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Information and Communication University, electricity load shedding: It's impact on SMIS in Ndola's industrial area in, Copperbelt province of Zambia

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Abstract
This report aimed at assessing the economic impact of electricity rationing on the selected SMIs operations in the industrial area of Ndola. The study investigated the potential economic impact of differently distributed rationing options aimed at reducing peak electricity usage and consumption.
One of the objectives was to assess short- and medium effects on businesses operating from the Ndola's industrial area. The research was carried out in Ndola's industrial area using stratified sampling. The methodology consisted of business houses survey in which questionnaires were distributed to respondents. The methodology of the direct assessment approach used direct loss by which it estimated the cost of power outages through lost production, materials and time. The direct assessment method is an economic appraisal tool that estimates the cost of power outages by allowing electricity consumers to express their losses in monetary terms.
This report is organised in three main sections. The first section analyzed the potential economic impact of electricity rationing on businesses. Secondly, uncertainty that surrounded the timing of power cuts and the damage done by the unplanned electricity cuts.
The negative impact on industry and business was greater in the short term than in the medium or long term. However, there might be long-term consequences of industries being forced to adjust to an immediate electricity cut. Examples included the closure of insignificant mines, loss of investor confidence in direct investments, extra costs of materials, labour such as the payment of idle labourers and cost of overtime to meet production and orders, damage to equipment cost, restart cost, time or opportunity cost per load shedding are part of the load shedding cost by the direct assessment.
The paper presents the analysis of the direct costs incurred by businesses that went beyond production loss or output loss. In addition to output loss cost, other direct costs were the negative impact on direct investment, output and employment. The exact impacts was a shift in resources from tradable manufacturing such as smelters or motors to inward-oriented activities such as construction or personal services appeared to offer employment a boost and reduced the current account deficit as imports for production exports fell.
Respondents suggested their solutions to the current electricity shortages like the construction of extra hydro power stations and the investment into alternative sources of energy like solar and wind.

Keywords: load shedding, rationing, business, questionnaire, employment

1. Introduction
Energy is a critical input into all sectors of the any sound economy. A viable energy sector is, therefore, key to achieving sustainable economic growth and development in the country. During the Fifth National Development Plan (FNDP) of 2005 to 2011 period, the sector's goal was to ensure availability of reliable, affordable and environmentally sound energy for sustained social and economic development. (FNDP, 2006)
Zambia is richly endowed with a range of indigenous energy sources, particularly sunshine, hydropower, wind, coal and renewable sources of energy. The country's hydropower resource potential stands at an estimated 6,000 Mega Watts (MW) while the installed capacity was a mere 1,876 MW. Hydroelectric plants represent 99 percent of electricity production in the country with the major sources being Kafue Gorge, Kariba North Bank and Victoria Falls Power Stations. The country's electricity was predominantly consumed by the mines and commercial firms accounting for 68 percent while households only use 19 percent of the total. (EAZ, 2014)
The availability and accessibility of modern energy services result in sustained economic growth and development. Access to energy services was a prerequisite to the achievement of the Millennium Development Goals (MDGs). (SNDP, 2012)
In implementing the Sixth National Development Plan (SNDP), economic growth and development could be achieved by increasing access to energy services. Every economic and social sector needed adequate, reliable and affordable energy input to grow.
During the feasibility studies of the Sixth National Development Plan (SNDP) the Kafue Gorge Lower (600 Mw) were completed, works on Kariba North Bank extension (360

Mw) were commenced and a Special Purpose Vehicle for Itezhi-Tezhi Power Company (ITPC) was formed to spearhead development of the 120 Mw Itezhi-Tezhi Hydro-Power Plant. (Source: FNDP, 2011)

The major challenge in the electricity sub-sector was the huge capital requirement for the development of hydro-power projects such as Kafue Gorge Lower, Itezhi-tezhi and Kalungwishi which required US $1.8 billion, US $350 million and US $741 million respectively

The reason for this action had been attributed to insufficient water in the reservoirs at Kariba and Itezhi Tezhi due to "below average" rainfall experienced during the 2014/15 rainy season. Since July, 2014, Zambia Electricity and Supply Corporation (ZESCO), the only national electricity utility had increased load shedding or electricity rationing throughout the country. The load shedding averaged 6-10 hours per day and affected industries, commercial undertakings and administration offices alike. This had led to a public outcry and anger against the national utility especially from the business community. (ZESCO, 2014)

This situation concerned the Engineering Institution of Zambia (EIZ). The EIZ, in keeping with their mandate stipulated in the EIZ Act No. 17 of 2012, on 13th July 2015 constituted a team of experts, to among other things:

1. Investigate the load shedding,
2. Recommend immediate measures to reduce load shedding and
3. Recommend long term measures to avoid or minimize load shedding in future under similar circumstances.

