

**Gordon Institute  
of Business Science**  
University of Pretoria

**The economic impact of load shedding:  
The case of South African retailers**

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

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## Abstract

South Africa is currently experiencing an electricity crisis. A structural shortage of electricity supply remains one of the country's most critical challenges going forward as legacy infrastructure ages and needs to be replaced. In this context an understanding of the economic impact of load shedding is a critical consideration for all businesses in South Africa. This is particularly true for the retail sector as the impact of load shedding on consumers is dynamic and complex.

The current research examines the impact of unstable electricity supply on South African retailers. A mixed-methods approach has been employed across three studies. Study 1 consists of a qualitative view of the impact of load shedding through semi-structured interviews with financial and operational retail managers. Study 2 and 3 contribute toward quantifying the cost of load shedding on the retail sector by implementing the subjective evaluation and marginal cost of backup methodologies respectively.

The results of study 1 are captured in a model which highlights the major pain points experienced by the retail industry due to load shedding. The results of study 2 indicate that R13.72 billion rand was lost in revenue for the first six months of 2015. The results of study 3 indicate that a conservative estimate of R716 million has been invested by retailers in backup generation power during the same period.

The impact of load shedding has been significant and far reaching. It is hoped that these results will be of value for industry stakeholders in dealing with the crisis and will provide powerful motivation to ensure the correct measures are taken to keep lights on.

### **Keywords:**

Load shedding

Economic Impact

Retail

## Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Ariel Goldberg

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# 1 Introduction

South Africa is currently experiencing an electricity crisis. A structural shortage of electricity supply remains one of the country's most critical challenges. Frequent incidents of load shedding have had a significantly negative impact on the economy. Future load shedding remains a possibility as much of the nation's electricity generation infrastructure is approaching an age at which it will need to be replaced (Findt, Scott, & Lindfeld, 2014). Our track record of building new generation capacity since the crisis began in 2007 has not been good. South Africa's two most recent power stations, Medupi and Kusile, are both severely over budget and behind schedule. If this pattern continues the country's electricity reserve margin will remain under pressure.

In this context an understanding of the economic impact of load shedding is a critical consideration for all businesses in South Africa. This is particularly true for the retail sector as the impact of load shedding on consumers is dynamic and complex. The value generated by the retail sector is not a linear production system such as a factory in which a power outage leads to a predictable and measurable loss of productivity. For this reason, the impact of load shedding on the retail sector is not well understood, despite it being one of the most important components of the South African economy.

The retail sector is one of the largest industries in the South African economy accounting for 14.8% of GDP in 2014 (Statistics South Africa, 2015). It is an important driver of consumption and is characterised by high linkages and spill overs. The retail industry is a hyper-competitive product-market with razor-thin margins. It is fair to say that success in South Africa's retail industry depends on integrated supply chain and logistics systems that are underpinned by a common denominator: reliable electricity supply. It is equally fair to say that the sustainability of South African retailers—and their ability to provide products at affordable prices—is potentially placed at risk by the problems at Eskom.

The current research examines the impact of unstable electricity supply on South African retailers, which arises from the electricity crisis at Eskom and its negative impact on the economy. The crisis, which became publicly evident in 2007 due to a period of widespread load shedding, is characterised by a chronic shortage of supply and is largely attributable to “years of poor planning and under-investment — seen as a symptom of failed management at state-owned entities” (England, 2015, para. 9).

The failure to adequately cater for the growing demand in electricity was not entirely Eskom's fault. In 1998, a white paper by the Department of Minerals and Energy acknowledged that "Eskom's latest Integrated Electricity Plan forecasts ... that Eskom's present generation capacity surplus will be fully utilised by about 2007. Timely steps will have to be taken to ensure that demand does not exceed available supply capacity and that appropriate strategies, including those with long lead times, are implemented in time" (Department of Minerals and Energy, 1998, p. 53). Unfortunately, due to a host of reasons, government did not react decisively enough to Eskom's recommendations and the energy supply shortages occurred as predicted.

Although the worldwide financial crisis in 2008 reduced the growth in demand for electricity and enabled Eskom to reduce the incidence of load shedding for a period of time, efforts to resolve the underlying causes of the electricity crisis have suffered from the same poor execution and management. Towards the end of 2014 regular occurrences of load shedding began again as Eskom "has battled to keep its ageing, under-maintained infrastructure going. The utility has been putting off scheduled maintenance since South Africa hosted the 2010 football World Cup as its priority has been keeping the lights on" (England, 2015, para. 8). The load shedding is foreseen to continue well into 2016 (The Economist, 2015) as the building of two new coal fired power stations at Medupi and Kusile, designed to add 9,600MW to the grid, are three years overdue and billions of Rands over budget (England, 2015).

## 1.1 Research Objectives

The current research is intended to make an empirical contribution. To achieve this end, a mixed-methods approach will be employed across three studies.

1. **Study 1:** To assess the qualitative impacts of load shedding on the retail sector, the researcher will conduct semi-structured interviews with financial and operational retail managers.
2. **Study 2:** To contribute toward quantifying the cost of electricity supply instability to the South African retail sector, the researcher will collect primary data directly from retail outlets using a questionnaire administered online and in-store.
3. **Study 3:** To assist in making the estimates more rigorous, the researcher will collect secondary data from retailers in study 1. The secondary data will inform estimates of the marginal cost of backup electricity supply, which will be assumed to be a proxy for

the minimum economic impact of load shedding on the retail sector. Thus, estimates will be informed by the subjective evaluation method and the revealed preferences method, respectively.

Empirically, the three studies will make an important contribution by adding to the current understanding of the impacts of electricity supply instability on an industry that is among the highest contributors to GDP. It will expand our knowledge further in respect of the electricity crisis as an impediment to economic growth in the country. Practically, the results will help explain the qualitative impact of load shedding in this sector and provide policy-makers with the information necessary to make better informed decisions.

For much of the past three decades, South Africa has experienced an abundance of electricity supply at amongst the cheapest rates in the world (Deloitte, 2011). This was a huge source of competitive advantage for the South African economy and despite the recent setbacks in South Africa's electricity supply infrastructure, all the elements are still in place for the South African economy to benefit from a cheap and abundant supply of electricity going forward. The country has an abundance of coal reserves with experienced technical capacity for managing coal fired power stations. There are vast opportunities for the generation of electricity by means of renewable energy and with the "availability of natural gas in neighbouring countries, such as Mozambique and Namibia, and the discovery of offshore gas reserves the gas industry in South Africa is undergoing rapid expansion" (The South African Department of Energy, 2015, para. 2).

If the current crisis is effectively managed and the right measures are put in place South Africa's electricity supply could once again become a source of competitive advantage. The researcher believes that a critical component in motivating for the political will to make the hard choices that are required to deal with the current electricity crisis is an understanding of the cost the crisis is causing to the economy.

There are many opinions as to the economic cost of the electricity crisis. "Ratings agency, Standard & Poor's, says load shedding will cut around 0.3 percent from South Africa's economic growth this year" (Grootes, 2015, para. 2). In January the IMF revised their growth forecast for South Africa from 2.3% to 2.1%. "Nhlanhla Nene, the finance minister, highlighted energy supply as the government's critical challenge as he projected that growth for the year would be 2 per cent, down from the 2.5 per cent the Treasury forecast in October" (England, 2015, para. 2). The Governor of the South African Reserve Bank (SARB), Lesetja Kganyago, has warned that load shedding could limit the impact of current

lower interest rates as the SARB has revised its growth expectations for 2015 from 2.5% to 2.2% (SABC News, 2015). “Nersa deemed that these 23 days of load shedding had cost the SA economy R50 billion in 2008. This estimate was based on a figure of R75 per lost kWh (the so-called cost of “unserved energy”), which is stipulated in SA’s National Integrated Resource Plan. By extension, the 62 days of load shedding that Eskom fears are now on the cards [for 2015] could cost the economy over R134-billion, or 3% of nominal GDP” (Bisseker, 2015, para. 6). Chris Yelland, an energy expert, has projected the economic costs associated with Eskom’s various stages of load shedding for a cost of unserved energy of R100/kWh. “The cost to the economy during stage 1 load shedding – 10 hours of blackouts per day for 20 days a month – is R20 billion per month. Stage 2 load shedding, using the same time parameters, costs the economy R40 billion per month, while stage 3 is estimated to cost SA R80 billion per month” (MyBroadBand, 2015, para. 7).

All of the above estimates however are based on citations from the grey literature and do not constitute a peer reviewed academic study. The researchers do not publish their full methodology and sometimes they are based on a broad assumption such as the cost of unserved energy being R75 per kWh. The National Energy Regulator of South Africa (NERSA) published a consultation paper on the 25<sup>th</sup> of May as part of a process to establish an industry accepted method for estimating the Cost Of Unserved Energy (COUE). This is required by “Section 7.2.1(6) of the Distribution Network code and section 7.7(5) of the Transmission Network Code” (NERSA, 2015, p. 6) as COUE is an important parameter used in the planning of electrical power networks.

A review of the literature regarding the costs of power interruptions studies shows that the COUE varies depending on the country and the sector being studied as well as by the length of time of the interruption, the time of day, the season and methodology used to measure it.

The objectives of this research are to estimate the direct cost of power interruptions to the South African retail sector, using a rigorous method that is firmly grounded in accepted theory and methodologically sound. A search of the literature pertaining to consumer interruption cost studies does not yield any results for a study done in South Africa. This is noteworthy because the literature is silent on the impact of load shedding on the retail sector. Given the importance of the retail sector to South Africa’s gross domestic product, there is an urgent need to understand the direct costs of load shedding on the sector.

The costs of power interruptions can also be divided into the types of impacts resulting from the power interruption. The three broad categories found in the literature are the direct

economic cost, the indirect economic cost and the social cost. Although the indirect economic cost and social cost are important components when considering the impact of power interruptions, they do not lend themselves to reliable quantification. The only methodology found in the literature to consider the indirect cost and social cost of power interruptions was the case study; however, the results of a case study cannot be extrapolated to the broader economy. For this reason, the indirect cost and social cost of power interruptions on the South African retail sector are beyond the scope of the current research. The researcher is mindful of the fact that the full costs of power interruptions are greater than the direct cost measured here.

In order to effectively deal with a problem, an essential first step is to measure and understand its full implications. Policy issues pertaining to what needs to be done to resolve the current supply shortage or steps that can be taken to mitigate the negative impacts are beyond the scope of this research. The current research will contribute an independent and reliable estimate of the cost of power interruptions to the South African retail sector. This will be one source of knowledge upon which to ground further policy decisions and actions.

## **1.2 Research Problem Statement**

Reliable estimates of the direct costs of load shedding on the South African retail sector are not available for the retail industry, one of the most important drivers of South Africa's economy. Retailers, industry stakeholders, investors and policymakers need more rigorous estimates of the direct and indirect costs of load shedding on the retail sector—as well as a deeper understanding of how load shedding impacts the retail sector—for use in their decision making.

## 2 Literature Review

One of the most critical determining factors of South Africa's economic success over the next 5 years and beyond will be the management of the current electricity supply shortage. Having benefited from one of the cheapest and most abundant supplies of electricity in the world from the late 1980's through to 2007, the South African economy is now constrained by an electricity supply side shortage that could have severe implications for future economic growth.

### 2.1 South Africa's electricity crisis

The current electricity supply side constraint is a result of poor planning and flawed historical cost accounting policies on the part of Eskom and the South African government. Declining electricity tariffs (in real terms) lead to a situation in which Eskom was selling electricity at a price well below the true cost of generation and over many years this led to Eskom being unable to recover the full cost of capital it had invested in generating capacity.

Although still able to make a profit, the parastatal was unable to finance further capital investments required to meet demand. Appeals were made to government in the 1990's and early 2000's by Eskom management to finance additional generation capacity because strong growth in the economy and the resulting strong growth in electricity demand made it clear that the country would experience capacity problems with supply before 2010. The appeals were not answered quickly enough and in 2007/2008 the load shedding crisis brought the urgency of the problem into sharp focus and placed it very high on the political agenda. "Eskom resorted to national rotational 'load shedding' from late in 2007 to protect the power system from a total blackout, and a national emergency was declared on 25 January 2008. Load shedding continued until the end of March 2008, while Eskom initiated a recovery plan, with the support of government and business." (Joffe, 2012, p. 33)

One of South Africa's primary sources of competitive advantage, a cheap and abundant electricity supply, had become a limiting factor and potential downside risk to foreign direct investors. "Economic recession helped initially to provide the space for recovery, and Eskom [had] since 2008 made significant progress towards stabilising the power system" (Joffe, 2012, p. 33), but with supply margins remaining very constrained and significant delays in the construction of the Medupe and Kusile power plants eventually load shedding became a regular part of South African life again in November 2014.

In the six years since the initial spate of load shedding in 2008, “many stations were operated beyond their maintenance window to keep the lights on” (Van der Nest, 2015, para. 3). The results was consistent load shedding for the last two months of 2014 and the first seven months of 2015. Moving forward “Eskom’s power stations require an ever-increasing amount of routine maintenance, because most of them are in their mid-life, and because they have been run hard over the past few years to compensate for the shortage of capacity” (Joffe, 2012, p. 33).

The result is that South Africa will most likely experience an electricity supply side constraint for the foreseeable future. This will have an impact on the South African economy as an adequate and reliable supply of electricity are essential preconditions for economic growth. “The energy sector of the economy remains an integral part of infrastructural development which, in effect, will set the foundation for broad based sustainable long term economic growth and development” (Pan-African Research and Investment Services (Pty) Ltd, 2011, p. 2). The remainder of this literature review concerns how to measure the economic impact of power interruptions in order to quantify the effect that the recent series of load shedding has had on the retail sector.

## **2.2 Measuring the economic impact of power interruptions**

Electrical power is an essential input into all modern day economies. Mining operations require electricity to maintain conditions hospitable to human life underground. Manufacturing processes are dependent upon electrical machines to perform the precise and repetitive tasks that have increased the total factor productivity of present day industry. Electricity powers the traffic lights that moderate our traffic, it is the source of energy that lights the night and moderates the temperatures around us. It is the foundation of the digital economy and the primary source of energy upon which our lives are built. As a result of our dependence on electricity it has become a critical enabling resource without which we are severely hampered. But how do we measure and quantify this? How do we measure the value that is lost to a consumer or to society or to the broader economy during a power interruption?

This question has been considered in the literature under the concepts of energy security and the reliability of electricity supply. Energy security or “security of supply is an important goal of energy policy in many countries around the world. The three pillars of the European Union’s energy policy are efficiency, sustainability and security of energy supplies. Despite

the high importance of energy security in policy, several authors have pointed out that the term is not clearly defined.” (Winzer, 2012, p. 36). In the words of Loschel (2010, p. 1665) “the concept of ‘security of energy supply’, or in short form ‘energy security’, seems to be rather blurred.” This is echoed by others who claim that “there is no common interpretation” (Checchi, Behrens, & Egenhofer, 2009, p. 1). This is due to the fact that the term is used across many disciplines and in many different contexts.

For the purposes of this study, of particular interest is the technical aspects of electricity supply security that concern the design and maintenance of an electricity network to provide physical availability of electricity to consumers. “When analyzing interruption costs, the goal is to identify outage costs incurred by end-users of electricity within a wide range of industries for varying durations of time” (Balducci, Roop, Schienbein, Desteese, & Weimar, 2003, p. 111). In this context it is important to understand the costs associated with power interruptions in order to maximize the economic utility in the trade-off between increasing investment in a power supply system and the reliability of supply. “Information on consumer interruption costs (CIC) can be used to assess the economic efficiency of investments in power systems, to target investments to specific areas that receive the most benefit from system improvements, and to quantify the risk associated with different operating and planning strategies” (Cheng & Venkatesh, 2014, p. 1). Information on the costs of interruptions can be a “key input in planning power system reliability using an economic cost-benefit approach” (Sanghvi, 1982, p. 1) and can be used to “help assess the potential benefits of investments in improving the reliability of the grid” (LaCommare & Eto, 2006, p. 1).

There are two important distinctions identified in the literature regarding the cost of power interruptions. The first distinction concerns the types of impacts resulting from power interruptions and the second distinction concerns the types of power interruptions that are studied.

### **2.2.1 Types of Impacts Resulting from Power Interruptions**

The consequences of power interruptions are shown in **Error! Reference source not found.** The costs of a power interruption are divided according to the types of impacts resulting from the power interruption. A cost can be seen as any loss in utility that has resulted due to the power interruption. Due to the pervasive nature of electricity in our lives today there are many impacts that can be identified as resulting in an economic cost to society and its members. The nature of these costs will also “depend critically upon a host

of factors such as the severity of the outage as defined by its time and duration of occurrence, magnitude, and extent of advance notification” (Sanghvi, 1991, p. 426). The ability of the affected party to mitigate the impact of the power interruption will also be an important consideration in measuring the true cost.

*Table 1: The consequences of power interruptions (Linares & Rey, 2013)*

<b>Direct economic impacts</b>	<b>Indirect economic impacts</b>	<b>Social impacts</b>
<b>Loss of production</b>	The cost of income being postponed	Uncomfortable temperature
<b>Restart costs</b>	The financial cost of loss of market share	Loss of leisure time
<b>Equipment damage</b>		Risk to health and safety
<b>Raw material spoilage</b>		

The indirect effects of power interruptions can carry significant economic costs which can be very challenging to measure. In a case study designed to measure the economic costs of the 1977 New York City blackout it was found that “looting and arson (defined as an indirect impact) accounted for almost one-half of the total economic costs associated with the blackout” (Assistant Secretary for Energy Technology, 1978, p. 2).

In the context of the South African economy one of the largest economic impacts of the present power supply shortages is the change in investor confidence that it has resulted in. Electricity supply is a critical factor in the profitability of an industrial investment. The price and the reliability of electricity supply can influence whether a multibillion dollar industrial plant is profitable or not. The lack of certainty around South Africa’s current electricity supply and the seeming inability of stakeholders to resolve the problem add significant risk to any investment made in the South African economy. The electricity crisis is not a once-off event but rather an unfolding story that will dynamically affect market sentiment and investor confidence in the South African economy. At the time of the present research the crisis seems to be deepening .Although electricity supply is not the only factor that investors will consider in choosing where to put their capital, in the South African context it is probably the most influential at the present time and it would not be unreasonable to suspect that it has resulted in large losses to both local and foreign direct capital investments. Even if investors choose to base their projects within South Africa, the higher risk associated with the investment makes it more expensive.

To measure all the costs of a power interruption would be impractical. There are some impacts such as the decline in investor confidence that do not lend themselves to quantification. The scope of the current research is limited to measuring the direct economic costs of power interruptions in the South African retail sector. A review of methodologies found in the literature to measure the cost of power interruptions will follow in Section 2.2.3.

## **2.2.2 Types of Power Interruptions**

The second point of distinction in the literature regarding the cost of power interruptions can be made regarding the nature of the power interruptions being investigated. The types of power interruptions were classified into two types of studies. The first type of studies were conducted in high-income countries in which the reliability of supply is of the order 99.98% (Sanghvi, 1991) and seek to understand the impact of isolated and rare fault occurrences in their electrical networks. Some of these studies were sponsored by electric utilities in order to refine the reliability and cost of supply they provide to their customers (Cheng & Venkatesh, 2014) (Woo, et al., 2014) (LaCommare & Eto, 2006) whereas other studies are conducted to understand the policy implications that cost interruptions have on managing energy policy (Leahy & Tol, 2011) (Linares & Rey, 2013) (De Nooij, Koopmans, & Bijvoet, 2007).

In Germany, a country that has one of Europe's most reliable supplies of electricity, there is a specific reason why the cost of power interruptions has recently become an active area of interest. In light of the "Energiewende" (translated as Energy Transition) the German government has planned to decommission all nuclear power by 2022 and set a target of generating 35% of the country's electricity requirements from renewable sources by 2020 (Growitsch, Malischek, Nick, & Wetzel, 2014). "One of the greatest challenges of the German energy transition for the electricity supply lies in growing temporal discrepancies between electricity consumption and generation" (Praktiknjo, 2014, p. 82). As renewable sources of energy supply a greater percentage of the country's energy demands, new challenges arising due to the uncontrollable nature of meteorological conditions which determine the amount of electricity supply at a given time. Because it is not possible to control the supply of electricity by burning more coal for example, this will lead to circumstances in which the demand cannot be met. It is foreseen that as Germany progresses along the renewable energy path there will be times at which there will be insufficient supply and load shedding will be required to reduce demand.

The second type of study concerns power interruptions in medium- and low-income countries. Although technical faults also occur in the power systems of low-income countries, they are not responsible for the bulk of power interruptions. In low-income countries there is a structural electricity deficit which results in a chronic shortage of supply. The economic impact of these types of power interruptions are fundamentally different from the types of power interruptions discussed previously. In Cameroon “the electricity supply to industries is frequently disrupted by power outages whose total duration is, on average, 35 h/week” (Diboma & Tamo Tatietsse, 2013, p. 582). “Electricity provision in Africa has been marred by low generation, poor supply and frequent power outages” (Oseni, 2012, p. 1). In a paper focusing on the costs of power interruptions in low-income countries, particularly India and Pakistan, Sanghvi states that “the objective of this paper is to draw attention to the short and long run economic impacts of power supply inadequacy in developing countries and to discuss some policy implications related to this problem” (Sanghvi, 1991, p. 425).

The nature of power interruptions in many low-income countries is such that they are a regular occurrence and a part of the environmental conditions of doing business in those economies. The impacts of these power interruptions are more than the short run loss of production or inconvenience caused to households. They have a long run impact on the business confidence within an economy and may significantly influence investment decisions. If power interruptions become a regular occurrence, then it cannot be absorbed as a once off anomaly within the normal operations of a business. Regular power interruptions fundamentally change the profitability of industries and negatively impact on the economic growth of a country. With electricity supply being a critical underlying infrastructure for modern economies, there are large secondary effects of power interruptions that ripple through an economy. This implies that the “socio-economic cost of power outages can be considerably larger when the cascading effects and interdependencies among infrastructures are taken into account” (Jamasp & Poudineh, 2015, p. 5).

Due to the differences in the types of power interruptions and the differences in the impacts resulting from the power interruptions studied in high-income and low-income countries, it is important to ensure that the methodology applied is relevant to the type of economy that is being studied. A review of the methodologies used within various countries and their applicability within the South African context will follow in Section.

### **2.2.3 Methodologies to Measure the Costs of Power Interruptions**

A minute of unsupplied power is not a tradable item but it is recognized to be of significant value to society. “Although almost everyone considers the security of power supply to be very important, it is not known what value society places on it. Because there is no market where electricity interruptions are traded, there is no market price that shows the marginal cost per minute of supply interruption” (De Nooij, Koopmans, & Bijvoet, 2007, p. 279).

There is a broad body of research that has been developed to answer the question of how much a power interruption is worth yet “there is no widely accepted methodology to come up with a credible and acknowledged solution to estimate the worth of electric power reliability” (Kufeoglu & Lehtonen, 2015, p. 588). The first mention in the academic literature found for this research is a study by Lolander in 1948 entitled “Memorandum Concerning Estimation of the Costs of the National Economy in the Event of a Loss of Supply”. Since that study, academics have developed a number of methodologies for evaluating the cost of a power interruption. These methodologies can be grouped into three categories, each of which is discussed below.

#### ***2.2.3.1 Analytical methods using secondary data***

Analytical methods use existing data concerning the economic utility and the amount of electrical energy consumed by activities. “The objective is to find the value of one unit of electricity, also known as the value of lost load (VoLL)” (Linares & Rey, 2013, p. 753). The VoLL will differ by economic sector, company size, geographic location, time of year, time of the day, duration of the power interruption and whether or not the power interruption was expected. By seeking out proxy measures to give an idea of the economic value added using electrical power we are able to estimate the economic value that is lost if that electrical power is not available.

The advantages of this method are that it requires less effort and cost to implement if the data is available. “This method uses readily available economic data to perform a straightforward analysis for any industry for which electricity consumption data exist” (Cheng & Venkatesh, 2014, p. 1).

“The disadvantages of this approach are that it is based on severely simplistic assumptions that are often invalid in reality, it does not capture many direct costs, and it ignores virtually all indirect costs” (Balducci, Roop, Schienbein, Desteese, & Weimar, 2003, p. 111). Often the data required is not available or is aggregated at a level that makes it unreasonable to

apply at an industry level. The VoLL will differ based on various criteria mentioned above, but if economic and electrical consumption data do not exist for each of the types of industry or company size etc. then the overall measure will be an aggregate which is unlikely to be accurate.

### **2.2.3.1.1 Production Function**

The first methodology based on secondary data is called the production function approach. It provides an aggregated estimate of the VoLL. “This method uses the ratio of an economic measure (e.g., gross domestic product, gross value added) and a measure of electricity consumption (e.g., kWh) to estimate interruption costs” (Linares & Rey, 2013, p. 753). Theoretically the (VoLL) is equivalent to “the average willingness of electricity consumers to pay to avoid an additional period without power” (Leahy & Tol, 2011, p. 1514).

The production function approach measures the value added for firms as the output due to production processes and the value added for households as the value of lost leisure time.

There are a number of assumptions underlying the production function approach. Firstly, it only measures a firm’s loss of production and does not take into account damage to equipment or goods or other indirect effects of power interruptions. “The production function approach only considers production losses; other impacts such as equipment damage or raw material spoilage are not quantified” (Linares & Rey, 2013, p. 754). It also does not take into account the effects of startup times and fringe effects. “We are unable to account for restart time in businesses after an outage or annoyance in households caused by a supply interruption” (Leahy & Tol, 2011, p. 1515). This would generally lead to an underestimation of the cost of power outages.

