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The Effects of electricity cost on the overall production cost: the case of manufacturing companies in Nairobi

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**The Effects of Electricity Cost on the Overall Production Cost: The Case of
Manufacturing Companies in Nairobi**

TRUSHIT SHAH

99606/2017

**A dissertation submitted to Strathmore Business School in the partial
fulfilment of the requirements for the degree of Master of Business
Administration**



Strathmore Business School

Nairobi Kenya

JUNE 2019

DECLARATION

I, Trushit Shah declare that this is my original work and has not been submitted partially or in full to Strathmore University or any other learning institution for examination purposes. To the best of my knowledge, this dissertation is original and any borrowed materials have been duly referenced to recognise the authors.

Student Name: **Trushit Shah**

Sign.....

Date.....

Approval

This dissertation has been reviewed and approved for examination purposes.

Supervisor: **Dr. Helen Osiolo**

Sign.....

Date.....



ABSTRACT

Electricity as a source of power for production is a key aspect in the growth and development of the manufacturing sector. The availability of electric power and its costs directly affects the quality, quantity and cost of production. However, there lacks substantive studies on the contribution of proportionate costs of mains electricity in determining the overall production cost from the manufacturing companies in Nairobi. Thus, this study evaluated the role of mains electricity as an input of production in determining the cost of production in the manufacturing companies in Kenya. The specific objectives of the study were; determining the effect of mains electricity availability on the overall production cost; ascertain the effect of mains electricity fluctuations on the overall production cost and finally, establish how the cost of mains electricity affects the cost of production. A descriptive cross-sectional design was utilised in the methodology employing a mixed method of survey. Non-probabilistic sampling was utilised to acquire the study population. A total of 1072 manufacturing companies registered with Kenya Association of Manufacturers (KAM) were targeted. A survey questionnaire was administered to the sampled 92 respondents involving employees of manufacturing companies. Further, key in-depth interviews were conducted to 14 production managers from the same sampled companies. Study findings showed electricity availability, electricity fluctuation and electricity cost have a direct positive impact on the overall production cost. Regression analysis showed that availability of electricity with relation to extent of blackout and outage, backup generator, frequency of electricity fluctuation and number of employees was found to have significant relationship to overall production cost. It was found that higher the production cost of companies, the higher the impact of electricity fluctuation. For the companies having production cost of over 3 billion, fluctuation was significant at 1% which implies that a unit increase in fluctuation resulted in 1.684 increase in overall production cost. The increased proportion of availability and fluctuation was attributed to the use of power backups like generators to supplement insufficient power. Further, the use of power stabilisers and maintenance due to fluctuation affecting machine efficiency increasingly contributed to high effect on the production cost. Further, manufacturers should consider installing renewable energies like solar where applicable to supplement insufficient supply of power. This also contributes towards green energy initiative aimed at reducing global warming. The study therefore recommends the government to continue easing of electricity access, fair pricing and incentives to foster alternative sources installation like solar energy for industries. To address fluctuation, utility provider should ensure efficient transmission lines to industries and stabilising power for them.

Key Words: Electricity cost, manufacturing, availability, fluctuation, outage, blackout overall production cost.

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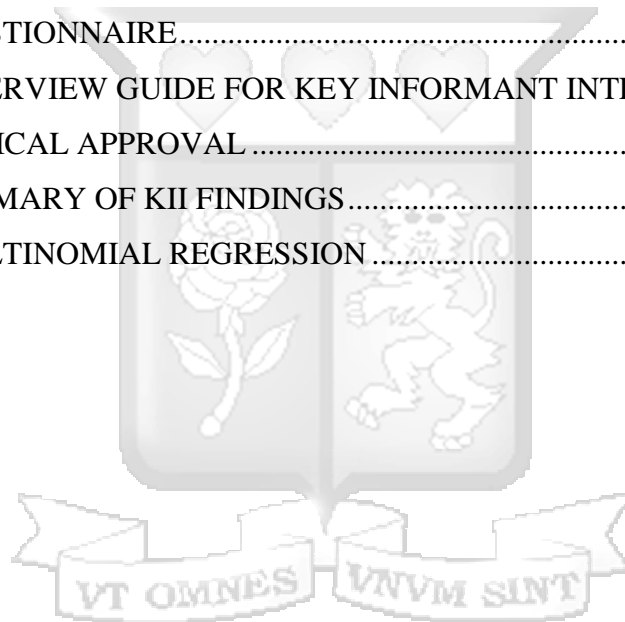
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DEDICATION

This research work is dedicated to my family for their immense support, love and encouragement throughout the study process.



CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

Electric energy has been utilised in the modern day as a source of energy with increased efforts being championed to produce sufficient power to sustain economic growth (Owusu, Asumadu-Sarkodie & Dubey, 2016). The shift from fossil fuel use like coal and petroleum in the manufacturing sector has been progressive in the twentieth and twenty-first centuries. This has been supported by the greater need to reduce carbon emission by embracing clean energy sources and curb the continued climatic changes like global warming orchestrated by fossil fuels consumption (Kaygusuz, 2012). Further, access to sustainable energy has gained prominence in the recent years as exemplified in the sustainable development goal seven (SDG7) to ensure expansion of infrastructure to provide affordable and clean energy (Vezzoli et al., 2018). Onuonga, Etyang and Mwabu (2011) state that electrical energy has been a driver of many economic sectors like manufacturing, business, transport, communication, agriculture and the related areas of the economy. The manufacturing sector consumes substantive proportion of the global energy production with 54% of global total energy production being consumed in the industrial sector (International Energy Outlook, 2016). Thus, the Kenyan government has put in place targets in the Vision 2030 and the Big 4 Agenda to meet the electric energy requirements, as well as improve the manufacturing sector.

The Kenyan Vision 2030 and Big 4 Agenda have been designed by the government with the main aim of revamping the manufacturing sector. The Vision 2030 envisaged the manufacturing sector contributes at least ten percent (10%) of the GDP annually. The plans are in tandem with the need for increased mains electricity production in the Kenyan front as observed with an installed capacity of 2,370MW and peak demand of approximately 1,770MW. Subsequently, one aspect of the Big 4 Agenda is manufacturing that incorporates providing a favourable environment to spur growth of the manufacturing sector with the main aim of creating more job opportunities for Kenyans (KAM, 2018A). Mains electricity involves the general-purpose alternating current (AC) electric power supplied from power stations to the consumption unit or site (Luo, Wang, Dooner & Clarke, 2014). The aim of the Kenyan government is to ensure structures and incentives are put in place to ensure manufacturing sector attains 15% of the GDP by 2022 up from 6.6% (KAM, 2019). The targets are in line with the Vision 2030 of driving the Kenyan economy to a middle income

country by improving the manufacturing sector through provision of sufficient and cheap electricity.

The pricing of electricity is affected by various factors with tariffs calculation being pegged on the fuel and non-fuel components. Grainger and Zhang (2017) states that electricity processes are normally region-specific, with three major factors affecting the price paid for consumed electricity power. The three factors impacting on the price of electricity involves availability of capacity to generate power, ability for generating companies to deliver produced power and the changes in weather patterns. Additionally, the factors do not impact on the electricity pricing in isolation but collectively with other minor factors combine to create friendly or wild prices. Weather patterns are normally the most critical factors that determine electric generation and supply (Bee, 2016). Power goes up during extreme hot or cold weathers pushing prices up multiple times due to snow during winter and extreme during summer which require power for heating and air conditioning respectively. The African region and especially Kenya also experiences similar changes during extreme hot weather and rainy seasons (Kasae, 2014). During droughts, production of hydroelectric power goes down resulting in the production of electric power from generators to supplement the shortage increasing the cost.

The cost of electricity is affected by fuel costs which vary with time resulting in high power tariffs (StimaRegulus, 2018). Further, the Energy Information Administration (EIA, 2018) asserts that transmission and distribution systems affect the price of electricity due to the cost of maintenance that also incorporates the repair of damages to the system or extreme weather conditions impact. Unreliable infrastructure leads to increased costs of operation due to repairs and maintenance increasing the proportionate cost of mains electricity which is priced as tariffs (Abotsi, 2016). At the consumption phase, the cost of mains electricity varies with volume of consumption and type of customer and the tariffs for domestic use are different compared to the manufacturing sector, same for small and large business enterprises. According to Fisher-Vandem, Mansur and Wang (2015), the cost of electricity is highest for residential and commercial consumers as it costs more to distribute less components of power. However, industrial consumers of electric power are charged lower tariffs as they are supplied at higher voltages which are more efficient and less expensive (International Energy Outlook, 2016). Generally, the price of electricity to manufacturers is closer to the wholesale price of electricity. For example, in the US annual average price of electric power was 10.54¢

per kilowatt hour (kWh) with annual averages for utility customers being; 12.90¢ for residential; 10.68¢ for commercial; 6.91¢ for industrial and 9.67¢ for transportation (EIA, 2018). The Kenyan mains electricity market is divided into various classes as per the Kenya Power tariffs indicated in the table below.

Table 1.1: Approved charge Rates for Kenyan Electricity Tariffs for various Consumer Categories 2018/19

| Tariff | KES Charges (KES) | |
|------------------------------|--------------------------------|-------|
| | Energy charge (per kWh) | |
| DC (Domestic, 240 V) | 10kWh or less: | 12.00 |
| | Over 10kWh: | 15.80 |
| SC (Small Commercial, 240 V) | | 15.60 |
| CI1 (Commercial, 415 V) | Peak: | 12.00 |
| | Off-peak: | 6.00 |
| CI2 (Commercial, 11 kV) | Peak: | 10.90 |
| | Off-peak: | 5.45 |
| CI3 (Commercial, 33 kV) | Peak: | 10.50 |
| | Off-peak: | 5.25 |
| CI4 (Commercial, 66 kV) | Peak: | 10.30 |
| | Off-peak: | 5.15 |
| CI5 (Commercial, 132 kV) | Peak: | 10.10 |
| | Off-peak: | 5.15 |
| Street Lighting | | 7.50 |

Source: (ERC, 2019)

Table 1.1 presents mains electricity consumption categories into seven classes spanning domestic and commercial consumption in the Kenyan electric power market. Domestic consumption (DC) involves voltage supply of 240v where consumption of 10kWh or less is charged at Ksh. 12.00 and above consumption of 10kWh, the charge is Ksh. 15.80. The commercial category takes the remaining seven categories with the lowest being small commercial (SC) at 240v which is charged at Ksh. 15.80. The other categories of commercial involve CI1 supplied at 415V with charges during peak at Ksh. 12.00 and Ksh. 6.00 off-peak. CI2 is supplied at 11kV and charged Ksh. 10.90 during peak and Ksh. 5.45 off-peak and CI3 supplied at 33kV is charged at Ksh. 10.30 at peak and Ksh. 5.15 during off-peak. CI4 supplied at 66kV and charged at sh. 10.30 during peak and Ksh.5.15 during off-peak and CI5 supplied at 132kV and charged at Ksh. 10.30 peak and Ksh. 5.15 off-peak. However, the charges cited above only indicate the base tariff charges which rise upon average with other

charges and taxes during electric cost arithmetic calculation. For example, the average charge in the industrial sector is KSh17 per kilowatt hour against Ksh. 10.30 to Ksh. 12.00 base tariff charges.

The cost of power in the Kenyan manufacturing sector is not appealing when compared with emerging industrial nations where one kilowatt hour costs \$0.03 (Sh3) per unit in China and \$0.09 (Sh9) in India (Statistica, 2018). The great disparities can be attributed to increased manufacturing sector that requires stable and cost effective power supply to compete effectively at the global front in the two highly developing economies. Electricity for manufacturing purposes in Egypt costs \$0.11 (Sh11) per unit favoured with increased production of electricity for many decades from the Aswan-High Dam and stable supply to the manufacturers. Scott et al. (2014) state that the South African electricity costs at about \$0.06 (Sh6) backed by development and investment over time of its power sources to meet the industrial needs especially in the mining sector. However, for developed economies like Germany has a high electricity cost in Europe at 35 US cents (Sh. 35) per kWh triggering increased contribution towards investment towards renewable sources of energy up to 80% by year 2050 (Dillinger, 2018). Other countries for comparative purposes involve the United States whose electric power ranges between 8-45 US cents (Sh. 8-45) per kWh, UK with an approximate of 22 US cents per kWh and Canada’s which ranges between 6-11 US cents (Sh. 6-11) per kWh (Dillinger, 2018).

Table 1.2: Total Imports by Country to Kenya

| Country | Total Imports (%) |
|-----------------------------|--------------------------|
| India | 19.9% |
| China | 17.8% |
| United Arabs emirates (UAE) | 8.8% |
| Japan | 5.0% |
| Saudi Arabia | 3.9% |
| South Africa | 3.7% |
| United States | 3.6% |
| United Kingdom | 3.2% |
| Germany | 2.1% |
| Egypt | 2.1% |
| Others | 30.0% |

Source: (Daoui, 2018)

The cost variances show varying mains electricity prices in different markets and thus, a substantive input in the production cost with mains electricity being a factor in the production process. This results in increased importation of goods from favourable markets in the world with the Kenyan situation on total imports represented in table 1.2. The overall imports indicate substantive imports coming from India and China at 19.9% and 17.8%, with United Arab Emirates, Japan and Saudi Arabia following at 8.8%, 5.0% and 3.9%. Individual products involve medication accounting for 3.1% of total inputs valued at \$ 496 million and mainly come from India at 59%, China 5%, UK at 7.6%, Pakistan and Switzerland at 8.9%, Belgium, France and Germany at 3.5%, 2.4% and 1.3% among others (Daoui, 2018). Other overall product imports involve automobiles 5.77% and electronics at 4.65% (Daoui, 2018). Thus, the study aims to establish the proportion cost of production that is determined by mains electricity's cost in the manufacturing industries in Kenya.

Thus, this study aims at evaluating the role of mains electricity in determining the cost of production in the Kenyan manufacturing sector. The introductory part of the proposed study evaluates the context in respect to electricity use and availability in Kenya. This leads to further, analysis of the impact of electricity cost to the manufacturing sector and the effect of overall electricity availability to the cost of production in the manufacturing industries in Kenya. The chapter also presents the problem statement, study objectives, scope of the research and finally the significance of the study.

1.2. Problem Statement

Kenya's manufacturing sector is the most developed in East Africa and accounts for 14% of gross domestic product (GDP) of the region (Kenya Economic Outlook, 2017). Just like the global case, the leading sector in terms of energy consumption in Kenya is the manufacturing sector (Kasae, 2014). However, literature reviewed indicates that some of the factors that may impact on the performance of the manufacturing sector include electricity supply especially its cost, reliability and sufficiency. Available data shows that the cost of mains electricity in Kenya is high compared to other countries resulting in high cost of production affecting the competitive advantage of locally produced goods (KAM, 2017). Further, power unreliability brought about by mains electricity fluctuations and rationing results in the use of diesel driven generators which increase the cost of production. For Kenya to realise her plans of growing manufacturing to account for at least 15% of GDP, it is instructive that the competitiveness of the manufacturing firms is addressed.