During the meeting the EIZ team learnt that ZESCO had put a number of measures in place to alleviate the inconvenience load shedding caused to commercial customers and to also ensure that there was a minimized interruption in the operations of commerce and industry. Some of the measures were as follows:

Imports from the SAPP Day Ahead Market of up to 150MW depending on availability, Imports of 100MW from Mozambique, rental power of 100MW from a ship docked at Beira port and Emergency rental power from Aggreko of 148MW. Most of these imports came at a premium tariff due to the nature of their fuel for generation. The imports would continue until such time that they were substituted with supply from the new generation to be commissioned at Maamba (300MW) and Itezhi tezhi (120MW) towards the end of 2015 and during the first quarter of 2016 as well as recovery of Lake Kariba.(Source: EIZ)

A further request was given to the Department of Meteorology to provide the departments' interpretation of the 2014/15 rainy season which was said to have had caused the inadequate generation of hydroelectricity.

Table 1: Rainfall Performance as At 10th April, 2015

Rainfall Performance As At 10th April,2015				
Station	**Seasonal Total**	**Normal**	**Departure**	
Mwinilunga	972	1326	-27%	Below
Mansa	1006	1064	-5%	Normal
Kasama	1026	1233	-17%	Normal
Zambezi	1125	1664	-32%	Below
Kasempa	1048	1149	-9%	Normal
Ndola	1217	1162	-5%	Normal
Chipata	827	992	-17%	Normal
Kawambwa	1419	1293	10%	Normal
Misamfu	1020	1233	-17%	Normal
Isoka	827	1059	-22%	Normal
Msekera	879	977	-10%	Normal
Lundazi	682	861	-21%	Normal
Lusaka City	720	818	-12%	Normal
Mongu	814	919	-11%	Normal
Solwezi	1123.9	1330	-15%	Normal
Livingstone	635.5	761	-16%	Normal
Kaoma	1080	928	16%	Normal
Sesheke	574	699	-18%	Normal
Chipepo	649.4	760	-15%	Normal

Source: Data provided by the department of Meteorology (2015)

Information obtained from the Department of Meteorology showed that the upper reaches of the Zambezi River such as Mwinilunga and Zambezi received below normal rainfall whereas the middle reaches such as Mongu, Sesheke and Livingstone received normal rainfall. For the Department of Meteorology, normal rainfall was 75-125% of expected figures whereas anything less than 75% was considered to be below normal.

The Kariba dam was designed as a multi-year reservoir this meant one average rainy season was not sufficient to fill it up. Further if operated at the designed firm generation; there was sufficient water for 3 rainy seasons. This meant that a single drought event should not drastically impact negatively on operations of the power stations particularly when the drought was preceded by an average rainy season.

Whilst Zambia's installed capacity was sufficient to meet the needs of the economy, the "fuel" that was water was currently a big constraint as it was provided by nature.

Generation of electricity in Zambia was predominantly from three (3) main hydropower stations, namely: Kafue Gorge,

Kariba North Bank and Victoria Falls. These accounted for 96% of total supply of the country. Due to the below average rainfall during the 2014/2015 rain season, water inflow into the reservoirs had not been adequate enough to meet the national power requirement till the end of 2015.

In response, the Zambezi River Authority, carried out hydrological modeling, reviewed the water allocation to ZESCO for hydropower generation from 45 billion to 33 billion cubic meters for the period March-December, 2015 in order to allow generation to last till the next rain season. This led to a shortfall in power generation of approximately 560 MW.

ZESCO then began implementing revised load shedding schedules of between 5 and 6 hours for the industrial and commercial customers on a rolling basis through a 24 hours period. In order to mitigate the reduced power generation caused by the reduced water levels at the three major stations, ZESCO embarked on the load shedding programme country wide. The Mines supplied by ZESCO and Copperbelt Energy Corporation (CEC) still received their full complements of the contracted power thus mines were later not load shed.

Table 2: National total demand forecast demand/power balance projections

	2014	2015	2020	2025	2030
Total Energy Demand(GHz)	13388	13734	15666	15954	17176
Maximum Demand(MW)	2065	2119	2417	2450	2650
Total Net Energy Generation (GWh)	16100	16100	26288	32875	40085
Installed Generation Capacity(MW)	3045	3045	4992	6035	7240
Energy Balance (GWh)	553	302	8688	22748	21378
Capacity Balance(MW)	647	608	2277	4566	4354

Source: National Total Demand Forecast by ZESCO (2015)

2. Statement of the Problem

The Economic Association of Zambia (EAZ) in 2015 produced a paper saying and I quote, 'what is very true is that energy and electricity in particular is the lifeblood of the economy. Needless to say, the power deficit was already having an impact on business operations. Water utility companies were beginning to ration water because of the electricity shortage. Business houses were likely to be more affected going forward should all things became equal'.

The other major sectors already feeling the effect of load shedding was agriculture. The Poultry Association of Zambia (PAZ) had noted that long hours of electricity load shedding and increased fuel prices were likely to negatively hinder development in the industry. Power outages were expected to lead to losses especially during the first days where brooding and lighting were critical for poultry. While the aggregate losses could not be immediately quantified, PAZ "is certain that most players in the sector are finding it difficult to operate at desired operational capacity" (Source: JCTR, 2016).