The second assumption is that the costs of power interruptions are a constant value irrespective of time of day or outage time. “Typically, production functions are estimated for a year as a whole, and may not be appropriate for an assessment of the impact of an event such as electricity interruptions for a few hours” (Leahy & Tol, 2011, p. 1515). The VoLL will change according to the time of day and season of the year. If the data used to calculate the production function is not granular enough to reflect these subtleties, it is unlikely that the aggregated value of the production function will be accurate.

The third assumption underlying production functions is that power interruptions cannot be mitigated. In many circumstances it is possible to shift production schedules to accommodate power interruptions or to invest in self-generating capacity to reduce the

impacts. This assumption would generally lead to an overestimation of the cost of power outages.

The fourth assumption underlying production functions is the measure of value added for homes. De Nooij et al. (2007) describe the following logic that is used to ascribe a value to the time that is lost by residential users of electricity during a power outage:

“Lost leisure time is monetized by using the model developed by Becker (Becker, 1965). The core of Becker's model is that people do not get utility (welfare) from money or goods alone, but from the combination of goods (bought with money) and time. Households produce welfare (utility), using time and money as inputs. The marginal utility of money decreases with the increasing amount of money one has, while the utility of free time increases with the number of hours worked. As a consequence, there is an optimal amount of time for a person to work. In this optimum, the income generated with 1 h of work equals the value of an additional hour of leisure time. Put differently, the value of a marginal hour of leisure time equals the income per hour” (p. 282).

This theory does not apply to the South African context as the majority of people do not have the luxury of balancing free and working time to maximize their utility. In an economy with such a high unemployment rate and widespread levels of poverty this theory has no grounding. De Nooij et al. acknowledge the shortcomings of Becker's theory when they say “this method assumes a well-functioning labour market, in which individuals are more or less free to choose the number of hours they work” (De Nooij, Koopmans, & Bijvoet, 2007, p. 282).

The model developed by Becker also assumes that members of households cannot mitigate the impact of power interruptions by finding something else to do with their time. This could be more relevant in an economy where the majority of power interruptions are due to isolated fault incidents, but again in the context of South Africa and the electricity supply shortage power interruptions have become a regular occurrence and households will develop a pattern of activities when there is not power available. The economic cost of power interruptions become greatly diminished from a household perspective as people adjust their lives to the conditions. The leisure time of a household is not a tangible contributor to the GDP of a nation and under supply shortage conditions, the majority of the economic cost of power interruptions lies in their disruption to industrial and commercial activities.

The production function approach is also referred to as Ratio of Gross Economic Output to Energy Consumption (EO/C) in some studies (Cheng & Venkatesh, 2014).

#### **2.2.3.1.2 Revealed Preferences Method**

The revealed preference method uses proxy data in which “the costs of outage are inferred from the actions taken (e.g. captive power generation) by firms to reduce the economic costs of power interruptions” (Oseni, 2012). A study by Bental and Ravid (1982) was the first to point out that the costs of power outages to a firm can be estimated using data on backup generators.

“This model is premised on the assumption that firms operate essentially to maximise their profits. Hence, a firm faced with frequent power outages will act to ensure itself against (all or some of) the damage caused by power outages by acquiring back-up generating power. However, since acquiring a generating plant is not costless, the firm will choose the optimal amount of back-up power by equating at the margin, the expected cost of generating a kWh of its own, to the expected gain due to that kWh” (Adenikinju, 2003, p. 1526). Firms are managed by rational managers seeking to maximise profits and when confronted with power interruptions, managers will choose to invest the optimal amount of money into generating capacity which will minimise the economic cost of the power interruptions.

“Investing in backup generation is expensive and may not be economically viable if it is not well planned. Firms have to choose the optimal amount of backup power by considering its energy load and the damage the remaining unserved energy would cause” (Oseni, 2012, p. 18).

The revealed preferences method has two possible implementations. The marginal cost method proposed by Bental and Ravid (1982) and implemented by (Adenikinju, 2003) and Steinbuks and Foster (2010) seeks to calculate “the marginal cost of own-generation [which] serves as an estimate for marginal outage cost because the expected marginal gain from auto-generation equals the expected loss from the kWh not supplied by the utility provider” (Oseni, 2012, p. 18). “The cost to the firm of generating its own power consists of two elements. First, the yearly capacity cost of the generator per kWh. Second, the variable cost-per kWh. This is mainly fuel cost, and is practically constant” (Bental & Ravid, 1982, p. 250). This method is based on the assumption of a perfectly competitive market for generators, the ability to incrementally increase generating capacity, and the ability of generating capacity to effectively replace the usual source of electricity.

The second implementation of the revealed preferences method was developed by Beenstock (1997) and is known as the incomplete backup method. Oseni (2012) considers this methodology to be superior to the marginal cost method as it makes it possible to “account for the possible losses that a firm may incur due to incomplete backup in the event of power interruption. Thus, the method allows for separate estimation of the total and unmitigated outage costs” (Oseni, 2012, p. 18). The method is more mathematically complex than that of Bental and Ravid’s (1982) and requires the estimation of a vulnerability curve for the operation and mathematical modelling of the trade-off between mitigated and un-mitigated losses (which are beyond the scope of this literature review).

The advantages of the revealed preferences methodology is “that the data on back-up generators are reliable and easy to collect so that the cost of data collection tends to be relatively cheap when compared with the cost of surveys required for subjective and contingent evaluation” (Beenstock, Goldin, & Haitovsky, 1997, p. 43). The results of a revealed preference methodology are also far more likely to be accurate as they are based on the actual behaviour of consumers of power and are less prone to biases associated with the survey methodologies. “Self-assessments obtained from business surveys have strong incentives for strategic misrepresentation. For example, reported outage costs may be exaggerated to impress upon the power company the need for more reliable electricity. Or they may be often have strong incentives for strategic misrepresentation. Or they may be unreliable: interviewees may simply be unaware of the costs or unable to devote the necessary time to complete the questionnaire, which is often complex and long, with sufficient care. These problems do not exist, or are less pronounced, with revealed preference” (Beenstock, Goldin, & Haitovsky, 1997, p. 41).

### **2.2.3.2 Customer surveys**

“The most extensively applied procedure for estimating industrial sector outage costs is the survey method” (Sanghvi, 1982, p. 186). This methodology relies on the end-user of the electricity, referred to in the literature as the customer or the consumer, stating how much the lost power was worth and as such is also known as the stated preferences method. Note the term consumer in this context refers to the end-user of the electricity and is not to be confused with the concept of a consumer from the business literature. “Surveys of industrial, commercial and residential sector customers [are used] to determine the cost of an interruption from the perspective of the individual customer” (Balducci, Roop, Schienbein, Desteese, & Weimar, 2003, p. 111). “The customer is in the best position to assess the

effects of interruption and therefore best able to determine the associated costs” (Tollefson, Billinton, Wacker, Chan, & Aweya, 1994, p. 444).

By measuring the economic impacts of power interruptions at a micro economic level it is possible to infer the overall impact for the macro economy. “Customer surveys are designed to obtain a statistically significant sample from several different consumer or industry sectors. When properly designed and executed, this approach can generate reliable cost estimates based on data provided directly by end-users” (Cheng & Venkatesh, 2014, p. 1). If the surveys are methodologically sound and the sample is representative, the results can be used to extrapolate the cost for the wider industry and economy. “When properly designed and executed, this approach can generate reliable cost estimates based on data provided directly by end-users” (Balducci, Roop, Schienbein, Desteese, & Weimar, 2003, p. 111).

The majority of customer survey studies use one of three techniques for extracting the customer’s perceived cost of power interruptions. These are: contingent valuation method (CVM); conjoint analysis; and the direct worth or subjective evaluation method. Each of these is described below.

#### ***2.2.3.2.1 Contingent Valuation Method***

Contingent valuation is an economic technique for establishing a value for which no marketplace exists. In the context of establishing the costs of power interruptions “consumers are asked how much they would be willing to pay (WTP) to avoid an interruption or how much they would be willing to accept (WTA) in compensation for having one” (Diboma & Tamo Tatietse, 2013, p. 584).

The impact of power interruptions will vary depending on several factors such as the duration of the power interruption, the time of day, season of the year etc. ‘There are several components of a power outage that may affect the valuation, where both the timing of the outage as well as the duration are likely to be important’ (Carlsson & Martinsson, 2008, p. 1233). CVM requires the respondent to assess the cost implications of several scenarios and “the interruption cost incurred by a consumer of electricity is presented as a function of the various input factors. The interruption cost estimate represented as a function of outage duration is a customer damage function (CDF)” (Balducci, Roop, Schienbein, Desteese, & Weimar, 2003, p. 113). “The respondent is presented with a hypothetical or experienced scenario of an electricity interruption or voltage disturbance, and asked for the willingness

to pay to avoid it or willingness to accept compensation when it occurs. The scenarios must be understandable, realistic and accepted by the respondent” (Council of European Energy Regulators (CEER), 2010, p. 19). CVM allows “for a simultaneous valuation of several possible characteristics of an outage: the duration of the outage (4, 8 and 24 h), time of the week (working day and weekend) and the time of the year (winter months and the rest of the year)” (Carlsson & Martinsson, 2008, p. 1233).

“Contingent valuation questions establish a monetary value of reliability worth for incremental changes in levels of service. This is quantified either through the consumer's willingness to pay (WTP) to avoid having an interruption, or the willingness to accept (WTA) compensation for having had one” (Tollefson, Billinton, Wacker, Chan, & Aweya, 1994, p. 444). “The first approach is the analysis of the maximum amount of money an individual would be willing to pay (WTP) to avoid the reductions. The second one is to figure out the minimum amount of money an individual would be willing to accept (WTA) as a compensation for the unavailability of the good” (Praktiknjo, 2014, p. 83).

“Several types of questions can be used to elicit the respondents' WTP by applying CVM, such as open-ended questions, a bidding game, a payment card, a dichotomous choice, and others. The dichotomous choice type is commonly used in CVM surveys because this avoids biases, and also gives more reliable results” (Kim, Nam, & Cho, 2015, p. 80). A dichotomous choice method presents the respondent with a ‘yes’ or ‘no’ question as to whether they would be willing to pay the proposed amount to avoid the power interruption. An open ended question asks the respondent how much they would be willing to pay and contains more information than the dichotomous choice question.

In order to design an effective CVM survey, the researcher must be familiar with the types of costs that would be associated with a power interruption for the consumer and be able to develop relevant scenarios that would be experienced by the consumers.

#### **2.2.3.2.2 Conjoint Analysis**

Conjoint analysis is a methodology for measuring the relative values of attributes. In the context of measuring the cost of power interruptions, this method would be applied to measure the value that a consumer places on the reliability of power supply. Conjoint analysis “is based on customers expressing their preferences for different hypothetical scenarios. Instead of asking directly for the costs, willingness to pay to avoid or willingness to accept certain interruptions or voltage disturbances, customers are asked to select the

preferred option between pairs of hypothetical scenarios, or they may be asked to rank or rate a list of different hypothetical scenarios. Based on the choices, the costs are estimated indirectly through econometric models” (Council of European Energy Regulators (CEER), 2010, p. 20). “Conjoint analysis does not directly ask for willingness to pay, but requires that respondents rank possible outcomes from most preferred to least preferred, while several attributes of the good are varied. This results in a relative value, in the sense that the expressed value depends upon the other alternatives that have to be ranked. The inclusion of a price, as one of the attributes, enables the derivation of implicit prices for each of the other attributes” (Baarsma & Hop, 2009, p. 1380).

The researcher will need to understand the potential implications of a power interruption for the consumer and design a questionnaire by creating various hypothetical situations or conditions that the consumer would need to rank or rate. “The typical question presents each respondent with a number of commodity descriptions or situations (vignettes: cards describing fictitious but not unrealistic situations) that differ according to the attributes described. Survey respondents are then asked to rank and/or rate the desirability of each vignette” (Baarsma & Hop, 2009, p. 1380).

#### **2.2.3.2.3 Subjective Evaluation Method**

The subjective evaluation method relies upon the experience and knowledge of consumers of electricity to evaluate the cost of power interruptions to their business. Also known as the direct worth approach, “the customer is directly asked to provide answers for the economic value of distinct outage scenarios” (Kufeoglu & Lehtonen, 2015, p. 589). “Firms are asked to report the values of the losses they suffer due to power outages” (Oseni, 2012, p. 21).

Direct costing questions are the most obvious type of questions for determining the customer’s interruption costs for given outage conditions. The respondent is given a 'worksheet' and asked to identify the effects of the interruption” (Tollefson, Billinton, Wacker, Chan, & Aweya, 1994, p. 444).

“When costs resulting from interruption are tangible and quantifiable, the direct method is often used. Power interruptions disrupt the production of goods and services with disastrous economic and financial consequences for the countries concerned” (Diboma & Tamo Tatietsse, 2013, p. 584). This method can be particularly useful in measuring the cost of power interruptions in industrial operations in which the “impacts of an outage are more directly measurable in terms of the dollar losses associated with the cost of idle resources,

equipment damage, material losses, process re-start costs, and human health and safety effects” (Sanghvi, 1982, p. 185). This is also applicable to the commercial sector in which operations such as retail are often halted and unrecoverable at a later stage.

Self-assessments are prone to biases on the part of respondents who may provide exaggerated responses in order to send a particular message to the electrical utilities or who may not be aware of the true cost implications of power interruptions for their businesses. In the context of the South African electricity crisis there is a lot of ill will towards Eskom and a study seeking to measure the cost of these power interruptions would need to be cognizant of the potential for bias amongst respondents.

### **2.2.3.3 Case studies**

The last methodology for measuring the cost of power interruptions is that of a case study. In this method a particular power interruption event is studied in detail to gain a better understanding of the economic consequences of a loss of electricity.

Examples include the impact assessment of the 1977 New York City blackout in which “the approach taken in this study has been to collect data on a wide variety of impacts related to the power failure in a number of different sectors of society, e.g., business, government, health, transportation and the utility. Both economic and social costs are considered although no attempt is made to place an economic value on levels of inconvenience or disruptions of societal activities” (Corwin & Miles, 1978, p. 36).

“The basis of this method is an after-the-fact analysis of specific interruptions. The blackout case study method provides more detailed and direct cost estimates that include indirect costs not adequately captured in other forms of analysis however, the study findings are limited due to geographic constraints and the characteristics and duration of the specific outage being studied.” (Bliem, 2009, p. 5). “According to Chowdhury, this method is questionable because case studies are useful in demonstrating the importance of a reliable electricity supply but do not provide results from which general cost estimations can be made” (Chowdhury & Koval, 1999).

### **2.2.4 A Review of Cost Interruption Studies**

The field of consumer interruption costs has been an active area of research since the 1980's. “Various studies on estimating the economic loss caused by power outages have been conducted up to the present. The most commonly used approach is the value of lost load (VoLL), which is the annual value of the GDP divided by the total energy consumption

and survey-based method” (Kim, Nam, & Cho, 2015, p. 79). A summary of consumer interruption studies performed in the last 15 years are shown in

Table 2.

The majority of CIC studies to date have intended to measure the cost of isolated electrical network faults with the aim of determining the amount of investment required to achieve the economically optimal level of electricity security (Beenstock, 1991) (De Nooij, Koopmans, & Bijvoet, 2007) (LaCommare & Eto, 2006) (Linares & Rey, 2013) (Woo, et al., 2014). These studies have tended to take place in developed countries in which the electricity supply is very reliable and consumers experience less than 1 hour of power outage per year (Woo, et al., 2014).

The production function approach is based on secondary data and seeks to estimate the VoLL by dividing a measure of economic value added by the amount of electricity consumed. This method was used to study the cost of power interruptions to households in Holland by De Nooij et al. (2007), in Ireland by Leahy and Tol (2011), in Spain by Linares and Rey (2013), in Korea by Choi et al. (2002) and in Germany by Wolf and Wenzel (2014), Praktijnjo et al. (2011) and Growitsch et al. (2014). Zachariadis and Poullikkas (2012) employ a production function approach to measure the economic losses due to power shortages in Cyprus in 2011 after an explosion destroyed 60% of the country’s generating capacity. In the majority of the studies mentioned, the economic loss in the residential sector is very significant. The basis for economic value added in households is Becker’s theory on the allocation of time (1965) which states that the marginal hour of leisure time equals the income per hour. This theory is not applicable in a developing economy such as South Africa and in a society in which it is expected that people will take measures to mitigate the economic costs of frequent power outages in their everyday lives. Whether it be through finding other activities to do during power interruptions or through self-generating capacity in residences. For this reason, the researcher does not believe that the production function approach to measuring the economic costs in the residential sector is appropriate. The production function approach is also used to measure the VoLL in the industrial and commercial sectors and this will be appropriate in the South African context.

The use of surveys is another frequently used methodology for measuring the cost of power interruptions. Surveying studies can be distinguished by the methodology used to elicit the value of lost load. The contingent valuation methodology was used to measure consumer’s willing to pay by Reichl et al. (2013) and Praktijnjo (2014) in Germany, by Hensher et al.

(2014) in Australia and Carlsson (2015) in Sweden. All of these studies were performed in economies that did not suffer from supply shortages. The CVM methodology was used in studies in which there was a shortage of supply. Abdullah and Mariel (2010) applied the CVM methodology to measure the WTP of Kenyan households to avoid blackouts. “In recent years, the rapid increase in electricity consumption has been a critical issue in South Korea” (Kim, Nam, & Cho, 2015) leading to a supply shortage. In this context Kim et al. (2015) use CVM to measure the cost of power interruptions to the residential sector in their country. Conjoint analysis is used by Woo et al. (2014) to assess whether consumers in Hong Kong would pay more for a more reliable supply of electricity and by Baarsma and Hop (2009) in Netherlands to determine the cost of power outages to the Dutch economy. The researcher could not find an example of conjoint analysis to measure the economic impact of power outages in an economy suffering from a supply shortage.

LaCommare and Eto (2006), Tollefson et al. (1994) and Lawton et al. (2003) base their studies on the economic cost of power outages to the US and Canadian economies on direct worth customer surveys conducted by electrical utilities. The customer survey data they use was commissioned by electricity utilities to understand the amount of investment required to meet customer’s electrical security requirements, but there are examples of direct worth studies conducted in economies that have a shortage of supply. Nam et al. (2006) use the direct worth method to measure the cost of power interruptions to industrial electricity consumers in South Korea and Diboma and Tamo Tatietsse (2013) apply the direct worth method to measure the economic cost of power interruptions to industrial users of electricity in Cameroon.

Oseni (2012) used data for 12 African countries from a World Bank Enterprise survey in 2007 to investigate “the extent to which firms’ characteristics might create incentives for auto-generation and whether these incentives lead to lesser unmitigated outage costs.” A part of the methodology of the study was to measure the cost of power interruptions to firms by means of the revealed preference methodology and the subjective evaluation method (direct method). Adenikinju (2003) uses the marginal cost of backup methodology and the direct worth survey method to estimate the economic costs of power interruptions to Nigerian consumers.

Table 2. A summary of some consumer interruption cost studies performed in the last 15 years.

Study (Year)	Country	Sector	Method	Results
Praktijnjo et al. (2011)	Germany	Residential Industrial Commercial	Production Function	Residential: 15,70 €/kWh Commercial: 16,35 €/kWh Industrial: 2,49 €/kWh
Wolf and Wenzel (2014)	Germany	Residential Manufacturing	Production Function	Results reported at county level Residential: 6.56 €/kWh to 15.11 €/kWh Manufacturing: 0.42 €/kWh to 12.49 €/kWh
De Nooij et al. (2007)	Netherlands	Residential Industrial Commercial	Production Function	Residential: 16.38 €/kWh Industrial: 3.90 €/kWh Commercial: 7.94 €/kWh
Leahy and Tol (2011)	Ireland	Residential Industrial Commercial	Production Function	Residential: 24.60 €/kWh Industrial: 4.00 €/kWh Commercial: 14.00 €/kWh
Balducci et al. (2002)	US	Residential Industrial Commercial	Surveys	Residential: 0.15 \$/kWh (1h) Industrial: 13.93 \$/kWh (1h) Commercial: 12.87 \$/kWh (1h)
Billinton (2001)	Canada	Residential Industrial Commercial	Surveys	Residential: 0.31 \$/kWh (1h) Industrial: 5.19 \$/kWh (1h) Commercial: 5.88 \$/kWh (1h)
Linares and Rey (2014)	Spain	Residential Industrial Commercial	Production Function	Residential: 5.67 €/kWh Industrial: 1.24 €/kWh Commercial: 6.77 €/kWh
Growitsch et al. (2014)	Germany	Residential Industrial Commercial	Production Function	Residential: 11.92 €/kWh Industrial: 2.19 €/kWh Commercial: 11.04 €/kWh

Study (Year)	Country	Sector	Method	Results
Choi et al. (2002)	Korea	Residential Industrial Commercial	Production Function	Residential: 18.4 won/kWh Industrial: 20.7 won/kWh Commercial: 61.8 kWh
Reichl et al. (2013)	Germany	Residential Non-residential	Suveys (CVM)	Residential: 1.2 €/kWh Non-residential 5.7 €/kWh
Baarsma and Hop (2009)	Netherlands	Residential Firms	Surveys (Conjoint analysis)	Residential: 4.22 €/kWh Firms: 3.83 €/kWh
Woo et al. (2014)	Hong Kong	Residential	Surveys (CVM)	Residential: 45 US\$ per hour
Carlsson and Martinsson	Sweden	Residential	Suveys (CVM)	Residential: 6.30 SEK per hour
Kim et al. (2014)	Korea	Residential	Surveys (CVM)	Residential: 3900.67 KRW/month per household for two hours of outage (unnoticed) (3.56US\$)
Hensher et al. (2014)	Australia	Residential	Surveys (CVM)	Residential: Varies from 60 AUS\$ for 8 hour outage to 9 AUS\$ for flicker
Zachariadis and Poulikkas (2012)	Cyprus	Residential Industrial Commercial	Production Function	Residential: 9.07 €/kWh Industrial: 1.91 €/kWh Commercial: 6.12 €/kWh
Abdullah and Mariel (2010)	Kenya	Residential	Survey (CVM)	Residential: 57 KSh per outage
Diboma and Tamo (2013)	Cameroon	Industrial	Survey (Direct worth)	Industrial: 3.62 €/kWh (with notification) and 5.42 €/kWh (without notification)

### **3 Research Questions**

The impact of the current electricity crisis on the South African retail sector is not well understood. In order to inform decision making retail managers are likely to have an understanding of the impact of load shedding at the level of an individual company, but a comprehensive sectorial analysis is not available at the time of writing.

Although there is a consensus, in both the academic literature and the broader public domain, that load shedding has a negative impact on economic activity, the extent of this impact is not agreed upon. The current research will expand our understanding of the qualitative issues faced by retailers due to frequent power outages as well as the quantitative costs directly associated with load shedding. Practically the results will provide retailers, stakeholder industries and policy-makers with the information necessary to make better informed decisions.

The following research questions are proposed in order to address the objectives of the current research.

#### **3.1 Research Question 1**

How does load shedding impact the South African retail sector?

#### **3.2 Research Question 2**

What is the direct economic cost of load shedding to the South African retail sector?

## 4 Research Methodology

The proposed methodology used to achieve the objectives of understanding the cost of load shedding to the South African retail sector was a mixed method design consisting of the following three studies:

1. **Study 1:** To qualitatively assess the most pertinent impacts of load shedding on the retail sector, semi-structured interviews with financial and operational retail managers were conducted.
2. **Study 2:** To contribute toward quantifying the cost of electricity supply instability to the South African retail sector, primary data was collected directly from retail outlets using a questionnaire administered online and in-store to quantitatively measure the economic impact of load shedding on the retail sector. This study was based on the subjective evaluation methodology.
3. **Study 3:** To assist in making the estimates from study 2 more rigorous, data from retailers was collected. The secondary data informed estimates of the marginal cost of backup electricity supply, which can be assumed to be a proxy for the minimum economic impact of load shedding on the retail sector. Thus, estimates have been informed by the subjective evaluation method and the revealed preferences method, respectively.

### 4.1 Study 1: The Qualitative Impact of Load Shedding

From a review of the existing literature the researcher was not able to find any studies that explored the impact of power interruptions on the retail sector in emerging markets. Although a large body of literature exists for measuring the impact of power interruptions, the researcher felt that many of the issues that would specifically relate to the retail sector were not well understood. “Exploratory research is about discovering general information about a topic that is not understood clearly by the researcher” (Saunders & Lewis, 2012). Inductive research is an “approach which involves the development of a theory as a result of analyzing data already collected” (Saunders & Lewis, 2012).

As such, an inductive qualitative study to explore the impact of load shedding on South African retailers was appropriate. The use of grounded theory to iteratively build a theoretical framework from the qualitative data collected will be the primary means of analysing the data. Saunders and Lewis describe grounded theory as “a research strategy

in which theory is developed from data generated by a series of observations or interviews principally involving an inductive approach” (Saunders & Lewis, 2012).

#### **4.1.1 Unit of Analysis and Population**

The relevant population for this research was financial and operational managers of organisations involved in the South African retail sector. This includes private and publicly listed companies involved in all categories of retail as well as retail landlords.

The unit of analysis was the organisation represented by the financial and operational managers as the aim of the study was to understand how load shedding impacted these organisations from a financial and operational point of view.

#### **4.1.2 Sampling Method and Size**

A complete list of all retail related organisations in South Africa was not available. Although it was possible to get a list of all publicly listed organisations, there are companies that form part of the South African retail industry are privately held. As such, a form of non-probability sampling was required. Non-probability sampling is “a variety of sampling techniques for selecting a sample when you do not have a complete list of the population” (Saunders & Lewis, 2012).