A report by the Kenya Engineer (2014) stated that the key challenge facing the manufacturing sector in Kenya is inadequate and expensive electric energy. Efficient use of industrial energy coupled with appropriate use of electricity need to be addressed to curb on the use of expensive electric energy (O’Rielly and Jeswiet, 2015). The Kenyan industrial sector is often characterised by inefficient and inappropriate use of mains electricity due to lack of appropriate and lean technologies that ensure proper use of power especially with manufacturing facilities that use large quantities of mains electricity for their daily operations (Were, 2016). The consequence is that firms incur high power bills affecting the performance of these firms. For Kenyan manufacturers to prosper and thrive in the increasing competitive global environment, it is important that the inputs into the manufacturing process such as electricity engender competitiveness.

Studies have focused on the challenges and efficiency in the use of electricity as a measure of addressing the cost of energy and assessing the performance of the manufacturing sector in Kenya (Aduda, 2009; Githuka, 2012; Kiarie, 2014; Dorcas, Agyeman & Bonn, 2017). However, there is the need to study the effect of proportionate cost of mains electricity in determining the cost of production in the Kenyan manufacturing companies.

1.3. Objectives of the Study

1.3.1. General Objective

The main aim of the study was to evaluate the effects of electricity costs on the overall production cost in the manufacturing companies in Nairobi County.

1.3.2. Specific Objectives of the Study

- i. To assess the effect of mains electricity availability on the overall cost of production in the manufacturing industries in Nairobi County.
- ii. To evaluate the effect of mains electricity fluctuations on the overall costs of production in the manufacturing industries in Nairobi County.
- iii. To establish the proportion cost of production determined by mains electricity in the manufacturing industries in Nairobi County.

1.4. Research Questions

- i. What is the effect of mains electricity availability on the overall costs of production in the manufacturing companies in Nairobi County?
- ii. What is the effect of mains electricity fluctuations on the overall costs of production in the manufacturing industries in Nairobi County?
- iii. What proportion of the overall production cost is determined by the mains electricity consumption in the manufacturing companies?

1.5. Scope of the Study

The study concentrated on Nairobi County and acquires a representative sample for survey with the aim of acquiring a representative sample. The selected scope was convenient in respect to time constraints and manageable with limited financial resources to collect data. Nairobi City County is the economic hub of Kenya with majority of industries located within or in the surrounding towns. This informs the decision to select Nairobi County as the delimitations where virtually all sectors of manufacturing are represented.

1.6. Significance of the Study

The study findings are useful in various fronts and also contribute to diverse fields of study.

First, this study may act as a guide to the policy makers in the Government of Kenya on the need to ensure efficient generation, transmission and distribution of mains electricity to the manufacturing companies. This is with the goal of ensuring reduced cost of production with respect to availability of mains electricity to make manufactured goods are priced fairly and thus become competitive in the local, regional and international market. Specifically, the study is critical in providing insights on the role of mains electricity to the manufacturing sector and its contribution to the achievement of the Big 4 Agenda of manufacturing and Vision 2030.

Secondly, the study findings positively impact on the manufacturing companies as it informs the management on the necessity for ensuring electricity cost is properly managed and monitored for them to manufacture products that compete effectively in the market with fair pricing. The study also provides the management of the manufacturing plants with the

knowledge and choice of effective strategies that can be useful to create sustainable competitive advantage with efficient use of electricity.

Finally, in the field of academia, the research study adds to field of knowledge, as well as provide an opportunity for the future studies to further the literature and concepts in this field of study based on the findings acquired.



CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter reviews literature on the aspect of mains electricity role in the manufacturing sector and its contribution to the determination of the final price of products. The chapter contains the theoretical framework, the empirical review and the study gap. The chapter finally presents the conceptual framework, followed by the operationalisation of the study variables and then a summary of the chapter.

2.2. Theoretical Literature

2.2.1. Availability of Electricity and Overall Production Costs

The availability of electricity forms a key attribute in the continuous sustenance of performance in the manufacturing sector. Insufficient electricity supply and outages result in the use of generators which are costly increasing the cost of production and eventually affecting the overall production costs. Further, power interruptions result in abrupt halt of production lines in a manufacturing industry translating to loss of production, material, machine breakdown and loss of productive time. The two theories reviewed present electricity as a critical resource in the manufacturing sector towards improvement of overall performance.

The General Equilibrium Theory

The General Equilibrium Theory brings to focus the possible estimated effects of electricity availability and the actual results with a specific manufacturing sector. This theory as depicted by Lanz and Rausch (2011) indicates the behaviour of supply, demand and prices of electricity with the entire economy while putting into consideration factors interacting with demand and supply to bring about equilibrium. The general equilibrium theory is changed from an abstract form to a realistic and computable one to bring to focus the availability of electricity in the manufacturing companies to ensure equilibrium in the production of quality products compete effectively in the market (Akkemik & Oguz, 2011). The model clearly outlines the interdependence of the factors of production in bringing equilibrium within the manufacturing process. The factors involved in the production interact to reach equilibrium and directly determine the cost of production which is the basis for the final product's price.

Basically, the main trait of partial equilibrium model is to establish the price and quantity in the supply and demand curves that are drawn to achieve equilibrium with other factors being constant (Lanz & Rausch, 2011). The model focuses on the exogenous variables that affect the supply of electricity involving the infrastructure for production and supply, as well as the sufficiency of power to ensure adequacy. On the same note, endogenous variables involving quantity and price come to focus on their impact to the production processes in the manufacturing sector (Fisher-Vanden, Mansur & Wang, 2015). During the production process, the equilibrium state is achieved with changes from one form to another and a change in external conditions results in new equilibrium quantities and prices. Thus, electric power input as a factor of production is established to reach equilibrium as required in the manufacturing processes which indicate availability. Sufficient electric power supply results in the achievement of equilibrium with other factors being at play and with all other aspects being favourable to the manufacturing process, production cost is fair (Okoye & Madueme, 2016). Thus, the price of final products is fair and competent in the market share.

2.2.2. Electricity Fluctuation and Overall Production Costs

Electricity fluctuation focuses on the change in capacity and intensity of supplied power to the manufacturing plant resulting in declined production. The theory review outlines a critical framework of the declined performance with variation or instability in the electric power supply.

Fluctuation Theorem

The Fluctuation Theorem (FT) arose from statistical mechanics and deals with the relative probability of achieving a thermodynamic equilibrium with increased or decrease of supply within a given time (Mansour & Baras, 2017). The supply of electricity to any component of production is done within a specific capacity and voltage as per the operating machine specification with less or excess supply of power affecting the production process. Thus, the machine operation in the manufacturing sector is at optimum with a constant supply of electric power and within a given voltage equilibrium. Petersen et al. (2014) assert the fact fluctuation of power away from the required equilibrium affects the efficiency of the production system. Abrupt drop in electric power voltage may lead to inefficiencies with increased power supply leading to power upsurge which may be detrimental to the machine's operation efficiency or even lead to breakdown due to short circuit (Chen, Cui &

Wang, 2012). The breakdown or inefficiencies in the production process results in the declined production impacting on the performance of the manufacturing company.

The fluctuating power supply directly impacts on the production process with respect to input inefficiency and thus, reduced output. According to Frederick and Selase (2014), electric power fluctuations directly affect the profitability of small and medium enterprises in Ghana as the production quantity and quality are affected directly. Power variations impact negatively on the machine efficiency causing breakdown and affecting the production processes. According to Qureshi et al. (2013), the presence of inefficient machines in a manufacturing entity has a direct impact on the performance to the extent as electricity impacts on the performance. Thus, electricity fluctuation in a manufacturing firm has direct effect on the production unit of a company.

2.2.3. Electricity Cost and its Contribution to the Overall Production Cost

Efficiency of electricity and cost involved in the production process directly impacts on the quantity, quality and overall production cost. This in turn has a direct influence on the price of final products for any given manufacturing entity. The dynamic capabilities theory and Porter's theory of competitive advantage exemplify the aspect of competition and relates to the aspect of electricity costs and adequacy, as well as how they contribute to the competitive advantage of products.

Theory of Production: Cost Theory

The theory of production looks into the manufacturing or the economic process of producing products which are the outputs from inputs which are the raw materials and other factors involved in the process (Dosi, Grazzi, Marengo & Settepanella, 2016). The theory explains the facets under which a manufacturing company decides the cost of commodity it produces at sale period. In this context, the inputs involve factors of production in respect to raw materials, power and labour that collectively bring up outputs in form of final products and services (O'Rielly & Jeswiet, 2015). Further, the theory establishes the amount of factors of production that is labour, raw materials and capital is to be employed in the manufacturing process (McCaffrey, 2017). The process of production utilises resources to create goods and services that suitable for use or sale within a given market economy. This theory brings out production as a process of combining a number of material inputs and immaterial inputs to

make goods and services for consumption which is the output (Zajac& Olsen, 1993). Generally, it is the process of utilising various inputs to create outputs (goods and services) that possess value and contribute to the utility of individuals.

Factors of production involving the inputs of raw materials, energy and labour during the processing has a direct impact on the price of commodities on one hand with quantities produced also being determined by the same factors on the other hand (Qureshi et al., 2013). The proportion of electricity cost utilised in the production process contributes to a certain extent in determining the cost of production and final product's price. The concept of cost in theory of production is categorised into two; fixed and variables costs based on the factors being considered (Were, 2016). Electricity as a variable in the study process falls in the category of varying cost with its marginal cost impacting on the cost overall production costs at varying degree. Production cost changes with varying aspects in the electricity supply to the manufacturing sector that directly affects the price of power tariffs (Scott et al., 2014). The theory of production possesses crucial principles of economic in respect to the price of commodities relationship to the factors utilised in the production process. Thus, the percentage cost input of power has a direct relation to the final product's cost.

2.2.4. Theoretical Literature Overview

The theoretical literature examined above provides a clear overview of the three factors under consideration in this study. General Equilibrium Theory best describes the factor of electricity availability in respect to optimum supply equilibrium and its effect on the production process. Thus, the theory clearly outlines how electricity availability directly influences the production process in respect to sufficiency and efficiency. Subsequently, Fluctuation is clearly defined by the Fluctuation Theorem with respect instability in supply and its effect on the production process. The achievement of thermodynamic equilibrium in production occurs with stable electric power supply to the manufacturing companies. Therefore, unstable electricity supply which points to fluctuation directly affects the thermodynamic equilibrium necessary for effective production processes. Finally, the factor of electricity cost contribution to overall production costs is best described by the Production: Cost Theory which brings to focus the contribution of inputs in the manufacturing process in determining the cost of production. Electricity input directly impacts on the overall production cost as variable costs alongside other factors of production and fixed costs in the manufacturing process.

2.3. Empirical Review

2.3.1. Availability of Electricity and Overall Production Costs

Burlando (2010) through a descriptive study established that the month long blackout in Zanzibar-Tanzania which started on 21st may 2008 and at 10 p.m. up to 18th June 2008 affected the income of households working in firms requiring electricity supply for production. Work hours for companies relying on mains electricity had to be reduced by 8% daily in the blackout period affecting overall production process and performance of the firms. This is supported by Anderson and Geckil (2003) on the August 2003 blackout experienced in New York, Ohio, Michigan, Vermont, New Jersey and Connecticut within the USA which caused approximately \$6.4 billion in losses.

Moyo (2012) conducted an empirical study on the availability of electricity with respect to power interruption, outages and surges to the production units on Nigerian manufacturing sector. The study employed utilised the ordinary least squares (OLS) and Tobit Models of study to measures the power outage variables in form of hours per day without power and percentage of output that was lost due to power disruptions. The primary source of data was the World Bank's Investment Climate Surveys (ICS) touching on the manufacturing sectors in Nigeria. A total of 2387 establishments were targeted in 2007 and covered 11 Nigerian states. The study findings were that power outage variables in form of hours per day experienced without power and the percentage of output lost to the power disruptions. The study found that such power outages caused negative implications to the productivity of the manufacturing companies. However, the study was categorical in that power outages have a greater negative impact on smaller firms in comparison to larger ones due to extreme financial constraints.

Forkuoh and Li (2015) evaluated the power insecurity and its impact on the growth of SMEs in Ghana. The theoretical approach looked into the electrical outages and SMEs growth indicating a positive correlation between efficiency of electricity infrastructure to the growth of the firm's productivity and the economy. Further, it looked into the electricity outages and cost of operations indicating high operational costs in developing countries. Finally, the study reviewed the alternative power supply and cost implications to the SMEs asserting the use of alternative power supplies like generators increases the cost of operations. Through a mixed method of study employing a questionnaire survey and interview, the study sampled 250 cold

store operators in Asafo Market through purposive sampling. Data analysis was conducted using SPSS version 21.0 to establish the relationship that existed between the dependent and independent variables in the study. The research established that power outages negatively impact on the growth of SMEs and the cost of operating businesses increase considerably. The significant increase in operation costs was also attributed to the use of alternative sources of power to counter power outages.

Abotsi (2016) evaluated power outages and production efficiency of firms in Africa. The research through a descriptive study that employed deterministic and stochastic models evaluated the technical efficiency of firms with respect to the impact of power outages. Through a systematic survey of data obtained from the World Business Environment Survey conducted by the World Bank, the study established that power deficiency in Africa greatly affects the economic development. Power outages that are experienced within a month have a negative impact on the manufacturing firms' efficiency. The study therefore recommended for increased investment in the new production of electricity to ameliorate the negative impact of power crisis to the African manufacturing companies.

2.3.2. Electricity Fluctuations and Overall Production Costs

Frederic and Selase (2014) defined electricity fluctuations as random variations in potential, voltage or capacity of power in electrical lines. The study looked into the effect of electric power fluctuations on the profitability and competitiveness of SMEs in Ghana's Accra Business District using a cross-sectional survey. Reviewed literature evaluated the role of electricity in business and its input with respect to the return on assets (ROA) and return on investments (ROI). The study employed a mixed method of data collection involving the questionnaire and interview to selected study subjects. A total of 450 SMEs were targeted and sampled systematically to give a study population of 70. Data analysis was conducted via SPSS version 17 and established that the lack of reliable energy supply affects the production of SMEs in terms of quantity and quality leading to poor sales and declined profitability. Reduced profitability negatively impacts on the ROA and ROI of the SMEs. Further, with increased profitability, ROA and ROI are expected to rise and eventually enhance profitability of SMEs.

Mwai (2015) looked into the strategic quality management and competitiveness in power supply by studying generator suppliers in Kenya. The study utilised a descriptive design

adopting a formal question crystallisation to obtain primary data. The study established a direct positive correlation between strategic quality management and competitiveness among generator suppliers in Kenya. Further, Mwai found out that in most cases power fluctuations results in destruction of electrical machines forcing manufacturers to put up measures to avert the implications of any impending power fluctuation. Insufficient power supply, power rationing and blackouts are common in the Kenyan electricity consumption. Thus, the study recommended that generator suppliers in Kenya develop innovative and diversified products and services to ensure consistent power supply.