Dairy farmers told the then Agriculture Minister Honorable Given Lubinda MP that "load-shedding was causing havoc in the economy". The dairy plants were taking five hours to regenerate after eight hours of power cut, which equated to a loss of around 13 hours. This was affecting the dairy farmers because it meant their milk could not be bought. Minister Lubinda had gone on to say that there was no reasonable person who could dispute the negative impact of the power deficit on the economy generally". (Manufacturing Association of Zambia, 2014)

The cost of running these dairy farms had doubled because of the alternative sources of energy to run them such as gen sets which required extra fuel which meant extra costs and increased working capital. These costs were passed on to consumers or customers to say thus adding extra burden on the citizens. These increased prices made it even more difficult for people to access the essential vitamins or proteins from dairy products. (Source: Farmers' Union, 2016).

The Millers Association of Zambia (MAZ) had also indicated that they intended to increase mealie-meal prices due to the double whammy of higher fuel and load shedding of electricity. MAZ President Allan Sakala indicated that increased load shedding had reduced production days from six to three days in a week. The millers wanted to compensate the reduction in revenue with higher prices.

This was one of the contributing factors to the escalating mealie meal prices of the commodity which is also a staple food and further low productivity by milling companies

A reduction in output in these sectors inevitably meant reduced economic growth and development as a consequent. It was much more than that. The real losers were ordinary Zambians who not only faced the indignity of more load shedding from ZESCO but also higher prices for some products, as business passed on some of the costs to maintain their profit levels as well as the big story job losses.

Table 3: Demand Forecast by Customer Category (Zesco)

Year	Heavy Industries Demand(GWh)	Light Industries Demand (GWh)
2008	1800 GWh	1800 GWh
2009	1850 GWh	1850 GWh
2010	1900 GWh	1900 GWh
2011	1950 GWh	1950 GWh
2012	2000 GWh	2000 GWh
2013	2020 GWh	2020 GWh
2014	2040 GWh	2040 GWh
2015	2060 GWh	2000 GWh
2016	2100 GWh	2000 GWh

2017	2550 GWh	2450 GWh
2018	2750 GWh“	2650 GWh
2019	3000 “GWh	2700 GWh
2020	3150 GWh	2800 GWh
2021	3200 GWh	3000 GWh
2022	3500 GWh	3050 GWh
2023	3650 GWh	3200 GWh
2024	4000 GWh	3300 GWh
2025	4250 GWh	3400 GWh
2026	4400 GWh	3500 GWh
2027	4700 GWh	3650 GWh
2028	5100 GWh	4050 GWh
2029	5300 GWh	4100 GWh
2030	5850 GWh	4250 GWh

Source: Commercial Customers' Energy Demand Forecast (ZESCO, 2014)

The Jesuit Centre for Theological Reflection (JCTR, 2016) noted that the potential impact of power rationing on economic activities. It observed that "considering the existing socio-economic conditions and levels of poverty prevailing in our country, the impacts of load shedding would be felt more by the poor majority". The increase in the cost of production on businesses carried the potential risk of the cost being transferred to consumers through the increase in prices on both basic food items and essential none food items. This meant the cost of basic food items, which were fundamental to food security, are likely to go up. (Source: JCTR, 2016)

3. Research Objectives

The general objective of this study is to assess the effects of the energy crisis on micro and small scale industries (SMIs) in Ndola's industrial area.

The specific objectives of this study included:

1. To assess the frequency of electricity load shedding.
2. To get hold of information from SMIs on the impact of load shedding on their operations.
3. To get information on the effect of load shedding on profitability of the SMIs.

4. Literature Review

4.1 Introduction

The chapter presents the literature review of the study. It provides review on sustainable energy and strategic interventions to promote universal modern energy access in Zambia. The concept of micro and small scale enterprises is also reviewed taking into consideration its role in economic development and role of modern energy access in promoting the development of MSEs. Furthermore, the chapter provides review on the cost of power rationing on medium and small industries.

The concept of energy efficiency as a measure to mitigate the losses made by businesses as a result of unplanned power rationing and policy interventions to promote economic growth and development in Zambia.

4.1.1 Situation from the global perspective

Scott *et al*. (2014) [1] examine the impact of electricity insecurity on productivity, cost competitiveness and investment decisions. Their study reveals that unreliable electricity supplies tend to negatively affect the productivity of manufacturing SMEs and duration of outages appears to have a greater effect on productivity than the number of days outages are experienced. Thus, the duration of outages (measured by hours in a day) negatively impact on firm productivity more than the frequency of outages (days per month that outages occur) (Scott *et al.*, 2014) [1]. On cost competitiveness, the study concludes that SMEs experiencing electricity insecurity do not have higher unit costs of production than other SMEs and so are not competitively disadvantaged. The reason being that, electricity cost makes up only a small proportion of total cost of manufacturing SMEs. Lastly on investment decision by SMEs, the study suggests that electricity insecurity influences the location of investments by SMEs. Thus, countries with high electricity insecurity are more likely to have limited investments in their energy-intensive sectors (Scott *et al*. 2014) [1].

Evidence from Indian manufacturing firms show that high electricity cost leads firms to reduce their electricity consumption and switch to industries with less electricity intensive production processes, limiting factor productivity (Abeberese, 2013) [3].

In another study by Allcott et al.(2014), examining the effects of power shortages in Indian manufacturing firms, it was estimated that productivity losses due to power outages is significantly smaller compared to revenue losses because production inputs can be stored during outage periods. Secondly, shortages have heterogeneous effects across firms with and without generators and firms with high and low electric intensity. The study further reveals that because small firms are less likely to own generators, outages have much stronger negative effects on small firms than medium and large firms (Allcott et al, 2014).