Quota sampling was used to ensure that all of the categories of retail organisation were represented in the final sample. Saunders and Lewis define quota sampling as “a type of non-probability sampling that ensures the sample selected represents certain characteristics in the population that the researcher has chosen” (2012).

The sample size required for qualitative research depends on the point at which saturation is reached. The researcher was able to achieve a sample of eight managers who conformed to the above requirements. The researcher is not convinced that saturation was achieved with the eight interviews, but due to a lack of time and resources more interviews were not possible.

#### **4.1.3 Data Collection Process**

Data was collected through semi-structured interviews over the phone. The interview consent form is shown in Appendix A. A list of ten questions detailed by an interview guide formed the outline of the interviews. Question 3 of the questionnaire from study 2 asked respondents to describe the impact that load shedding had on their business. The questionnaire was pretested in face to face surveys with a sample of 18 retail branch

managers and a qualitative analysis of the responses to this question were used to construct the interview guide for study 1. The interview guide is detailed in Table 3 and the profile of interviewees is detailed in Table 4.

*Table 3. Interview guide for study 1*

<b>How large an impact has load shedding had on your business?</b>
<b>How are operations affected?</b>
<b>How are revenues affected?</b>
<b>How are costs affected?</b>
<b>How is security an issue?</b>
<b>Have you installed backup generation power to mitigate the impact of load shedding?</b>
<b>What issues do you still experience despite having backup generation in place?</b>
<b>Do you find that your brand is affected by load shedding?</b>
<b>Are there any unexpected opportunities as a result of a load shedding?</b>
<b>Are there any unexpected knock on consequences as a result of load shedding?</b>

*Table 4. Interview participants for study 1*

<b>Interview number</b>	<b>Retail category</b>	<b>Role</b>
<b>1</b>	<b>Pharmaceuticals and medical goods, cosmetics and toiletries</b>	Operations manager
<b>2</b>	<b>Food, beverages and tobacco in specialised stores</b>	Financial manager
<b>3</b>	<b>Textiles, clothing, footwear and leather goods</b>	Financial director
<b>4</b>	<b>Food, beverages and tobacco in specialised stores</b>	Financial manager
<b>5</b>	<b>General dealers</b>	Operations manager
<b>6</b>	<b>Food, beverages and tobacco in specialised stores</b>	Operations manager
<b>7</b>	<b>Textiles, clothing, footwear and leather goods</b>	Operations director
<b>8</b>	<b>Restaurants and Pubs</b>	Technical operations manager

The interview guide was sent to the interview participants ahead of time in order for them to familiarise themselves with the content and types of questions that would be asked. Interview participants were not held strictly to the interview questions and were encouraged to describe the issues and impacts that they felt were most pertinent to their business. All interviews were recorded and later transcribed for further analysis.

#### **4.1.4 Analysis Approach**

Transcripts of the interviews were analysed using Atlas Ti. Phase 1 of the analysis was an initial round of open coding to identify concepts in the data. Phase 2 involved a process of densification and clustering of the open codes resulting from phase 1 to identify major themes within the data. This was achieved by considering the content of various codes and their co-occurrence within the data. Once the initial codes were gathered into themes a code hierarchy was established by comparing the content within codes and how they relate to one another.

A third phase of coding sought to recode the data with the new code hierarchy established in phase 2. A model describing how load shedding impacts retailers was developed by observing how the emergent themes interacted with one another.

The outcome of the qualitative analysis was an understanding of the most pertinent issues related to load shedding for retailers.

### **4.2 Study 2 & 3: The Quantitative Impact of Load Shedding**

The second two studies will be quantitative with a descriptive design. A descriptive study will “produce an accurate representation of persons, events or situations” (Saunders & Lewis, 2012). There is a consensus in the academic literature and in the broader public domain that load shedding has a negative impact on the South African economy, but estimates of these effects vary. The proposed research is intended to provide reliable cross-sectional impact estimates by estimating effects using a rigorous quantitative approach that is firmly grounded in theory and established as an appropriate approach in previous power interruption studies.

The ultimate result of the first two studies will be a monetary value that represents the costs of load shedding. As described in the literature review, there are a range of methods that have been developed in the academic literature to measure the cost of power interruptions (Bental & Ravid, 1982) (De Nooij, Koopmans, & Bijvoet, 2007) (Council of European Energy Regulators (CEER), 2010) (Oseni, 2012) (Corwin & Miles, 1978). In selecting the methodology for the current research, two important distinctions with regards to power interruptions studies were considered.

The first distinction regards the types of impacts resulting from power interruptions. Linares and Rey (2013) consider the impacts of power interruptions to fall into one of the three categories listed below:

- Direct economic impacts
- Indirect economic impacts
- Social impacts

The scope of the proposed research will be to measure the costs of the direct impacts of power interruptions. Although there are large costs associated with the indirect and social impacts of power interruptions, these costs do not lend themselves to quantitative measurement. The only methodology from the literature that sought to measure the costs associated with indirect and social impacts was the case study, and the results of these studies could not be extrapolated to the broader population (Corwin & Miles, 1978). For the proposed research, the scope of the research was limited to measuring the direct impacts and recognize that there is a broader set of costs beyond what was measured. This implies that the total costs are greater than the final results that will be shown.

The second distinction was the nature of the power interruptions. Sangvhi (1991) notes that in some countries “the overall system reliability index ... is of the order of 99.98%” and in other countries “the generation deficiencies are so acute that ... even if peak period demand levels (kW) were trimmed so that operating reserves were adequate at such times, the energy capability of the system on a daily basis would be insufficient to meet energy requirements”. In countries with a highly reliable supply of electricity, power interruptions are a rare event mostly of short duration (less than 1 hour) and are usually caused by an unexpected technical malfunction. In countries with an unreliable supply of electricity, power interruptions are a common and expected occurrence. Outages usually last for several hours and due to the fact that the interruption is expected, it is often found that end consumers of electricity will have made provisions to mitigate the costs of the supply interruption. Several studies have noted that the costs associated with a power interruption can be significantly reduced if the end consumers are given notice of the upcoming outage (Diboma & Tamo Tatietsse, 2013) (Kjølle, Samdal, Singh, & Kvitastein, 2008) (Kim, Nam, & Cho, 2015).

South Africa is suffering from a structural shortage of electricity supply and the policy of load shedding means that electricity consumers are experiencing regular and sustained power interruptions. Four studies which sought to measure the direct economic costs associated

with power interruptions in countries with similar electricity supply constraints are identified. The studies and a brief description of the methodology used are listed below:

- Diboma and Tamo Tatietse (2013) used customer surveys to apply the direct worth method to measure the economic cost of power interruptions to industrial users of electricity in Cameroon.
- Oseni (Oseni, 2012) use customer survey data from a World Bank survey to apply the direct worth, marginal cost and incomplete backup methods to measure the economic cost of power interruptions for firms across 12 African countries.
- Adenikinju (2003) use customer surveys to apply the direct worth and marginal cost of backup methods to measure the economic cost of power interruptions to Nigerian consumers.
- Nam et al. (2006) use customer surveys to apply the direct worth method to measure the economic cost of power interruptions to industrial electricity consumers in South Korea.

Based on the four studies listed above, the use of customer surveys to apply the subjective evaluation method and the use of secondary data to apply the revealed preferences method and in particular the marginal cost of backup method are acceptable means to measure the direct costs of power interruptions to electricity consumers operating in an environment in which there is a structural shortage of electricity supply.

#### **4.2.1 Study 2: Subjective Evaluation Methodology**

##### ***4.2.1.1 Unit of Analysis and Population***

The unit of analysis was an hour of retail time during the first six months of 2015. The subjective evaluation method was used to understand the impact that an hour of load shedding has on individual retailers. This was then extrapolated out to the broader retail sector by using the monthly revenue for both the retail and the food and beverage sectors, as provided by StatsSA.

The population was all hours of retail time during the first six months of 2015 for all retail outlets in South Africa. This includes all categories of retailers as well as restaurants and entertainment facilities that would be found within a shopping mall.

#### **4.2.1.2 Sampling Method and Size**

The sampling method was stratified random sampling defined as “a type of probability sampling, in which the sampling frame is first divided into relevant strata. Sample members are then selected at random from within each stratum, using either simple random or systematic random sampling” (Saunders & Lewis, 2012). This is the sampling technique recommended by the majority of the studies identified in the literature review for the subjective evaluation method. The stratification is necessary to reflect different characteristics such as company size and location as recommended by the Council of European Energy Regulators (CEER) Guidelines of good practice (Council of European Energy Regulators (CEER), 2010).

In order for the results to be statistically relevant, the sample size for the questionnaire will need to be in excess of 100 samples.

#### **4.2.1.3 Data Collection Process**

Data was collected by means of a questionnaire administered online and in-store. The subjective evaluation methodology relies directly on the electricity customer’s evaluation of the costs of power interruptions to their business. In circumstances in which power interruptions result in direct economic losses to a company, this method is particularly effective as it can capture costs associated with “idle resources, equipment damage, material losses, process re-start costs, and human health and safety effects” (Sanghvi, 1982).

The cost of power interruptions is measured using the algebraic sum of the costs of production losses, the extra costs and the savings made (Diboma & Tamo Tatietsse, 2013). The outage costs for a particular scenario can be represented by Equation 1.

*Equation 1. Cost of a power interruption*

$$DW = VLP + ORC - ORS$$

Where  $DW$  is the direct worth of the outage costs of the power interruption,  $VLP$  is the value of lost production and  $ORC$  and  $ORS$  is the outage related costs and outage related savings respectively. The subjective evaluation methodology seeks to present the electricity customer with a series of power outage scenario’s and asks them to estimate the various elements of the outage costs related to the power outage scenario.

#### **4.2.1.3.1 Questionnaire Pre-Testing**

Initially, the survey presented retail branch managers with a variety of load shedding scenarios and asked them to estimate the percentage of daily revenue that was lost due to each scenario. While trialling the questionnaire in face to face surveys with a sample of 18 retail branch managers, the following issues were discovered:

##### **4.2.1.3.1.1 Appropriate Scenario Definition**

Respondents were hesitant to estimate the direct worth of load shedding incidents that they had not experienced. It was also found that there was not a single set of scenario's that were relevant for all respondents. The result was that if the questionnaire presented the respondents with a predetermined set of scenarios they would generally give the same estimation of the impact across all scenarios. Presenting a pre-determined set of scenarios significantly complicated the questionnaire and was found to confuse the respondents.

In order to accommodate this, the questionnaire was adapted to ask the respondents to think of a particular load shedding incident that they could remember. They were then asked to describe the day of the week that it occurred, the time that it started and the time that it ended. This achieved two important outcomes. The first was that respondents were estimating the direct worth of a self-selected load shedding scenario which they could more reliably comment on. The second was that the day of the week, the time of day and the duration of various load shedding incidents would be collected and could be used to construct a CDF based on those three criteria.

##### **4.2.1.3.1.2 Sales Revenues as Primary Measure of Direct Worth**

When considering a specific load shedding scenario, respondents tended to focus on the loss of sales revenue above any other outage related costs. The qualitative learning from study 1 lead to a deeper understanding of the elements of costs in the retail context. *VLP* in Equation 1 can be considered to be revenue loss during a load shedding incident and is one of the most significant contributors to the direct worth of a power outage. It was thus decided to focus primarily on measuring the revenue loss associated with load shedding. Retail branch managers were found to have difficulty in assigning outage related costs and outage related savings back to specific load shedding scenarios.

Outage related costs are a significant factor in some categories of retail such as grocery stores. It was found that a significant number of grocery retail operations had backup generation facilities in place as far back as the 1990's. This is due to the fact that outage

related costs represented such a significant threat to some grocery retail businesses that backup generation was required when power interruptions were a rare and infrequent occurrence. For other grocery retailers that did not have backup generation in place before the electricity crisis became apparent in 2007, the occurrence of regular load shedding was a strong motivation to acquire backup generation.

#### ***4.2.1.3.1.3 Respondents Unwilling to Share Absolute Revenue Figures***

Trial respondents were not willing to share an absolute estimation of the loss of sales revenue due to load shedding. This information was considered to be very sensitive by the majority of trial respondents.

In order to accommodate for this, the questionnaire was adapted to ask for a percentage of daily revenue impacted by the load shedding. This was found to be a more reasonable request and can be extrapolated to an absolute number from the overall retail sector revenues available from StatsSA.

#### ***4.2.1.3.1.4 Branch Managers Don't Know the Cost of Backup Power***

The questionnaire also asked for details on the company's expenditure on backup generating power. The original goal was to use the survey to measure the monthly cost of providing backup generation power and use these figures to apply the marginal cost of backup methodology, to get a lower bound for the cost of load shedding to retailers. This involves capital expenditures as well as variable running costs in order to determine the "marginal cost of own-generation [which] serves as an estimate for marginal outage cost because the expected marginal gain from auto-generation equals the expected loss from the kWh not supplied by the utility provider" (Oseni, 2012).

Trial respondents did not know the monthly costs of backup power for the stores that they managed. Occasionally, in a small franchise operations, the manager may know how much the backup generator cost and how much they need to spend on fuel each month, but the majority of retail managers did not know these costs. Study 3 sources secondary data from head office on the costs associated with providing backup generation power in order to implement the marginal cost of backup method. The details of this methodology are described in Section 4.2.2.

#### **4.2.1.3.2 Final Questionnaire**

According to the subjective evaluation method the questionnaire requested the retail branch manager to consider a specific load shedding scenario that they have experienced and to estimate the economic value associated with that scenario. A qualitative description of the impact of a loss of power on the business was also captured and analysed with the interview transcripts in study 1. The details of the questionnaire are shown in Appendix B.

#### **4.2.1.4 Analysis Approach**

The load shedding incidents described by the respondents were divided into a set of hourly data. To demonstrate by example, a response in which the load shedding incident was from 10am to 2pm would represent 4 hours as follows

- 10am → 11am
- 11am → 12am
- 12am → 1pm
- 1pm → 2pm

The percentage daily revenue lost as a result of the load shedding incident was divided by the total number of hours to produce an hourly measure of the percentage daily revenue loss. The hourly measure is called Percentage Daily Revenue Loss Per Hour (PDRLPH) and is shown in Equation 2.

*Equation 2. Calculation of PDRLPH*

$$PDRLPH = \frac{\text{Direct Worth Estimate of Load shedding Scenario}}{\text{Number of Hours in Scenario}}$$

The PDRLPH is then distributed across various factors to produce a Customer Damage Function (CDF). A customer damage function shows how the impact of load shedding varies depending on the various factors. The factors considered for this analysis were:

- Hour of the day
- Day of the week
- Duration of the load shedding incident
- Hour of the week

Each CDF provided insight into how the impact of load shedding varies with that factor. The hour of the week factor explains what percentage of daily revenue is lost for a particular hour of load shedding during a particular hour and day. This CDF was used to extrapolate the

overall impact of load shedding on the retail sector for the first six months of 2015. In order to extrapolate the impact to the overall retail sector, the following data was necessary:

- The total revenue per month of the retail and food and beverage sector for the first six months of 2015
- The stages of and the hours of the week during which load shedding occurred for the first six months of 2015
- The percentage of retailers that are impacted by a particular stage of load shedding during a particular hour

The total revenues per month of the retail and food and beverage sectors for the first six months of 2015 are available from StatsSA retail trade figures. (Statistics South Africa, 2015). The stages of and hours during which load shedding occurred were sourced from the Eskom twitter feed which announced all load shedding activity down to an hourly level. An understanding of the load shedding timetables and what the various stages mean were used to determine the percentage of retailers affected by a particular stage of load shedding.

A retailer's turnover could only be affected by load shedding if the load shedding occurred during operating hours. The percentage of retailers open during a particular hour of load shedding were also factored in to determine the total percentage of retailers likely to be affected by a particular hour of load shedding. The trading hours of 61 shopping malls were used to create a distribution of the percentage of retailers open during each hour of the day.

The various sources of data were used to determine the overall retail sector revenue loss for each hour of the first six months of 2015. The revenue loss for each hour was then tallied up to produce the revenue loss for each day and this was subsequently tallied up to produce the revenue loss per month. This total loss per month was then multiplied by the overall retail sector revenue per month to produce the loss in revenue due to load shedding for the first 6 months of 2015.

## **4.2.2 Study 3: Revealed Preferences Methodology**

### ***4.2.2.1 Unit of Analysis and Population***

The unit of analysis was a square meter of retail space. The revealed preferences methodology was used to understand the monthly cost per square meter of providing backup generation power to a retailer for the first six months of 2015. The total monthly cost for the South African retail sector was then extrapolated by multiplying the monthly cost per square

meter by the percentage of retailers who have backup generation facilities in place and the total general leasable area (GLA) of the South African retail industry.

The population was all retail space (square meters) for all retail outlets in South Africa. This includes all categories of retailers as well as restaurants and entertainment facilities that would be found within a shopping mall.

#### ***4.2.2.2 Sampling Method and Size***

Purposive sampling was used to select a variety of retail organisations and categories of retailers in order to reflect a diverse range of backup power generation facilities. Acquiring financial data from organisations is a challenge and the use of purposive sampling allowed the researcher to exercise his judgment in selecting sample member that he believed were most appropriate to answering the research questions (Saunders & Lewis, 2012).

The sample included financial data for over 41 stores and represented over 6000 square meters of retail space.

#### ***4.2.2.3 Data Collection Process***

The means of collecting data was to approach retail organisations and request that they share the monthly costs of providing backup generation facilities per square meter for the first six months of 2015. The information request for is shown in Appendix C. Many retailers were hesitant to participate as they considered it to be sensitive information. For the few retail organisations willing to participate a financial report of the costs of backup generation facilities were provided. The financial report broke the costs down into capital, maintenance and diesel costs associated with providing backup generation facilities and detailed the number of stores and the GLA represented by these monthly costs. This could be used to calculate the cost per square meter.

#### ***4.2.2.4 Analysis Approach***

“The cost to the firm of generating its own power consists of two elements. First, the yearly capacity cost of the generator...Second, the variable cost-per kWh. This is mainly fuel cost, and is practically constant” (Bental & Ravid, 1982).

From the insights gained from study 1 the cost of fuel is not constant and varies depending on the amount of load shedding experienced during that particular month. This cost component was found to have large variations for the first six months of 2015.

Another insight from study 1 is that a third component of the costs of backup generation which is particularly important in light of the increased incidence of load shedding in South Africa is that of regular equipment maintenance. This cost has seen a dramatic increase as the generators installed in the majority of retail outlets in South Africa were not designed to operate for the number of hours currently brought about by frequent load shedding.

These three components constituted the components of cost for the analysis in study 3.

Using the secondary data provided by participating companies, the average monthly cost for each component of cost per square meter was calculated for each month of the first six months of 2015. The components of cost were then added together to produce the total average cost per square meter for each month of the first six months of 2015.

Using an estimate of the total GLA in the South African retail sector and an estimate of the percentage of retail outlets that make use of backup generation facilities, the average monthly cost per square meter of retail space was extrapolated to determine the overall cost of providing backup generation power to the South African retail sector. This figure was then considered to be a proxy for the minimum economic impact of load shedding on the retail sector.

## 5 Results

### 5.1 Study 1: The Qualitative Impact of Load Shedding

#### 5.1.1 Introduction

Data was collected through semi-structured interviews over the phone. A list of ten questions detailed by an interview guide formed the outline of the interviews, but interview participants were encouraged to describe the issues and impacts that they felt were most pertinent to their business. All interviews were recorded and later transcribed for further analysis.

#### 5.1.2 Phase 1 – Open Coding

##### 5.1.2.1 *Methods employed*

All interviews were recorded and transcribed by the interviewer for further qualitative analysis. The qualitative responses from the survey in which respondents described the impact that load shedding had on their business were also included in this analysis.

##### 5.1.2.2 *Results*

A process of line-by-line coding was employed which resulted in 148 open codes. The complete list of open codes is shown in Appendix D.

#### 5.1.3 Phase 2 – Axial Coding

##### 5.1.3.1 *Methods employed*

A process of densification and clustering of the open codes resulting from phase 1 of the qualitative analysis was used to gather the codes into themes and constructs. A process of comparing the codes to one another and the content that they represented was used to identify the dominant factors emerging from the interviews.

A hierarchy of 115 new codes representing the themes as they cluster was created and the interviews were coded again deductively using the new coding structure. The researcher attempted to remain open to new themes as they emerged and an additional 12 codes were added resulting in 127 codes. These codes were then considered again in another iteration of the data. A final iteration of the data with the final set of codes was done to confirm the frequency of occurrence of the various themes within the data.

### **5.1.3.2 Results**

Saturation is considered to have occurred once no new themes emerge from further data collection. Although saturation was not achieved with the eight interviews, a reasonable and interesting sample of data was collected upon which an analysis could be performed. The final analysis resulted in nine major themes to be considered in understanding the impact of load shedding on the retail sector. These themes are listed below:

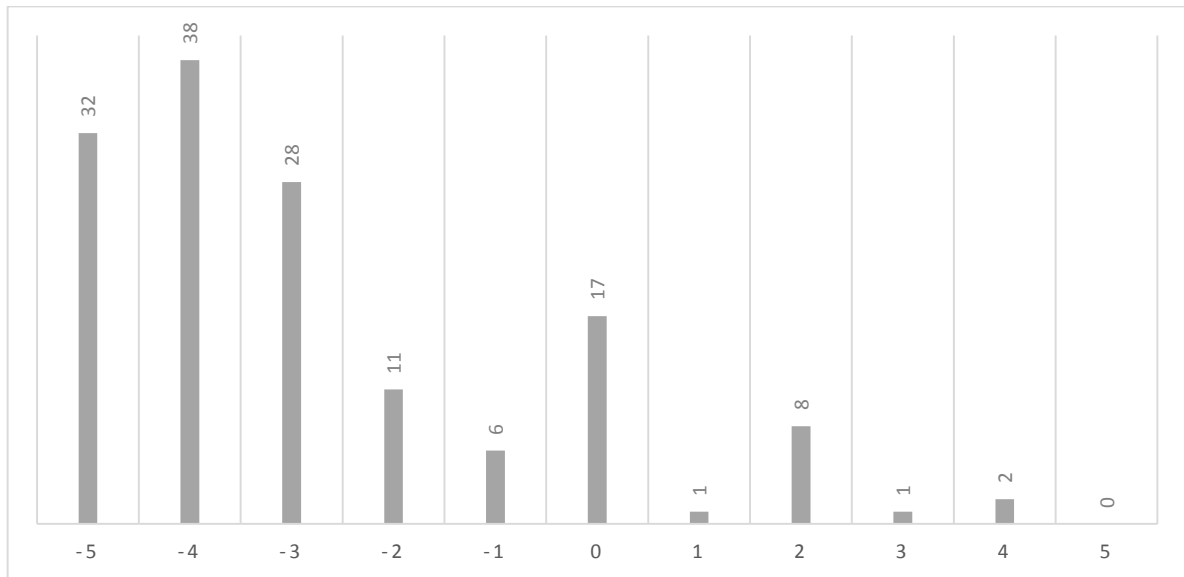
- Degree of impact depends on various factors
- Costs associated with load shedding
- Revenue loss due to load shedding
- Mitigation of the impact of load shedding
- Operational impact of load shedding
- Security issues related to load shedding
- Stakeholders affected by load shedding
- Positive outcomes of load shedding
- Second order effects of load shedding

The following section includes a brief description of each of the major themes emerging from the analysis as well as evidence in the form of transcribed quotes. An extensive list of all the quotes which substantiates the major themes can be seen in the Appendix G.

### **5.1.3.3 Degree of Impact depends on various factors**

Interview comments and survey responses which mentioned the impact of load shedding were rated on a scale from negative 5 to positive 5 to reflect the degree of impact that load shedding has had on the business. A negative 5 represents a severely negative impact and a positive 5 represents a very positive impact. A 0 on the scale means that the respondents comment indicates that load shedding had a neutral impact on the business. The frequency of comments describing the degree of impact load shedding has had on the business is shown in Figure 1.

Figure 1. Frequency of comments describing the degree of impact load shedding has had on the business



The degree of impact that load shedding has on a business was found to depend on a number of factors. These factors are related to the business itself as well as the nature of the load shedding incident. The first distinction found in the data is that the degree of impact of load shedding differs significantly based on the category of retailer.

- **Interview 4:** *We need to differentiate between normal retailers who sell dry goods and supermarkets who sell fresh and chilled products. The impact of load shedding is considerably different for these kinds of customers.*

The location of the store is also an important factor. The data suggests a distinction between stores located in large super regional malls, smaller strip malls and high street CBD stores not located in a shopping mall.

- **Interview 5:** *We are the largest mall in the area... the only competitors in the area are the strip malls who can take business from us but they don't have backup generators and they also receive electricity from the municipality and not directly from Eskom, so they will be on a different load shedding schedule. So people know that if they go to another mall in area and they are not trading they can most likely come to us and we will be an option*

The duration of, the day of the week and the time of the day that that load shedding occurs impacts the degree to which the business is affected.

- **Interview 5:** *If you have a long power outage of 8 hours you can easily end up throwing away R50k worth of stock. So it can have quite a potential impact. A 2 hour outage can be dealt with... but when it gets to 8 hours the impact can be quite substantial*

Reliable notification of when load shedding will occur is an important factor in determining the impact on the business and is important in assisting retailers to manage mitigation efforts.