Danmaraya and Hassan (2016) evaluated consumption of electricity and the manufacturing sector productivity in Nigeria through an auto-regressive distributed lag technique. The methodology was aimed at acquiring evidence on the short and long-run relationship, as well as the causality between manufacturing output and the consumption of electric power between 1980 and 2013. Consistent electric power in manufacturing processes was found to have a direct effect on the improved productivity and performance of the manufacturing companies in Nigeria. Further, bidirectional causality was established between the productivity levels of manufacturing processes and consumption of electric power. The study established the need for consistent flow of electricity during manufacturing processes to ensure improved productivity, we all as enhance continuous growth in the Nigerian manufacturing sector. In conclusion, the study proposed energy policies that assure manufacturing companies that electricity does not create negative effects on the manufacturing performance.

2.3.3. Electricity Cost and the Overall Production Cost

The high cost of electricity affects manufacturing companies by increasing the cost of production. Abeberese (2013) through a system review surveying Indian manufacturing companies utilised manufacturing firm-level panel data from the Indian Annual Survey of Industries (ASI) between the years 2001 and 2008. The study employed econometric analysis where simple regression of company performance with respect to electricity price was evaluated. The study outcome indicated that increased costs of electricity results in companies lowering their electricity consumption and switch to less electricity-intensive production process. Such interventions eventually bring down the factor productivity affecting overall performance of a manufacturing company. Further, unreliable electricity forces manufacturers to have standby generators for back up increasing their cost of energy

due to the high cost of thermal electricity. Thus, the study recommended manufacturing firms to come up with coping strategies on the negative outcomes while addressing the unreliable electricity.

Stephen (2015) study on the effect of energy crisis in Kumasi metropolis employed a case study approach to study the SMEs in Kumasi Metropolis. The study utilised snowball sampling to acquire a representative sample size of study in the target population. Data analysis involved both quantitative and qualitative means through the use of SPSS to present findings in a descriptive statistical format. The research findings indicated that the load shedding compelled businesses to use alternative power sources in form of LPG and generators to meet their energy needs. The alternative energy uses increased their costs from a range of GH¢50 up to GH¢292 within a month. Such increase in electricity tariffs were termed by respondents as quite high compared to their expenses without power back up. The study recommended increased investment by the government in power production especially renewable energy and buying more power from neighbouring countries. Further, adhere to the load shedding pattern as a short term measure to allow consumer to plan their operations and activities effectively.

Grainger and Zhang (2017) looked into the impact of electricity shortages on the productivity of firms in Pakistan by evaluating 4,500 manufacturing firms between 2010 and 2011. Employing a critical empirical study survey, the shortage in electricity was determined in form of hours per day when power fluctuations were experienced. The study found out that a 10% increase in the duration of power outage led to a 0.14% decrease in the firms' total revenue and 0.36 decline in the value added. Thus, it is apparent that electricity fluctuation affects performance of manufacturing companies but, there lacks substantive studies on the Kenyan manufacturing sector. This study evaluated the extent of power fluctuations and its effect to the Kenyan manufacturing sector productivity and profitability.

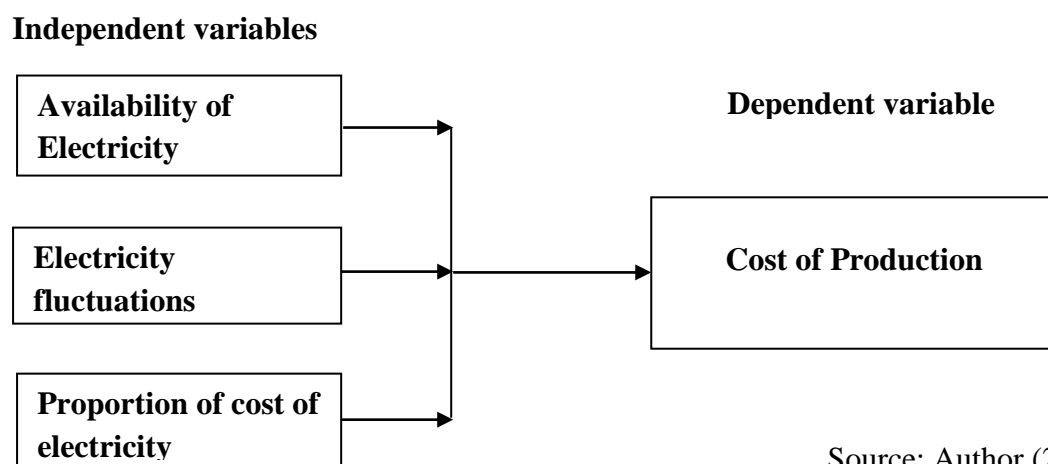
2.4. Gap in the Study

The studies reviewed outline the three aspects of electricity availability, fluctuation and cost of electricity impact on the manufacturing industries in respect to overall production costs separately. Electricity availability involves the duration or time that power is sufficiently supplied to the manufacturing entities to run the machines (Moyo, 2012; Forkuoh and Li, 2015; Abotsi, 2016). Further, Kasae (2014); Best and Burke (2018) assert that the level of

electricity availability affects the efficiency of operations in the production process. The aspect of mains electricity fluctuations involves instability or dropping in the voltage of the power supply (Frederic and Selase, 2014; Mwai, 2015). Fluctuating electric power affects the production process by slowing the rate of production with the use of stabilisers increasing costs of production (Frederick & Selase, 2014). Increased costs of electricity tariffs alongside high costs due to backups and stabilisers directly increase overall production costs (Abeberese, 2013; Stephen, 2015). The disintegrated analysis of the three study aspects makes it difficult to have a comparative effect of the three factors on the overall production costs on the Kenyan manufacturing sector. The lack of comprehensive studies on the impact and role of electricity availability, fluctuation and costs in determining the overall production cost creates a knowledge gap that this study sought to bridge. Thus, this study evaluated the extent to which availability, fluctuation and proportionate cost of mains electricity as a crucial factor in the manufacturing sector in Nairobi County determines the overall production cost. Further, empirical review of studies showed descriptive study design being utilised extensively to yield descriptive studies, with SPSS being utilised for statistical analysis of data obtained. This formed the basis for opting to utilise a mixed method of data collection based on descriptive study and utilise SPSS version 22.0 alongside Stata to acquire efficient statistical data for discussing study findings.

2.5. Conceptual Framework

This section presents the conceptual framework shown in figure 2.1 below to be adopted by the study in the study indicating both the independent and dependent variables and their relations to each other.



Source; Author (2019)

Figure 1.1: Conceptual framework

The independent variables evaluated in the study involve electricity availability, fluctuation and electricity costs to establish how it affects the price of products in respect to overall production cost in the manufacturing companies in Kenya. The dependent variable is thus, the proportionate cost of electricity utilised by the manufacturing companies. The cost and quality of production is one variable established in the literature review that follow the independent variable, but precedes the dependent variable. The variable is basically a hypothetical aspect in the research study forming a causal link thus, the intervening variable in the research study. The conceptual framework has been contextualised in both schematic and narrative form to bring out a comprehensive analysis of the variables being studied. Electricity as a source of energy is hypothesized to have a direct impact on the overall production cost and final product's price in the manufacturing industries.



2.5.1. Operationalisation of Variables

Table 2.1: Operationalization of Variable

| Name of Variable | Definition | Measurement | Type of Variable |
|--|---|--|--------------------|
| Electricity availability | Sufficiency of electricity supply and the duration. Best and Burke (2018) assessed availability of electricity in respect to the presence of power outages once in every 24 hours. The World Bank Report (2017) outline electricity availability as also incorporating consistent and quality supply throughout the day. | Electricity outage; 1= Once in 6 Hrs 2=Once in 12 Hrs 3=Once in 24 Hrs 4=Once weekly 5=Once Monthly | Discrete/ Dummy |
| Electricity fluctuations | Frederick and Selase defined electricity fluctuation as a 10% decline in the required voltage supply to machines. Thus, Voltage fluctuations based on Kenyan scenario was considered to occur at 415v $\pm 10\%$. | Fluctuation: 1=Yes 2= No Extent of Fluctuation 1= Least extent 2= Low extent 3= Neutral 4= Moderate extent 5= Great extent | Dummy |
| Proportion cost of electricity in Production | Moya and Boulamanti (2016) outline the cost of electricity in production cost as a fraction of the production cost resulting from electricity in percentage (%). The study found a 15% input of electric power in the production process. | Proportion of cost: 1=0-5% 2=6-10% 3=11-15% 4=16-20% 5=Above 20% | Discrete/ Dummy |
| Cost of Production | The entire costs incurred in the process of goods production in a year. | 1= Ksh. 100 million and below 2= Ksh. 101-500 million 3= Ksh. 501 million- 1 billion 4= Ksh. 1-3 billion 5= Above Ksh. 3 billion | Discrete |

Source; Author (2019)

2.6. Summary of the Literature Review

The literature review presents a comprehensive analysis of theoretical framework in respect to this research study. A critical review of theoretical framework is outlined as per the three study aspects from the research questions. The empirical review extensively analyses various studies on electricity availability, fluctuation and cost of electricity with respect to competitiveness in the manufacturing sector. Critical literature review shows a clear a connection of performance of manufacturing companies to the availability of electricity. The next chapter describes the methodology to be utilised in the research process to collect data for answering the research questions.



CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Introduction

This chapter focuses on the research methodology for the proposed study. The chapter discusses the methods and tools that utilised in collecting data and subsequent analysis to enable informed reasoning and achievement of the study objectives. Its coverage includes the research design, population and sampling, data collection methods, data analysis approaches, research quality and ethical issues that were taken into consideration.

3.2. Research Design

According to Creswell (2014) research design refers to the study's set of decision that creates the foundation of the master plan that explains the methods and procedures for collecting and analysing data in research. The study utilised a descriptive design to evaluate the study objectives and derived appropriate inferences. The study variables in this study involve overall production cost as the dependent variable that is impacted by availability, fluctuation of electricity and the cost of electricity to the manufacturing industry, as well as the cost of electricity to cost to the overall production cost.

3.3. Target Population

According to Mugenda and Mugenda (2008), a target population is group that the study chooses for data collection and then generalises the results. The study targeted manufacturing companies in Kenya with a focus on Nairobi County where employees directly involved in production and power management were surveyed. The study population size stands at 1072 and is distributed among different sectors as shown in the table 3.1 below.

Table 3.1: Target Population of the Manufacturing Industry

| Sector | Target Population (Companies) | (%) | Survey Sample | Interview Sample |
|------------------------------------|--------------------------------------|-------------|----------------------|-------------------------|
| Building, Mining and Construction | 39 | 3.6% | 4 | 1 |
| Chemical and allied | 90 | 8.4% | 8 | 1 |
| Energy, Electrical & Electronics | 58 | 5.4% | 5 | 1 |
| Food and Beverages | 234 | 21.8% | 17 | 1 |
| Leather and Footwear | 9 | 0.8% | 2 | 1 |
| Metal and Allied | 96 | 9% | 9 | 1 |
| Automotive | 59 | 5.5% | 5 | 1 |
| Paper and board | 82 | 7.7% | 7 | 1 |
| Pharmaceutical & Medical Equipment | 30 | 2.8% | 3 | 1 |
| Plastics & Rubber | 90 | 8.4% | 8 | 1 |
| Services and Consultancy | 169 | 15.8% | 13 | 1 |
| Textile and Apparel | 73 | 6.8% | 6 | 1 |
| Timber, Wood & Furniture | 30 | 2.8% | 3 | 1 |
| Agriculture/ Fresh Produce | 13 | 1.2% | 2 | 1 |
| Total | 1072 | 100% | 92 | 14 |

Data Source: (KAM, 2018b)

3.4. Sampling Design

Sampling incorporates selection of a part of the entire population under study. In this study, a sample of staff working in the manufacturing plants was selected utilising non-probabilistic sampling to answer questionnaires and some of the management staff undertook a key in-depth interview. There are 1072 manufacturing firms registered with Kenya Association of Manufacturers in Nairobi County spanning fourteen sectors of the economy. Fourteen (14) manufacturing companies within Nairobi County were selected through random sampling representing two from every manufacturing sector for the key in-depth interview. Purposive random sampling was utilised to acquire the respondents for the survey which involved both a questionnaire and Key In-depth Interview. The reason for selecting purposive sampling was for the study to selectively target the workers in the manufacturing companies involved with production having the knowledge of electricity role in the production process. However, the

criteria for inclusion of the target companies involved; company must have been in operation for at least ten years and have over 100 employees. This to ensure that the company has a substantive power input and had been in operation for a duration sufficient to analyse the role of electricity in the Kenyan manufacturing industry and the changes observed in the past decade.

The study population was conveniently sampled from the fourteen (14) companies for study purposes where both qualitative and quantitative data collection methods were used. To acquire a representative sample, the study employed the Yamane formula to estimate the sample size (Yamane, 1967).

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

The formula illustrates n as the sample size, N as the target population and E as the margin of error which for this research was 10%. With a target population from the twenty companies of being 1072, the study sample was;

$$n = \frac{1072}{1 + 1072 (0.01^2)}$$

$$= 91.5 \sim 92$$

A total of 92 respondents were targeted for the quantitative study targeting the supervisors or employees in charge in production and power control in the factory. Further, Key in-depth interviews (KII's) were conducted with the production managers of one company from each manufacturing sector giving a total of fourteen interviewees for the qualitative study. The reason behind targeting the production managers is because they are key individuals with information pertaining to the impact of electricity on the production process.

3.5. Data Collection Procedure

The study utilised a mixed method of data collection involving a survey and key in-depth interviews to obtain primary data. The mixed method research is preferred because it offers strengths that offset the weakness of both qualitative and quantitative research methods. Creswell (2014) indicates that data collection methods for obtaining primary data involve; structured and semi structured questionnaires, mailed questionnaires, observation, structured

and semi-structured interviews and focus groups. Questionnaires are best utilised in populations that are accessible and co-operative for study purposes.

The survey was administered to employees from manufacturing companies in the production sector and required to answer the set out questions in the research tool. A total of 92 questionnaires were presented to the respondents from the sampled companies using the drop off and pick up method. The questionnaires were presented to the sampled respondents using the drop off and pick up method and two weeks were given for answering the questions before collection for analysis. Close-ended questions were utilised for the questionnaires utilising the Likert scale (see appendix II). Likert scale questions are crucial in data collection for abide by the principles of validity, reliability and consideration (Bryman & Bell, 2003). Key in-depth interviews were carried out targeting the production managers at the companies to get concrete information on the impact that supply of electricity has on the overall production cost of the company (see appendix III). The reason behind targeting production managers was because they are the key individuals in the company with critical information on the role of electricity in the manufacturing companies. One key in-depth interview was conducted for each sector from the sampled companies giving a total of 14. The survey yielded quantitative data while the interview yielded qualitative data for the study objectives. Both methods complemented each other to give robust findings for the study questions.

3.6. Research Quality

The quality of the research was assessed through a pilot study carried out in ten manufacturing companies within Nairobi County to assess the research instruments validity and reliability. This pilot study was guided by Saunders, Lewis and Thornhill (2009) position that the purpose of pilot testing is to establish the accuracy as well as the appropriateness of the research design and instruments for data collection. Further, Cooper and Schindler (2016) concur that the pre-testing purpose in research study is to detect weaknesses in a design and implementation and further provide proxy for data collection within a sample of probability. The companies were selected randomly where ten (10) respondents were sampled selectively for the pre-test. The results obtained have not been utilised in the final study. The pre-retest study helped in refining the questionnaire, enhance readability and reduce the chance of questions misinterpretation.