Moyo (2012), on the impact of power outages on firm productivity in the manufacturing sector in Nigeria shows that power outage variables (measured using hours per day without power and percentage of output lost due to power disruptions) have a negative effect on productivity. The study further reveals that power outages negatively affect smaller firms more than large firms probably due to their severe financial constraints (Moyo, 2012). However, Oseni and Pollitt (2013) asserts otherwise by revealing that large firms suffer higher unmitigated outage costs than smaller firms despite having a higher propensity of investing in own generation.

In India, SMEs contribute nearly 45percent share of manufactured products, 40percent of overall export of the country and employment to over 32million people and

produce more than 8,000 quality products for the Indian and international markets. In South Africa, "SMEs contribute 30percent to GDP, 70-80percent in employment. SMEs have been the engine of Europe's economy during the period of the Eurozone crises accounting for 80percent of the European jobs in the last 5 years" (Arkoh, 2013). This goes to prove that "for Ghana to attain economic self-sufficiency it desperately seeks then SMEs must be the focal point of major government policies to develop the economy. The high degree of unemployment in the country combined with the relatively lower standards of living can be reduced if SMEs are given the necessary support to expand and overcome the numerous challenges that they face. This will go a long way to accelerate our vision in attaining economic self-sufficiency" (Arkoh, 2013).

4.1.2 Situation from the regional perspective

The Ghana Statistical Service (GSS) considers small-scale enterprises as firms which employ less than 10 workers whiles firms that employ more than 10 are considered as medium and large-scale enterprises regardless of the sector (Kufour, 2008).

The National Board for Small Scale Industries (NBSSI) describes Micro and Small Enterprises (MSE"s) as those enterprises employing 29 or fewer workers. Micro enterprises are those that employ between 1-5 people with fixed assets not exceeding 10,000 US Dollars excluding land and building. Small enterprises employ between 6 and 29 or have fixed assets not exceeding 100,000 US Dollars, excluding land and building.

Amponsah (2010) defines micro-scale enterprises as enterprises which employ up to 5 workers and have fixed assets (excluding estate) of US$10,000 or less. Again, small scale enterprises are businesses which employ 30 or less workers and have fixed asset value of US$100,000 or less. In addition, medium-scale enterprises are firms which employ less than 100 workers with total fixed asset value of US$1000, 000 or less. Thus, Amponsah (2010) agrees with the definition propagated by NBSSI. It must however be noted that, the use of currency limits will require the definitions to be updated frequently to cater for exchange rate changes (that is cedi per dollar exchange rate changes) (Ocloo et al., 2014) [10].

The Ministry of Energy and Water Development (MEWD) is responsible for policy development. The Energy Regulation Board (ERB) is the independent regulator. As is the case in Kenya, Tanzania and Uganda, there is a quasi-independent body charged with extending electrification in the rural areas, the Rural Electrification Agency. The Office for the Promotion of Private Power Investment (OPPPI) is a distinctive feature of the Zambian set-up. OPPPI is a specialized unit within the energy ministry that aims to promote private-sector investment in generation and transmission, and to manage the attendant and complex planning, procurement and contracting processes. Dawmore Musademba, department of Fuels and Energy, Chanboyi University of Technology and Tawanda Hove of Department of Mechanical Engineering, University of Zimbabwe wrote in the international Journal of Energy Engineering in February, 2012 about the "Effects of Load shedding in Chinhoyi urban residential Areas of Zimbabwe .

Kaseke N. and Hosking S.G of the department of Economics and Economic history of Nelson Mandela Metropolitan University South Africa wrote a paper which was published in the International Journal of Economics Development Research and Investment in December, 2011 titled Cost of Electricity Load shedding to Mines in Zimbabwe: Direct Assessment approach. They wrote about Zimbabwe's mining sector been hit hard by electricity load shedding from the power utility. Load shedding was seen as a solution to the inability of power utility to supply electricity to meet demand. Electricity supply problems has so many cause and some of which are inability to expand generation capacity, aging equipment, droughts, cost coal supply to thermal plants, vandalism and political disturbances. Mines flooded as a result of poor pumping of water outside the tunnels and mine shafts, and also lost productive hours of production. This study applied the direct assessment approach to estimate the cost of load shedding.

Public Protector South Africa report No. 31 of 2008/9 named Report on Preliminary Investigation relating to Electricity load shedding implemented by ESKOM Holdings limited. The Office of the Public Protector conducted a preliminary investigation, on own initiative, into incidents of electricity shortages and power outages due to load shedding by Eskom, that affected the large parts of South Africa from November 2007 to January 2008.

Cost is a variable input in determining profit by any business. Profit is only realizable if cost of production is less than revenue generated. Haanes et al., (2011) identified "reduced costs due to energy efficiencies" as the second highest possible source of sustainability next to improved brand reputation. In order words the higher the frequency and longer the duration of erratic power supply, the greater the cost incurred by small and medium enterprises and vice versa and the lesser or greater their ability to sustain their business interest. Many small and medium enterprises (SMEs) are folding up such as a hairdressers, welders, barbers; seamstresses are virtually out of business because they cannot sustain their cost of doing business.