- **Interview 8:** *In the places where the timetables were more reliable we managed to get into some kind of planning cycle. A lot of the places in Johannesburg followed the planned load shedding timetables quite well and so we managed to start to get into a more organized system, but in KwaZulu Natal they didn't follow the timetables at all and it became very challenging to try and manage that.*

#### **5.1.3.4 Operational impact of load shedding**

Electrical systems are an important component of modern day retail operations. A power outage effects a retailer's ability to display goods, process transactions and communicate with their customers via the internet and telephone. The most common operational impact described by retailers was a lack of lighting.

- **Survey Response:** *You can't serve the customers with the lights out. Customers stand outside and say they will come back later, but some don't come back.*
- **Survey Response:** *Customers don't come into the shop. The center is dark. The customers go away.*
- **Survey Response:** *Very badly. We will be in the middle of a consultation and it will become pitch black.*
- **Survey Response:** *We lost a lot of customers. Stock theft is an issue because its so dark.*
- **Interview 7:** *Yes – no lights no trade... the systems are off so you can't generate the necessary receipts. To go on a manual booklet with half the lights and having people in the stores with the security risk – it's just not on.*
- **Interview 7:** *The unpacking of boxes, the displaying of merchandise just can't be done in the dark and it had a negative effect on the quality of our systems.*
- **Interview 1:** *In the strip malls you can carry on, but in the centers when the power goes out it is complete darkness.*
- **Survey Response:** *I have to stop working because there is no light.*

Payments are also a significant issue. Many POS card machines require a power source and a landline connection. The till systems will often be computerised and will also require electrical power to process payments.

- **Interview 8:** *Yes, for our business we definitely close the stores down if we don't have electricity. There are two reasons. The first is extraction... The second is point of sales. Without point of sales you can't keep track of anything. It's like the heart of the business so you can't operate without that. It is there to keep everybody honest and keep visibility on what's happening. Apart from load shedding if either of those systems broke, the extraction or the point of sale, we would close the restaurant.*
- **Interview 4:** *If you can't process the payments there is no point in them being there.*
- **Interview 7:** *If the payments systems don't work we would have to do things manually and this causes major issues*
- **Interview 1:** *A lot of customers know they will essentially stand in a que and the lighting is poor and the air conditioner doesn't work... so I won't shop today... I will shop tomorrow when the lights are on.*
- **Interview 3:** *We wanted to make sure that if load shedding occurred while they were at the store they would be able to complete their shopping experience and pay for their items. Our intentions was thus to make sure that customer service was uninterrupted*
- **Interview 7:** *if we were to continue trading and operating with the systems offline is a major nightmare.*
- **Survey Response:** *Lose clients. Most people don't want to pay cash... so can't pay with the speedpoint.*
- **Survey Response:** *Card machine transactions don't work - customers can EFT but we can't confirm because we don't have an internet connection.*
- **Survey Response:** *Losing revenue. No electrical systems to manage payments.*

Customers tend to prefer cash when paying for goods. The need to pay by credit card is often a source of inconvenience and frustration and leads to loss of sales. Respondents to the survey mentioned that even if the customer were willing to go to a nearby ATM to draw cash the ATM's would also be unavailable due to load shedding.

- **Survey Response:** *They can't pay because the machine is off... and the banks don't work so they can't draw money. Computer doesn't work*
- **Survey Response:** *Customers couldn't pay with POS. 90% of customers use cards. We couldn't process transactions.*

- **Survey Response:** *Sales must be in cash. Customers don't have cash so we lose a lot of sales.*
- **Survey Response:** *Speedpoint doesn't work and customers don't pay with cash.*
- **Survey Response:** *We don't take credit card. Most people don't carry cash so we lose some customers. Even the tills don't work.*
- **Survey Response:** *Unfortunately the card machine doesn't work when there is load shedding so customers cannot pay by card. There are ATMs close by but usually customers are unhappy about having to come back to pay so they ask to do an EFT. This often means that the waiters do not receive tips.*
- **Survey Response:** *we weren't able to use our credit card machine or electronic funds transfers. The ATM in the centre were also affected so that customers could not draw cash either.*

The cold chain is an important consideration for all grocery retailers and power outages bring complications to maintaining the temperature of goods. The consequences of not maintaining the cold chain are a loss of stock which is a very severe cost for a retailer to endure.

- **Interview 4:** *Whereas previously a breakdown meant it would take a support staff member 2 or 3 hours to get to a store... the increased number of breakdowns meant that it would take up to 8 hours for someone to get onsite. Response times were largely impacted and this lead to a large impact on the business... in terms of loss of sales and loss of stock as things would go out of temperature and we would end us losing those products.*
- **Survey Response:** *The health regulations regarding the safe storage and handling of food are very strict. Stricter than so called first world standards. If you don't have massive generators to keep the fridges and freezers going through load-shedding, then the temperatures would rise to the point of stock having to be destroyed because we would have breached the acceptable thresholds. A store of this size would typical hold R250000 to R350000 worth of cold and temperature sensitive stock at any time. If we were to ignore the regulations the customer would notice the degraded product anyway and not want to come back and shop here anymore, at very least.*
- **Interview 8:** *We move a lot of product to the freezer rooms and managers monitor during the period. If the load shedding is only around 2 hours or so it is possible to manage our stock without losing it. We can keep it in the freezer rooms and it will stay cold enough.*

- **Interview 6:** *In a supermarket we need generators that can supply ten times that power because I need to run refrigeration and baking.*

Many retailers rely on telephone or internet communications to perform their base service or to interact with customers and receive orders. The lack of communications during a power outage is cited a cause for lost revenue by several respondents.

- **Survey Response:** *We can't quote or book flights can't take payment. Can't do anything... Can only manual enquiries from walk in customers We will literally sit doing nothing during load shedding*
- **Survey Response:** *Because internal network traffic offline we can't bank pos transactions for the day. This means that we have to come in the early the next day to complete the previous day.*
- **Survey Response:** *We close our doors. We are so reliant on price lists, emails and the credit card machine that we can't do business.*
- **Survey Response:** *No internet - we get orders by internet - we can't see the orders for a couple of hours so we can't process them. We will lose the same day orders such as a birthday. There is no point in delivering the flowers the day after the birthday.*

The electrical systems currently in place for the majority of retailers were not designed for the present load shedding conditions. Even if a retailer did have generators installed before the electricity crisis became apparent they were never designed for the frequency of power outages occurring during 2015. The change in circumstances makes any business investment a challenge.

- **Interview 5:** *The generator units were always intended as standby units and are not designed or intended to operate continuously or for long extended periods of time or at the frequency that they operate at now due to load shedding.*
- **Interview 6:** *The generators were installed about 8 or 9 years ago when load shedding was expected to happen once or twice a year. Now that the power cuts are happening much more often, it is having a huge impact on the generators.*

#### **5.1.3.5 Costs associated with load shedding**

There are a number of costs associated with load shedding. These costs can be associated with efforts to mitigate the impact of load shedding and with damages that arise as a result of load shedding. It is important to note that the majority of these costs come straight off the

bottom line and that the funds required by a business to pay for these costs would otherwise be profit or directed to other areas of the business such as expansion and growth.

- **Interview 1:** *The overall capital investment over the three years will be R50m. That has an impact on the bottom line. We would have rather invested that R50m in new stores and upgrades and refurbishments and opening up pharmacies.*

We have classified the costs associated with load shedding into fixed and variable costs. With regards to the fixed costs there is often a large initial capital outlay required which is difficult for marginal and small businesses.

- **Interview 4:** *When you consider someone who is running a marginal business – and as a result can't afford to pay for a generator... can stock losses put that business into an even worse situation... the answer is definitely yes.*
- **Interview 5:** *Many of the larger shopping centres have begun to install generator farms so that they can power up the entire shopping centre and so they can attract customers back into the shopping centre, but there are only a small number of those. The smaller guys just can't afford that sort of thing.*

If a business is able to afford the initial capital outlay to provide backup generation power there are still ongoing operational costs associated with load shedding. The variable costs associated with running generators and maintaining them have increased significantly with the increased frequency of load shedding. The more a generator needs to run the more diesel it will use and the more maintenance that is required.

- **Interview 5:** *The 6 months leading up to August the Diesel bill was almost a million rand. You can imagine the impact that it has on the tenants. The landlord takes the brunt, but we do recover some of it from the tenants.*
- **Interview 4:** *Yes, there is the capitalized cost of the generator. There is also the cost of diesel. Depending on how much load shedding there is for the month that cost can run up to R10k to R15k for the month. Then there would also typically be a service contract in which someone would maintain the generator on a monthly basis and check to make sure it is ok. So it's the capitalized cost, cost of diesel and the maintenance. In the fresh food business this becomes a significant cost.*

The majority of electrical systems currently installed in retail establishments were not designed for the present load shedding conditions and an increased incidence of equipment failure has resulted from the frequent cuts in power.

- **Interview 6:** *The frequency of the load shedding we have seen also caused a number of other failures. We have noticed that UPS failures have increased as they are just not designed for the constant on off that they are experiencing. Beyond just the generators, the damage to other equipment such as compressors in refrigeration and people getting stuck in lifts.*
- **Interview 5:** *If you look at generators supply power there is higher wear and tear on the units. Generators are like motor cars in that they need to be serviced more regularly if they used more regularly. The generators were installed about 8 or 9 years ago when load shedding was expected to happen once or twice a year. Now that the power cuts are happening much more often, it is having a huge impact on the generators. The switching gear is not designed to be used once a day, but rather once a month or something like that. So the impact on servicing and maintenance was quite severe.*

A significant cost associated with load shedding is the loss of stock that can result from a break in the cold chain.

- **Survey Response:** *No too much - it would have been worse in summer. We wouldn't have been able to run our airconditioner and our flowers wouldn't last. The health regulations regarding the safe storage and handling of food are very strict. Stricter than so called first world standards. If you don't have massive generators to keep the fridges and freezers going through load-shedding, then the temperatures would rise to the point of stock having to be destroyed because we would have breached the acceptable thresholds. A store of this size would typical hold R250000 to R350000 worth of cold and temperature sensitive stock at any time. If we were to ignore the regulations the customer would notice the degraded product anyway and not want to come back and shop here anymore, at very least.*
- **Interview 4:** *The danger of not having is the length of time of the load shedding. A 2 hour load shedding incident isn't too much of an issue as those fridges do retain a certain amount of the cold. But when it gets to 8 or 10 hours the possibility of significant stock loss becomes much much higher.*

Overall, the self-generation of electricity is a less efficient and more costly means of obtaining electricity per kWh.

- **Interview 5:** *The cheapest way to operate is probably a constant and reliable supply of electricity from Eskom*

- **Interview 8:** *The cost of supplying electricity from generators is much more expensive than electricity from Eskom*

### **5.1.3.6 Revenue loss due to load shedding**

Modern day retailers are reliant on many electrical systems to create a pleasant environment for shoppers and to process purchases. A major component of the impact of load shedding on retail is the loss in revenue that it causes.

- **Interview 1:** *We do keep track, this is not 100% accurate but we reckon anything up to 1% of our annual turnover. Our annual turnover is about R13,6bn... so 1% of that would be R136m. Between 0.8 and 1%. A fairly sizable number.*
- **Interview 4:** *If my store is closed for a third of the day, that's a third of my revenue gone. My cost structure hasn't changed too much. If I make on average R200k per day and I lose R80k... it is gone. Revenue loss like that is very difficult to make up.*
- **Interview 3:** *So we have the ability to measure our sales on an hourly basis and we came to a number of 2 to 2.5% drop in top line sales when load shedding hits in the first year. It has dropped down to about 2% now*

Many retailers will stop trading during a load shedding incident if they do not have backup power. There a number of reasons why a retailer may decide to stop trading in a particular store during load shedding. The most common reasons are a lack of sufficient lighting, an inability to process payments and the fact that a store without electricity is vulnerable to fraud and theft.

- **Survey Response:** *We close the doors because it's dark. We are not allowed to trade manually according to company policy because it is easy to steal. It is very easy to steal CD's in the dark and make fraudulent transactions at the till.*
- **Interview 8:** *Yes, for our business we definitely close the stores down if we don't have electricity. There are two reasons. The first is extraction... because we cook over an open flame we have to have extraction working. You can't cook on an open flame without extraction. So we have a lot of gas equipment which helps, but you still can't cook without the extraction. The second is point of sales. Without point of sales you can't keep track of anything. It's like the heart of the business so you can't operate without that. It is there to keep everybody honest and keep visibility on what's happening. Apart from load shedding if either of those systems broke, the extraction or the point of sale, we would close the restaurant.*

If retailers do remain open during load shedding there is often a significant decrease in the amount of foot traffic. Retailers report a decrease in sales due to the decline in customers passing through their stores.

- **Survey Response:** *We will be in the middle of a consultation and it will become pitch black. We have decreased customers - we have to open the door to let customers know that we are open otherwise they will leave.*
- **Survey Response:** *I have spoken about our revenues – it really affects business. The centre closes down and then they leave and they rarely return to that same centre.*

The lost sales that occur during a load shedding incident are partially made up for in subsequent days as retailers indicate there is a lift in sales following a day of load shedding. The increase in sales the following day however is only a partial recovery of what was lost and is dependent on the category of retail. It is suspected that shoppers purchasing daily milk and bread will be permanently lost.

- **Interview 1:** *What we decided was that where we communicated through our website and through our store at point of sales that we have UPS where we were losing 100% of our business previously now were only recouping about 60%. So it's not as if the 100 customers would come back and shop... only 60 would come back and shop.*
- **Interview 3:** *So in order to understand the impact of load shedding we need to use our MIS system to disaggregate the hourly sales data from normal sales data... although the sales definitely do drop while the electricity is out, we do notice that shoppers do generally tend to come back the next day. So we lose about 2% during the load shedding day, but we see a 1% lift the next day.*
- **Interview 3:** *We are fortunate to have a fairly high customer retention. Our customer retention is in the upper 60 and lower 70 percent. So our repeat shoppers do come back... so we see peaks and troughs across a week.*

A retail business can also experience a loss of revenue due to a decrease in the amount their customers order or the retailers own limited capacity to fulfil their normal order book. An example would be a coffee shop being unable to serve all the items of their menu or a butchery getting fewer orders for meat from the surrounding restaurants.

- **Survey Response:** *Restaurants stop buying and this decreases our sales a lot.*
- **Survey Response:** *We cannot make coffees, teas, juices or smoothies which means people are spending a lot less than if they could order that to drink with their meals*

- **Survey Response:** *We also supply a town lodge (our menus are in their room) and when there is load shedding we can't fulfil those orders. That is a large loss of revenue.*

The inability to process payments by credit card and through the computerised till system will lead to a decline in sales and retailers have reported incidents of customers having to leave items at the checkout point because they cannot pay for them.

- **Survey Response:** *The few customers who come in have to pay with cash. Lots of customers don't carry cash. We have to enter it in the book. Customers will come with a trolley full and find we are not online and then leave.*
- **Survey Response:** *We do have UPS so our tills do stay open for about 20min, so we can serve the last of the customers in our stores and then we would lock our doors and obviously escort customers out. They would leave their baskets unfortunately, but that's the reality.*

Load shedding can also lead to an increase in revenue particularly in the fast food restaurants. The fact that people can't cook in their own homes means that they will have an increased tendency to go out to get something to eat and multiple restaurant retailers report an increase in revenues during a load shedding incident. This requires the retailer to be prepared for load shedding and able to operate off their own backup power supply.

- **Interview 8:** *So I don't think it has been as massive in terms of revenue as people think because people have adjusted their buying patterns. At our restaurants where we have generators we actually see an increase in sales because you're trading when a lot of other restaurants are not*
- **Interview 3:** *Our customers know we are well prepared for power outages and they have no anxiety with regards to load shedding when they are in our stores and in fact they will come to our stores in particular when there is load shedding*
- **Interview 5:** *We get our power directly from Eskom whereas residential power is supplied through the municipality. What this means is that we get load shed at different time to people's homes... and that means that when people experience load shedding at home they will come to the mall to kill time or eat or whatever it may be.*

#### **5.1.3.7 Security issues related to load shedding**

Internal systems are important in tracking stock and transactions and avoiding internal pilferage of goods by the staff working in the store. Power outages decrease a retailer's ability to balance their stock and revenue and provide an opportunity for staff to steal.

Sensormatic and CCTV systems being offline and decreased lighting within stores makes retailers more vulnerable to external criminals.

- **Interview 2:** *No... I've never come across anybody employing more people to do that. It's just a matter of closing down entrances and backdoors and so forth. Normally there would be a security guy at the backdoor, you would just put him in front. So one would just manoeuvre the practical situation and increase the security management of the shop. That's it. No additional costs.*
- **Interview 3:** *We have to increase the stock takes and we have increased the security at stores... but to be able to isolate the shrinkage and prove whether it is customers or staff is very difficult. We have not been able to do that as yet, but we are aware of patterns. Any change in a stable environment brings with it opportunities and threats. And threats for our environment or organisation are opportunities for staff to take advantage of that situation.*
- **Interview 7:** *The sensormatic systems don't work and that means we have to chase the customers out of the stores so from a customer service point of view that's obviously not great and we also have a lot of losses because people are walking out of the stores with garments knowing that the sensormatic systems won't go off*
- **Survey Response:** *Safety is an issue... customer insist on paying with cash... then people know that there is cash in the till*

#### **5.1.3.8 Mitigation of the impact of load shedding**

Retailers are implementing various systems, policies and procedures in order to mitigate the impact that load shedding has on their business. The means that businesses employ to mitigate the impact of load shedding are informative as they speak to the trade-off between the revenue losses and costs resulting from load shedding. Businesses will seek to maximise their profits and thus the amount of money and effort they invest in order to work around load shedding is a proxy indicator to the fuller economic costs implications the phenomenon has on the retail sector.

The first means of mitigating the impact of load shedding is through the provision of alternatives to normal activities that require electricity. In restaurants this will frequently take the form of gas cooking where appropriate. Traditional retailers have some means for maintaining lighting and payment systems.

- **Survey Response:** *Our retail store has an iPad point of sale and a mobile card machine so sales can take place for 8 hours without electricity. We have led lamps for change rooms and therefore trade continues as normal during load shedding*
- **Survey Response:** *Our kitchen uses gas stoves so we can luckily still cook.*
- **Survey Response:** *Cooking has moved to gas so able to supply only food*
- **Survey Response:** *I have a mobile credit card machine because I lost a R10000 sale and the customer didn't come back.*
- **Interview 7:** *We bought at huge cost a number of backup lights at centres where the price to have access to backup power was ridiculously expensive*

In 2007 there was a large increase in investments in backup generation power throughout South Africa. This trend was replicated again towards the end of 2014 and through 2015 as load shedding became a regular experience. In the retail industry this occurred both at the retailer level in which individual stores would manage their own generator and amongst shopping mall landlords. In the case of shopping landlords access to backup power is charged on a monthly basis and provided to individual stores as a service.

- **Interview 3:** *Our stores that are not in malls all have their own generators.*
- **Interview 4:** *One of my clients had to put in a generator that cost R1,3m because of the amount of load that the generator had to take due to refrigeration and baking equipment such as ovens.*
- **Interview 2:** *We have a generator that is about 400kVA... so if you replace you would pay about R100k to R140k per 100kVA which would mean our generator would cost us R500k to replace.*
- **Interview 7:** *The centres where they do supply generators – even though it comes at a huge cost and we had to rewrite the lease agreements. We have done it at a few stores where we felt it was viable.*
- **Interview 7:** *I would say that the malls are starting to provide backup generation power where the tenants are requesting it.*
- **Interview 3:** *There are also a lot of malls that have their own generator power, and we would need to plug into that mall's generator power.*
- **Interview 4:** *There are some guys on occasions who don't have generators... when it becomes apparent that there will be a problem, they are able to rent a temporary generator for a couple of days... but that is quite an expensive option*

- **Interview 2:** *Where we have UPS, that kicks in and we have reduced lighting and everything else.*
- **Interview 2:** *Our stores that are located in malls typically have UPS's and that UPS would need to power the store for the duration of the load shedding.*
- **Interview 3:** *We have had to invest quite a bit in upgrading the UPS's and we have retrofitted many of stores with generators and UPS's that moderate the input from the generators. So there is a very large investment that comes from mitigating the impact.*

There have been different levels of preparedness with regards to load shedding. Some retailers have had backup generation facilities in all their stores in place prior to the 2007 load shedding incidents due to the sensitive nature of their business while others still have less than 10% of their stores backed up despite the heavy load shedding experienced during 2015.

- **Interview 3:** *We believe that this investment has resulted in goodwill with customers in the sense that they know we are well prepared for load shedding*
- **Interview 6:** *I have been in a shopping centre when there is load shedding and it's a positive thing when suddenly everything is dark and then a couple seconds later the Woolworths lights come on and people see that and we hear them talk and say... you can go to Woolies during load shedding, so it definitely does have a positive impact because we are prepared.*
- **Interview 3:** *We were caught totally unaware. Load shedding caught most other retailers unaware too... so on the whole retailers were unprepared.*
- **Interview 7:** *We have about 750 stores and I would say that less than 10% of them have backup power*

Load shedding has added a new dynamic consideration to doing business in South Africa and companies have had to develop new operational competencies and procedures to manage their stores in the midst of a loss of power. There are significant complexities regarding the management of backup generation facilities and the impact that load shedding has on normal business operations.

- **Interview 5:** *What we have also experienced is because of legislation in South Africa and the differences in local bylaws (the Western Cape only allows 200l of Diesel on the premises) we have had to manage this. We have had instances of generators running out of Diesel and stores needing to stop trading due to this.*

- **Interview 8:** *Yeah, we have sent out a lot of procedures for how to operate during load shedding. We have guidelines regarding how to close the restaurant.*
- **Interview 8:** *So I wouldn't say it's business as normal. There are additional complexities. Our product can't sit around for too long. We generally don't try to over order or under order. We strive to get that right as accurately as possible... but now if you have a week of load shedding and you do have a generator what you might find is that you will double your sales. It brings all kinds of complexities... Customers don't understand, they are all already stressed and upset with Eskom. And so they don't understand your problem and they have no sympathy for you not planning properly... but you can't really plan for something like that can you?*
- **Interview 5:** *Let's talk about Diesel management... making sure that we have enough Diesel to run the generators when load shedding occurs. At that time Diesel was R14 per litre. We have a company that assist us with that... they will charge a mark-up on that Diesel and they will charge us for delivery. There are a number of regulations in terms of transporting Diesel. To top up Diesel will basically cost you twice what it should. So in order to cut down costs we have retrofitted one of our vehicles to be able to deliver Diesel... but it still means that one of my staff is now off sight to collect the Diesel. We also need to make sure that the generators start correctly and that the power is given properly to the clients and we have to constantly monitor it. The start-up phase is the most severe time and it requires a lot of time and effort.*
- **Interview 5:** *Exactly – we have had to develop new operational skills*

Despite significant investments and efforts to mitigate the impact that load shedding has on businesses there are still unforeseen problems that companies need to deal with. An increase in equipment damage is a common theme as backup systems are not designed to deal with the frequency of power shutdowns experienced during 2015.

- **Interview 6:** *An interesting thing we have noted is also the quality of the power supply after a load shedding incident is a problem. Even once the power returns, it can take quite a while for it to stabilize. And the erratic power supply can also cause a problem for electrical equipment.*
- **Interview 6:** *We have seen a tremendous amount of equipment damage... and it's not just the generators themselves... but the UPS's the light bulbs in the stores... any electrical equipment can really take a hammering.*

- **Interview:** *So even though you guys were fairly well prepared and you have had generators in place since before load shedding happened – it still had an impact even to the point of losing stock.*
- **Interview 5:** *Now that the power cuts are happening much more often, it is having a huge impact on the generators. The switching gear is not designed to be used once a day, but rather once a month or something like that.*

A number of strategic choices need to be made by companies with regards to the types of mitigation they employ. The particular store locations chosen and the pace at which generation capacity is rolled out speak to each company's strategic response to the electricity crisis.

- **Interview 2:** *We are phasing it in over 3 years so we are doing about 140 stores per year and we obviously starting in our biggest stores and it's difficult to know.*
- **Interview 8:** *Our strategy was to go with the more expensive generator options, the ones with the automatic switchover and a UPS to make sure everything runs properly. So we have invested a little more to avoid hassles on that side.*
- **Interview 2:** *We have a preference of for new stores to be at shopping centres that do have backup power so that shoppers don't have to stop when load shedding occurs.*
- **Interview 7:** *We did an exercise and made a decision in some of the smaller shops not to do install any backup power. Lately it has been ok – if it gets worse we may need to start backing up these stores.*

#### **5.1.3.9 Stakeholders impacted by load shedding**

The interviews and survey revealed 3 sets of stakeholders in the retail sector who are impacted by load shedding. The first set are the retailers and retail landlords. The impact is seen across large scale corporate retailers, franchisee's and small scale family owned businesses.

- **Interview 5:** *Our generators are not stock standard – they can't be bought off the shelf – so it takes a long time to replace. These kinds of issues force the landlords to come up with solutions to these problems.*
- **Interview 7:** *We have a preference for new stores to be at shopping centers that do have backup power so that shoppers don't have to stop when load shedding occurs.*
- **Interview 3:** *We don't have the protection that major malls have, generally the CDB dies when there is load shedding... so customers tend to disappear.*

The second category of stakeholders affected are the retail customers. Load shedding often leads to a poorer standard of service, longer waiting times in queues and general inconvenience for customers.

