accounting ☐ (Chikowore, 2017)

Human Resources ☐

Research & Development ☐

Workshop ☐

Transport, Logistics & Dispatch ☐

Sales & Marketing ☐

Other (Specify)………………..

4. Part A.

The questions in this section are designed to collect information on your education and how you have been financially supported during your tenure in the organization.

A1. When did you first start working in this company?

Month ☐☐ Year ☐☐☐☐

A2. What education level did you reach?

High School	Certificate	Higher National Diploma	Degree Level	Masters Level	Doctorate

4. Part B.

4. How long have you been working for the organization?

5 year and below	6- 10 years	11 years and above

5. When last did you have access to unlimited supply of electricity?

1-2 Year ago	3-4 Years ago	5-8 years ago	9 Years and above

5. How long have you been accessing unlimited supply of electricity at the work premises?

0-2 Years	3-5 years	6-8 years	9 Years and above

6. How many hours do you spend on one job?

1-4Hours	4-8Hours	8-12Hours	12 and above	Other (Specify)

7. How many hours do you spend at work?

1-4Hours	4-8Hours	8-12Hours	12 and above	Other (Specify)

SECTION B

Please tick (✓) or write in the appropriate answer in the box.

1. Have you ever lost data due to unexpected power cuts?

Yes	**No**

2. Have you ever had any electrical appliances and equipment been damaged.

Yes	**No**

3. Have you ever had any electrical interruptions?

Yes	**No**

4.

On Average How many hours per week do you spend working in the business during a year? (e.g. the period 1 January 2021 to 31 December 2021)	

5.

How many interruptions can you say you have experienced in a **(week | year)**.		

6. In the event that company equipment has been damaged due to voltage fluctuations, has the company obtained any compensation from the utility service provider?

7. If private equipment is damaged due to voltage fluctuations, can customers obtain compensation from the utility?

YES	NO

If yes, please select how compensation requests are filed:

☐ At the office of the utility

☐ At the office of a third-party agency

☐ The utility's website

8. How frequent are these Power Cuts?

Very Frequent	Moderate	Extremely Frequent

9. How Many cuts do you have per day?

1-3 Times	3-4 Times	5-9 Times	9- 15 Time	Other Specify

10. Do these Cuts affect your Business Process? **YES** ☐ | **NO** ☐

11. Do these cuts affect your work procedure? **YES** ☐ | **NO** ☐

12. To your knowledge how much funds do you know have been lost due to these unexpected power cuts in day?

$3000-$7000	$7000-$12000	$12000-$20000	$20000-$50000	$50000 OR ABOVE

13. According to your working Responsibility and Department How do these Power Cuts or interrupts prolong waiting time?

1-4 Hours	4-8Hours	8-12 Hours	12-18 Hours	More than a Day	Other (Specify)

14. What is the per low-voltage required for customers job to be done.

15. What is the per low-voltage required for customers job to be done Per medium-voltage customers

16. What is the per low-voltage required for customers job to be done Average for all customers

17. What is the minimum outage time (in minutes) that the utility includes in the calculation of SAIDI/SAIFI:

SAIDI = (System Average Interruption Duration Index) total duration of interruptions for a group of customers. Number of all customers.
SAIFI = (System Average Interruption Frequency Index) – a system index of average frequency of interruptions in power supply.

SECTION C:

1. What are the challenges and problems being encountered when electricity goes off and when you experience an electrical cut?

Please tick (✓) the appropriate answer in the box.
Scale: 1 Strongly Disagree (**SD**), 2 Disagree (**D**), 3 Neutral (**N**), 4 Agree (**A**), 5 Strongly Agree (**SA**)

Statements	**SD 1**	**D 2**	**N 3**	**A 4**	**SA 5**
a) Is the current Electricity supply lowering productivity					
b) Is the current Electricity supply are damaging equipment					
c) Is the current Electricity supply lowering work moral on workers					
d) Is the current Electricity supply triggering discomfort on the employees					

2. What any other challenges are faced encountered due to lack of adequate electricity supply in your organization?

……………………………………………………………………………………………

……………………………………………………………………………………………

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………………

3. How could you describe your work rate when there is no electricity?

Good	Bad	Excellent	Indifference

4. How could you describe your work rate when there is electricity?

Good	Bad	Excellent	Indifference

5. What percentage of your work requires you to use power?

0-25%	25-50%	50-75%	75-100%

6. When are you most motivated to work? A - When there is electricity or B - No Electricity?

A	**B**

7. What alternative sources of power do you use in your organization?

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8. What alternative sources of power do you suggest your organization have to curb the issue of power losses?

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9. How much do these sources take up in terms of expenditure as compared to electricity?
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10. Suggest any ways to improving turnover even when there are electric faults or cutoffs.
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11. Do you think it's to greater advantage to use other sources of sustainable sources of energy apart from electricity?
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12. How do you think electricity is affecting other players in your industry?
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13. Does electricity supply reduce product quality?