4.1.3 Situation from the Zambian perspective

A lack of a "consistent access to reliable power costs businesses and the economy as a whole. Even with access to energy, unreliable power makes operating a business even more challenging than usual. African manufacturing enterprises experience power outages 56 days a year on average. As a result, firms lose six percent of sales revenues in the informal sector. Where back-up generators are limited, losses can be as high as 20 percent. These losses have severe consequences for the health and growth of the wider economy, not to mention the dramatic impact in achieving other development objectives outlined by the Millennium Development Goals"(Gretchen, 2013)

Government of the Republic of Zambia, 2012 in its Sixth National Development Plan dubbed "sustained economic growth and poverty reduction" The fore word was done by President Dr. Rupiah Banda. The Sixth National Development Plan (SNDP,) which covers the period 2011 – 2015, charts an ambitious path to transform the lives of Zambians. This plan is the successor to the Fifth National Development Plan (FNDP), 2006 – 2010, the first in the series of medium-term plans aimed at making Zambia "a prosperous middle-income

country by 2030".

Zambezi River Authority is a corporation jointly and equally owned by the governments of Zambia and Zimbabwe. It is a governed by a four-person council consisting of the Ministers of Energy and Finance of each country. Its primary function is to operate and maintain the Kariba Dam on the Zambezi River. The ZRA was established in 1987 as a successor to the Central African Power Corporation, which had formerly managed power generation and transmission from the Kariba Dam. The Zambezi River Authority www.zaraho.org.zm/index.html (ZRA) 1987Lusaka, Zambia.

A paper presented by the Engineering Institution of Zambia's Technical expert's team in September, 2015 on ZESCO and Load shedding where they indicated that in the recent past ZESCO, the national electricity utility has heightened load shedding (electricity rationing) throughout the country. The reason for this action has been attributed to insufficient water in the reservoirs at Kariba and Itezhi tezhi due to "below average" rainfall experienced during the 2014/15 rainy season. The load shedding averages 6-10 hours per day and affects industries, commercial undertakings, offices and domestic customers alike. This has led to a public outcry and anger against the national utility.

Mushiba Nyamaza (PhD) Research fellow Institute of Economics and Social Research UNZA presented a paper at Economic Association of Zambia in July, 2014 during a monthly discussion tiled Load shedding in Zambia: What should be the plan? In his presentation he indicated that in the 1990s SAPP projects SADC power deficit if capacity not increased but the Southern African Development Community (SADC) Governments took no action it was the "business as usual" approach. From 2005/6 massive load shedding began and now there is lots of talk of more investment but load shedding continues.

The Ministry of Energy and Water Development (MEWD) is responsible for policy development. The Energy Regulation Board (ERB) is the independent regulator. As is the case in Kenya, Tanzania and Uganda, there is a quasi-independent body charged with extending electrification in the rural areas, the Rural Electrification Agency. The Office for the Promotion of Private Power Investment (OPPPI) is a distinctive feature of the Zambian set-up. OPPPI is a specialized unit within the energy ministry that aims to promote private-sector investment in generation and transmission, and to manage the attendant and complex planning, procurement and contracting processes.

By and large, most studies reviewed show that load shedding has an impact on firm's operations and productivity; the effect on households has not been stressed fully in Zambia and Ndola in particular. Globally, regionally and locally, the causes and consequences of power rationing on businesses are different and multifaceted. Consistent also in the studies has not shown that load shedding adversely affects levels of poverty and inflation. It is also important to mention that most studies have concentrated more on impact on businesses.

5. Methodology

This study is a causal study deploying a mixed method approach for the gathering and analysis of data. A total of 50 formed the population for the study, representing the total number of SMEs within the industrial area which use electrical power as core resource for their businesses.

A self-administered questionnaire was used to collect primary data from 50 SMEs. Because the questionnaire was interviewer- administered, all 50 were retrieved signifying a success rate of 100%. SPSS (version 17) was used to analyze the data. Associations between the power outages and various profitability ratios were examined and a correlational analysis was used to analyze the data collected.

From the five selected homogeneous MSEs, the researcher critically selected 50 respondents who were the business owners as the sample size. The method used to determine the sample size was adopted because the selected businesses were from the non-formal sector and so was difficult to determine the actual population size.

Though the five selected homogeneous MSEs and the sample size may not be true representation of the population, they have been selected as prototype of MSEs in the industrial area to achieve objectives of the study.

This study adopted a survey research design, to have a comprehensive overview of the variables under examination. In this study, Small and Medium Enterprises Performance such as: damage to equipment and machinery, complaints from customers, growth, and profit margin and so on.

Primary source of data collection was used. Four (4) point Likert scales (ranging from 1: strongly disagreed, 2: disagreed, 3: agreed and 4: strongly agreed), were used to measure responses from respondent.

A total of 50 questionnaires were distributed. To measure validity of the study instrument, face and content validity methods was used; while test-retest method were used to ensure internal consistency (reliability).

6. Findings and Data Discussion

6.1 Introduction

In this paper, the researcher described the constraints and performance of SMIs in the background of erratic power supply and its effect on businesses. Further, quantified and explained how SMIs in the Ndola's industrial area's performance was related to some of their characteristics, as well as to some characteristics of the environment in which they were involved. The study was cross-sectional in its design. After a graphic analysis of the information obtained, the researcher proceeded with a quantitative analysis using SPSS to evaluate how SMIs' productivity was related to the erratic power supply in the country.