- **Survey Response:** *Manual sales are very slow. It's hectic to do manual sales. Not having the usual 2 PC's to handle sales is a problem. Customers get frustrated sometimes - but knowing that it is load shedding - they have to be patient.*
- **Interview 8:** *Customers don't understand, they are all already stressed and upset with Eskom. And so they don't understand your problem and they have no sympathy for you not planning properly... but you can't really plan for something like that can you?*
- **Interview 3:** *When we were considering the different options, our primary intention was not to disrupt customer service.*
- **Interview 3:** *It also created a lot of confusion in the market. Customers didn't know if they could go shopping or not because they were not sure if there was going to be load shedding or not. We found it caused a lot of confusion in the market. That aspect is very difficult to measure*
- **Survey Response:** *We lose customers because manually takes longer and they get frustrated*

Much of the burden of load shedding falls upon the staff who have to operate under more stressful and pressured circumstances and will sometimes receive less tips or even no pay for a full day of the load shedding.

- **Interview 6:** *From a personnel point of view the number of breakdowns meant that we didn't have enough staff to be able to service all the breakdowns that were happening*
- **Interview 8:** *Yeah, I think if I was working in a Nandos and earning next to nothing, because the industry doesn't pay well, I would hate the fact that we have a generator because I would much rather sit there and do nothing during load shedding rather have to deal with that extra pressure associated with running during load shedding*
- **Survey Response:** *The shop was closed the whole day and we didn't pay some of the employees even though they caught a taxi and came to work that day.*
- **Interview 3:** *Another important factor that we saw was the morale of staff being affected. The fact that the environment became more unstable and that procedures changed a lot. We noticed a lot of staff absenteeism would increase... and it's just due to an increase in the pressure on staff and a huge increase in the rework that they need to go through.*

### 5.1.3.10 **Second order effects of load shedding**

The fact that load shedding is universal problem in South Africa reduces the downside risk towards a retailers brand as the public understand that it isn't the retailer's fault that they do not have power and are unable to provide their normal services. There is potential for a positive impact to the brand if the retailer reaction is proactive and distinguishes them from their competition. The ability to trade during load shedding can lead to increased foot traffic and business as competitors are not available to service their usual customers. The ability to provide backup power has become a point of competition in the market place particularly for shopping mall landlords seeking to attract retailers.

- **Interview 6:** *I have been in a shopping centre when there is load shedding and it's a positive thing when suddenly everything is dark and then a couple seconds later the Woolworths lights come on and people see that and we hear them talk and say... you can go to Woolies during load shedding, so it definitely does have a positive impact because we are prepared.*
- **Interview 7:** *I don't think that the brand is affected by load shedding because it's not something that is particular to our company or our business, but on the other side of the coin the retailers that do have backup power such as Woolworths, Game and Massmart – they obviously get a lot of mileage out of this because people would rather go do them shopping at Makro or Woolworths because they know that their lights will not go off.*
- **Interview 3:** *We believe that this investment has resulted in goodwill with customers in the sense that they know we are well prepared for load shedding*
- **Interview 3:** *I think the investment that we have made has had a positive impact on the image of our brand. All of these investments require continuous maintenance and continuous services.*

The incidence of load shedding brings complications and challenges to normal business. This can take the form of adding friction to business relationships between landlords and tenants or the added complexities and costs of providing backup power to stores. The problems associated with load shedding extend beyond the hours when load shedding occurs as one retailer describes the quality of the power supply is noted to be degraded even once the load shedding incident is over.

- **Interview 5:** *So they start to get unhappy with the landlords... and we say that a good tenant is a happy tenant. So another thing we have found is that load shedding can cause some friction in the business relationships between landlords and tenants.*

The impact of retail sector results in knock on consequences for the macro economy. Marginal business are less likely to survive and with that will come a loss of an economic active business and the employment it provided. Ultimately the costs associated with load shedding will be passed onto the final consumers as higher prices. It is an inefficiency in the economy and will ultimately translate to less consumption and declined profitability for businesses operating within the economy.

- **Interview 2:** *For the higher revenue stores where that is less of an issue... but in a marginal store... the extra burden of needing to pay for a generator can be a significant issue in terms of servicing debt etc.*
- **Interview 8:** *We have tried to use this to encourage other franchisees to be able to trade during load shedding because we would like to see all restaurants trading but it is obviously a huge investment and many of the guys haven't made the leap of faith..*
- **Interview 3:** *What this has done is it has created a new cost bucket within our business and that cost bucket within an organisation that needs to continuously show improvement will eventually be passed on to the consumer.*

#### **5.1.3.11 Positive outcomes of load shedding**

Although the impact of load shedding is overwhelmingly negative, when prompted the interview participants are able to identify some positive outcomes. The positive outcomes fall into two categories. The first type of positive outcome is an increased competitiveness and institutional learning of retail organisations as they respond to load shedding.

- **Interview 8:** *We are very conscious of energy at the moment, just in terms of our usage. We have started to move towards gas in all areas... so in terms of chip fryers or even gas ovens. In the long run I think that is a positive thing. We are more independent. I don't think there is a cost saving... it's probably equivalent.*
- **Interview 3:** *We have achieved some institutional learning through that exercise and any big decision we make now is measured against an improved customer experience measure. Is this going to improve the customer experience? We understand that if we can improve the customer's experience and the value we bring to them, they will spend that money at some time.*

- **Interview 3:** *Load shedding has tested the mettle of our retailers, and what we have found is that we are stronger than we thought we were.*
- **Interview 6:** *On the positive side we have had to consider things like the national black out plan. What will we do if we have a national black out, how will we respond and how will we bring our business back on line when the power returns. All of these things have made us more competitive.*
- **Interview 6:** *It has forced us to become more efficient and to make provision for events and circumstances. So in a sense it has made the businesses more competitive.*

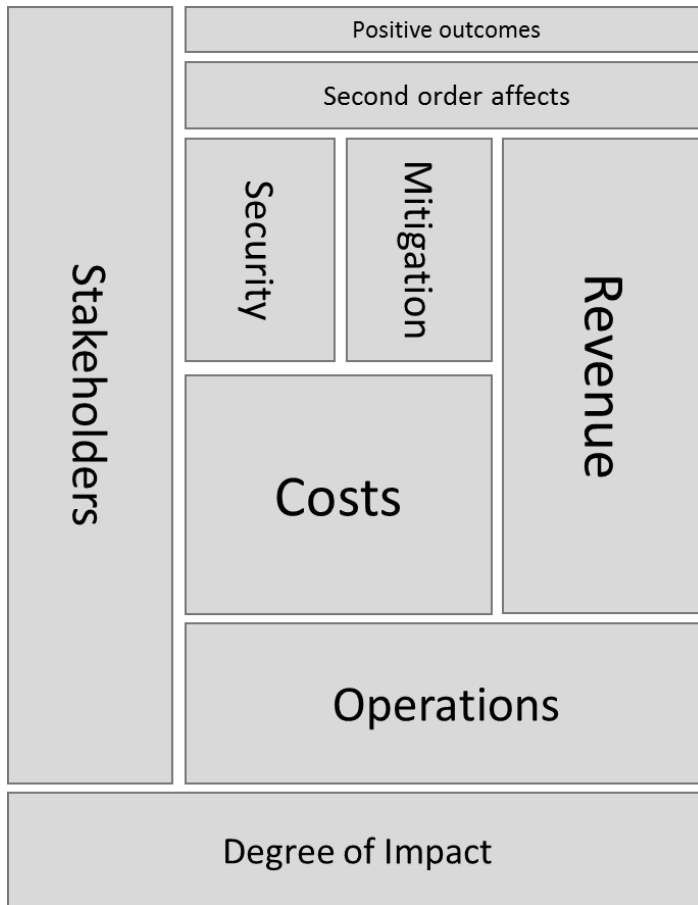
The second type of positive outcome is the fact that there are new business opportunities that have arisen due to load shedding. The demand for load shedding products such as lighting and gas stoves is noted as an opportunity for retailers to sell these goods to consumers. There is also the new market for generators and backup power service providers.

- **Interview 8:** *Another interesting thing, not specifically for us, but just in general... is people are looking at new innovative ways to power things. I get phone calls every week from people who are looking to provide us with energy. So the incentive to create new energy sources is hopefully spurning some good ideas and potential new businesses.*
- **Interview 5:** *For sure... have you seen how many people have started selling generators and started servicing generators. So there is definitely a lot of job creation and entrepreneurship related to load shedding.*
- **Interview 1:** *There are opportunities, if you have a look at our product range over the last 6 months we have brought in a lot of gas stoves, torches and lanterns. Anything that a customer would want to buy should they have load shedding.*

#### **5.1.4 Phase 3 – Theoretical Coding**

Nine major themes emerged from the analysis in phase 2. Phase 3 consisted of a final round of coding using the coding hierarchy established in phase 2. The manner in which the major themes and their constructs interacted was considered and a final model illustrating the relationship of the major themes to one another was derived. The final model is shown in Figure 2.

Figure 2. Qualitative model describing the impacts of load shedding on retailers



## 5.2 Study 2: Subjective Evaluation Methodology

Electronic and face to face surveys were conducted in which retail branch managers were asked to qualitatively and quantitatively describe the impact of various load shedding scenarios on their business. The subjective evaluation methodology consists of presenting the end user with a series of load shedding scenarios and asking them to estimate the direct worth that each scenario has on the business. The direct worth of each scenario can be broken down into the following components:

- VLP: The value of lost production
- ORC: Outage related costs
- ORS: Outage related savings

This is used to create a customer demand function which shows how the direct worth of the impact of the load shedding scenario varies, depending on various factors.

## 5.2.1 Response to Survey

The electronic survey was distributed to over 300 retail branch managers. The exact number of people the survey was sent to is not known as a request was made to forward it on to more contacts. Over a period of 2 months, 42 responses were received electronically. Face to face surveys were conducted with retail branch managers in a variety of neighbourhoods and shopping malls around Johannesburg in an attempt to improve the sample. A further 64 responses were received through face to face surveys bringing the overall sample to 106 respondents. This has caused the sample to be biased towards Gauteng and particularly Johannesburg. The initial question on the survey asks whether the respondent has experienced load shedding in 2015 without backup power. Table 5 to Table 8 show the responses to this initial question distributed across retail category, square meterage, number of employees and neighbourhood of the store in question.

*Table 5. Distribution of responses by retail category*

<b>Retail Category</b>	Have you experienced load shedding in 2015 without backup power?		<b>Total</b>
	<b>No</b>	<b>Yes</b>	
Food, beverages and tobacco in specialised stores	5	8	13
General dealers	1	1	2
Hardware, paint and glass	1	2	3
Household furniture, appliances and equipment	2	11	13
Pharmaceuticals and medical goods, cosmetics and toiletries		5	5
Restaurants and Pubs	2	16	18
Services and Entertainment		12	12
Textiles, clothing, footwear and leather goods	4	27	31
Other	2	7	9
<b>Total</b>	<b>17</b>	<b>89</b>	<b>106</b>

*Table 6. Distribution of responses by square meterage of store*

<b>Square meterage of store</b>	Have you experienced load shedding in 2015 without backup power?		<b>Total</b>
	<b>No</b>	<b>Yes</b>	
Less than 50 square meters		5	5
50 to 100 square meters	5	20	25

Have you experienced load shedding in 2015 without backup power?			
Square meterage of store	No	Yes	Total
100 to 200 square meters	2	35	37
200 to 400 square meters	2	14	16
400 to 800 square meters	1	7	8
800 to 1600 square meters	6	6	12
1600 to 3200 square meters	1	2	3
<b>Total</b>	<b>17</b>	<b>89</b>	<b>106</b>

Table 7. Distribution of responses by number of employees working in store

Have you experienced load shedding in 2015 without backup power?			
Number of employees	No	Yes	Total
1 to 5	5	37	42
5 to 10	3	29	32
10 to 20	1	11	12
20 to 40	4	8	12
More than 40	4	4	8
<b>Total</b>	<b>17</b>	<b>89</b>	<b>106</b>

Table 8. Distribution of responses by neighborhood of store

Have you experienced load shedding in 2015 without backup power?			
Neighborhood	No	Yes	Total
Not Completed	1	3	4
Brooklyn		6	6
Douglas	1		1
Fordsburg	3	9	12
Germiston	1		1
Groenkloof		1	1
Illovo		2	2
JHB CBD		5	5
Killarney		8	8
Lynwood		1	1
Melkbosstrand		1	1
Midrand	4	15	19
Mulbarton	1		1
Muldersdrift		1	1

Northriding		1	1
Parkhurst	2	7	9
Parkview	2	4	6
Randburg		2	2
Roodepoort		2	2
Summerstrand		2	2
Woodmead	2	19	21
<b>Total</b>	<b>17</b>	<b>89</b>	<b>106</b>

### 5.2.2 Direct Worth Estimates of the Impact of Load Shedding

The 89 respondents who stated that they had experienced load shedding in 2015 without backup power were asked to think of a specific load shedding scenario and describe the day of the week and the time that it started and ended. They were asked to estimate the impact this load shedding scenario had on the daily revenues of the store. The response results are shown in Table 9. Of the original 89 respondents who had experienced load shedding without backup power, 4 failed to describe the details of the scenario and 15 failed to give an estimate for the impact on daily revenues.

*Table 9. Follow on questions for respondents who stated they had experienced load shedding in 2015 without backup power*

	Impact on daily revenues estimated	Impact on daily revenues not estimated	Total
<b>Scenario described</b>	70	15	85
<b>No Scenario described</b>	4		4
<b>Total</b>	<b>74</b>	<b>15</b>	<b>89</b>

This left a sample of 70 respondents who estimated the direct worth of a load shedding scenario on their business. Table 10 to Table 13 show the number of direct worth estimates distributed across retail category, square meterage, number of employees and neighbourhood of the store in question.

*Table 10. Distribution of direct worth estimates by retail category of the store*

Category	Sample size
<b>Food, beverages and tobacco in specialised stores</b>	6
<b>General dealers</b>	1
<b>Hardware, paint and glass</b>	2

Category	Sample size
Household furniture, appliances and equipment	10
Pharmaceuticals and medical goods, cosmetics and toiletries	5
Restaurants and Pubs	13
Services and Entertainment	6
Textiles, clothing, footwear and leather goods	21
Other	6

Table 11. Distribution of direct worth estimates by square meterage of the store

Square meterage of store	Sample size
Less than 50 square meters	4
50 to 100 square meters	16
100 to 200 square meters	23
200 to 400 square meters	14
400 to 800 square meters	7
800 to 1600 square meters	4
1600 to 3200 square meters	2

Table 12. Distribution of direct worth estimates by number of employees of the store

Employees	Sample size
1 to 5	26
5 to 10	26
10 to 20	8
20 to 40	8
More than 40	2

Table 13. Distribution of direct worth estimates by neighborhood of the store

Neighborhood	Sample size
(blank)	2
Brooklyn	2
Fordsburg	8
Illovo	1
JHB CBD	4
Killarney	7
Lynwood	1

Neighborhood	Sample size
Melkbosstrand	1
Midrand	11
Muldersdrift	1
Northriding	1
Parkhurst	5
Parkview	3
Randburg	2
Roodepoort	2
Summerstrand	1
Woodmead	18

### 5.2.2.1 Customer Damage Functions

The direct worth estimations of respondents are considered at an hourly level in order to construct a customer damage function (CDF). An example of a direct worth estimation would be a response that describes that a load shedding scenario of 4 hours on a Tuesday starting at 10am and ending at 2pm decreased daily revenues by 40%. This response holds information for the following four hours:

- Tuesday 10am → 11am
- Tuesday 11am → 12am
- Tuesday 12am → 1pm
- Tuesday 1pm → 2pm

The response is therefore broken up into 4 responses for each hour that it covers and the impact on the daily revenues is averaged across those 4 hours. To capture the impact of each hour we define the metric of “Percentage Daily Revenue Lost per Hour” (PDRLPH). The PDRLPH contains the direct worth estimate for the percentage amount of daily revenue that is lost as a result of that hour of load shedding. In the example described above a revenue decrease of 40% over 4 hours equates to a 10% PDRLPH for each of the hours described. The calculation of PDRLPH is shown in Equation 3.

*Equation 3. Calculation of PDRLPH*

$$PDRLPH = \frac{\text{Direct Worth Estimate of Load shedding Scenario}}{\text{Number of Hours in Scenario}}$$

The CDF can be constructed to show the impact of various factors. The CDF shows the distribution of PDRLPH across various factors that would influence the impact of load shedding. For the purposes of this research we will construct CDF's across the following factors:

- Hour of the day
- Day of the week
- Duration of the load shedding incident
- Hour of the week

The CDF's show how the retail branch manager's estimation of the direct worth of a load shedding incident varies depending on the factors listed above. Data on the dates, times and duration of load shedding incidents experienced during 2015 can then be used to apply the CDF's to extrapolate the impact of load shedding on the broader retail sector. The four CDF's are shown below, but only the hour of the week CDF is used to extrapolate the cost to the broader retail sector.

Figure 3 and Table 14 show how average PDRPLH is distributed across the hour of the day when load shedding occurs.

Figure 3. CDF showing PDRLPH distributed across Time of Day

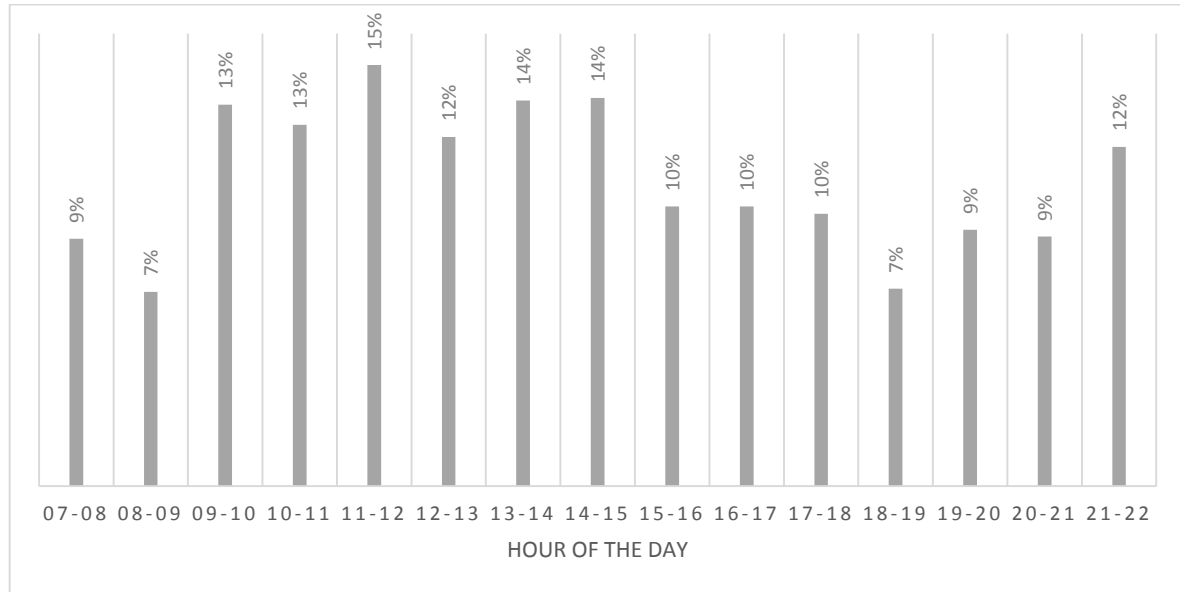


Table 14. Detail behind CDF showing PDRPLH distributed across Hour of the day

Hour of the day	Sample size	Average of PDRPLH	StdDev of PDRPLH	Min of PDRPLH	Max of PDRPLH
07-08	1	9%	-	9%	9%
08-09	2	7%	3%	5%	9%
09-10	12	13%	9%	2%	30%
10-11	28	13%	11%	0%	50%
11-12	35	15%	14%	0%	70%
12-13	31	12%	9%	2%	40%
13-14	31	14%	18%	2%	100%
14-15	29	14%	13%	2%	60%
15-16	24	10%	6%	0%	23%
16-17	24	10%	6%	0%	23%
17-18	22	10%	6%	0%	23%
18-19	9	7%	5%	0%	13%
19-20	5	9%	4%	3%	13%
20-21	4	9%	5%	3%	13%
21-22	1	12%	-	12%	12%

Figure 4 and Table 15 show how average PDRPLH is distributed across the day of the week when load shedding occurs.

Figure 4. CDF showing PDRLPH distributed across Day of the week

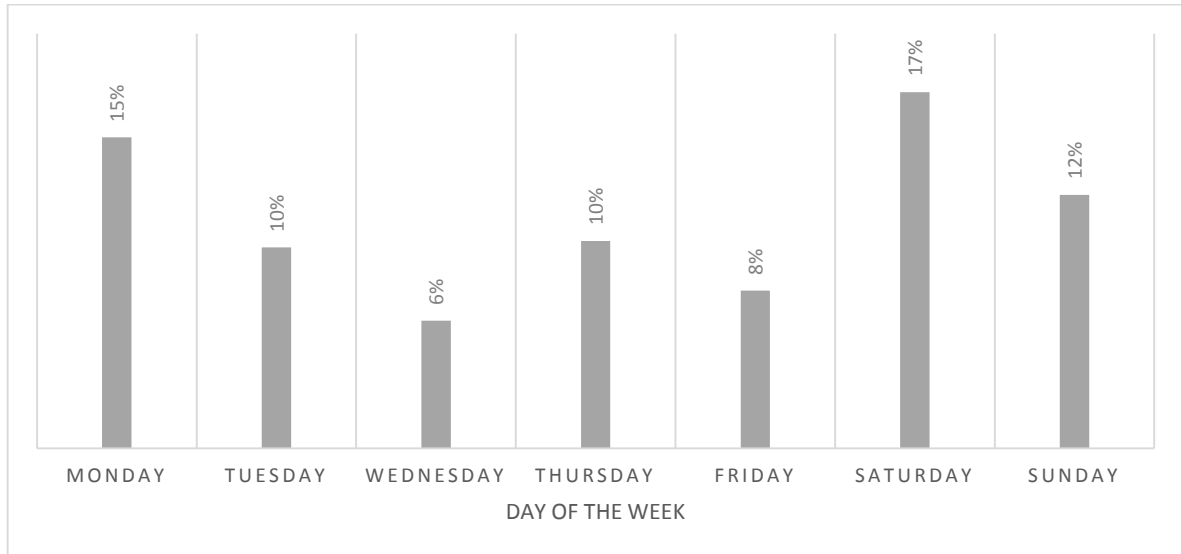


Table 15. Detail behind CDF showing PDRPLH distributed across Day of the week

Day	Sample size	Average of PDRPLH	StdDev of PDRPLH	Min of PDRPLH	Max of PDRPLH
Monday	20	15%	21%	0%	100%
Tuesday	32	10%	7%	0%	23%
Wednesday	26	6%	3%	3%	13%
Thursday	31	10%	5%	0%	15%
Friday	46	8%	9%	0%	60%
Saturday	85	17%	12%	3%	70%
Sunday	18	12%	8%	2%	23%

Figure 5 and Table 16 show how average PDRPLH is distributed across the duration of the load shedding incident.