Reliability of a research study refers to the stability, or internal consistency of the outcome of a questionnaire (Bolarinwa, 2015). The reliability of the research tools were ensured by pre-testing in the pilot study to ensure the questionnaire's relevance and effectiveness'. Further, various studies on the same have been analysed and the approaches utilised in data collection were replicated to ensure reliability of the study. The researcher also assessed the reliability of the research tool by getting the Cronbach alpha of the pilot study outcome. The findings of the pre-test have been excluded from the main study to avoid bias.

Validity is defined by McMillan and Schumacher (2006) as the degree of congruence between the phenomena as explained and the reality on the ground. Validity of the research tools were ensured by having all objectives and research questions incorporated to ensure analysis of data brings out the phenomenon of the study (Robinson, 2002). Through the pilot study, the researcher administered the same questionnaire in the pilot study and assesses its correlation at different points in the survey to establish validity. The final questionnaire for data correction was adjusted based on the outcome to ensure enhancement of validity of final outcome. The outcome of the pilot is shown in tables 3.2 and 3.3 below. Table 3.2 shows the cases processed in the reliability analysis involving eight (8) questionnaires that were positively responded to in the pilot study.

Table 3.2: Case Processing Summary

| | N | % |
|-----------------------|---|-------|
| Cases | | |
| Valid | 8 | 100.0 |
| Excluded ^a | 0 | .0 |
| Total | 8 | 100.0 |

Source; Author (2019)

Table 3.3 outlines the reliability test outcome based on the Cronbach alpha of 35 case items (questions) that were statistically analysed to assess reliability of the research tool.

Table 3.3: Reliability Statistics

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|-------------------------|---|-------------------|
| .802 | .814 | 35 |

Source; Author (2019)

Assessment of the pilot study outcome indicates in table 3.3 that the research tool as presented to various participants show consistency in respect to study outcome. Further, reliability test shows internal consistency with a Cronbach alpha value of 0.802 which is within the parameters that indicates research tool reliability as presented in table 3.3. An alpha value above 0.70 meant the research tool is reliable.

3.7. Data Analysis

Raw data from the study survey was refined through coding and categorising information collected as per the study's preliminary analysis. Data analysis for the questionnaire survey involved statistical methods to acquire descriptive findings by use of the Statistical Package for Social Sciences (SPSS 22.0) and Stata. The findings were presented statistically as obtained from the analysis to give descriptive analysis of the study objectives and presented in chapter four. Descriptive findings in form of average scores, variance and standard deviation calculated via SPSS are presented for comparison purposes of the study variables. Further, tables, pie charts and graphs are utilised to indicate percentages and trends in the data while the spread of data over sample population. Regression analysis has been utilised by getting the coefficients that shows the relationship between the study variables as shown below.

For interview analysis, the research reviewed and categorised the responses of participants into various concepts to be discussed in the study findings. Content in form of themes have been outlined and discussed according to the research objectives. Further, thematic analysis from the secondary data has been categorised into concepts and themes as per the study findings and discussed alongside the primary findings and assess if they complement each other.

To address the effect of electricity on the overall production cost with respect to other aspects; the study considered the characteristics of the firm made the final equation as;

$$Y = \alpha_0 + \delta'_i x_i + \beta'_i z_i + \mu$$

Where x_i represents the factors related to power and z_i are the factors related to firm characteristics

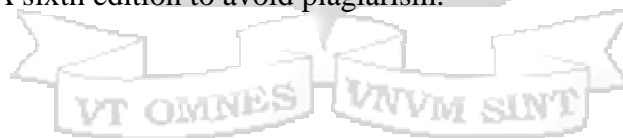
Thus, for the research study; $PC = \alpha_0 + \delta_1 A + \delta_2 F + \delta_3 C + \beta_1 Ag + \beta_2 L + \beta_3 S$

$$PC = \alpha_0 + \delta_1 A + \delta_2 F + \delta_3 C + \beta_1 Ag + \beta_2 L + \beta_3 S + \mu$$

Where PC is the Production cost, α_0 stand for the constant production factor, δ and β are the vectors of parameters to be estimated for variables, A is the availability of electricity, F is fluctuation and C is cost of electricity. The characteristics of firms involve; Ag represents the age of the firm, L is the labour force, S is the business ownership and μ is the error term.

3.8. Ethical Issues

The study was conducted in compliance with Strathmore University research requirements and follow ethical guidelines and principles where honesty and integrity was the guiding values. First, the study sought research approval from National Commission for Science and Technology and Innovation (NACOSTI) (see appendix IVA), as well as the Strathmore business School approval (see appendix IVB) prior to commencement of study. Further, participants were informed of the study objectives and requested to voluntarily participate in the survey (see appendix I). Informed consent forms were signed by participants and anyone willing to withdraw was allowed at any stage. Confidentiality of information collected throughout the study was maintained and only be utilised for study purposes, while participants' identity remains anonymous. Borrowed concepts have been referenced accordingly using APA sixth edition to avoid plagiarism.



CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION OF RESEARCH FINDINGS

4.1. Introduction

The chapter presents findings of the research as obtained from the survey and statistically analysed to give the relationship existing between the study variables. The findings from the key in-depth interviews has been categorised into themes as per the study objectives and then presented and discussed alongside the survey findings to complement the overall study finding outcome. Ninety-two (92) questionnaires were distributed to the sampled participants from various manufacturing sectors, but only eighty (80) were picked up for data analysis giving a response rate of 87%. The missing 12 questionnaires (13%) involved 3 questionnaires which were incomplete and 9 which the respondents failed to give back as they were unavailable. Further, a total of 14 key in-depth interviews (KII) were conducted to managers of a company from each of the fourteen sectors. The findings have been summarised as in appendix V.

4.2. General Information

The research sought to established general information on the respondents and the company they were sampled from. The name of the company has been disregarded for reporting although included in the survey for purposes of ensuring all sectors in the manufacturing industries are covered. General information relevant to the study involved position of the respondents, power backups use in the company, age or number of years the company has been in operation, size of the company with respect to number of employees and ownership.

Table 4.1: Position of respondents in the Company

| Position | Frequency | Percent (%) |
|-----------------|------------------|--------------------|
| Directors | 15 | 18.75 |
| Managers | 18 | 22.5 |
| Engineer | 19 | 23.75 |
| Technical Staff | 11 | 13.75 |
| Operation Staff | 8 | 10.00 |
| Supervisors | 7 | 8.75 |
| Others | 2 | 2.50 |
| Total | 80 | 100 |

Source; Author (2019)

Respondents involved employees in manufacturing industries holding various job designations in the company were represented with a majority of respondents being individuals involved in the direct production process. The job positions have been categorised into directors, managers, engineers, technical staff, operational staff, supervisors and others as indicated in table 4.1. The highest proportion of respondents involved engineers at 23.753%, followed by managers at 22.5% and then directors at 18.75%. Technical staff involved 13.75%, operations staff at 10% and supervisors at 8.75% with other designations being 2.5% representing in charge of utilities. The highest ranked respondents possess crucial information necessary to highlight the role of electricity in determining the overall production costs in their companies. The relevance of the position of respondents in the company was to ascertain the credibility or give weight to the study outcome based on the concentration of respondents with crucial information on the companies studied. The fact that a high percentage of the respondents cumulatively totalling to 65%% involves directors, manager and engineers are key individuals in the company overall management: Further, the rest proportion involving technical staff, operations and supervisors are involved directly with production processes and constituted 32.75%. Their response on electricity role in the production gave effective insights on the study objectives.

Power Backups in the Companies

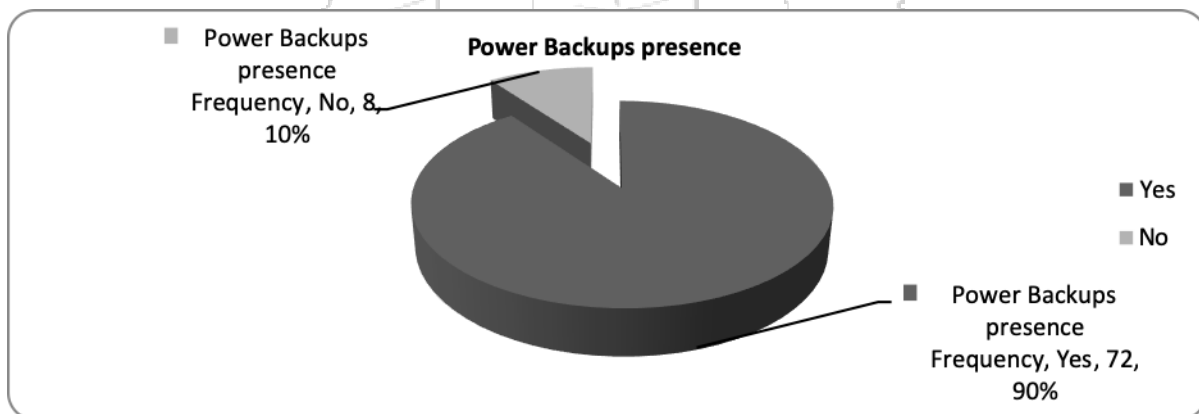


Figure 4.1: Power back use in the Company

The study sought to establish companies having power backups and as presented in figure 4.1 found that 90% of surveyed companies had standby generators. The managers interviewed stated it was necessary to have alternatives in case of power outage and always have generators on standby to supplement lack of electric power. This is in line with Abotsi (2016)

findings that manufacturing companies counter the lack of sufficient supply or any eventuality of power outage by having power backups in form of generators.

Years of Operation

The study analysed the number of years that companies had been in operation to assess the extent of electricity role in affecting overall production costs and the changes experienced over time. Companies that have operated for longer periods have greater insights on the state of electricity availability and changes experienced over time in the country. The study findings are presented in table 4.2 below.

Table 4 2: Age of the Company

| Years of Operation | | |
|---------------------------|------------------|--------------------|
| Frequency | Frequency | Percent (%) |
| 0-5 years | 6 | 7 |
| 6-10 years | 5 | 6 |
| 11-15 years | 10 | 13 |
| 16-20 years | 18 | 23 |
| Above 20 years | 41 | 51 |
| Total | 80 | 100 |

Source; Author (2019)

Majority of the companies surveyed had been in operation for over 20 years a total of 41 (51.25%), followed by 16-20 years at 18 (22.5%), 11-15 years at 10 (12.5%), 0-5 years at 6 (7.5%) and 6-10 years at 5 (6.25%). Analysis of the sample studied indicates it had a higher concentration of companies that have been in operation for more than ten years at a cumulative proportion of 87%.

The study also sought to establish the size of the company being surveyed to ascertain the level of electricity availability. Large companies based on output and employees number tend to consume more power for production purposes and thus, the larger the company, the better it is positioned to give feedback on the electricity as a factor of production in determining overall production costs. According Menezes, Cripps, Buswell and Bouchlaghem (2014) and Schwalbach (2016) indicates that large companies tend to consumer huge proportions of power. However, Menzes et al. (2014) state that companies which tend to embrace efficient technologies utilise lesser power as new technologies are developed with high efficacy and

less power consumption. Therefore, large companies embrace efficient machines and technology to bring down their level of power consumption.

Table 4.3: Number of Employees in the Company

| | Frequency | Percentage |
|-----------|------------------|-------------------|
| 1-100 | 17 | 21.3 |
| 101-200 | 12 | 15 |
| 201-300 | 13 | 16.3 |
| 301-400 | 17 | 21.3 |
| Above 400 | 21 | 26.3 |

Source; Author (2019)

From the table 4.3, it is evident that companies with 400 employees incorporated 26% being the highest, followed by those with between 1-100 employees at 22%, 301-400 employees at 21%, 201-300 at 16% and 101-200 at 12%. This parameter has no much relevance on the study variables, but gives insights on the extent of electricity use in the company. However, larger companies showed increased capacity to understand electricity issues and have back up measures to address insufficient supply. This is supported by Bee (2016) study, which states that larger companies are able to utilise power efficiently for production purposes to meet high production output and reduce costs per unit increasing their competitiveness.

Table 4.4: Ownership or Company Type

| | Frequency | Percentage |
|---------------------|------------------|-------------------|
| Sole Proprietorship | 49 | 61.3 |
| Public | 3 | 3.8 |
| Public-Private | 7 | 8.8 |
| Cooperative | 4 | 5 |
| Others (Specify) | 17 | 21.3 |

Source; Author (2019)

Table 4.4 clearly outline that the most prominent type of business ownership involved sole proprietorship companies at 61%, followed by others at 21% which mainly involved private-partnership companies. Other forms of ownership included public-private at 9%, cooperatives at 5% and public owned companies at 4%. Company ownership was relevant with respect to

showing the diversity of sampled companies for the survey. However, the findings have no direct influence on the study variables outcome.

4.3. Availability of Electricity and Overall Production Cost

The first study objective was to assess the effect of mains electricity availability on the overall cost of production in the Kenyan manufacturing industries. Various aspects were assessed with a likert scale ranging from 1 to 5 depicting least extent to great extent for production cost, production schedule and quantity of products. Further, a scale of 1 to 5 indicating strongly disagrees, disagree, Agree, slightly agree and strongly Agree.

The mean values show the weighted average of the responses with values 3 and below indicating disagreement or low extent/neutral and those above 3.5 being taken to indicate agreement or moderate extent with the statement assessed. The study outcome is presented as in table 4.5 below;

Table 4.5: Perception on Electricity Availability and Overall Production Cost

| | N | Min | Max | Mean | Std. Deviation |
|--|-----------|------------|------------|-------------|-----------------------|
| Production Cost | 80 | 1.00 | 5.00 | 3.9500 | 1.23144 |
| Production Schedule | 80 | 1.00 | 5.00 | 4.0875 | 1.06965 |
| Quantity of Products | 80 | 1.00 | 5.00 | 3.8250 | 1.21983 |
| Insufficient power supply | 80 | 1.00 | 5.00 | 2.7250 | 1.36850 |
| Generators are always on standby | 80 | 1.00 | 5.00 | 3.7750 | 1.39597 |
| Increased costs with power backups | 80 | 1.00 | 5.00 | 4.2000 | 1.02377 |
| Rate of production reduces | 80 | 1.00 | 5.00 | 3.9625 | 1.17402 |
| Many man-hours lost | 80 | 1.00 | 5.00 | 4.0875 | 1.12727 |
| Insufficient supply affects machine efficiency | 80 | 1.00 | 5.00 | 4.0750 | .99078 |
| Extent of power black outs in the company | 80 | 1.00 | 5.00 | 3.6750 | .97792 |
| Duration of typical power outage | 80 | 1.00 | 5.00 | 4.1250 | .86236 |
| Valid N | 80 | | | | |

Source; Author (2019)

For the analysis on the perception of respondents on the extent of electricity availability: All respondents stated that that mains electricity availability affects production costs, production schedule and quantity of products to some extent with means 3.95, 4.1 and 3.8 respectively.