6.1 Characteristics of Enterprises

Table 4: Type Of Business the Firm is in

	Frequency		Percent (%)	
Extractive	4		8	
Processing	12		24	
Service Provsion	27		54	
Retailing	4		8	
Others	3		6	

Source: Primary Data

In Zambia, SMIs could be categorized into urban and rural enterprises. The former could be subdivided into "organized"

and "unorganized" enterprises. The organized ones mostly had paid employees with a registered office.

The study identified that the average number of businesses where respondents came from where barbering salons, hair salons, printing presses, retailing formed service providers represented 54%, grinding mills ,printing presses, restaurants, wood processes, carpentry works, agro processing, manufacturing, ,poultry and welding firms formed processing industry and represented 24% as shown in table 4.

As shown in the table 4, SMIs dealing with photocopying and printing, stationery, hair dressing and barbershop which is service providers had a high percentage of 54% with frequency of respondents at 27 and experienced declined productivity because they depended highly on power availability in order to be able to provide services to customers.

The respondents pointed out that without power they could not print or photocopy works, dress hairs, cut hair or process the grains.

From the Table 4 below, it could be seen that, out of a total of 50 respondents received, most of the SMI firms were dominated in wholesale and retail business sector, represented 4(8%) of the total responses. Whilst manufacturing, agro and timber processing sectors recorded 12(24%).

From the results in Table 6.1 a, it could be observed that the number of businesses surveyed were in operation. The result of the research revealed that the erratic power supply made significant impact on SMIs in various ways. These could clearly be seen from the analysis that showed that the country was losing its industrial base due to unavailability of electric power.

6.2 How Do You Evaluate the Demand of Power in Your Firm's Operations

Table 5: Firm's operation

	Frequency	Percent (%)
Very low	5	10
Low	6	12
'High	21	42
Very high	18	36

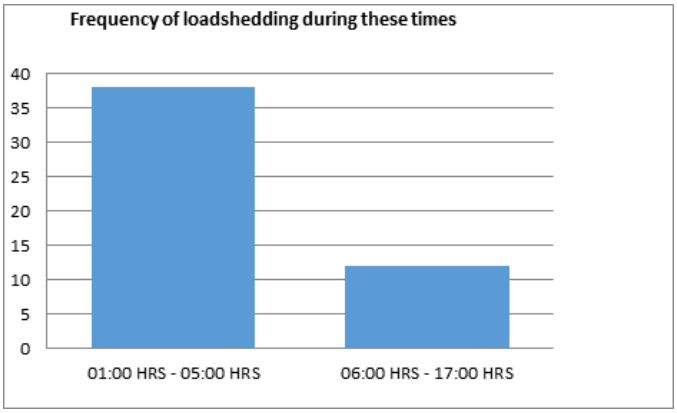
Source: Primary Data

Performance Global Entrepreneurship Monitor (2004) defined performance as the act of doing something successfully using knowledge as distinguished from merely possessing it. However, performance seemed to be operationalised and measured in different ways thus making cross-comparison difficult.

From the data analysis conducted it was evident that SMEs in Ndola's industrial area were suffering from the energy crisis that was going on. Due to the frequency of the load shedding exercise, enterprises that relied on electricity to operate were steadily becoming ineffective and inefficient in their operations.

This highly affected the operation of most SMIs in the areas that depended on power to run their production equipment or support service provision to customers such as barbershops, hair dressing, welding, grain milling, photocopying and printing, grocers and restaurants. Due to the absence of power, SMIs had low productivity and their productivity was declining depending on the nature of the business as shown in chart 5.

6.3 Frequency of Load Shedding



Source: Primary Data

Fig 1: Frequency of load shedding during these times

Based on the energy necessities of the businesses, the study investigated the frequency at which the power outages happen among enterprises. From questionnaires answered by enterprise owners, the load shedding occurred either daily or two or three times in a week. According to the enterprise owners sometimes they got the required amount of electricity for a day or two for their operations but not for a whole week(s).

Consequently, analysis of the data showed that even though some of the enterprises experienced daily load shedding, majority experienced it on weekly basis as depicted in figure 1. Particularly 38 respondents of the enterprises revealed that the load shedding occurred during off peak hours on a daily basis while 12 disclosed that load shedding occurred during peak hours.

According to Dr. Chiluba (2010), Small- and Medium-scale Enterprises (SMEs) were considered "the main drivers of every economy. However, it is also true that they are the most vulnerable of business entities and the recent power crisis in the country has impacted their businesses negatively. Welders,, hairdressers, small scale manufacturers and traders all depend on reliable supply of power to run their businesses profitably without which they will be out of business''.