Figure 5. CDF showing PDRLPH distributed across duration of load shedding scenario

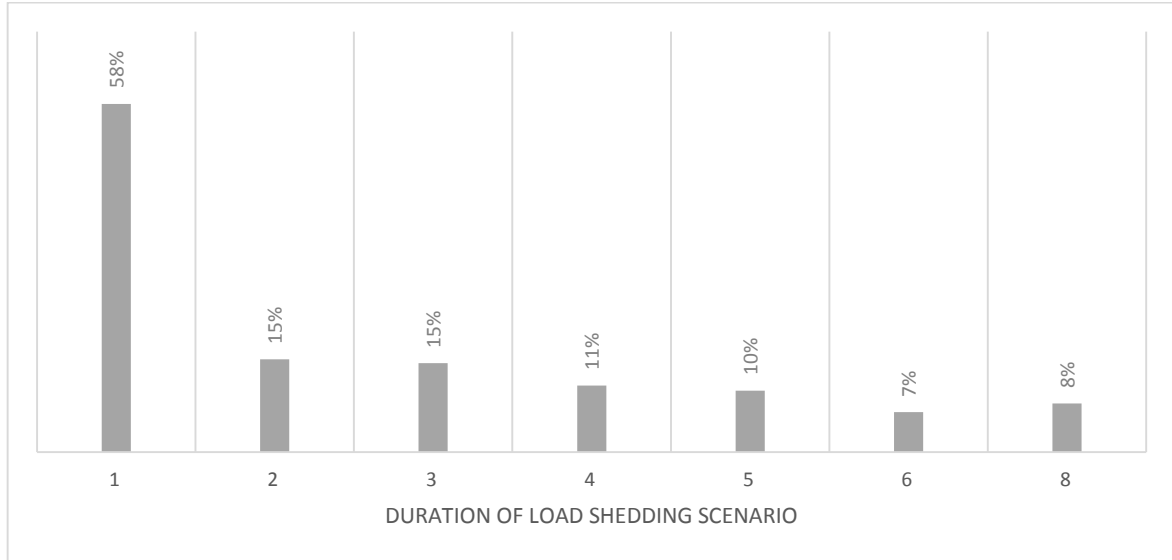
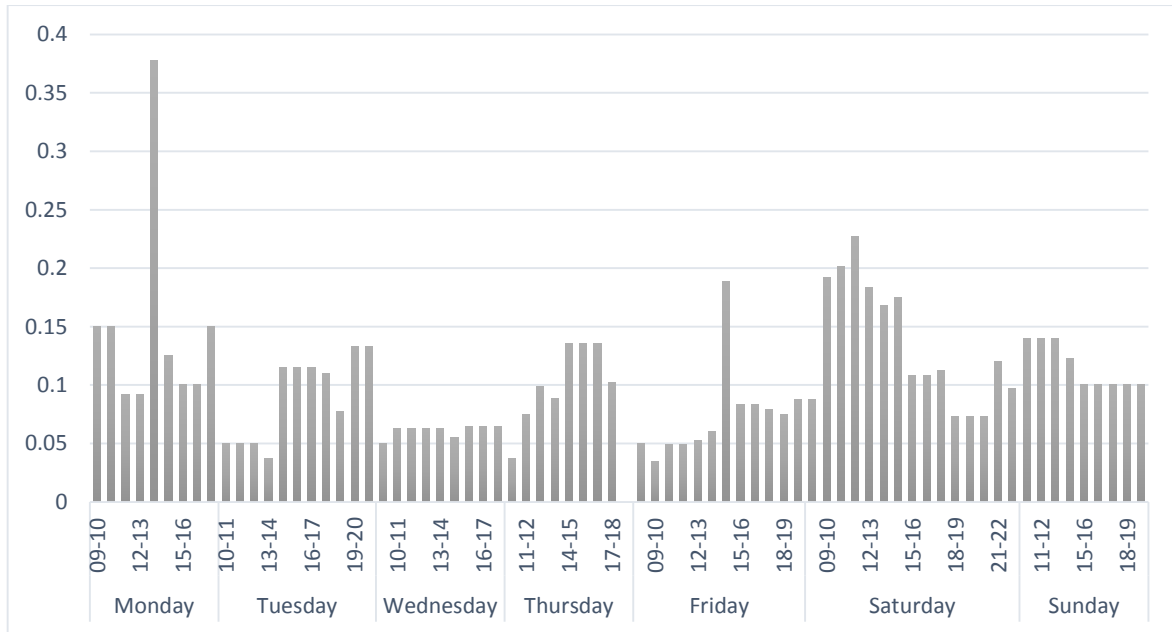


Table 16. Detail behind CDF showing PDRPLH distributed across Duration of load shedding scenario

Duration of load shedding	Sample size	Average of PDRPLH	StdDev of PDRPLH	Min of PDRPLH	Max of PDRPLH
1	5	58%	33%	10%	100%
2	22	15%	18%	0%	50%
3	27	15%	8%	3%	30%
4	124	11%	6%	3%	23%
5	40	10%	6%	2%	20%
6	24	7%	4%	2%	13%
8	16	8%	1%	8%	9%

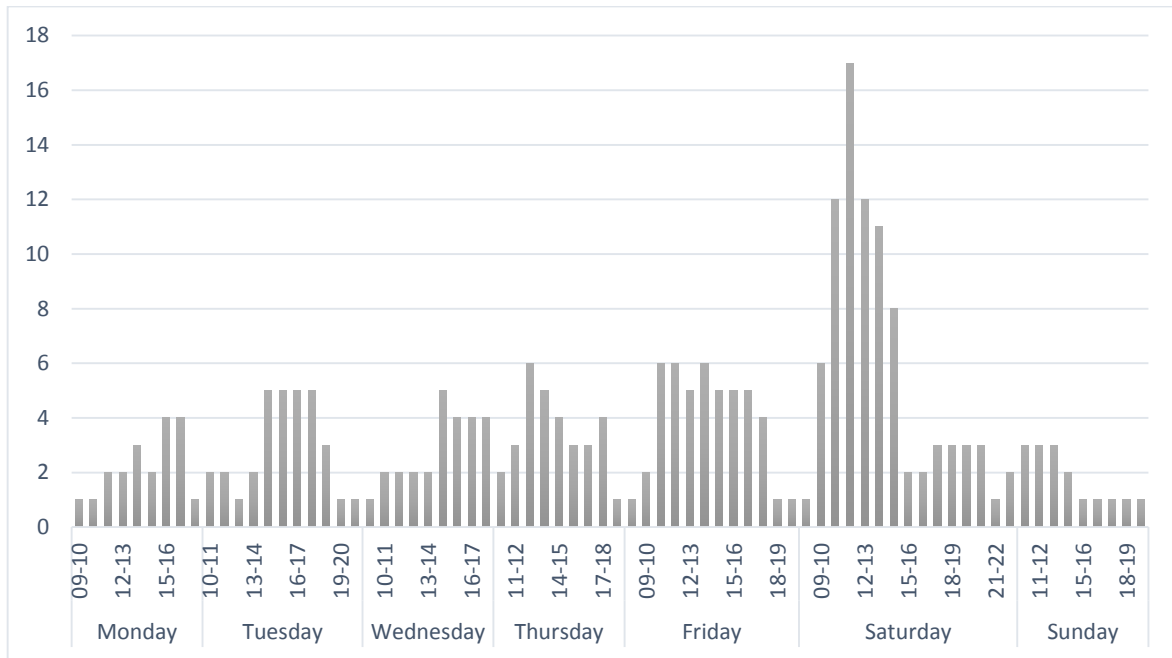
Figure 6 shows how the average PDRLPH is distributed across the hour of the week when load shedding occurs. A more detailed breakdown of the data behind this CDF can be found in Appendix E.

Figure 6. CDF showing PDRLPH distributed across day of the week and hour of the day combined



An interesting observation is that of the total 258 sample hours, 66 of these samples are concentrated between 9am and 3pm on a Saturday. This is illustrated in Figure 7 which shows the number of samples for each hour of the week.

Figure 7. Number of hourly samples for each hour of the week



When respondents are allowed to freely think of a load shedding scenario that impacted their business they have a tendency to recall load shedding scenarios that happened on a Saturday between 9am and 3pm. The average PDRLPH of these hours is also amongst the highest of the sample. Table 17 shows the top 10 hours of the week ranked by average PDRLPH. Of a total of 74 hours of the week represented in the sample 6 of the top 10 are the hours between 9am and 3pm on a Saturday indicating that this is a particularly costly time of the week to experience load shedding.

Table 17. Top 10 hours of the week ranked by average PDRLPH

Day	Hour	Sample size	Average of PDRLPH
Monday	13-14	3	38%
Saturday	11-12	17	23%
Saturday	10-11	12	20%
Saturday	09-10	6	19%
Friday	14-15	5	19%
Saturday	12-13	12	18%
Saturday	14-15	8	17%
Saturday	13-14	11	17%
Monday	09-10	1	15%
Monday	10-11	1	15%

### 5.2.2.2 Load shedding incidents from January to June 2015

Eskom’s official twitter handle has kept the South African public informed of all load shedding actions in 2015. The data from Eskom’s twitter account was analysed to determine when the various stages of load shedding were implemented down to an hourly level. This was possible as the tweets would specify the start and end times of the various stages of load shedding. An example of a tweet on the 16<sup>th</sup> of May 2015 was “Eskom regrets to announce that Stage 1 #load\_shedding will be implemented from 07:00 until 22:00 today”.

This data was used to determine an hourly view of all load shedding from the 1<sup>st</sup> of January to the 30<sup>th</sup> of June. An extract of this data for a single weekend that was particularly hard hit by load shedding is shown in Appendix F. It is clear that for each hour it is known what stage of load shedding is active. The impact that this has on the broader retail industry can be extrapolated using the methodology described in Section 4.2.1.4.

Figure 8 shows the number of hours per day of the various stages of load shedding from the 1<sup>st</sup> of January to the 30<sup>th</sup> June 2015. It is clear that the incidence and length of load shedding periods increased through May and June. This was presumably due to the colder weather and increased usage of electricity by consumers to ward off the cold.

Figure 8. Number of hours per day of various stages of load shedding from the 1st of January to the 30th of June 2015

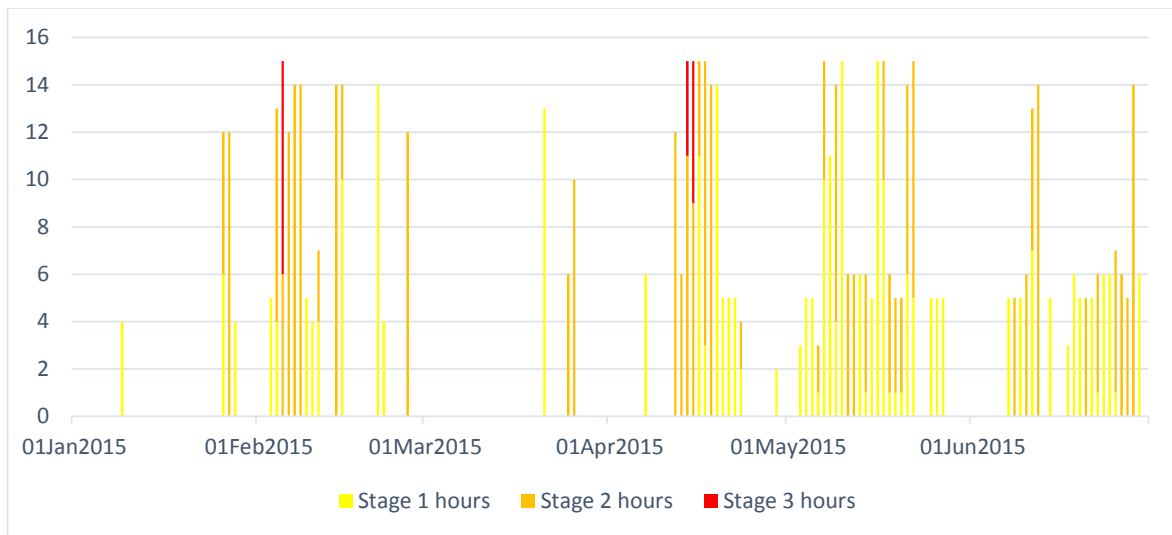


Figure 9 shows the number of hours of various stages of load shedding that occurred between January and June 2015 distributed across the days of the week. Although the weekends are not characterized by a high demand for electricity a significant portion of the load shedding hours occurred during the weekend as Eskom attempted to build up reserves during these times in order to minimise the amount of load shedding required during the week. This was an attempt to minimise the impact of load shedding on the economy. For the retail sector however, the weekends are the most profitable and valuable hours of the week and thus this policy is likely to have increased the impact of load shedding on the retail sector.

Figure 9. The number of hours of various stages of load shedding distributed across the day of the week for the period of January to June 2015

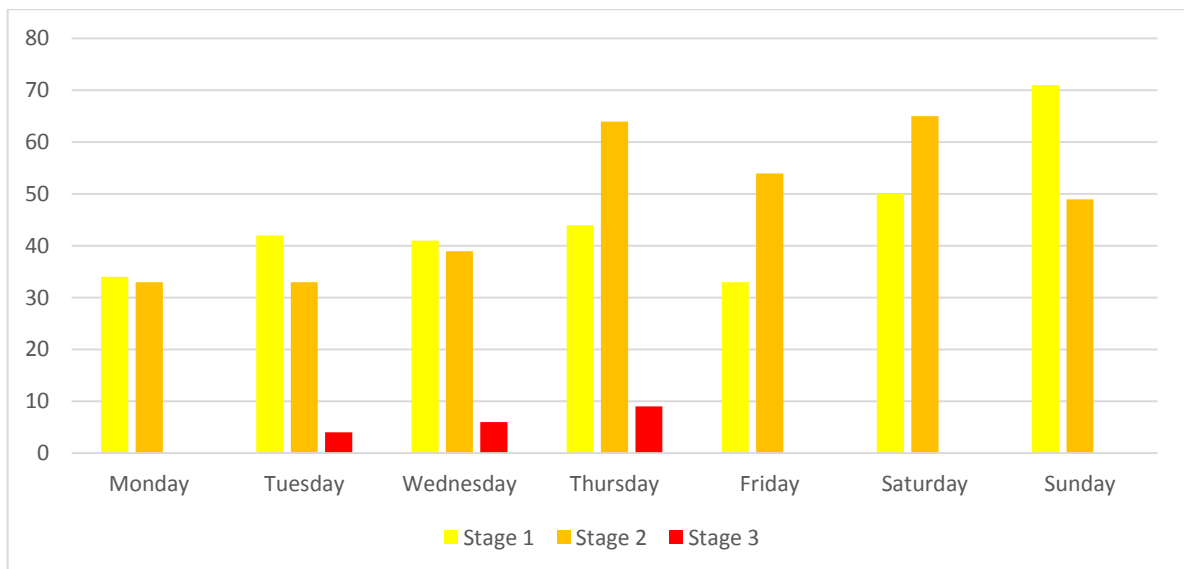
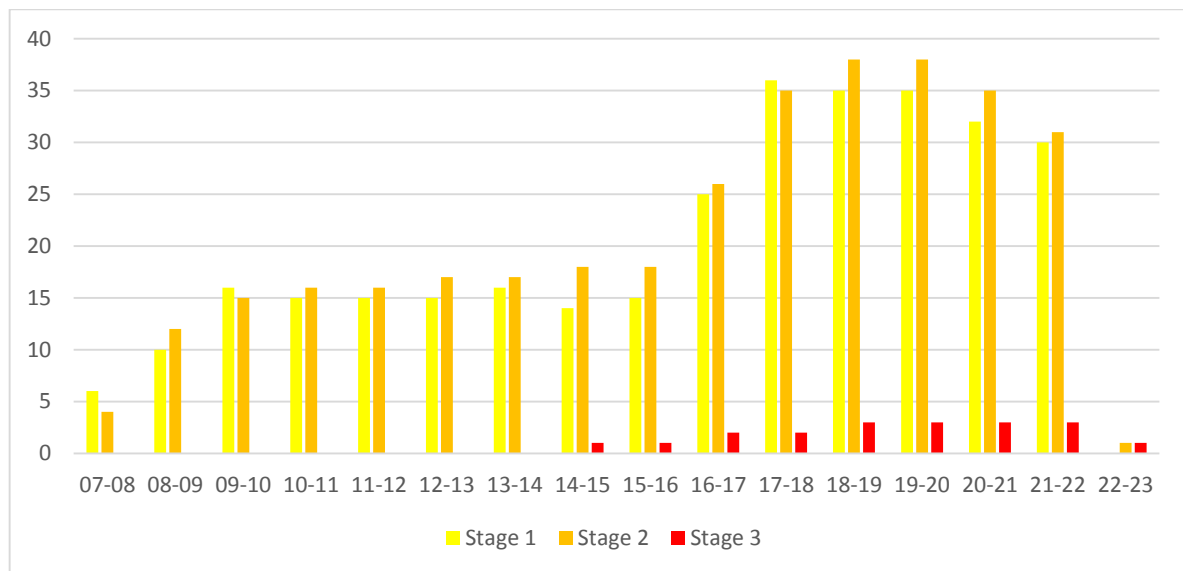


Figure 10 shows the number of hours of various stages of load shedding that occurred between January and June 2015 distributed across the hour of the day. The bulk of load shedding hours occurred between 5pm and 10pm as these represent times of particularly high demand as people go home and cook dinner. This pattern was exacerbated by the onset of colder weather as an increase in the incidence of load shedding can be seen as winter sets in during May and June.

Figure 10. The number of hours of various stages of load shedding distributed across the day of the week for the period of January to June 2015



The data extracted from the Eskom twitter handled was verified against data provided by a company that has developed an Iphone and Android app to inform their customers of when and where load shedding is happening. The data was found to correlate very closely with the extract from the load shedding app company and is thus considered to be a reliable estimation of when load shedding occurred for the first six months of 2015.

### 5.2.2.3 *Extrapolation of the impact of load shedding to the broader retail sector*

In order to extrapolate the costs associated with a particular hour of load shedding to the broader retail sector we need to know the following information:

- The total daily revenues for the broader retail sector
- The impact that the particular hour of power outage has on the retailer's daily revenues

- The percentage of retailers experiencing a power outage during that particular hour due to the stage of load shedding

The details on how these pieces of information are derived are described below.

#### **5.2.2.3.1 The total daily revenues for the broader retail sector**

The CDF derived in Section 5.2.2.1 is expressed as a percentage of daily revenues per hour. In order to extrapolate this impact to a figure we need to have a view of the revenues that are earned in the retail sector per day. During the analysis, the percentage losses in daily revenues will be tallied up to produce a percentage loss in monthly revenue. This assumes that all days contribute an equivalent percentage to the monthly revenue, which is not an accurate reflection of reality. Retail trade tends to increase towards the end of the month once people are paid. If the CDF derived in Section 5.2.2.1 reflected the impact of the hour of the month the changes in revenue earned on different days of the month could be factored into this analysis. The percentage losses in monthly revenue will then be extrapolated against the monthly revenues earned in the retail, and food and beverage industries. This information is available from quarterly retail trade sales (Statistics South Africa, 2015) and food and beverage (Statistics South Africa, 2015) figures published by StatsSA and are shown in Table 18.

*Table 18. Monthly revenues for retail and food and beverages sectors from January to June 2015 (R million)*

Month Y2015	Revenue		
	Retail Trade Figures	Food and Beverage	Total Revenues
January	65 436	3901	69 337
February	65 502	3701	69 203
March	67 756	4057	71 813
April	67 818	3908	71 726
May	70 082	3927	74 009
June	68 338	3708	72 046

#### **5.2.2.3.2 The impact that a power outage has on the retailer's daily revenues**

The CDF derived from the subjective evaluation method gives us insight into the impact that a particular hour of power outage has on the retailers daily revenues. The impact is expressed as the percentage of daily revenue loss per hour (PDRLPH). This will be used to determine the percentage of daily revenues lost by affected retailers. The percentages

of daily revenues lost will then be tallied up to produce the percentage of monthly revenues lost due to all the load shedding that happened for that month.

#### ***5.2.2.3.3 The percentage of retailers experiencing a power outage during a particular hour of load shedding***

While load shedding occurs, not all electricity consumers are simultaneously affected. Only a percentage of the country's electricity consumers will experience a power outage during any particular hour of load shedding. We will assume that the percentage of retailers experiencing a power outage during an hour of load shedding is equivalent to the percentage of electricity consumers experiencing a power outage during an hour of load shedding.

In order to obtain a reasonable estimate for the percentage of retailers experiencing a power outage during an hour of load shedding, an understanding of how the various stages of load shedding are scheduled was necessary. By understanding the structure of the load shedding schedules, we can work out a percentage of retailers that are likely to experience a power outage during a particular stage of load shedding. The details of this estimation are described below. The operating hours of the retailers also need to be considered because if the hour in question is outside of general retail operating hours it is unlikely to impact daily revenues.

An extract from the Eskom website (Eskom, 2015) describes the various stages of load shedding as follows:

- Stage 1 requires the least amount of load shedding, 3 times over a four day period for two hours at a time, or 3 times over an eight day period for four hours at a time.
- Stage 2 will double the frequency of Stage 1, which means you will be scheduled for load shedding 6 times over a four day period for two hours at a time, or 6 times over an eight day period for four hours at a time
- Stage 3 will increase the frequency of Stage 2 by 50%, which means that one will be scheduled for load shedding 9 times over a four day period for two hours at a time, or 9 times over an eight day period for four hours at a time.
- Stage 4 will double the frequency of Stage 2, which means that one will be scheduled for load shedding 12 times over a four day period for two hours at a time, or 12 times over an eight day period for four hours at a time.

Consider stage 1 load shedding. It consists of 3 outages for two hours at a time over a 4 day period. Because load shedding only occurs between the hours of 7am and 10pm, there

is therefore a total of 60 available hours to be load shed during the 4 day period. The details are shown in Equation 4.

*Equation 4. Available hours to be load shed in a 4 day cycle*

$$\text{Available hours to be load shed in 4 day period} = (10\text{pm} - 7\text{am}) * 4 = 15 * 4 = 60 \text{ hours}$$

The description of load shedding from Eskom's website details the number of hours of load shedding experienced during each stage. If for instance, stage 1 involves being load shed 3 times for 2 hours at a time over the 4 day period, the percentage of time that an individual retailer will experience load shedding during the 4 day period for stage 1 load shedding can be calculated. The details are shown in Equation 5.

*Equation 5. Percentage of time an individual retailer will experience load shedding during stage 1*

$$\% \text{ time an individual retailer will experience load shedding stage 1} = \frac{3 * 2}{60} = 10\%$$

This means that during stage 1 load shedding any particular retailer should experience 10% of the time between 7am and 10pm without power. This is equivalent to saying that the probability that an individual retailer experiences a power outage during stage 1 load shedding is 10%. If there is a 10% probability for each retailer to experience a power outage during stage 1 load shedding, then collectively 10% of all retailers will experience a power outage during stage 1 load shedding. This is show in Equation 6.

*Equation 6. Percentage of retailers experiencing a power outage during stage 1*

$$\text{Percentage of retailers experiencing a power outage during stage 1} = \frac{3 * 2}{60} = 10\%$$

Using the same principle the percentage of retailers that will experience a power outage during stage 2 and stage 3 load shedding can be calculated. The details are shown in Equation 7 and Equation 8.

*Equation 7. Percentage of retailers experiencing a power outage during stage 2 load shedding*

$$\text{Percentage of retailers experiencing a power outage during stage 2} = \frac{6 * 2}{60} = 20\%$$

*Equation 8. Percentage of retailers experiencing a power outage during stage 3 load shedding*

$$\text{Percentage of retailers experiencing a power outage during stage 3} = \frac{9 * 2}{60} = 30\%$$

Load shedding occurs between 7am and 10pm. It is possible that load shedding can occur at hours during which retailers are closed, in which case the load shedding should not have

any impact on the daily revenues. The CDF derived in Section 5.2.2.1 is only valid if the load shedding occurs during normal operating hours. It is thus important to consider the trading hours of retailers in order to understand what percentage of retailers will be open during a particular load shedding hour.

In order to understand the percentage of retailers that would be open during a particular hour of the week a trading hour's survey was conducted. The trading hours of a sample of 61 shopping malls were gathered from the shopping mall's websites and processed to calculate the percentage of retailers open during each hour of the week. A distinction was made between retailers and restaurants. Retailers were considered to operate according to the shopping mall trading hours whereas restaurants were considered to open during the shopping mall trading hours and to close at 10pm. This is an important assumption regarding the operating hours of restaurants as a significant portion of the hours of load shedding occurred between 5pm and 10pm. The final results of the trading hours survey was a percentage of retailers and restaurants open during each hour of the week. A sample for a Friday is shown in Table 19 and the full table is available in Appendix G.

*Table 19. Percentage of retailers and restaurants open during a Friday distributed across the hours of the day*

<b>Day</b>	<b>Hour</b>	<b>% Retailers Open</b>	<b>% Restaurants Open</b>
<b>Friday</b>	07-08	2	2
<b>Friday</b>	08-09	10	10
<b>Friday</b>	09-10	100	100
<b>Friday</b>	10-11	100	100
<b>Friday</b>	11-12	100	100
<b>Friday</b>	12-13	100	100
<b>Friday</b>	13-14	100	100
<b>Friday</b>	14-15	100	100
<b>Friday</b>	15-16	100	100
<b>Friday</b>	16-17	100	100
<b>Friday</b>	17-18	92	100
<b>Friday</b>	18-19	59	100
<b>Friday</b>	19-20	16	100
<b>Friday</b>	20-21	11	100
<b>Friday</b>	21-22	0	100

#### **5.2.2.3.4 Extrapolation of impact of load shedding to the retail sector**

Using the hourly data of all load shedding events between the 1<sup>st</sup> of January and 30<sup>th</sup> of June 2015 the impact that each hour of load shedding had on the broader retail sector can be estimated. The outcome from the subjective evaluation method survey was a CDF distributed across the hour of the week. This CDF estimated the percentage of daily revenue a retailer would lose depending on which hour of the week the load shedding occurs.

In order to understand the impact beyond a single retailer an understanding of the percentage of retailers affected by each hour of load shedding was necessary. By understanding the structure of the load shedding timetables for the various stages of load shedding, the following estimations can be made:

- 10% of retailers are affected during an hour of stage 1 load shedding
- 20% of retailers are affected during an hour of stage 1 load shedding
- 30% of retailers are affected during an hour of stage 1 load shedding

Load shedding can only impact the revenue of a retailer if it occurs during operating hours. In order to estimate the percentage of retailers that would be open during an hour of load shedding a survey of the trading hours of 61 shopping malls was conducted. The outcome was a distribution of the percentage of retailers and restaurants open during each hour of the week.

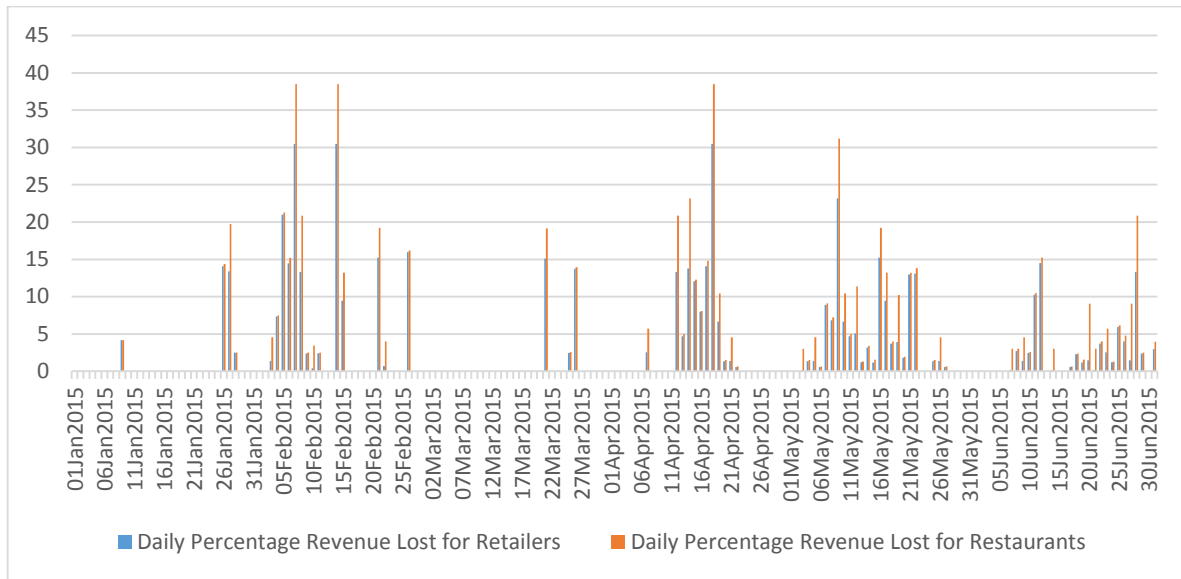
The percentage of daily revenue lost by the broader retail sector due a particular hour of load shedding was calculated using Equation 9.