For the analysis in agreement to perception of electricity availability: All the aspects assessed except insufficient supply of electricity to companies scored a mean above 3.5 showing agreement with assessed aspects. However, the respondent did not agree that there is insufficient supply of electricity to the companies at a mean of 2.7, but generators are on standby for backups at 3.8 mean, increased costs are incurred at 4.2, reduced production rate at 3.9, loss of man hours at 4.09 and machine efficiency affected with insufficient supply at 4.075. In respect to the extent of power blackouts in the company, the respondents state that there is a blackout at least once a month and a typical outage lasts at least one hour. The findings are in line with Frederick and Selase (2014) which found that availability of electricity to the manufacturing companies directly affects the performance in respect to production quantity, quality and the overall costs.

4.4. Electricity Fluctuation and Overall Production Cost

The second study objective was aimed at evaluating the effects of mains electricity fluctuations on the overall costs of production in the Kenyan manufacturing industries. Obtained data was analysed and presented in form of descriptive findings that show the weighted means of the responses on the evaluated study aspects. The values ranged from a likert scale of 1 to 5 representing strongly disagree, disagree, agree, slightly agree and strongly agree for the main study aspects. Mean values above 3.5 have been taken to indicate agreement or moderate and great extent with the statement assessed. The study outcome is presented as in table 4.6 below;

Table 4.6: Perception on Electricity Fluctuation and Overall Production Cost

| Item | N | Minimum | Maximum | Mean | Std. Deviation |
|---|----------|----------------|----------------|-------------|-----------------------|
| Fluctuations are common | 80 | 1.00 | 5.00 | 3.3375 | 1.34017 |
| Fluctuation affects productivity quantity | 80 | 1.00 | 5.00 | 3.8750 | 1.14045 |
| Unscheduled fluctuations affects cost of production | 80 | 1.00 | 5.00 | 3.9625 | 1.21638 |

| | | | | | |
|--|-----------|------|------|--------|---------|
| Fluctuations results in the use of power stabilisers which increase overall cost of production | 80 | 2.00 | 5.00 | 4.1875 | 1.03231 |
| Fluctuations affects machine efficiency | 80 | 1.00 | 5.00 | 4.0625 | .97232 |
| Extent that electricity fluctuation affects operating efficiency | 80 | 1.00 | 5.00 | 3.9250 | .97792 |
| Extent that electricity fluctuation affects quantity of products | 80 | 1.00 | 5.00 | 3.8875 | 1.01873 |
| Extent that electricity fluctuation affects overall production cost | 80 | 1.00 | 5.00 | 4.1375 | 1.02801 |
| Extent that fluctuation affect production schedule | 80 | 1.00 | 5.00 | 4.2125 | 1.00245 |
| Extent of fluctuation in your company | 80 | 1.00 | 5.00 | 3.4625 | 1.12445 |
| Frequency of mains electricity fluctuation | 80 | 1.00 | 5.00 | 3.4875 | 1.20120 |
| Valid N | 80 | | | | |

Source; Author (2019)

The aspects assessed clearly indicate the influence of electricity fluctuation to the production process and overall production costs. However, respondents pointed to fluctuations not being common in the current Kenyan situation with a mean of 3.34 which indicated disagreement that fluctuation occurs regularly in the manufacturing sector. Respondents were in agreement that fluctuations affect production at 3.96 mean, results in use of power stabilisers which increase costs of production at 4.19 and affects machine efficiency at 4.06. Frederick and Selase (2014) in their study in the Ghanaian electric supply found that fluctuations affect the production and performance of the company.

The extent of electricity fluctuation was further shown to affect operating efficiency, quantity of product, production costs and production schedule to a moderate extent with values of 3.92, 3.89, 4.14 and 4.21 as shown in table 4.5. The last two aspects assessed extent and

frequency of power fluctuations in the companies showing extent to be moderate at 3.46 and frequency at fluctuation occurring very rarely. According to Nyanzu (2016), electricity instability directly affects production by increasing the costs of operations and reducing the production rate, quantity and quality.

4.5. Electricity Cost and Overall Production Cost

The third study objective was aimed to establish the proportion cost of production determined by mains electricity in the manufacturing industries in Kenya. Data obtained from the survey was categorised into the various aspects studied and presented in form of descriptive findings that show the average or weighted means of the responses on the evaluated study aspects. The values ranged from a likert scale of 1 to 5 representing strongly disagree, disagree, agree, slightly agree and strongly agree for the main study aspects. The study outcome is presented as in table 4.7;

Table 4.7: Perception on Electricity Cost and Overall Production Cost

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|-----------|----------------|----------------|---------------|-----------------------|
| Mains Electricity cost affects overall production cost | 80 | 2.00 | 5.00 | 4.4250 | .77582 |
| Unscheduled power costs affects overall production costs | 80 | 1.00 | 5.00 | 4.3000 | .91955 |
| Mains electricity costs and overall productions costs enhance acquisition of efficient machines | 80 | 1.00 | 5.00 | 4.1375 | 1.00308 |
| Extent mains electricity costs affects overall production cost | 80 | 1.00 | 5.00 | 4.3625 | .97102 |
| Extent mains electricity costs affects quantity of products | 80 | 1.00 | 5.00 | 4.1375 | 1.00308 |
| Extent mains electricity costs affects production schedule/planning | 80 | 1.00 | 5.00 | 4.0750 | 1.00347 |
| Percentage of overall production cost due to mains electricity in the company | 80 | 1.00 | 5.00 | 2.5750 | 1.37588 |
| Valid N | 80 | | | | |

Source; Author (2019)

All aspects assessed in establishing the cost of electricity contribution to the overall production cost are presented in table 4.6 and showed mean values above 3.5 showing agreement to the statements. Respondents were in agreement that the cost of mains electricity directly impacts the overall cost of production at a 4.4 mean value out of a possible maximum of 5. Unscheduled power costs affect overall production was agreed upon with a mean of 4.3 out of 5. Further, the respondents indicated that mains electricity costs and overall production costs affect acquisition of efficient machines with mean agreement of 4.1375.

For operating efficiency, quantity, production cost and production schedule, the same scale of 1 to 5 was utilised representing least extent, low extent, neutral, moderate extent, great extent in that order. Mean values above 3.5 have been taken to indicate agreement or moderate extent with the statement assessed. The extent to which mains electricity costs affects overall production costs, quantity of products and production schedule or planning at means of 4.36, 4.13, and 4.075 respectively. The means are in agreement with respect to electricity cost affecting the product process and eventually overall production cost. The percentage of overall production cost arising due to the mains electricity during production was established by the last question whose outcome is highlighted in table 4.6 with bold.

Table 4.8 presents the study outcome with responses on the range of proportion of electricity cost which contributes to the overall production costs.

Table 4.8: Percentage of overall production cost due to mains electricity in the company

| Likert Scale Value | Range (%) | Frequency | Percent | Valid Percent | Cumulative % |
|---------------------------|------------------|------------------|----------------|----------------------|---------------------|
| 1 | 0-5% | 20 | 25.0 | 25.0 | 25.0 |
| 2 | 6-10% | 27 | 33.8 | 33.8 | 58.8 |
| 3 | 11-15% | 12 | 15.0 | 15.0 | 73.8 |
| 4 | 16-20% | 9 | 11.3 | 11.3 | 85.0 |
| 5 | Above 20% | 12 | 15.0 | 15.0 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

Mean: 2.5750

Std Deviation: 1.37588

Source; Author (2019)

From table 4.8, the mean of 2.57 assert that the overall average production cost due to mains electricity in the sampled companies falls in the category of 6-10% and 11-15%. Thus, the actual value of electricity cost contribution to overall cost falls in between 10-11% mean

proportion. The effect of electricity costs to overall production costs is supported by Moya and Boulamanti (2016) to directly affect the overall production costs to given extent based on the projected power tariffs. Further, Palmer (2016) cites source of power and its costs parameters to directly the entire cost in the operations of the company involved. The study further asserts that an increase in power costs directly translated to a proportionate increase in the production costs and eventually affects the costs of products in the market affecting their competitive nature.

4.6. Inferential Analysis

The inferential data was analysed to establish the relationship existing between the dependent variable (overall production cost) with three aspects of the independent variables; electricity availability, fluctuation and electricity costs. Correlation and regression analysis was utilised in obtaining the coefficients to bring out inferential statistics.

4.6.1. Coefficient of Correlation

The coefficient of correlation is a statistic value that gives the relationship between the independent and the dependent variables and is represented by the variable having the range of -1.00 to +1.00. The correlation coefficient established in the tables 4.9 and 4.10 show a positive correlation between overall production costs with the three aspects of electricity role involving; electricity availability, electricity fluctuation and cost of mains electricity.

Table 4.9: Coefficient Correlations

| | | Constant | Electricity Availability | Electricity Fluctuation | Electricity Cost |
|--------------------------|---------------------|----------|--------------------------|-------------------------|------------------|
| Constant | Pearson Correlation | 1 | .408** | .320 | .325** |
| | Sig. (2-tailed) | | .000 | .113 | .003 |
| | N | 80 | 80 | 80 | 80 |
| Electricity Availability | Pearson Correlation | .408** | 1 | .554** | .438** |
| | Sig. (2-tailed) | .000 | | .000 | .000 |
| | N | 80 | 80 | 80 | 80 |
| Electricity Fluctuation | Pearson Correlation | .320 | .554** | 1 | .479** |
| | Sig. (2-tailed) | .113 | .000 | | .000 |
| | N | 80 | 80 | 80 | 80 |
| Electricity Cost | Pearson Correlation | .325** | .438** | .479** | 1 |
| | Sig. (2-tailed) | .003 | .000 | .000 | |
| | N | 80 | 80 | 80 | 80 |

** . Correlation is significant at the 0.01 level (2-tailed).

Source; Author (2019)

Since the values of Pearson correlation between any of the two variables yield a positive value greater than 0, there is a positive association between the variables. Electricity availability indicated positive correlation with a 0.408 change resulting in similar variation of production costs. For electricity fluctuation and electricity costs, the coefficients also showed positive correlation with an increase affecting overall production costs at 0.320 (0.113 significance) and 0.325 (0.003 significance) respectively as presented in table 4.9. Thus, from the coefficients of correlations significance (2-tailed), it is evident that electricity availability and electricity costs are statistically significant and affect the overall production costs based on the significance levels at 0.000 and 0.003 which are lesser than the standard significance level of 0.001 (2-tailed). However, the correlation between electricity fluctuation and overall production cost is statistically insignificant with the level value of 0.113 being greater than the standard value of 0.001.

4.6.2. Regression Results

Regression analysis was conducted to ascertain the relationship existing between the various aspects of electricity as a factor of production and its effect to the overall production cost. The aspects under consideration involved extent of black and outage, fluctuation extent and frequency and the costs of mains electricity. Further, the size of company and ownership aspects have been included in the regression analysis to bring out their effect on the overall production costs. The regression took into consideration electricity cost based on the availability, fluctuation and cost of mains electricity and their impact to the dependent variable; overall cost of production. Further, size of company and ownership were also analysed as per five categories of overall production costs as indicated in table 4.10.

Table 4.10 presents the regression results of various dummy variables from the survey and analysed in the five categories of overall production costs for manufacturing companies. Category 101-500 million is the base outcome or the reference category under which all the other categories; 100 million, 501 million to 1 billion, 1-3 billion and above 3 billion have been analysed reference to. The regression results are as presented in table 4.10 below.

Table 4.10: Multinomial Regression results

| Variable | | 100 million and below (Ksh.) | 101-500 million (Ksh.) | 501-1000 million (Ksh.) | 1001-3000 million (Ksh.) | 3 billion and Above (Ksh.) |
|--|------------------|------------------------------|------------------------|-------------------------|--------------------------|----------------------------|
| | | Coefficient (Std. Err.) | Base outcome | Coefficient (Std. Err.) | Coefficient (Std. Err.) | Coefficient (Std. Err.) |
| Availability of Electricity | | -1.193 ⁺ | | -1.986 ^{**} | -0.928 | -1.759 ^{**} |
| _Extent of Blackout | | (0.741) | | (0.778) | (0.638) | (0.740) |
| Availability of Electricity | | -0.601 | | -1.304 ^{***} | -0.940 ⁺ | -0.334 |
| _Outage | | (0.670) | | (0.677) | (0.575) | (0.653) |
| Backups Generators | | -14.496 | | 2.383 | 2.528 ⁺ | 2.890 ^{***} |
| | | (5902.931) | | (1.898) | (1.541) | (1.647) |
| Fluctuation of Electricity | | 0.636 | | 0.734 | 0.460 | 0.497 |
| _Extent | | (0.577) | | (0.566) | (0.479) | (0.489) |
| Fluctuation of Electricity | | 0.459 | | 0.865 | 1.448 ^{**} | 1.684 [*] |
| _Frequency | | (0.626) | | (0.589) | (0.592) | (0.638) |
| Overall production cost due to mains electricity | | -0.198 | | 0.137 | -0.034 | -0.451 |
| | | (0.348) | | (0.347) | (0.327) | (0.379) |
| Number of Employees | 101-200 | -1.119 | | -3.720 ^{***} | -18.344 | -1.065 |
| | | (1.820) | | (2.082) | (5049.474) | (1.529) |
| | 201-300 | 2.039 | | 3.041 | 3.089 | 2.579 |
| | | (2.264) | | (1.951) | (1.944) | (1.890) |
| | 301-400 | 0.602 | | -1.293 | -1.207 | -19.525 |
| | | (1.794) | | (1.603) | (1.509) | (3742.723) |
| | Above 400 | -0.152 | | 0.071 | 1.101 | 1.152 |
| | | (1.652) | | (1.404) | (1.402) | (1.423) |
| Ownership | Public | -3.496 | | -23.228 | -2.502 | -18.991 |
| | | (2.478) | | (11796.28) | (1.998) | (11125.87) |
| | Public-private | -17.605 | | -17.911 | 1.185 | 1.054 |
| | | (6996.310) | | (7032.372) | (1.733) | (1.608) |
| | Co-operative | -1.681 | | -19.391 | -0.432 | 1.097 |
| | | (1.818) | | (6873.568) | (1.931) | (2.009) |
| | Others (Specify) | -19.668 | | -2.664 ^{**} | -2.249 ^{***} | -2.378 ^{***} |
| | | (4388.232) | | (1.250) | (1.264) | (1.438) |
| | Constant | 18.457 | | 5.245 | -1.665 | -1.275 |
| | | (5202.932) | | (4.126) | (3.875) | (4.151) |

Number of observation = 80

LR Chi2 (20) = 79.14

Prob > chi2 = 0.0226

Pseudo R2 = 0.3096

*: Significant at $\leq 1\%$ (0.01)***: 5% (0.05) < Significance $\leq 10\%$ (0.1)**: 1% (0.1) < Significance $\leq 5\%$ (0.05)

+: Significant closer to 10%

Source; Author (2019)

The regression output involved assessment of 80 study aspects that were under observation which involved the 80 responses made by respondents as presented in table 4.9. The LR chi2 (20) at 79.14 is the likelihood ratio of chi-square test indicating that at least one of the regression coefficients is not equal to zero at 20 degrees of freedom of the distribution used in testing the chi-square statistics. The probability of getting LR tests as extreme (Prob> chi2) is 0.00226 which smaller than 0.01 leading to the conclusion that at least one of the regression coefficients in the model does not equal to zero. The pseudo R2 shows the measures of how close the data is to the fitted regression model. A higher pseudo R2 value points towards decreased standard error indicating better model fit: thus, the pseudo R2 at 0.3096 shows that the values deviate by the same margin from the model. Thus, the statistics show that regression coefficients in the distribution have a higher probability of not being equal to zero indicating the presence of significance and degrees of relationship among the variables. The statistics obtained have been derived with reference to 101-500 million as the base outcome or the reference category.