6.4 Job Cuts in the Firm

Table 6: Rate of job losses in your business

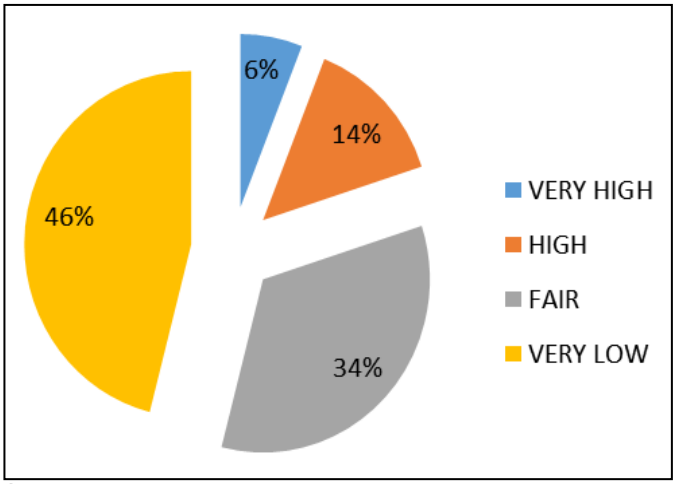
	Frequency	Percent
Very high	3	6
High	7	14
Fair	17	34
Very low	23	46

Source: Primary Data

It was generally recognized worldwide that Small to medium businesses were the engines of economic development and industrial growth, solving the twin problems of unemployment

and poverty. They were said to account for approximately 95 percent of all the companies in the world.

Small and Medium enterprises (SMEs) were mainly described as the engine of growth in most economies but also in most cases they were not given the due recognition and needed support. All the SMEs were described particularly with regard to the number of employees and the size of capital investment. In Zambia, there was no by and large accepted definition for SMEs.



***Source*:** Primary Data

Fig 2: Impact of load shedding on job losses

In Zambia, SMIs contributed immensely to the industrial output and export of goods and services. They play an important role as the engine of growth of our economy and these registering of businesses in Zambia with significant contribution to Gross National Product (GDP), accounting for huge general employment.

6.5 Extra Costs to Repairs of Machinery and Equipment Due To Stoppages

Table 7: Repairs to machinery

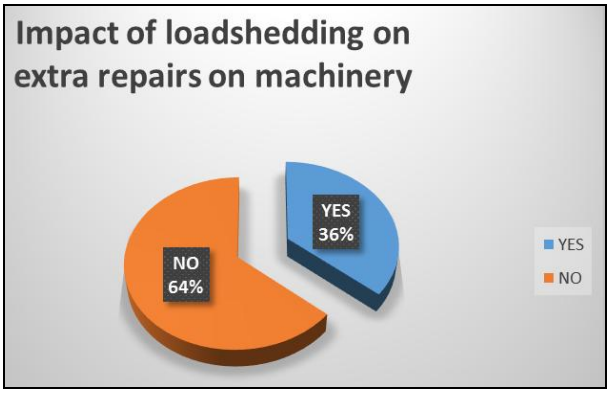
Response	Frequency	Percentage (%)
Yes	32	64
No	18	36

***Source*:** Primary Data

Table 7 shows a summary of the responses to the extra costs to repairs of machinery and equipment due to stoppages as a result of electricity load shedding. Table 7 is a summary of those whose agreed that there were damages or losses incurred by firms due to repairs to machinery and equipment.

(32)64% of the respondents agreed to that the damages and losses were incurred. There were damages such as loss of perishable food stuffs due refrigeration failure and compressors of refrigerators damaged. They went on to report of replacing at least two blown out incandescent lamps weekly.

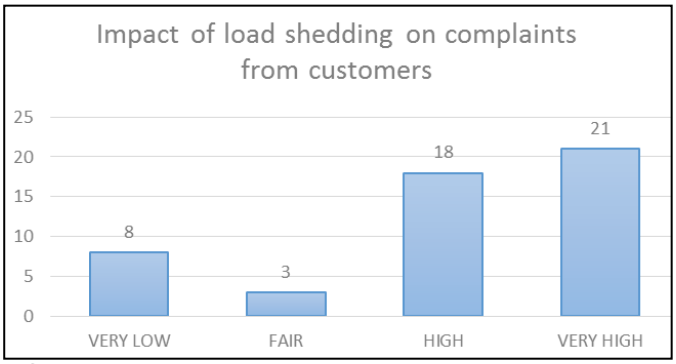
There could be many more losses which might not have been captured in this survey. All these losses had a financial bearing on the victims who might have had to incur extra costs in repairing the damaged gadgets or to replace it with a new one.



Source: Primary Data

Fig 3: Impact on extra repairs on machinery

6.6 Complaints from Customers



Source: Primary Data

Fig 4: Impact on complaints from customers

Most of the businesses lost some customers at the time of power rationing which implied that part of their business income was lost as customers were not served. Table 6.6a shows what the respondents evaluation of the frequency of complaints from customers.

Statistics as showed in chart 6.6a indicates that SMIs that lost income included food vending stalls, stationery, photocopying, printing, hair dressing, barber shops barbershops, grain milling and welding firms as a result of customer dissatisfaction and complaints.

Similarly it was observed that food vendors and grocers with income loss had a challenge of keeping products that needed warming, cooling or refrigeration to preserve the quality until served to customers. Due to lack of power, food vendors had to throw away some rotten vegetables and fruits as a result of not being able to store them properly and preserve its quality.