*Equation 9. Percentage daily revenue lost by the broader retail sector due to a particular hour of load shedding*

$$PDRLPH_{Retail\ sector} = PDRLPH_{CDF} \times \% Retailers\ affected \times \% Retailers\ open$$

The PDRLPH for all hours of the day are then added up to get the daily percentage of revenue lost for each particular day due to load shedding. Figure 11 shows the daily percentage of revenue lost for each day during the sample period. During some days when load shedding occurred for 14 hours of the day, the extrapolation estimates the percentage daily revenue to be as high as 38%. These estimates occur particularly on days when stage 3 load shedding was active during February and April.

Figure 11. Daily percentage revenue lost due to load shedding for retailers for period from January to June 2015



The percentage of revenue lost for each day is then averaged across the whole month to get the average percentage of revenue lost per day. The average percentage revenue lost per day is equivalent to the percentage of revenue lost for the month. This is shown in Equation 10.

Equation 10. Percentage of revenue lost per month

$$\% \text{ Revenue lost per month} = \text{Avg } \% \text{ Revenue lost per Day} = \frac{\sum_i^n PRL_i}{n}$$

where,

- $PRL_i$  is the percentage revenue lost for the  $i^{th}$  day of the month
- $n$  is the number of days in the month

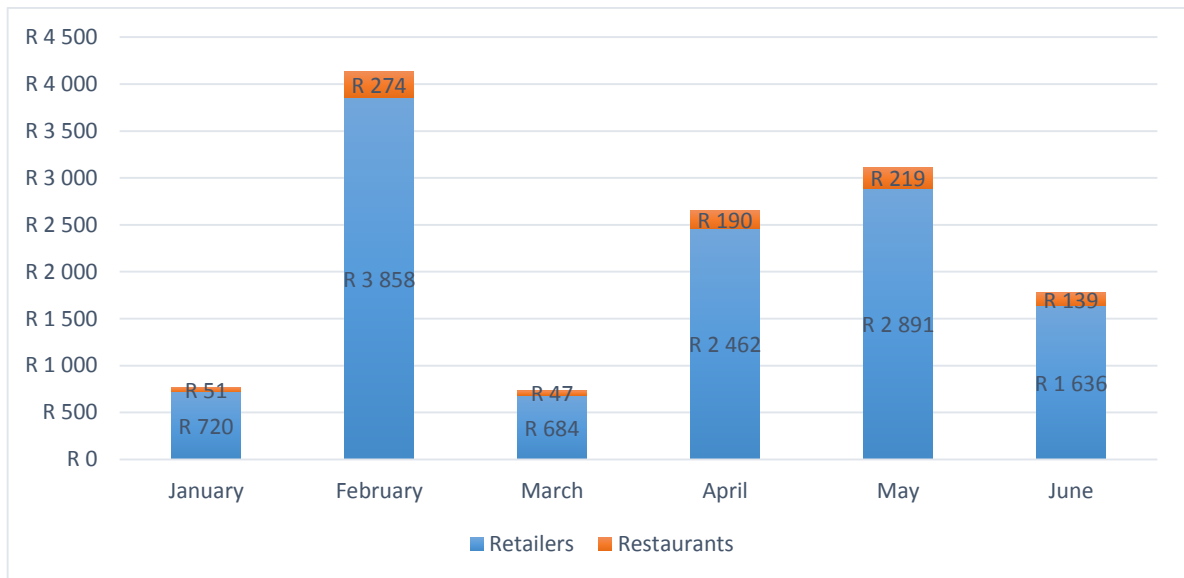
The percentage of revenue lost for the month are then extrapolated against the monthly revenues for the retail and the food and beverage sectors. The results are shown in Table 20 and Figure 12.

Table 20. Impact of load shedding on the retail sector from January to June 2015 (R million)

Month 2015	Revenue		% Revenue lost per month		Revenue lost per month		
	Retail Trade Figures	Food and Beverage	Retailers	Restaurants	Retailers	Restaurants	Total
January	R 65 436	R 3 901	1%	1%	R 720	R 51	R 771
February	R 65 502	R 3 701	6%	7%	R 3 858	R 274	R 4 133

Month 2015	Revenue		% Revenue lost per month		Revenue lost per month		
	Retail Trade Figures	Food and Beverage	Retailers	Restaurants	Retailers	Restaurants	Total
March	R 67 756	R 4 057	1%	1%	R 684	R 47	R 731
April	R 67 818	R 3 908	4%	5%	R 2 462	R 190	R 2 651
May	R 70 082	R 3 927	4%	6%	R 2 891	R 219	R 3 110
June	R 68 338	R 3 708	2%	4%	R 1 636	R 139	R 1 776

Figure 12. Impact of load shedding on the retail sector from January to June 2015 (R million)



Thus the total cost of load shedding to the retail sector for the first six months of 2015 was R13.17 billion as estimated by the subjective evaluation methodology based on customer surveys of retail branch managers.

### 5.3 Study 3: Revealed Preferences Methodology

#### 5.3.1 Secondary data on the cost of backup generation

Financial data on the cost of providing backup generation to retail stores was obtained from two organisations. The first was a large chain retail organisation with 343 stores in South Africa. The data from this organisation showed the diesel and maintenance expenses associated with providing backup generators for the first six months of 2015. The organisation was not able to supply the capital amortisation expenses associated with the generators in their stores.

The second organisation is a shopping mall management company. The data obtained from this organisation showed the monthly charges that the shopping mall charged 40 individual tenants for the provision of backup generation services for the first six months of 2015. The charges are broken down into capital amortisation, maintenance and diesel expense components. The capital charges for January and February were not available in the data. For each store, the capital charges in January and February were assumed to be equal to the average capital charge for the remaining months. This is an acceptable assumption because the capital charge is a fixed monthly figure that only changes once a year.

In both sets of the data, the number of stores and the gross leasable area (GLA) of the stores are known. Table 21 and Table 22 show the number of stores and the GLA respectively.

*Table 21. Number of stores represented in the financial data showing the costs of providing backup generation power*

<b>Month</b>	<b>Type of expense</b>		
	<b>Capital</b>	<b>Diesel</b>	<b>Maintenance</b>
<b>Jan</b>	40	343	366
<b>Feb</b>	40	344	376
<b>Mar</b>	40	356	391
<b>Apr</b>	40	386	385
<b>May</b>	40	386	384
<b>Jun</b>	40	386	383

*Table 22. Total GLA represented in the financial data showing the costs of providing backup generation power*

<b>Month</b>	<b>Type of expense</b>		
	<b>Capital</b>	<b>Diesel</b>	<b>Maintenance</b>
<b>Jan</b>	6 429	816 520	819 500
<b>Feb</b>	6 429	816 807	821 027
<b>Mar</b>	6 429	818 560	825 913
<b>Apr</b>	6 429	824 649	824 362
<b>May</b>	6 429	824 649	824 317
<b>Jun</b>	6 429	824 649	824 073

The average cost per square meter per month of providing backup generation power was then calculated per expense component. The results are shown in Table 23. The total average cost per square meter per month is the sum of each of the expense components

and is consistent with the ballpark figure of R5 per square meter per month mentioned by financial managers during the qualitative interviews.

*Table 23. Average cost per month of providing backup generation power*

Month	Type of expense			Total
	Capital	Diesel	Maintenance	
Jan	R 4.90	R 0.40	R 0.24	R 5.55
Feb	R 4.91	R 1.44	R 0.77	R 7.12
Mar	R 4.71	R 0.88	R 0.81	R 6.40
Apr	R 4.91	R 0.47	R 0.38	R 5.76
May	R 5.01	R 0.96	R 0.39	R 6.36
Jun	R 5.03	R 1.16	R 0.40	R 6.59

### 5.3.2 Survey response data on the cost of backup generation

There has been a significant move towards retailers adopting backup generation facilities during 2015 as shown in Table 24. Of the 89 responses that stated that they had experienced load shedding without backup power in 2015, 41 now have backup generation facilities. Of the 17 respondents who have stated they have not experienced load shedding in 2015, 16 have backup power. The one anomaly is a respondent who has stated they have not experienced load shedding without backup power and they do not have backup power now.

*Table 24. Change in use of backup power in 2015*

Have you experienced load shedding in 2015 without backup power?	Do you have backup power now?	Total
No	No	1
No	Yes	16
Yes	No	48
Yes	Yes	41
<b>Total</b>		106

Respondents who indicated that they use backup generation power were asked whether they manage their backup power themselves or receive it as a service. Table 25 shows the number of respondents who manage their own backup power as opposed to receive it as a service. The majority of backup power is self-managed for retailers in our sample.

There is an increasing trend for shopping malls to install generator farms and include an option for tenants to have access backup power. It is important to note that there is an increasing trend for retailers to receive backup power as a service. The charge is based on a fixed monthly fee and a variable service fee that changes depending on how much load shedding occurs for that month. The fixed monthly fee will cover the amortisation of the generator installation and the variable service fee will cover the diesel and maintenance costs.

*Table 25. Source of backup power*

<b>Self-managed</b>	<b>49</b>
<b>Provided as a service</b>	<b>8</b>
<b>Total</b>	<b>57</b>

The cost of backup power is more expensive than electricity from Eskom and as such retailers tend to only backup the essential elements of their operations. Air conditioning, for example, is a very electricity intensive service and the majority of retailers consider it a non-essential operational element that does not get backed up. Table 26 shows the percentage of the store that is backed up from the 57 respondents who said they do have backup power now.

*Table 26. Percentage of stores backed up by retail category*

<b>Retail category</b>	<b>Sample size</b>	<b>Average percentage of stores backed up</b>
Food, beverages and tobacco in specialised stores	11	77%
General dealers	2	20%
Hardware, paint and glass	2	65%
Household furniture, appliances and equipment	7	60%
Pharmaceuticals and medical goods, cosmetics and toiletries	3	63%
Restaurants and Pubs	11	70%
Services and Entertainment	8	83%
Textiles, clothing, footwear and leather goods	8	75%
Other	5	65%
<b>Grand Total</b>	<b>57</b>	<b>70%</b>

During the trial survey it was found that branch managers tend to not know the monthly cost of backup power for the stores that they manage. In order to implement the marginal cost of backup methodology reliably, the cost of providing backup power was sought from head office. The results of this analysis are detailed in Section 5.3.

The questions pertaining to the cost of providing backup power were left in the survey and of the 57 respondents who said that they use backup power now, 37 estimated their monthly cost of providing backup power per SQM. The results are shown in Table 27.

*Table 27. Monthly cost of providing backup power per SQM by retail category*

<b>Retail category</b>	<b>Sample size</b>	<b>Average monthly cost of backup power per SQM</b>
Food, beverages and tobacco in specialized stores	10	R 8.61
General dealers	2	R 3.96
Hardware, paint and glass	1	R 2.08
Household furniture, appliances and equipment	5	R 2.28
Pharmaceuticals and medical goods, cosmetics and toiletries	2	R 9.17
Restaurants and Pubs	9	R 23.41
Services and Entertainment	3	R 3.61
Textiles, clothing, footwear and leather goods	2	R 1.04
Other	3	R 2.68
<b>Grand Total</b>	<b>37</b>	<b>R 9.66</b>

### **5.3.3 Extrapolation of the cost of load shedding to the retail sector**

In order to understand how much South African retailers are spending collectively at an industry level to provide backup generation power we need to know the GLA of the South African retail sector and the percentage of stores that implement backup generation power.

The GLA of the South African retail sector is not publicly available. Through qualitative interviews with industry experts a figure of 24 million square meters of gross leasable area retail space is available in South African shopping malls. This figure shall be used for the purposes of our analysis.

One of the questions in the survey of retail branch managers was whether the store has backup generation power in place. Although it was found that branch managers tend not to

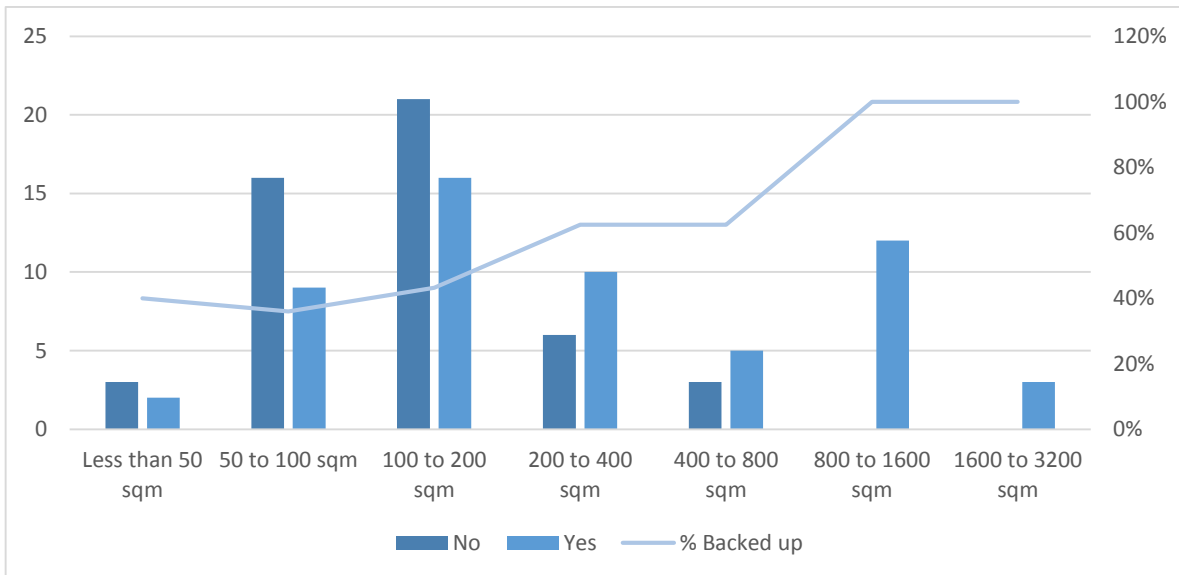
know the details of the costs associated with providing backup generation power, they are able to reliably answer whether or not a store has backup generation power. The results of this question are shown in Table 28. The number of stores that use backup generation facilities is 54%, but if we consider the GLA of the stores it is apparent that there is a bias towards smaller stores not making use of backup generation facilities. Table 28 shows that 79% of the GLA of stores is backed up.

Table 28. Survey response to the question "Does your retail outlet use backup generation facilities?"

Does your retail outlet use backup generation facilities?	Number of stores	% Number of stores	GLA of stores	% GLA of stores
No	49	46%	8 025	21%
Yes	57	54%	30 725	79%
<b>Total</b>	<b>106</b>		<b>38 750</b>	

Figure 13 shows the use of backup generation power distributed across the size of the store. It is clear that as the size of the store increases the likelihood of there being backup generation increases. All 15 stores in the survey sample with 800 square meters (sqm) or more made use of backup generation power.

Figure 13. Survey response to the question "Does your retail outlet use backup generation facilities" distributed across the size of the store



This would be an expected result as one of the obstacles of implementing backup generation facilities is the high capital cost and smaller stores would be less likely to be able to afford

this. For the purposes of this analysis, the percentage of GLA of stores was used, because the extrapolation toward the broader retail sector is based on the GLA. Therefore, 79% of the GLA in the South African retail sector is backed up. This results in a total of 18,960,00 square meters of GLA for the South African retail sector as shown in Equation 11.

*Equation 11. Percentage of retail space backed up in the South African retail sector*

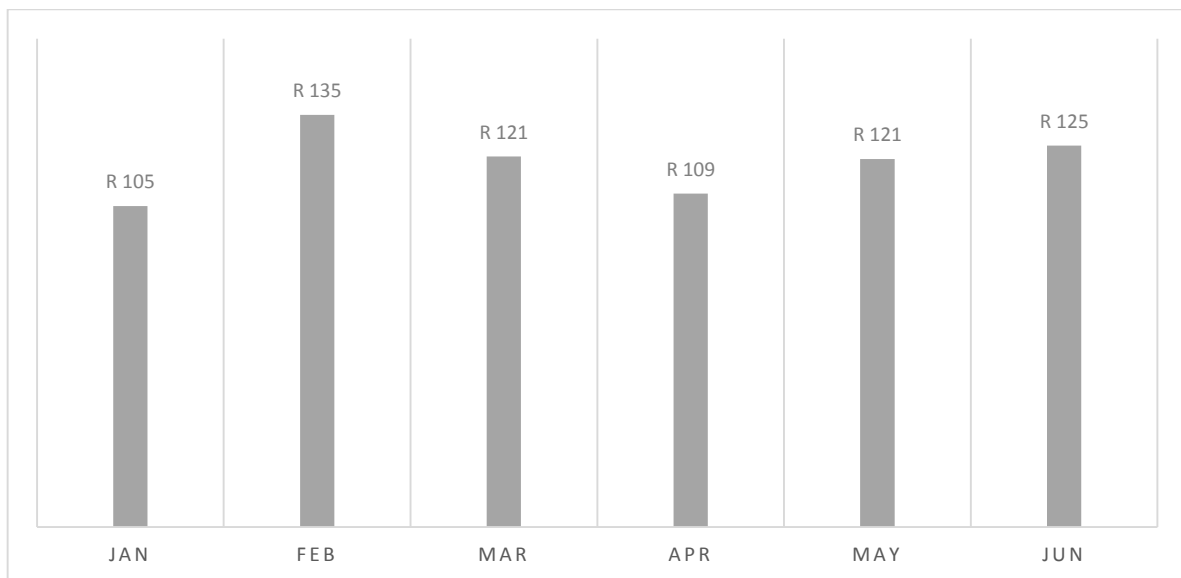
$$GLA_{backed\ up} = 24,000,000\ m^2 \times 79\% = 18,960,000m^2$$

Using the total cost per square metre (sqm) per month shown in Table 23 the total costs of providing backup generation power to the broader South African retail sector can be extrapolated. The results of this are shown in Table 29 and Figure 14.

Table 29. Total costs of providing backup generation power for the South African retail sector (R million)

Month	GLA backed up	Total cost per sqm	Total cost to broader retail sector (R million)
Jan	18 960 000	R 5.55	R 105
Feb	18 960 000	R 7.12	R 135
Mar	18 960 000	R 6.40	R 121
Apr	18 960 000	R 5.76	R 109
May	18 960 000	R 6.36	R 121
Jun	18 960 000	R 6.59	R 125

Figure 14. Total costs of providing backup generation power for the South African retail sector (R million)



Thus the total cost of providing backup generation power to the retail sector for the first six months of 2015 was R716 million.

## **6 Discussion of Results**

### **6.1 Introduction**

The objectives of the current research were to expand our understanding of the impact that load shedding has had on the South African retail sector. This included a qualitative analysis of the issues that arise due to frequent power outages as well as a quantitative assessment of the overall costs to the retail sector as a whole.

This has been achieved through a mixed-methods approach and the implementation of three studies. Study 1 consisted of semi-structured interviews with financial and operational managers of retail organisations and resulted in the qualitative model describing the impacts of load shedding shown in Figure 3. A discussion of the results of this model will be done under research question 1.

Studies 2 and 3 consisted of the implementation of quantitative methods found in the academic literature for measuring the cost of power interruptions. The subjective evaluation method and the marginal cost of backup method were both found to be acceptable for measuring the direct costs of power interruptions in a supply constrained electricity environment. The results of these two studies are discussed under research question 2.

A third research question considered the ability of South African retailers to mitigate the impact of the current electricity crisis and the results of all three studies will be discussed when considering this question.

### **6.2 Research Question 1: How does load shedding impact South African retailers?**

Nine major themes emerged from the qualitative analysis in study 1. These themes describe the most pertinent issues retailers face due to frequent load shedding and are captured in the model shown in Figure 2 in Section 5.1.4.

#### **6.2.1 Degree of impact of load shedding**

The frequency of comments describing the degree of impact that load shedding has had on the business is shown in Figure 1 in Section 5.1.4.3. The majority of respondents consider the impact of load shedding to be severely negative. Occasional respondents consider the impact to be neutral and in some cases even positive as it leads to more business opportunities. These cases are however the exception and are due to specific conditions

relating to that business. More details on the positive outcomes of load shedding are covered in Section 6.2.9.

The degree of impact is also found to vary depending on a number of factors related to the retail business and the nature of the load shedding incident. The category of retailer is a significant factor in considering the impact of load shedding.

- **Interview 4:** *We need to differentiate between normal retailers who sell dry goods and supermarkets who sell fresh and chilled products. The impact of load shedding is considerably different for these kinds of customers*

This distinction between grocery retailers and other normal retailers highlights a shortcoming of studies 2 and 3 of the current research. In order to effectively measure the quantitative impact of load shedding the methodologies would need to distinguish between the categories of retail store. This would imply that the methodologies should be implemented per retail category. This would also imply category specific CDF's and category specific data on the cost of providing backup generation power.

A similar distinction exists concerning the location of the retail outlet. The data suggests a distinction between stores located in large super regional malls, smaller strip malls and high street CBD stores not located in a shopping mall.

An interesting extension to the current research would be a study that measured the quantitative costs of load shedding within each category of retailer and between the three locations identified above. A comparison between the various categories and locations would be informative.

The factors relating to the nature of the load shedding incident, including the day of the week, the time of the day and the duration of the load shedding are considered in studies 2 and 3 as they were highlighted as important factors to consider in the literature review. The nature of these costs will also “depend critically upon a host of factors such as the severity of the outage as defined by its time and duration of occurrence, magnitude, and extent of advance notification” (Sanghvi, 1991). A consistent feature of the qualitative data is the fact that a reliable notification can assist retailers in mitigating the impact of load shedding.

- **Interview 5:** *We have a decent relationship with Eskom in the sense that they inform me well in advance so that we can prepare for load shedding. And this is important.*

The degree of impact is at the base of the model shown in Figure 2 as these factors affect the impact across all elements shown in the model. It emerges as an issue of moderate importance in the qualitative data and is thus shown as moderate size in the model.

### **6.2.2 Operational impact of load shedding**

Load shedding has been a disruptive influence on retail operations. Prior to the electricity crisis retailers were used to a stable and reliable source of power and many of the systems and processes used to run a store were not designed to endure frequent power outages. The unpredictable nature of load shedding continues to make planning a challenge.

The most frequently cited operational problem in the data from study 1 is a lack of lighting. The display of goods is an essential element of retail and the ability to perform this task is not possible without power. The purchasing of items also emerge as a major problem. Both the ability to manage transactions and to receive payments are hindered. The majority of customers prefer to pay by credit card and a significant portion of sales will be lost if POS devices are not working. Many survey respondents mentioned that a power outage led to loss of communications and that without a telephone or internet connection they were unable to receive and process orders.

The maintenance of a cold chain in grocery retail is critical. Stock loss comes straight off the bottom line and can run into hundreds of thousands of Rands for a medium sized store. The duration of the load shedding incident is critical in determining the impact on stock losses. Fridges can maintain cooler temperatures by simply remaining closed if power outages are 2 hours or less.

The operations block in Figure 2 is represented underneath costs and revenue as it is disruptions in the normal operations that lead to impacts on costs and revenue.

### **6.2.3 Costs associated with load shedding**

The cost associated with load shedding is one of the two most significant themes emerging from study 1. In the model in Figure 2 this theme is shown as one of the largest blocks at the centre of the model. The costs theme rests on top of operations as the costs arise due to required changes in operations. The two most significant sub themes of costs are mitigation and security which themselves emerge as separate themes in the model. These will be discussed in Sections 6.2.5 and 6.2.5 respectively.

Other sub themes of costs associated with load shedding are the fact that the costs associated with load shedding come straight off the bottom line. The money that a business needs to spend on extra costs due to load shedding would otherwise appear as profit or would be invested in further expanding the business. This points to the opportunity cost to the retail sector and the economy as a whole. A decline in profitability of the retail sector leads to current participants in the market having less money being available for future investment.

The distinction between fixed and variable costs is important. The fixed costs are often associated with a large initial capital outlay in order to purchase a generator. This can be a significant challenge for smaller scale operations. Businesses that are marginally profitable can experience a larger impact due to their inability to finance generators.

- **Interview 4:** *When you consider someone who is running a marginal business – and as a result can't afford to pay for a generator... can stock losses put that business into an even worse situation... the answer is definitely yes.*

Variable costs associated with maintaining generators can also be significant. One respondent mentioned that for an 800sqm grocery store their generator uses up to 37 litres of diesel per hour. With the cost of diesel being approximately R11 per litre that equate to approximately R400 per hour to keep the power on. For a month such as May 2015 in which load shedding occurred on 21 of 31 days, the costs can be very significant. Added to this is the fact that much of the present infrastructure is not designed for the frequency of power outages experienced as a result of load shedding. Equipment damage and maintenance costs are cited as one of the most significant costs resulting from load shedding. It is not just generator equipment damage but all electricity related devices from computer hard drives to ovens and fridge compressors.

Should a company be able to make the large capital outlay for a backup generator and manage to absorb the high variable costs that come with every hour of load shedding, they will still see a further decline in their profitability as the cost per kWh of self-generated electricity is generally higher than that received from Eskom or a municipality.