The availability of electricity with respect to extent of blackout was significant in 501-1 billion categories at 5% and in above 3 billion categories at 5% as well compared to the base reference of 101-500 million. It was somehow significant in less than 100 million categories at 10%. A unit increase in electricity availability results in a 1.986 decrease in production cost in the category of 501-1 billion compared to the base reference. Similarly, a unit in availability of electricity results in a 1.759 decrease in production cost in the category of above 3 billion compared to the reference.

Availability of electricity with respect to outage was found significant in 501-1 billion categories at 10% and somehow significant at above 3 billion categories at slightly above 10%. Electricity outage had negative relationship with production cost. A unit increase in availability with respect to outage results in 1.304 decreases in production cost in the category of 501-1 billion categories when compared to base outcome.

Backup generators were found to significant at 10% in the category of above 3 billion categories compared to the base reference. A unit increase in generator use results in increase in production cost by 2.890 compared to the base outcome in the category of above 3 billion. It was also noted that companies with less than 100million production cost had negative relation with production cost meaning they were less likely to invest in generator. All

categories above 500 million showed positive relation meaning they have higher chances of investing in generator.

Electricity fluctuation was found significant in the category of 1 billion to 3 billion at 5% and in above 3 billion categories at 1%. It had positive relationship in both the cases. A unit increase in electricity fluctuation results in a 1.448 increase in production cost in the category of 1 to 3 billion when compared to the base reference. Similarly, when compared to the base outcome, unit increase in fluctuation results in a 1.684 increase in production cost in the category of above 3 billion. Electricity fluctuation also had positive relation to production cost in all the categories of production cost compared to the base outcome. This means fluctuation results in increase production cost for all categories.

The factor of company size showed negative relation for all categories of overall production costs for companies with 101-200 employees. Thus, a unit increase in the number of employees results in a 3.72 decline in the overall production at 7.4% significance when compared to the based outcome. Though not significant, the category of above 400 employees showed negative relation for below 100 million and positive relation for 501 million to 1 billion, 1-3 billion and above 3 billion categories compared to the base outcome. The results can be concluded that a unit increase in number of employees for companies above 500 million leads to increased overall production costs.

The ownership factor showed negative relation for the class of others in all production costs categories. This means that a unit increase in ownership leads to 2.664 decrease of production cost at 3.3% significance for category 501 million to 1 billion production cost when compared to the base outcome. Similarly, a unit increase in ownership leads to 2.249 decrease in production costs at 7.5% significance for 1-3 billion and a 2.378 decrease in production cost at 9.8% significance for above 3 billion production cost when compared to the base outcome. The findings for public, public-private and cooperative besides not being significant show no relevance in the study objectives to deduce any conclusions. However, the mixed relationship for ownership aspects can be attributed to the complexity in quantifying a unit of ownership to assess its effect on the overall production costs based on the impact of electricity. Thus, this aspect was utilised in the study for comparative analysis between the different ownership categories with respect to other aspects of electricity availability, fluctuation and costs of mains electricity.

Regression Model

The coefficients were generated as shown in table 4.9 and formed a linear model of representation to show the relationship with the various categories of overall production cost in Kenyan shilling (Ksh.). Based on the various study aspects in the survey process, specific aspects of study variables were selected for regression analysis to obtain coefficients for linear model. The selected variables involved the aspects in the empirical model which include; availability represented by extent of electricity outage, black out occurrence and use of backups; fluctuation represented by extent and frequency and the proportion of cost of electricity to overall production costs. The other aspects in the model involved size of the company or the labour force represented by the number of employees' study aspects, and the ownership aspects represented by type of company or business ownership. The study model obtained is discussed with representative variables from the multinomial analysis to bring out the relationship of the dependent variables with the various study aspects. The study model under consideration is;

$$PC = \alpha_0 + \delta_1 A + \delta_2 F + \delta_3 C + \beta_1 Ag + \beta_2 L + \beta_3 S + \mu \dots \dots \dots (i)$$

Where PC is the overall production cost, α_0 stand for the constant production factor, δ and β are the vectors of parameters to be estimated for variables, A is the availability of electricity in respect to outage or extent blackout, F is fluctuation in form of extent and frequency while C is cost of electricity. The characteristics of firms involve; L is the labour force proportion, S is the business ownership and μ is the error term. Three models are formulated based on the three categories of overall production costs of 501 million to 1 billion; 1-3 billion and above 3 billion represented by equations (i), (ii), (iii) and (iv). Taking the category of overall production cost 501 million to 1 billion, company size at 200-300 employees and public ownership; the study model is represented as follows;

$$PC = 5.245 - 1.987A + 0.734F + 0.137C + 3.041L - 23.228S + 4.126 \dots \dots \dots (ii)$$

The regression model obtained indicates a relationship between production cost and various aspects where all other factors held constant, the variable varies to the extent of the coefficient value. In context with fluctuation, mains electricity cost, ownership and size of company being constant, a unit increase in electricity availability results in decreased production costs by 1.987 times. Similarly, with others factors held constant, a unit increase

in fluctuation results in increased production cost by 0.734; a unit increase of cost of electricity results in overall production costs increasing by 0.137, and with unit increase in number of employees increasing production cost by 3.041. The variable of ownership presents a negative variable at -23.228; however, based on the state of the variable, it would be difficult and quantity a unit of ownership which can be attributed to the high negative values that cannot be directly related to the dependent variable.

Similarly, for the category of 1-3 billion, the model is represented by extent of outage at -0.940, extent of fluctuation at 0.460, electricity costs at -0.034, size (200-300 employees) at 3.089 and ownership (public) at -2.503. The model representation in the category of companies with 1-3 billions overall production costs involves;

$$PC = -1.665 - 0.940A + 0.460F - 0.034C + 3.089L - 2.503S + 3.875..... (iii)$$

From the model representing the relationship between dependent variable and the various study aspects; with other aspects being held constant, a unit increase in availability results in 0.94 times decline in production costs, unit increase fluctuation increases the costs by 0.46, unit increase in electricity costs resulting in declined overall production costs at 0.034, size of the company positively increasing costs of production at 3.089 and ownership having an inverse relationship at -2.503. The negative value of -0.034 for the mains electricity costs with overall production costs can be attributed to the large companies benefiting from economies of scale. A similar case presents for the category of over 3 billion where the model with availability at -1.759 (extent of blackout), fluctuation at 0.497, electricity cost at -0.451, size (200-300 employees) at 2.579 and ownership (public) at -18.991 is;

$$PC = -1.274 - 1.759A + 0.497F - 0.451C + 2.579L - 18.991S - 4.152..... (iv)$$

The model representation illustrates a relationship where with all other aspects being constant; availability increase reduces overall production costs by 1.759 times decline in production costs, unit increase in fluctuation raises the cost by 0.497 and an increase in electricity costs results in declined costs at 0.451. The size of company affects overall production costs by 2.579 and ownership at 18.991. The negative value of -0.451 observed for increased costs of electricity can be attributed to larger companies and large output which results in reduced costs per unit of the production process due to economies of scale. This is supported by Jadayil, Khraisat and Shakoor (2017) study which assert the fact that continuous

and sufficient supply of sufficient electricity to manufacturing companies enables them to work at optimum and ensure reducing costs of production through economies of scale by increasing output and thus, reducing the cost per unit charge. The study outcomes are further supported by Vezzoli et al. (2018), which cites that electricity sufficiency or insufficiency have a direct influence on the performance and especially overall production costs of the company involved. Key issues for consideration among manufacturing companies have always been on how to enhance constant and sufficient electricity provision in the manufacturing processes to avoid losses due and reduced performance. In essence, the input of electricity sufficiency and its costs proportion has a direct impact on the production process with respect to not just the efficiency of production process, quantity and quality of products, but also influencing the overall costs of production.

4.7. Summary of Key In-depth Interviews

Key in-depth interviews were conducted to 14 managers of the sampled companies from every sector and the findings are summarised as shown in Appendix V.

Managers interviewed gave significant insights on the electricity availability, fluctuation and cost of mains electricity influence to the overall production costs. One key aspect that was highlighted by the managers was the improved situation in the supply of electricity in the Kenya. However, the interviewees pointed to the continued unreliability by about 10-15% of power supply due to outages and fluctuation, as well as cost of mains electricity affecting Kenyan industries performance to compete effectively in the region and globally. Availability of mains electricity was shown to affect overall production costs to a greater extent with increased use of generators for supplementing insufficient power supply. Managers recommended improvement of production to ensure sufficient electric power availability, as well as improvement of infrastructure to ensure efficient supply.

Further, managers pointed to fluctuation affecting production by reducing the rate of production process, as well as affecting machine efficiency and at times causing breakdown. Poor infrastructure and incompetent technicians contribute to fluctuation through loss of power and lack of checking load to the factories. Interviewees pointed towards the use of power stabilisers to counter fluctuation effects in the factories which in turn results in increased costs.

The cost of electricity increase directly impacts on the overall production costs. However, although the government has introduced reduced tariffs for off-peak power use, the presence of conditions set to benefit from the incentive and the requirement for baseline threshold. Key recommendations were also proposed by the interviewed managers as outline in appendix V.



CHAPTER FIVE: DISCUSSION

5.1. Introduction

The chapter presents the discussions of the study findings as per the study objectives to bring out a clear comprehension on electricity as factor of production and its contribution to the overall production cost.

5.2. Discussion of Objectives

5.2.1. Availability of Electricity and Overall Production Cost

Electricity availability is evident in the manufacturing industries in Kenya with continued improvements being recorded in the past years. Power availability directly affects the cost of production, quantity of production and production schedule. According to Bee (2016), power outages negatively affect production processes by halting the process causing massive losses. Similarly, power outages were indicated to cause great loss in man-hours, as well as negatively affecting the efficiency of machines used for production. Power outages were indicated to occur averagely once a month and last for at least an hour which has a direct impact on the operations of the manufacturing companies. Thus, companies are forced to install backups for supplying power in case of a power outage caused by lack of electricity.

Qualitative findings from the key in depth interview revealed that lack of sufficient supply of electricity means industries ending up with no production, reduced production capacity or even closing down for the day operations. To counter insufficient supply of electric power supply, companies results in the use of generators or solar power backups which are expensive to install and maintain especially with use of generators running on fossil fuels. Other options for supplementing insufficient power supply in the industries involved use of solar energy to generate power. The outcome is supported by Grainger and Zhang (2017) study which states that lack of sufficient power for manufacturing companies result in the use of fossil fuels which increase the cost of production translating to high price of final products decreasing the competitive aspect of products based on their price. Similarly, Kiarie (2014) asserts that many companies invest in standby generators to ensure consistence of their operations. However, interviewees indicated that power supply has greatly improved in the last few years with improved infrastructure, production and less power outages. The

interviewees recommended more interventions by the government to bring down the cost of electricity consumed by manufacturers considerably.

5.2.2. Electricity Fluctuation and Overall Production Cost

Fluctuation of electricity in the study involved change in the intensity and capacity of electricity supplied to the industries by $\pm 10\%$. Power fluctuation due to drop in electricity voltage was cited as not being common for the surveyed companies with mean agreements either disagreeing or showing moderate to neutral extent. However, the study findings from both the survey and interview showed fluctuations have a direct effect on the production process and eventual overall costs. Managers interviewed stated that one instance of fluctuation results in switching of machines until power stabilises in the case where power stabilisers are absent. This results in reduced work-flow, loss of man-hours and declined production rates, in turn affecting overall production costs and company performance. According to Frederick and Selase (2014), power fluctuations results in inefficient production processes affecting overall outcome in manufacturing industries. Further, negative impact on the production schedule or planning leads to reduced production capacity and quantity. Tsitsiklis and Xu (2015) assert that demand fluctuations for electricity results in ancillary costs to suppliers impacting on the production processes. This eventually directly results in high costs of production incurred to produce less produce leading to declined performance.

Study findings in respect to machine efficiency and fluctuations showed relationship with fluctuation negatively impacting on the efficiency of machines. The result is stalling or slowing down of production affecting the rate or production output in the company. This is supported by Kasae (2014), which cites power surges and fluctuations as key contributors to machine breakdown and inefficiency that result in reduced production. According to Okoye and Madueme (2016), companies with efficient and sufficient electricity supply tend to have higher production rates; quantities and quality compared to those with poor power supply. This also supported by Scott et al. (2014) assertion that insufficient electricity supply impacts on the production process by looking for alternative processes like manual methods which lead to reduced quality of products or halt production all together. Thus, increased efficiency in electricity supply to the Kenyan manufacturing industries is necessary to enhance performance, reduce costs of production and ensure increased performance.

5.2.3. Electricity Cost and Overall Production Cost

The cost of electricity has been indicated to directly influence overall production costs to a specific extent. The power cost increases have been termed as unscheduled affecting performance of manufacturing industries significantly due to unexpected increase in costs of production. Interviews revealed that increased power tariffs affects production schedule with measures like running machines continuously to maximise production being embraced. Majority of interviewed managers cited that measures are taken to utilise electric power for manufacturing purpose only with power for lighting and other non-manufacturing practices not being prioritised to minimise consumption.

Dorcas, Agyeman and Bonn (2017) assert that overall production cost is impacted by various aspects but, electricity plays a significant central role based on its cost and supplementary energy costs that arise with insufficient power supply. Subsequently, the cost of electricity is impacted by various factors resulting in changing costs from time to time. Locmelis, Blumberga, Bariss and Blumberga (2018) on a study conducted in Latvia cites that increase in electricity costs directly impacts on the energy costs of industries resulting in higher production costs. The study recommended for energy efficiency policies in the European market to bolster the manufacturing companies performance and competitiveness. Thus, governments and stakeholders have the capacity to promote manufacturing by mitigating manufacturers from negative implications of electricity costs changes through incentives and subsidies. The Kenyan government has improved on incentives with companies utilising power off peak having to pay lesser tariffs, for example commercial C15 power transmitted at 132 kV costs Ksh. 10.10 during peak and Ksh. 5.15 off peak (ERC, 2019). The incentives are aimed at encouraging more commercial entities and manufacturing industries to maximise production during off peaks at lower costs.

Study findings also established that acquisition of efficient machines is affected by the costs of mains electricity eventually impacting to a large extent the quantity of products manufactured, production schedule and planning. Measures proposed in ensuring reduced costs of electricity by the Kenyan government have involved increased production of power from geothermal, solar and wind which are considered cheaper options and clean energy. Nevertheless, the increased output of electricity has only managed to ensure sufficient supply of electricity but not cheaper power tariffs to make manufacturing companies compete effectively in the region and globally. A good example is the German situation as illustrated

by Javied et al. (2016); the study cite Germany a developed economy as one with high electricity costs, but government interventions are essential in shielding manufacturing companies from competitive pressures within their market of operation. The German government is increasingly investing in renewable and clean energy sources to bring down overreliance on coal power which has greatly contributed to green house gases attributed to global warming (Apunn, 2018). However, since the target of phasing coal energy is 2038 and the huge electric power need is enormous in Germany, electric power costs have been rising recently with projections of up to 20% or one cent per kilowatt hour as indicated by Manuel Frondel an energy expert at RWI Leibniz Institute of Economic Research, Essen (The Local, 2019). Nevertheless, the government has encouraged solar energy installation with individuals supplying their surplus power to the national grid being paid as from April 2019 (Vaughan, 2019).