6.7 The Effect of Erratic Power Supply on Profitability

Table 8: Effect of load shedding on your company's profitability

	Frequency	Percent
Very High	20	40
High	17	34
Moderate	8	16
Low	5	10

Source: Primary Data

The poor quality of electricity supplies to businesses as a result of the energy crisis costs were losing millions of kwacha daily from their sales target due to the persistently erratic power situation and due to the electricity crisis.

On profitability, data in Table 6.7a below shows that majority of firms surveyed representing 40 percent had agreed strongly that the erratic power supply had decreased their profitability margin from 2013 to 2016 as compared to profit margin earned from stable power regime from 2009 to 2011.

From table 6.7a it could be observed that 20(40%) of the respondents were of the opinion that erratic power supply had led to the decrease in their profit margin. Whiles 17(34%) stated that there would have made more profit if they had regular and reliable power supply.

From the table above, it could also be observed that 8(16%) of the respondents agreed that their businesses would have produced and sold more products if they had regular and reliable power supply.

The times of frequent power cut some firms had devised coping strategies and proper management to overcome poor electricity supply to make profit. This coincided with the findings which indicated that the duration of power outage had a significant positive effect on firm's performance.

7. Conclusion

Based on the findings of this research, it could be concluded that the energy crisis was damaging the operations of SMEs in Ndola's industrial area. The load shedding exercise carried out to manage the deficit in supply caused by excess demand had led to disruptions in the operations of SMIs. The operational performance and efficiency of SMEs had dropped which had led to lower output.

In order to mitigate the adverse effects of the energy crisis, SMIs were forced to acquire and use alternative power sources such as diesel generators. These alternative power sources led to an increase in the operational cost of the enterprises. In addition to the increase in operations costs, the energy crisis had led to a decline in the income level of SMIs. This was because output of the enterprises depended on energy supply and as such the length of the load shedding experienced by the enterprises resulted in decline in output and income. Thus, it was established in the research that the longer the duration of load shedding the more income would decline.

Due to the decline in income, enterprise owners had devised means to reduce the effect of the load shedding on income. The measures to mitigate the decline in income level were identified as increase price, work overtime and combination of increasing price and working overtime. Thus, concerning the influence of the load shedding on output price, it was concluded that the influence was assorted among enterprises with and without alternative power such as generator.

The occurrence of power rationing had led to a decline in production in general as SMIs were not in a position to produce and the longer the duration of power rationing the higher the enterprises were losing productivity as they were in no position to run production equipment. Therefore, there was a significant relationship between power rationing occurrence and decline in productivity among SMEs. Also, it was determined that power rationing had an impact on the SMEs business incomes and profitability.

During the power absence, SMIs were not producing, customers went away while other SMEs incurred additional expenses to purchase power backup generators. All these reduced business incomes and increased expenditure which in return was reflected with declined business profits. Therefore, it was concluded that power rationing had an impact on the performance of SMEs as it affected SMIs productivity, sales volume, incomes and profits.

8. Recommendations

8.1 Short-Term Solutions to the Energy Crisis

ZESCO should strictly adhere to the load shedding pattern as it offers consumers the opportunity to plan activities and operations. This action would help to alleviate any costs or damages brought about by unexpected power cuts in the course of the load shedding exercise.

The price of fuel or diesel should be reduced drastically to enable micro and small scale enterprises that were constrained by the rising cost of fuel and its associated effect on cost of operations are able to own and use generators to supplement the short fall in energy requirements. This would help to reduce the high expenditure on using such alternative power source.

The government should buy power from neighboring countries such as Mozambique or South Africa to supplement the demand pressure on the national grid.

The country's dams that had developed mechanical problems causing them to be inefficient and operate under capacity should be given attention and repaired so that they could perform fully to capacity. (ZESCO, 2015) [14].

There was the need to intensify efforts to create awareness for energy conservation and efficiency. The problem of demand which had outstripped supply was the cause of the energy crisis and so there was the need to make every effort not to waste energy but rather use it productively.

Being efficient in the use of energy could help conserve energy and thereby reduce demand pressure on the national grid. Thus, stakeholder institutions should intensify efforts to educate the public on how to conserve energy and also use of energy efficient appliances.

8.2 Long-Term Solutions to the Energy Crisis

There was the need to tap into these energy resources and desist from depending solely on hydro power. Given the passage of the renewable energy bill in 2011 which provides for development, management and utilization of renewable energy resources for the generation of power and heat in an efficient and environmentally sustainable manner, the major effort required was to attract investments into the sub-sector, make flexible and expedite processes involved so potential investors were not discouraged. (SNDP, 2012)

The government as well as other Independent Power Producers (IPPs) like Lusemfya and Mulungushi Special Purpose Vehicle for Itezhi-Tezhi Power Company (ITPC), Maamba (Coal) 300 MW 2013, Kabompo (34 MW) Kabwelume + Kundabwika (210 combined MW) 2014, Lusemfya/Muchinga 120 MW 2016, EMCO (Coal) 300 MW 2016 and Luchinondo/Luchenene 70 MW 2017 should be accelerated as these development projects were already underway in the power sector.

Projects such as solar and wind energy and the mini hydro dams in the Central and Western provinces respectively among other projects that have been designed and earmarked for development to supplement power supply should be accelerated in order to permanently end the energy crisis. In other words, there is the need to increase government and private investment in the power sector of the country.

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