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14. How is electricity interruption affecting your work?
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15. Describe your moral and motivation to work when there is electricity in the work place.

☐ Very high
☐ High
☐ Low
☐ Very Low
☐ Indifferent

16. Describe your moral and motivation to work when there is no electricity in the work place.

☐ Very high
☐ High
☐ Low
☐ Very Low
☐ Indifferent

17. Describe your mood when there is no electricity in the work place.

☐ Happy
☐ Sad
☐ Low
☐ Very Low
☐ Indifferent

For Management:

SECTION D:

For Management Only

1. What type of ownership is the institution 1. Sole Proprietorship 2. Private Limited Company 3. Partnership 4. Cooperative 5. Public Limited Company 6. Central Government 7. Local Government 8. Parastatal 9. Non-Profit Making Institution 10. Private Business Corporation 11. Trust 12. Household Enterprises 13. Other *(Specify)*...……………...	2

2. What was/is the tenure status of this business premises/workspace? 1. Owner/Part owner 2. Rented with contract 3. Rent free with permission 4. Occupation without permission 5. Sub- tenant 6. Other *(Specify)*……………………………………………………………………………………	1

3. Did your business own the followingElectrical/ ICT equipment during the periods of operation?		
a) Landline/ Fixed Telephone	1. Yes 2. No	**1**
b) Mobile Cellular Telephone	1. Yes 2. No	**1**
c) Computer (desktop, laptop, tablet)	1. Yes 2. No	**1**
d) Power Tools	1. Yes 2. No	**1**
e) Heavy Duty Manufacturing Machinery	1. Yes 2. No	**1**
f) Heavy Duty Fabrication Machinery	1. Yes 2. No	**1**

4. Do these depend on power to be functional?

YES

5. Did any of these ever succumb to damage from power surges or interruptions?

YES

6. How much money did you spend of fixing the gadgets?

$300-$3000	$3000-$7000	$7000-$12000	$12000-$20000	$20000-$50000	$50000 OR ABOVE
	✓				

7. For what purpose did your business use the computer during the start of your tenure till today? (*multiple responses*) 1. Data processing 2. Data storage 3. Printing/scanning 4. Internet 5. Funds Transfer & Transactions Processing 6. Research 7. Other (*Specify*)…………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………	**1,2,3,4,5,6**

8. Did you use the internet in your business during the working period? **1. Yes 2. No**	**1**

9. For what purpose did your business use the internet during the working (*multiple responses*) 1. Online communication 2. Online payments 3. Online advertising 4. Online purchasing 5. Online selling 6. Online banking 7. Customer/ Client entertainment 8. Other (*Specify)*……………………………………………………………………………………………… …………………………………………………	**1,2,3,4,5,6,7**

10. Did you use mobile money transfer platforms in your business during the working tenure period 1. Yes 2. No	**1**

11. In which ways did you use mobile money transfer platforms in your business (*multiple response*) 1. Paying for goods and services 2. Receiving payments 3. Banking 4. Other (specify)………………………………………………………………………………… ………………………………………………	**1,2,3**

12. No.	Did you encounter any challenge in dealing with the following institutions in your business?	**(a)** **1. Yes** **2. No**	(b) If YES in 8.1, what was the main challenge	(c) How was the challenge resolved?
1.	Local Authority/ Council	1	3	3
2.	Zimbabwe Energy Regulatory Authority (ZERA)	2	n/a	n/a
3.	ZESA	2	n/a	n/a
4.	ZETDC	2	n/a	n/a
5.	Other Regulatory Agencies *(Specify)*………………………………………… …………………………………………………	2	n/a	n/a

Main type of challenge
1. Related to compliance costs
2. Related to the premises
3. Related to other rules & regulations
4, Related to taxes
5. Related to products used/sold
6. Related to licence
7.Other (*Speci*fy)

Settlement of the challenge
1. Payment of a fine
2. Payment of a bribe
3. In compliance with the law
4. No settlement
5. Amicable settlement
6. Other *(Specify)*

SECTION E:

PRODUCTION AND SALES

	Turnover/sales realised	Profits Realised
1991	169270	
1992	269165	
1993	288592	
1994	247910	
1995	302120	
1996	344454	
1997	137660	
1998	279788	
1999	252345	
2000	296312	
2001	268605	
2002	25030	
2003	205374	
2004	174157	
2005	199064	
2006	140678	
2007	15804	
2008	12302	
2009	21997	
2010	103561	
2011	57267	
2012	44844	
2013	32421	
2014	19998	
2015	17575	
2016	300000	
2017	279000	
2018	321785	
2019	141000	
2020	101908	
2021	98922	
2022	99778	