The expected growth and development in Kenya is likely to increase the need for electric power and thus, investment in production is inevitable. Were (2016) asserts that the costs of electricity in the Kenyan industrial sector have been determined mostly by demand and supply with availability being influenced by climatic conditions due to over-reliance on hydro-electricity. Reduced supply of electricity in the power grid results in increased power tariffs based on use of generators powered by fossil fuels to supplement deficit in electric supply. According to Moya and Boulamanti (2016), increased costs of production energy results in inflationary pressure that weakness the purchasing power with prices of goods increasing significantly due to high costs of electricity that increases overall production costs. Essentially, increased costs of electricity affect overall production costs directly, while at the same time influencing negatively the production schedule, planning and quantity. Thus, diversification to other forms of energy and increased incentives to embrace renewable sources of energy are key interventions by the Kenyan government which not only enhances sufficiency of power, but also bring down the cost of electricity significantly.

CHAPTER SIX: CONCLUSION, RECOMMENDATIONS AND AREAS OF FURTHER RESEARCH

6.1. Introduction

The chapter presents the conclusions of the study, recommendations and areas further research as per the study findings.

6.2. Conclusions

The study findings present outcomes in respect to how electricity availability, electricity fluctuation and electricity cost influences overall production cost in manufacturing industries in Kenya. Although the findings do not give exact parameters on the contribution of electricity availability and fluctuation, the study brings out insights into the extent of their influence to the overall cost of production. However, the study findings give the extent to which proportionate cost of electricity contributes to the overall production cost.

6.2.1. Availability of Electricity and Overall Production Cost

The study outcome indicates substantive influence on electricity availability to the overall production with lack of sufficient power leading to use of power backups that increased the costs of power. The cost of power directly has an input in the production cost and thus, positively influences overall production cost. However, availability of electricity to the Kenyan industries with satisfaction level above 80% for majority of the 80 respondents surveyed and a myriad of respondents quoting values between 60%-79%. Thus, it is evident that electricity availability influences overall production costs in the sense that unreliable or insufficient power supply results in increased costs of production due to backups use. However, sufficient supply of electricity to the manufacturing industries results in availability having no effect on the overall costs of production, but rather the actual costs of power utilised in the production process. In the Kenyan context, the sampled manufacturing industries managers interviewed indicated high satisfaction with electricity availability and cited improvements in the last few years with high expectations for better prospects in the future.

6.2.2. Electricity Fluctuation and Overall Production Cost

Electricity fluctuation is not very common in the Kenyan manufacturing companies as cited by respondents. From the study findings, it is apparent that poor electricity supply affects the operations of manufacturing companies with voltage fluctuation halting production, resulting in reduced machine efficiency and affecting production quantities. Thus, majority of manufacturing companies install power stabilisers to counter the effects of electric power fluctuation or surges to avoid damage and loss of their machines capacity and efficiency in the production process. The disruption in production processes due to fluctuation directly influences the overall production costs negatively with reduced outputs and need for interventions to stabilise power supply, shield machines from damage, as well as enhance efficiency in the production process through alternative power supply. Essentially, fluctuations can be addressed effectively by supplying company (Kenya Power) ensuring that sufficient power is available to manufacturing companies even at peak hours when demand is high.

6.2.3. Electricity Cost and Overall Production Cost

Electricity cost directly relates to overall production as increased power tariffs increases the production costs. The high costs of electricity have been indicated by participants to range from 10-11% to the overall production costs based on the average response acquired in the survey. Regression analysis for

However, the impact of cost may vary from one sector to another based on the energy needs and the consistency of production. Some industries have to continue with production irrespective of power insufficiency or costs to meet market demands especially the large industries. The positive relationship is evident with electricity being a key aspect of production and the lack of it, insufficiency or cost implication having a direct influence on the overall production process and eventual outcome. High costs of electricity have been cited to arise from high power tariffs, the use of generators to supplement insufficient power supply, and the use of stabilisers to counter fluctuations. The contribution is thereby substantive with increase in the cost of electricity directly increasing the overall production costs for manufacturing companies. Overall production cost is impacted by various aspects with electricity playing a central role based on its cost and supplementary energy costs that arise with insufficient power supply.

6.3. Recommendations

The study recommends the following based on the study objectives as per the findings;

With regard to electricity availability: although the government has increasingly enhanced production of electricity to ensure sufficiency. There is need for policy frameworks targeting ease of access to electricity; pricing and continuous supply without hitches to enable manufacturing companies reduce the proportionate cost due to electricity in the overall production cost. Further, continuous diversification of electricity sources by use of solar, wind and nuclear energy promote future needs for power consumption and lower costs. This enables local manufacturing companies to acquire leverage in the global standards of competitive measures. Further, improved transmission lines with new technology to ensure less vandalism and breakdown should be made a priority by Kenya Power to ensure sufficient supply of electricity at all times. This promotes realisation of a twenty-four-hour economy with many companies embracing production processes for longer hours. The government should enhance incentives for installing solar panels through providing channels for financing support for installation and tax rebates for manufacturers embracing solar energy sources. The need for supporting solar power is favoured by Kenya being along the equator possesses a lot of solar energy potential that can be exploited potentially by the manufacturing industries.

To effectively address fluctuation, the transmission company in the Kenyan electricity supply system (Kenya Power) should ensure all transmission lines are efficient always and continued inspection done with certainty. Further, Kenya power should install surveillance centres for checking loads and its effect to avoid fluctuations or surges that affect production. Subsequently, connections of the mains electricity to the production companies should be assessed periodically to ensure safety and efficiency in respect to lack of power surges that may cause periodical fluctuations. Compensation for electricity fluctuations especially with surges that cause damage to machines should be introduced to give leverage and act as incentives for manufacturers not to shy away from the Kenyan manufacturing sector. Further, the government should subsidise or avail power stabilisers at affordable costs to enable all manufacturers to own them and mitigate the impact of electricity fluctuations.

Electricity costs continuously change based on the various factors that affect the production, availability and transmission processes. Policy makers should bring about structures for

mitigating electricity costs increase due to availability and fluctuation by ensuring sufficient power supply and access to affordable alternatives supply of power for manufacturing. Further, the government should come up with policies and strategies that mitigate instances where electricity costs go up due to unforeseen aspects like drought. This is necessary to shield manufacturers from increased power costs that affect overall production costs. Further, the pricing of electricity in form of power tariffs by the Kenya Power should be objectively reviewed to enable manufacturing companies remain competitive with others in the regions. This is crucial for Kenyan manufacturing companies to remain competitive in the global market.

6.4. Limitations of the Study

The study was limited to accessing the exact overall production costs by manufacturing companies to assess the direct effect of electricity on it. Further, the diversity in production processes and products within a company could not give the actual effect on product basis, but was done holistically. Essentially, the study looked at the overall effect of electricity availability, fluctuation and mains electricity costs to the overall product on costs for various categories of manufacturing companies in respect to size and ownership within given range.

6.5. Areas for Further Research

Areas of further research should involve assessing specific measures that should be taken into consideration apart from increased electricity production in the Kenyan in the future. This is aimed at making electricity availability more sufficient and consistent, as well as its cost more favourable to the manufacturing industries in the Kenyan situation to ensure competitiveness of the industries in the countries. Further, studies should concentrate on what forms of electricity production, transmission and management practices would result in manufacturing companies having low costs electric power that would result in reduced overall production costs.

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APPENDICES

Appendix I: Letter to the Respondent

Dear Sir/ Madam,

RE: REQUEST THAT YOU FILL OUT A QUESTIONNAIRE

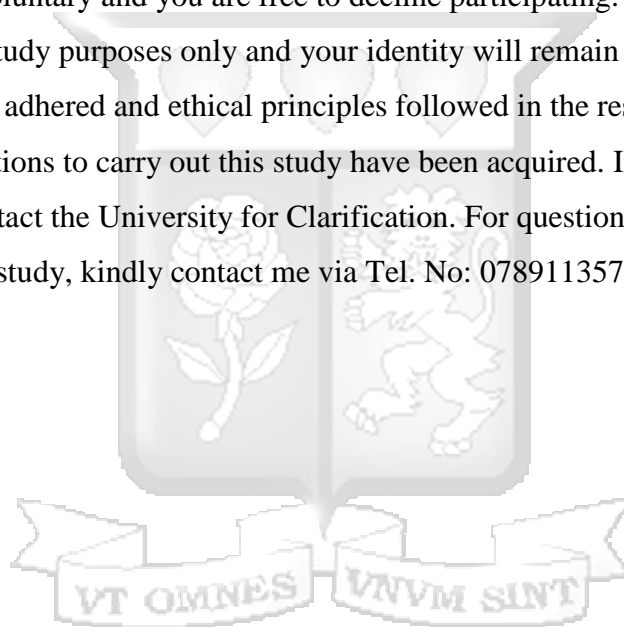
I am an MBA student at Strathmore University undertaking a research study titled “**THE EFFECTS OF ELECTRICITY ON OVERALL COST OF PRODUCTION: THE MANUFACTURING COMPANIES IN NAIROBI.**” Your company has been selected for survey and you are requested to kindly fill in the questionnaire to the best of your ability.

The participation is voluntary and you are free to decline participating. However, the findings of the survey are for study purposes only and your identity will remain anonymous. Utmost confidentiality will be adhered and ethical principles followed in the research study process. All relevant authorizations to carry out this study have been acquired. In case of any inquiries, you can contact the University for Clarification. For questions concerning the questionnaire and the study, kindly contact me via Tel. No: 0789113578.

Thank you

Yours

Trushit Shah,



I consent to participate in the research study.

Sign:

Date:

Appendix II: Questionnaire

Section A: General Information

1. Name of Company?
2. What is your current position in the business?
3. Do you have power backups in case of power blackouts?
Yes No
4. How long has your company been in operation (Age of company)
 0-5 years 6-10 years 11-15 years
 16-20 years above 20 years
5. Number of employees in your company?
 1-100 101-200 201-300
 301-400 Above 400
6. What is your company type or ownership?
 Sole proprietorship Public
 Public-Private Cooperative
 Others (Specify)
7. What is the average probable overall production cost in your company?
 Below Ksh. 100 million Ksh. 101-500 millions
 Ksh. 501M- 1 billion 1- 3 billion
 Above 3 billion
8. How do mains electricity availability, fluctuation and electricity cost affect the overall production cost of your firm? Provide your answer on a scale of 1 to 5.

1= Not at all; 2= Fairly seriously; 3= Seriously; 4= Very seriously; 5= Extremely serious

| | 1 | 2 | 3 | 4 | 5 |
|--------------------------|---|---|---|---|---|
| Electricity availability | | | | | |
| Electricity fluctuation | | | | | |
| High electricity cost | | | | | |

Section B: Availability of Electricity and Overall Production Cost

These questions assess the impact of electricity availability on the overall production cost of the company.

9. To what extent do the following aspects get affected by mains electricity availability
 1= Least extent 2= Low extent 3= Neutral 4: Moderate extent and 5= Great extent

| | 1 | 2 | 3 | 4 | 5 |
|----------------------|---|---|---|---|---|
| Production cost | | | | | |
| Production schedule | | | | | |
| Quantity of products | | | | | |

10. To what extent do you agree with following statements on mains electricity availability
 1= Strongly disagree; 2= Disagree; 3= Agree; 4= Slightly agree; 5= Strongly agree

| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
| Electricity supply to the company is insufficient | | | | | |
| Generators have to be on standby for back up always. | | | | | |
| Increased costs are incurred with power backups. | | | | | |
| Rate of production reduces with electricity insufficiency | | | | | |
| Many man hours are lost with power loss | | | | | |
| The efficiency of machines is affected by insufficient supply of electricity affecting production. | | | | | |

11. To what extent do power black outs occur in your firm?

- At least Once in 6 hours At least once per day
 At least once per week At least once per month
 Very rare

12. How long does a typical power outage last in your company?

- No Outage at all Few Seconds
 Few minutes At least one hour
 Half a Day More than one day

13. On scale of 0-100%, how satisfied are you with the mains electricity availability at your company in a month.

Zero (0) = no electricity at all; while 100% = electricity availability throughout.

.....

Section C: Electricity Fluctuations and Overall Production Cost

These questions establish the effect of electricity fluctuations and the performance of the company.

14. To what extent do you agree with following statements on mains electricity fluctuations

1= Strongly disagree; 2= Disagree; 3= Agree; 4= Slightly agree; 5= Strongly agree

| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
| Frequent mains electricity fluctuations are common in the company | | | | | |
| The quantity of products is affected by mains electricity fluctuations | | | | | |
| Unscheduled power fluctuations affect the overall cost of production | | | | | |
| Mains electricity fluctuations results in use of power stabilisers which increase the overall cost of production | | | | | |
| The efficiency of machines is affected by electricity fluctuations and in turn affects overall production cost. | | | | | |

15. To what extent do the following aspects get affected by electricity fluctuations

1= Least extent 2= Low extent 3= Neutral 4= Moderate extent and 5= Great extent

| | 1 | 2 | 3 | 4 | 5 |
|----------------------|---|---|---|---|---|
| Operating efficiency | | | | | |
| Quantity of products | | | | | |
| Production cost | | | | | |
| Production schedule | | | | | |

16. To what extent do you face power fluctuation in your company?

1= Least extent 2= Low extent 3= Neutral 4= Moderate extent and 5= Great extent

17. What is the frequency of mains electricity fluctuation during the working hours in your firm?

At least Once in 6 hours

At least once per day

At least once per week

At least once per month

Very rare

Section D: Electricity Cost and Overall Production Cost

These questions evaluate the effect of electricity cost on the overall production cost in the Kenyan manufacturing industries.

18. To what extent do you agree with the following statements on electricity cost and overall production cost?

1= Strongly disagree; 2= Disagree; 3= Agree; 4= Slightly agree; 5= Strongly agree

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Mains electricity costs affect the overall production cost | | | | | |
| Unscheduled increase in power costs affects overall production cost | | | | | |
| The cost of mains electricity and the overall production cost enhance the acquisition of efficient machines | | | | | |

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
|--|--|--|--|--|--|

19. To what extent do the following aspects get affected by mains electricity costs

1= Least extent 2= Low extent 3= Neutral 4= Moderate extent and 5= Great extent

| | 1 | 2 | 3 | 4 | 5 |
|-------------------------------|---|---|---|---|---|
| Production cost | | | | | |
| Quantity of products | | | | | |
| Production schedule/ planning | | | | | |

20. What percentage of the overall production cost is due to mains electricity in your company?

- | | | | |
|--------------------------|-----------|--------------------------|--------|
| <input type="checkbox"/> | 0-5% | <input type="checkbox"/> | 6-10% |
| <input type="checkbox"/> | 11-15% | <input type="checkbox"/> | 16-20% |
| <input type="checkbox"/> | Above 20% | | |

Thank you for your participation



Appendix III: Interview Guide for Key Informant Interview (KII)

General Questions

1. How long has your company been in operation (Age of company)
 0-5 years 6-10 years 11-15 years
 16-20 years above 20 years
2. Number of employees in your company?
 0-100 101-200 201-300
 301-400 Above 400
3. How long have you worked in the company?
 Less than 1 year 1-3 years 4-6 years
 7-9 years above 10 years

Availability of Electricity and Overall Production Cost

These questions assess the impact of electricity availability on the performance of the business.

4. On a scale of 1-10, rate the availability of electricity in a month.
5. Do you think mains electricity availability affects the overall cost of production in the company? (Kindly elaborate)
6. What problems are faced due to mains electricity availability affecting the overall production cost?
7. How do you supplement for insufficient mains electricity availability and does it affect the overall costs of production?
8. How many man-hours are lost due to mains electricity availability? How does this affect the overall production costs?
9. Does availability of mains electricity determine expansion of company? How?
10. Are there government interventions to improve mains electricity availability? Kindly give examples and explain.
11. Do you feel the government interventions have made positive impact on the manufacturing industry in respect to mains electricity availability and reduction in the cost of production?
12. Give recommendations necessary to bring better changes with respect to mains electricity availability?

Electricity Fluctuations and Overall Production Cost

These questions establish the effect of electricity fluctuations and the performance of the company.

13. How often do technical staffs complain of the mains electricity fluctuations in a month?
14. How does mains electricity fluctuation impact on the efficiency of machines in respect to production process?
15. Do you think fluctuation of mains electricity have an effect on the overall production costs? Kindly elaborate.
16. How do you counter mains electricity fluctuation in your company?
17. Are there any government interventions aimed at reducing frequencies of mains electricity fluctuations in the industrial sector? If any, give examples.
18. Do you feel the government interventions have made any impacts on the manufacturing process and production costs? If any, give examples.
19. Highlight a number recommendations or issues to be done to ensure reduced overall production costs with respect to the rates of mains electricity fluctuation.

Electricity and the Final Overall Production Cost

These questions evaluate the effect of electricity cost on the overall production cost and overall performance in the company.

20. Explain how proportionate cost of electricity affects overall production cost?
21. To what extent do electricity costs affect overall production costs?
22. Does changes in the overall production cost impact on the unit price of products and to what extent? Elaborate?
23. Do you think production costs have an impact on the expansion of the manufacturing companies? Elaborate?
24. Do electricity costs have an impact on the type of machines used and thereby affecting the production process?
25. What step do you take to counter increased costs of production due to electricity costs?
26. Is the government doing enough to address the situation? Elaborate your answer?
27. In your opinion, what is necessary to be done to improve the situation in respect to electricity costs and overall production costs in the manufacturing sector?

Thank you for your time.

Appendix IV: Ethical Approval

A: NACOSTI Approval



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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2241349,3310571,2219420
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When replying please quote

NACOSTI Upper Kabete
Off Wariyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref No **NACOSTI/P/19/36620/29447**

Date **30th April 2019**

Trushit Y Shah
Strathmore Business School
P.O. Box 59857 - 00200
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "*Effect of electricity cost on overall cost of production: The case of manufacturing companies in Kenya.*" I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **30th April, 2020.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit a **copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

**GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner
Nairobi County

The County Director of Education
Nairobi County

National Commission for Science, Technology and Innovation is ISO9001:2008 Certified

B: Strathmore Business School Approval



1st April 2019

SHAH, TRUSHIT YOGESHBHAI
P.O.Box:-64466-00620,
Nairobi.
trushitshah0612@gmail.com.

Dear Shah,

REF **Protocol ID:** SU-IERC0371/19 **Student Number:** 99606

EFFECT OF ELECTRICITY COST ON OVERALL COST OF PRODUCTION: THE CASE OF MANUFACTURING COMPANIES IN KENYA

We acknowledge receipt of your application documents to the Strathmore University Institutional Ethics Review Committee (SU-IERC) which includes:

1. Study Protocol submitted 25 March 2019
2. Cover letter listing all submitted documents 25 March 2019
3. Proposal declaration page signed by supervisors 25 March 2019

The committee has reviewed your application, and your study "EFFECT OF ELECTRICITY COST ON OVERALL COST OF PRODUCTION: THE CASE OF MANUFACTURING COMPANIES IN KENYA." has been granted approval.

This approval is valid for one year beginning **1st April 2019** until **1st April 2020**

In case the study extends beyond one year, you are required to seek an extension of the Ethics approval prior to its expiry. You are required to submit any proposed changes to this proposal to SU-IERC for review and approval prior to implementation of any change.

SU-IERC should be notified when your study is complete.

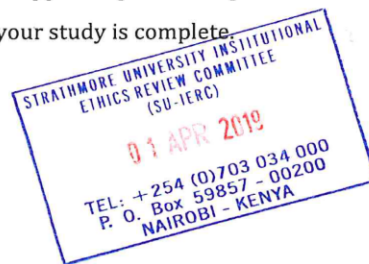
Thank you

Sincerely,

Prof. Florence Oloo

Secretary

Strathmore University Institutional Ethics Review Committee



Appendix V: Summary of KII Findings

Key In-depth Interviews Findings

- Availability of mains electricity affects overall production costs.
- Generators used mostly in supplementing power during outages.
- Lack of sufficient supply of electricity leads to industries ending up with reduced production capacity or even closing down for the day operations.
- Kenyan situation of electricity availability has greatly improved in the past years.

- Interview showed fluctuations have a direct effect on the production process and eventual overall costs.
- Fluctuation affects production rate and reduces output.
- Use of stabilisers to counter fluctuation increases overall production costs.
- Stabilisers not available for entire factor, but for specific sections.
- Poor infrastructure leads to fluctuation of electricity.
- Technicians from electricity suppliers fail to regularly check power loads.
- However, rate of electricity fluctuation have reduced in Kenya.

- Increase in electricity tariffs increases overall production costs.
- Use of backs and stabilisers increases overall
- Off peak incentive not working due to limit put in place.
- Commercial and industrial power use categorised in same pricing category.
- Government to continuously invest in cheaper electricity to bring down costs of electricity considerably.

Recommendations

- Government to introduce competition in electricity supply to remove monopoly and enhance electricity supply efficiency.
- Electricity supplier to notify manufacturers earlier of intended power disruption.
- Electric power supplier to compensate for destroyed machinery due to outages.
- Kenya power to be charged or penalised per hours lost in production due to outage to enhance efficiency.

- Technicians from electricity suppliers to regularly check power loads to the manufacturers and ensure fluctuations are mitigated.
- Kenya power to compensate for destroyed machinery due to fluctuations.
- Infrastructure improvement to continue for electricity transmission to ensure efficiency in supply by strengthening transmission and distribution.

- Continued reduction in power tariffs by Kenya Power.
- Enhancing compliance conditions for off peak power consumption to encourage more manufacturers to embrace the incentive.
- Solar incentive to be improved with tax rebates or financial support by the government to increase installation in the manufacturing sector to achieve cheaper power sources.
- Manufacturers installing solar energy to feed excess into the grid system to contribute in increasing generation of clean and cheaper energy.

Appendix VI: Multinomial Regression

```

multinomial logistic regression
number of obs      -      80
   <math>L\> chi2(56)   -      79.14
   Prob > chi2     -      0.0226
   Pseudo R2      -      0.3096
log likelihood = -66.358274
    
```

| cop | Coef. | Std. Err. | z | P> z | [95% Conf. Interval] | |
|----------------------------------|------------|-----------|-------|-------|----------------------|--|
| 1_billion__3_billion | | | | | | |
| back_up | 2.528502 | 1.540529 | 1.64 | 0.102 | -0.4910176 5.548023 | |
| number_of_employees | | | | | | |
| 101-200 | -18.34353 | 5049.474 | -0.00 | 0.997 | -2215.13 2078.443 | |
| 201-300 | 3.08855 | 1.244524 | 2.59 | 0.112 | -0.7226466 6.899747 | |
| 301-400 | -1.206677 | 1.508783 | -0.80 | 0.424 | -4.163238 1.750484 | |
| Above 400 | 1.101152 | 1.402689 | 0.79 | 0.432 | -1.648067 3.850371 | |
| Ownership | | | | | | |
| public-private | -2.502924 | 1.299093 | -1.92 | 0.210 | -5.412184 1.413196 | |
| Cooperative | 1.185318 | 1.732857 | 0.68 | 0.494 | -2.212125 4.56285 | |
| Others (specificity) | -0.4318893 | 1.230801 | -0.35 | 0.723 | -4.216385 3.352809 | |
| Oml_extent_of_blackout | -0.227259 | 0.6375783 | -0.36 | 0.716 | -2.177599 1.7210706 | |
| Oml_Outage | -0.2388081 | 0.5751527 | -0.42 | 0.672 | -2.067097 1.5894805 | |
| Oml_extent_fluctuation | -0.603723 | 0.4784165 | -1.26 | 0.337 | -2.092269 1.400011 | |
| Oml_frequency_fluctuation | 1.447777 | 0.5928532 | 2.44 | 0.015 | 0.2858065 2.609748 | |
| Oml_Percentage_Overall_Productio | -0.338252 | 0.327177 | -1.03 | 0.301 | -1.075074 0.40744 | |
| _conc | -1.664887 | 3.074281 | -0.54 | 0.587 | -8.252709 5.922926 | |
| 100___500_million | | | | | | |
| (base outcome) | | | | | | |
| 501___1_billion | | | | | | |
| back_up | 2.383109 | 1.898149 | 1.26 | 0.209 | -1.337125 6.103413 | |
| number_of_employees | | | | | | |
| 101-200 | -3.712576 | 2.082127 | -1.78 | 0.074 | -7.800047 0.3613179 | |
| 201-300 | 3.043397 | 1.250249 | 2.43 | 0.019 | -0.7824033 6.865177 | |
| 301-400 | -1.282805 | 1.602542 | -0.80 | 0.419 | -4.434729 1.867119 | |
| Above 400 | 0.710728 | 1.404688 | 0.51 | 0.606 | -2.082085 3.602021 | |
| Ownership | | | | | | |
| public-private | -23.22821 | 11746.28 | -0.00 | 0.999 | -23143.5 23097.05 | |
| Cooperative | -17.21109 | 7032.372 | -0.00 | 0.999 | -13881.11 13765.28 | |
| Others (specificity) | -19.32166 | 6873.589 | -0.00 | 0.999 | -13421.34 13452.55 | |
| Oml_extent_of_blackout | -2.663852 | 1.250101 | -2.13 | 0.033 | -5.114012 -0.2137052 | |
| Oml_Outage | -1.288679 | 0.7782226 | -1.66 | 0.097 | -3.512069 -0.0614917 | |
| Oml_extent_fluctuation | -1.303831 | 0.6765109 | -1.93 | 0.054 | -3.622864 -0.022302 | |
| Oml_frequency_fluctuation | 0.734836 | 0.5658806 | 1.30 | 0.184 | -0.3742501 1.8433177 | |
| Oml_Percentage_Overall_Productio | 0.652478 | 0.5888289 | 1.11 | 0.262 | -0.288225 2.013445 | |
| _conc | 1.374609 | 0.347109 | 3.96 | 0.000 | 0.6828583 2.0663601 | |
| _conc | 5.245227 | 4.12619 | 1.27 | 0.204 | -2.841258 13.33241 | |
| Above_3_billion | | | | | | |
| back_up | 2.882513 | 1.648871 | 1.75 | 0.079 | -0.3382244 6.117321 | |
| number_of_employees | | | | | | |
| 101-200 | -1.064805 | 1.522205 | -0.70 | 0.486 | -4.061291 1.932381 | |
| 201-300 | 2.578305 | 1.890286 | 1.36 | 0.173 | -1.126829 6.285569 | |
| 301-400 | -19.52539 | 3742.723 | -0.01 | 0.996 | -7355.129 7311.078 | |
| Above 400 | 1.152441 | 1.423489 | 0.81 | 0.418 | -1.637389 3.942271 | |
| Ownership | | | | | | |
| public-private | -18.28075 | 11125.97 | -0.00 | 0.999 | -21825.3 21787.32 | |
| Cooperative | -1.053895 | 1.688034 | -0.62 | 0.532 | -3.097881 4.205651 | |
| Others (specificity) | 1.0371 | 2.008709 | 0.52 | 0.595 | -2.838895 5.034094 | |
| Oml_extent_of_blackout | -2.37856 | 1.437228 | -1.65 | 0.099 | -5.196898 -0.397281 | |
| Oml_Outage | -1.758748 | 0.7402053 | -2.38 | 0.018 | -3.202824 -0.3078727 | |
| Oml_extent_fluctuation | -0.3342184 | 0.6534527 | -0.51 | 0.609 | -2.614276 1.945531 | |
| Oml_frequency_fluctuation | 0.4288225 | 0.4887887 | 0.88 | 0.379 | -0.611158 2.454901 | |
| Oml_Percentage_Overall_Productio | 1.68354 | 0.3823511 | 4.40 | 0.000 | 0.9323849 2.434695 | |
| _conc | -0.4508651 | 0.3723675 | -1.21 | 0.225 | -1.194412 0.2926816 | |
| _conc | -1.274765 | 4.1521707 | -0.31 | 0.759 | -9.411261 6.86243 | |
| less_than_100_million | | | | | | |
| back_up | -14.42565 | 5202.231 | -0.00 | 0.999 | -11584.03 11555.04 | |
| number_of_employees | | | | | | |
| 101-200 | -1.118077 | 1.812889 | -0.62 | 0.539 | -4.688563 2.447449 | |
| 201-300 | 2.038702 | 2.263865 | 0.90 | 0.368 | -2.394392 6.475795 | |
| 301-400 | 0.6020153 | 1.784135 | 0.34 | 0.737 | -3.214425 4.118456 | |
| Above 400 | -1.522511 | 1.651521 | -0.92 | 0.356 | -3.382473 3.080471 | |
| Ownership | | | | | | |
| public-private | -3.425529 | 2.477824 | -1.41 | 0.158 | -8.352182 1.560285 | |
| Cooperative | -17.6048 | 6226.31 | -0.00 | 0.999 | -13730.12 13694.21 | |
| Others (specificity) | -1.680789 | 1.82815 | -0.92 | 0.355 | -5.244227 1.882719 | |
| Oml_extent_of_blackout | -1.12273 | 0.7418515 | -1.51 | 0.138 | -2.646732 -0.212718 | |
| Oml_Outage | -0.6007859 | 0.6623407 | -0.90 | 0.369 | -2.912669 1.710279 | |
| Oml_extent_fluctuation | 0.6368933 | 0.5772644 | 1.10 | 0.271 | -0.4253341 1.767501 | |
| Oml_frequency_fluctuation | 0.4585093 | 0.6280056 | 0.73 | 0.464 | -0.684381 1.685458 | |
| Oml_Percentage_Overall_Productio | -0.1284589 | 0.347242 | -0.37 | 0.708 | -1.0804262 0.8235086 | |
| _conc | 18.45734 | 5202.232 | 0.00 | 0.999 | -11551.08 11587.29 | |