#### **6.2.4 Revenue loss due to load shedding**

Revenue loss is the other most significant theme emerging from the analysis of study 1. In the model in Figure 2 it rests on top of operations because changes in operations during a load shedding incident lead to a loss of revenue.

The most significant loss of revenue occurs when stores stop trading during load shedding. There are a variety of reasons for a store to stop trading during load shedding. The most frequently cited reasons in the qualitative data in study 1 are a lack of lighting, an inability to process payments and security concerns. Many large scale retail organisations with hundreds of stores in the country have a policy that when load shedding occurs they must stop trading.

For stores that do continue to trade during load shedding a decrease in the customer traffic is a common problem. The customer foot traffic is highly dependent on the location of the store. Some retailers report that in shopping malls where the majority of stores are backed up, there can actually be an increase in customer foot traffic as consumers from the surrounding area come to the mall to 'kill time'. Other retailers report that despite having their own backup power in place, the fact that their neighbouring stores do not, results in customers leaving the centre.

- **Survey Response:** *Doors stay open - it disrupts business - even though our stores are open the other stores all close down and customers stop coming to the mall.*

Retailers can also lose revenue due to their limited capacity to fulfil orders during a load shedding incident. Often a store will only be partially backed up and thus only able to provide a limited offering. An inability to process payments can lead to a decrease in sales. Many retailers mentioned that their point of sale (POS) devices do not work without electricity and that the majority of customers tend to pay for purchases by card. Even if the customer is willing to draw cash from an ATM, the ATM's will not be working due to load shedding and the result is an inability to transact. Many retailers report customers leaving full baskets of items at the checkout counter during load shedding.

A period of uplift following a load shedding incident is common as customers return to purchase the goods they could not purchase. This depends on the category of retail and the customer retention rates of the brand. An anomaly regarding the revenue of retailers during load shedding is that many fast food restaurants report a dramatic increase in customer traffic during a load shedding incident. This is due to the fact that customers cannot cook in their own homes and go to the mall to eat.

### **6.2.5 Security issues relating to load shedding**

The vulnerability of stores to both internal and external theft were a reoccurring theme in both the interviews and survey responses. Payments systems are required to track

transactions and when performed manually can be manipulated by employees. Some companies had a policy to stop trading due to a security risk associated with load shedding.

**Interview 8:** *In a sense during load shedding you just lose control of your business. Load shedding creates an opportunity for people to take advantage of that. We are more vulnerable.*

Other security mechanisms such as CCTV and sensormatic systems do not work during a power outage, leaving the store vulnerable to theft by external parties. Decreased lighting makes it more difficult for in-store employees to see what is going on. The fact that load shedding schedules are publicly known means that criminals can specifically target stores without electricity. Some survey respondents mentioned that the fact that cash sales increased meant that they were known to be a more lucrative target for criminal activity.

### **6.2.6 Mitigation of the impact of load shedding**

The response of retail companies to the current load shedding crisis has been diverse. Some retailers have had backup generation power in place in all their stores since the 1990's due to the large implications a power outage has for their brand and product, while other retailers only have 10% of their stores backed up in 2015 despite the instability of the power supply. The decision to implement backup power is based on a trade-off between the cost and benefit that it will provide. "Investing in backup generation is expensive and may not be economically viable if it is not well planned. Firms have to choose the optimal amount of backup power by considering its energy load and the damage the remaining unserved energy would cause" (Oseni, 2012).

The cost per kWh hour of self-generated power will always be more expensive than that received from Eskom or a municipality. This makes the decision to deploy backup generation capacity throughout retail operations a trade-off between the return in investment in a reliable source of self-generated capacity against the more cost effective yet unreliable supply from Eskom. In an industry in which margins are a key source of competitiveness this becomes a very complex decision.

Before implementing backup generation power, many retailers seek to find alternatives to electricity as a cheaper means of mitigating the impact of load shedding. This often takes the form of gas cooking or battery operated lighting.

When it comes to the implementation of the backup generation power there are two prevalent models. Either the landlord implements and manages a communal pool of backup

generation which is provided to the individual tenants for a monthly service fee, or the individual retail outlets implement and manage their own backup power. The availability of backup generation within malls is cited as an increasingly common distinguishing feature landlords use to attract retail tenants.

The costs associated with backup power extend beyond the direct costs of purchasing a generator and diesel to run it. The management of backup generation power has resulted in retail organisations needing to develop new competencies. This requires new roles and skills among staff as well as supporting infrastructure. One interview participant mentioned that they have converted one of their vehicles for the purposes of transporting diesel. The decision to develop these competencies in-house or outsource them is a strategic choice based on the particular retailer's outlook. The increasing cost of backup services due to the large increase in demand is a factor in these decisions.

Despite retailers attempts to mitigate the impact of load shedding there remain challenges. The large costs associated with equipment damage due to the frequency of load shedding as well as the decline in customer traffic during a load shedding incident are two examples of problems retailers face despite large investments in backup power.

### **6.2.7 Stakeholders impacted by load shedding**

Three sets of stakeholders are identified from the analysis of study 1. The first set are retail companies and landlords. Both large and small scale retailers are affected, but there is an indication that small scale retailers have less resources to mitigate the impact of load shedding. Stores that are financed by a large head office are more likely to afford the initial capital outlay required for a generator. Franchisees were also cited as struggling to manage the implications of load shedding as compared to stores run by head office.

The second set of stakeholders are the customers. The inconvenience due to load shedding is apparent in customers needing to leave full baskets at the checkout counter due to their inability to pay. Many retailers mentioned that manually processing transactions during load shedding leads to long queues and frustration on the part of customers.

The third set of stakeholders are employees. Much of the extra work caused by load shedding needs to be made up by extra hours on the part of employees. An example would be having to manually process payments on the day that load shedding happens and then having to come in early the next day to enter the transactions into the system. An increase

in absenteeism was noted by some managers due to the difficult working conditions caused by load shedding.

- **Interview 3:** *Another important factor that we saw was the morale of staff being affected. The fact that the environment became more unstable and that procedures changed a lot. We noticed a lot of staff absenteeism would increase... and it's just due to an increase in the pressure on staff and a huge increase in the rework that they need to go through.*

### 6.2.8 Second order effects of load shedding

Second order affects resulting from load shedding sit at the top of the model in Figure 2 and are shown as one of the smallest blocks because they emerge as one of the least important themes from the analysis in study 1.

The first consideration is the affect that load shedding has on retailer's brands. The downside risk to a brand is considered to be low because if customers are inconvenienced due to load shedding they generally understand that it is something out of the retail stores hands. Load shedding is a universal problem in South Africa that we all have to deal with. Customers are resigned to some degree, to the fact that we will experience inconveniences in our life and none of the interview participants considered brand damage to be a significant outcome of load shedding. There is however the potential opportunity to improve a brand within a customer's mind by responding to load shedding proactively and distinguishing a particular store or chain of stores from its competitors. Some of the retailers mentioned that they believe that they have experienced a positive outcome to their brand due to fact that they are able to trade through load shedding.

- **Interview 6:** *I have been in a shopping centre when there is load shedding and it's a positive thing when suddenly everything is dark and then a couple seconds later the Woolworths lights come on and people see that and we hear them talk and say... you can go to Woolies during load shedding, so it definitely does have a positive impact because we are prepared.*

Load shedding is a disruptive force to normal business operations and makes it very challenging to operate a business optimally. It is very difficult to integrate an unpredictable load shedding schedule into week to week planning. One interview participant mentioned that dealing with load shedding and backup generation has added friction to relationships between landlords and tenants. The effects of load shedding extend beyond the hours when

the power goes out. In areas near large industrial clients the quality of the power supply after a load shedding incident can take a long time to stabilize and can lead to further equipment damage.

The impact of load shedding on individual retailers will eventually translate into macroeconomic effects. Marginal retail businesses that cannot afford to invest in backup generation may become unprofitable and close down in the long run. The increased cost base for retailers that manage to survive will be passed on to consumers downstream, in the form of higher prices. The higher costs that retailers have to service means that money that would have gone to further investments and expansion of retail businesses are lost.

### **6.2.9 Positive outcomes of load shedding**

The positive outcomes of load shedding relate to businesses becoming more competitive by responding to the challenges posed by the electricity crisis. Retail organisations have acquired some institutional learning and responded to circumstances they would not have otherwise needed to. Their operations and energy requirements are more diversified and they will be better prepared to face future challenges.

Load shedding has also created a demand for new services and products. Retailers report that the sales of products which assist consumers in mitigating the impact of load shedding in their own lives have done very well. There is also a thriving market for backup generation products and associated services to companies.

## **6.3 Research Question 2: What is the direct economic cost of load shedding to the South African retail sector?**

### **6.3.1 Study 2: Subjective Evaluation Methodology**

The results of study 2 using the subjective evaluation methodology estimate the direct economic cost of load shedding to be R13.72 billion for the first 6 months of 2015.

The results are based on 3 sources of data listed below:

- Responses of 106 retail branch managers to a survey administered online and in store
- The incidence of load shedding at an hourly level for the first 6 months of 2015 as derived from the Eskom twitter handle

- The monthly revenues of the South African retail and the food and beverage sectors as published in the quarterly retail trade sales (Statistics South Africa, 2015) and food and beverage (Statistics South Africa, 2015) figures respectively

Although the use of customer surveys to apply the subjective evaluation methodology is an accepted means of measuring the direct economic cost associated with power outages in an environment in which there is a structural shortage of electricity supply as discussed in Section 5, there are some aspects of the analysis done in study 1 that can be improved.

The analysis does not take into consideration the differences in revenue that can occur on different days of the month and days of the week. The revenue for each day is considered to be the average monthly revenue per day and is calculated by dividing the total monthly revenue by the number of days in the month. This assumes that all days of the month make an equal contribution to the monthly revenue, whereas in reality, the distribution of the revenue across the days of the month is not uniform. Weekends are particularly important in the retail sector, as are month end periods. A more refined analysis would seek to integrate these factors.

The results of the qualitative study 1 suggest that there is a significant difference in the impact of load shedding, dependent on the category of retailer, and the location of the stores. The three types of store locations identified in study 1 were stores in larger super regional shopping malls, stores in smaller strip malls and stores in main street CBD locations. A more refined analysis would seek to segment the retail sector by retail category and store location. This would result in the creation of similar CDF's for each category of retail and each store location and the extrapolation of the direct economic costs for each segment respectively. A comparison of the quantitative impacts on each segment would be of interest.

Although more than 100 responses were achieved on the questionnaire, this only translated into 70 direct worth estimates of the impact of load shedding on the revenue of stores. Of the 106 responses, 17 said they had not experienced load shedding during operating hours without backup generation power in place. Of the remaining 89 responses, 15 did not sufficiently describe the start time, end time and day of the week of the load shedding incident and 4 did not estimate the impact on the revenue of the store. The 70 responses when broken down to hourly level data resulted in small samples of PDRLPH for some hours of the week. An example is shown in Table 30 in which the hour of the week samples for Monday are shown. For the hour from 1pm to 2pm there are only 3 samples. One of the

samples is that the PDRLPH was 100% for that hour which caused the average PDRLPH of that hour to be 38%.

*Table 30. Example of small samples for PDRLPH for some hours of the week*

Day	Hour	Sample size	Average of PDRLPH	StdDev of PDRLPH	Min of PDRLPH	Max of PDRLPH
<b>Monday</b>	09-10	1	15%	-	15%	15%
	10-11	1	15%	-	15%	15%
	11-12	2	9%	8%	3%	15%
	12-13	2	9%	8%	3%	15%
	13-14	3	38%	54%	3%	100%
	14-15	2	13%	4%	10%	15%
	15-16	4	10%	7%	0%	15%
	16-17	4	10%	7%	0%	15%
	17-18	1	15%	-	15%	15%

In order to perform a more reliable study it would be important to get a larger and more diverse sample. The fact that the majority of samples were collected from in-store questionnaires resulted in a bias towards Johannesburg and Pretoria. One of the major disadvantages of the customer survey approach is the high cost and effort associated with collecting the data. The researcher did not foresee the magnitude of the task of collecting a truly representative sample of data. “The primary problem with [customer surveys] is the time and high cost associated with survey design and distribution, as well as the collection and analysis of respondent data” (Balducci, Roop, Schienbein, Desteese, & Weimar, 2003, p. 111).

There are also inherent biases within the subjective evaluation methodology. The first concern is that the respondents do not thoroughly understand the direct costs associated with a power outage. “The customers with large amount of electricity consumption hires eligible personnel who are aware of the electric power dependency of their businesses... Although an exact prediction about losses is impossible, these professionals are able to inform the surveyors about the consequences of power outages with as credible as possible responses. However, it is seen that the majority of the customers are mid-level and low-level customers in terms of the amount of electric energy consumption. Whether or not the respondents from these consumers are qualified enough to be fully aware of the economic reflections of the power interruptions is questionable” (Kufeoglu & Lehtonen, 2015, p. 590). Although branch managers do have an understanding of how their revenue is affected it was

clear to the researcher, particularly during the in store surveys, that the majority of responses were based on a vague opinion of the revenue impact as opposed to any measurable data that branch managers had collected. The subjective evaluation method is also at risk of overstating costs. “Another shortcoming about customer surveys is the tendency towards exaggerating losses. This brings the suspicion that a considerable amount of reported costs might be higher than they actually are” (Kufeoglu & Lehtonen, 2015, p. 591).

The survey and branch managers also failed to consider the subsequent uplift that results from load shedding. Financial managers in study 1 mentioned that there is a tendency for customers to return after a load shedding incident and partially make up for lost sales. This phenomenon does not recover all sales but it was recognised as valid by multiple interview participants. Kahneman and Tversky’s (1979) famous dictum that losses loom larger than gains implies that branch managers are more likely to ascribe a higher value to the revenue they lose during a load shedding incident when compared to the subsequent uplift in sales they will gain after load shedding. That is, if they consider the subsequent uplift at all.

### **6.3.2 Study 3: Revealed Preferences Methodology**

The results of study 3 using the revealed preferences methodology estimate the minimum direct economic cost of load shedding to be R716 million for the first 6 months of 2015.

This is significantly less than the estimate of R13.72 billion resulting from the subjective evaluation methodology in study 2. The revealed preference methodology is generally considered to be a more reliable method for measuring the impact of a power outage due to the fact that the cost of a power outage is inferred from the actions taken by a firm as opposed to their opinion as to what it may have cost (Oseni, 2012). The profitability of the firm is affected by the manager’s decisions to invest in backup generation power and as such they are far more likely to be well considered and evaluated decisions. Despite the fact that the revealed preference methodology is generally considered to be more reliable, there are reasons to believe that the estimate of R716 million that has resulted from study 3 could be an understatement of the true costs of load shedding on the retail sector.

The first shortcoming of the implementation of the marginal cost of backup methodology implemented in study 1 is the fact that the analysis is not performed per category of retail and per category of location. It is clear from the qualitative analysis in study 1 that the degree of impact that load shedding has on a retail operations varies with the category of retail and the location of the store. It is also clear from Table 27 in Section 5.3.2 that the

cost of backup generation power differs significantly with the category of retail. The availability of data to perform a marginal cost of backup analysis segmented by retail category and store location was not available. It is likely that such an analysis would have resulted in a higher overall cost as the cost of backup per square meter per month shown in Table 23 is of the order of R5 per square meter per month. During the interviews performed in study 1, two financial managers mentioned that the ballpark figure for backup generation was R5 per square meter per month, but both of these financial managers were involved in clothing retail operations in which the cost of backup generation power is less than in grocery stores or restaurants.

There is also reason to believe that there is more retail space in South Africa than the 24 million square meters used in study 3. The total retail sector GLA that was is an approximation of the amount of retail space available in South African shopping centres. Although the researcher was unable to source the data, there is clearly more retail space in the South African retail sector beyond just shopping malls. A reliable source of data for how much retail space there is outside of shopping malls would cause the estimate from study 3 to increase.

Another important consideration is that the cost of the backup generator does not account for all the costs that companies spend in order to mitigate the impact of load shedding. The only costs considered in the literature were the fixed and variable costs associated with running a backup generator. “The cost to the firm of generating its own power consists of two elements. First, the yearly capacity cost of the generator per kWh. Second, the variable cost-per kWh. This is mainly fuel cost, and is practically constant” (Bental & Ravid, 1982). Study 1 demonstrated that there are additional costs associated with the alternative measures that companies take in order to mitigate the impact of load shedding. Examples of these are the costs of retrofitting restaurant kitchens with gas stoves or the costs associated with purchasing portable lighting. The data in study 3 also do not take into account the costs of equipment damage which was shown to be very significant during study 1. There are also additional secondary costs associated with managing backup generation power such as the training of staff and the development of new operational competencies. An implementation of the revealed preference methodology taking into account these additional costs would result in a larger estimate of the impact of load shedding than that generated by study 3.

The fourth reason that the results of study 3 are likely to be an understatement of the impact of load shedding is the fact that retailers are affected by load shedding despite having backup generation power in place. Multiple survey respondents and interview participants spoke to the fact that customer foot traffic tends to decline dramatically during a load shedding incident, and that stores experience a significant decline in revenue despite being well prepared for load shedding and having made investments in backup generation power. In a sense, a retailer's ability to mitigate the impact of load shedding goes beyond just their own store. Unless the overall retail ecosystem is fully backed up, customers will be less likely to leave their homes to go shopping. Even the potential impact of increased traffic due to traffic lights not functioning could be an inhibiting factor for shoppers to go out and would contribute an element of revenue loss to the retail sector.

The fifth and final reason for the potential understatement resulting from study 3 is the fact many retailers are unable to afford the large outlay of capital required to purchase, maintain and run a generator. Table 23 in Section 5.3.1 shows that the most significant component of cost associated with providing backup generation power is the capital amortisation which accounts for between 70% and 90% of the total monthly cost depending on the amount of load shedding that has occurred that month. Smaller scale retailers and franchise owners do not have the financial capacity to purchase a generator for hundreds of thousands and sometimes millions of Rands in order to back up their businesses. So even if it would be an economically sound decision to invest in a generator in order to maximise profits some retailers are not able to. This is demonstrated in Figure 13 in Section 5.3.3 which shows the use of backup generation distributed across the size of the store. It is clear that as the size of the store increases the likelihood of the store using backup generation increases. This is due, at least in part, to the increased ability of the store to finance the capital outlay required for a backup generator.

These results suggest a disparity between the need for backup generation power of smaller scale retail operations and their ability to provide such power. "FNB announced ... that it will help lessen the impact of load-shedding on its small business and residential clients by supplying 10 000 electricity generators at a significantly discounted price" (Roux, 2015). FNB's campaign to supply small business and residential clients with generators at significantly reduced cost is strategically well placed in order to alleviate the impact of load shedding as it addresses this disparity and assists a particularly hard hit segment of the South African economic community.

## 7 Conclusions

### 7.1 Introduction

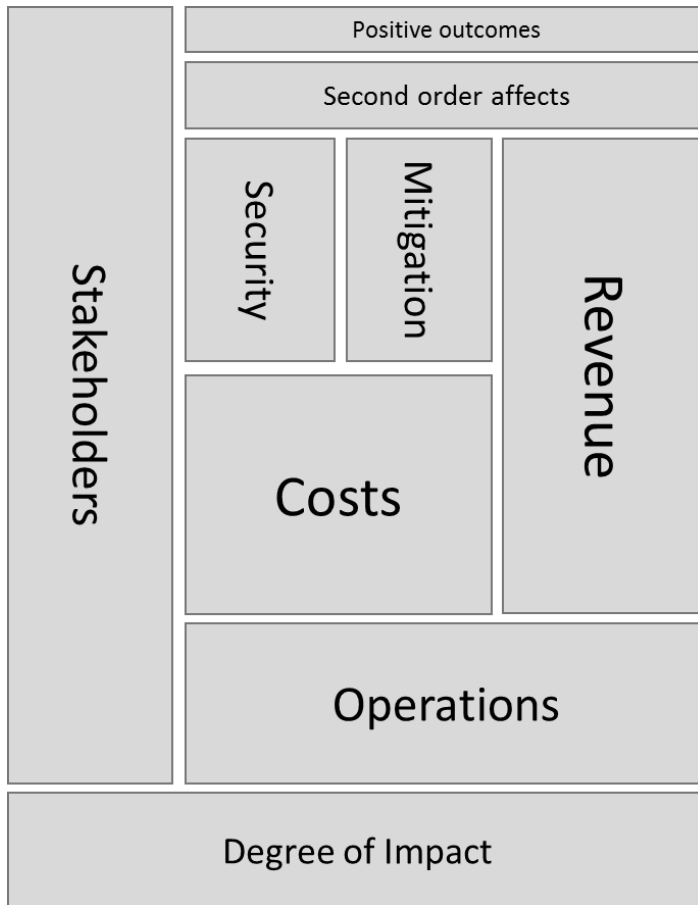
An understanding of the economic impact of load shedding is a critical consideration for all businesses in South Africa. Due to the complex nature of the impact this is particularly true in the retail industry, which is an important component of the South African economy contributing 14.8% of GDP in 2014.

The current research has made an important empirical contribution by adding to the current understanding of the impacts of electricity supply instability on the retail sector. A mixed-methods approach has been employed across three studies to produce a qualitative view of how load shedding impacts retail organisations as well as a quantitative estimation of the economic value lost in the retail sector due to load shedding for the first six months of 2015.

### 7.2 Research Question 1: How does load shedding impact South African retailers?

Eight interviews with financial and operations managers were conducted to discover how load shedding affected retail operations. A qualitative analysis of the data resulted in nine major themes which have been summarised in the model shown in Figure 15. The size of the block in the model is relative to the emphasis and importance placed on that theme and the position of the block speaks to its interactions with the other elements of the model.

Figure 15. Qualitative model describing the impacts of load shedding on retailers



The degree of impact of load shedding was found to vary depending on the category of retail and the location of the retail outlet. Various factors concerning the nature of a specific load shedding incident such as reliable notification of the incident, the day of the week, time of the day and the duration were also found to be important factors affecting the degree of impact. Load shedding disrupts the operational activities of retail businesses. The two most prominent affects in this regards were found to be lighting and the processing of payments. In grocery retail the maintenance of the cold chain is a critical element of all operations and load shedding is a particularly disruptive force in this regard.

The two major themes at the core of the model are costs and revenue. Underlying the theme of costs is the notion that these costs come straight off the bottom line, leading to a decline in the profitability of the businesses. An associated opportunity cost is evident in that many of the interview participants mentioned that those funds would have been better directed towards expansion. The two most significant elements of costs were with regards to security

and mitigating the impact of load shedding. Both internal and external security mechanisms are compromised during a load shedding incident, leaving stores vulnerable to pilfering by employees and theft from customers. In terms of mitigating the impact of load shedding, large capital investments and variable operational expenses are required to provide backup generation power.

Revenues are impacted as many stores stop trading during load shedding incidents. If stores are able to continue trading, a decline in customer traffic, limited ability to provide services, and challenges in processing payments lead to a decline in sales. Some interview participants did note an uplift of sales following a load shedding incident as some customers return but this could only account for a marginal recovery of lost sales.

The primary stakeholders affected by load shedding are retail companies and retail landlords. Customers experience decreased levels of service and inconvenience. Staff are also negatively impacted in that they are often required to make up for the operational gap left by load shedding by working extra hours or working under stressful conditions.

Second order affects consider the impact that load shedding has on retailer's brands. The downside risk is marginal as load shedding is a universal problem and customers understand it isn't a specific retailer's fault. The potential for retailers to improve their brands in the eyes of customers by responding proactively to load shedding was noted. Other second order affects include the challenges of integrating load shedding into normal business planning and knock-on macroeconomic affects.

Positive outcomes of load shedding are the increased competitiveness and preparedness on the part of companies as well as new product and service opportunities to assist consumers in mitigating the impacts of load shedding in their daily lives.

### **7.3 Research Question 2: What is the direct economic cost of load shedding to the South African retail sector?**

The subjective evaluation methodology has been applied to the South African retail sector to produce an estimate of R13.72 billion loss in revenue to the retail and food and beverage industries for the first six months of 2015. A more accurate estimate would consider the variations in revenue that occur on different days of the month and week and would also consider the varying degrees of impact based on retail category and store location. The sample of that data that was collected for study 1 can also be significantly improved.

The revealed preferences methodology was implemented to obtain a minimum estimate of R716 million for the cost of load shedding to the retail and food and beverage industries for the first six months of 2015. An implementation of this methodology per category of retail and with a more accurate estimate for the total GLA of the South African retail sector (including stores outside of shopping malls) would likely result in the overall estimate increasing.

It is also important to note that generators do not represent all of the costs that companies spend in order to mitigate the impact of load shedding and that this method does not account for the revenue loss that companies experience, despite the fact that they have invested in backup generation power. A last shortcoming of the revealed preferences methodology is the fact that smaller retail operations are unable to finance an investment in backup generation. For these smaller operators, the impact of load shedding is not measured by the revealed preference methodology, but ironically load shedding probably impacts them more than any other segment of the market due to their inability to mitigate the impact.

The overall conclusions that can be drawn from the results of study 2 and 3 is that the total costs associated with load shedding are likely to be higher than the R716 million estimated by study 3 for the first six months of 2015. It is not possible to say how much higher. Further research would need to be conducted in order to establish this. The overall economic impact in terms of a loss of revenue to the retail sector would be as high as R13.72 billion for the first six months 2015 if retailers were unable invest in backup generation power. This figure is likely to provide an upper limit to the amount of money that would be invested in order to mitigate the impact of load shedding.

## **7.4 Limitations**

The limitations of study 1 were that the sample size could have been larger and more representative. Although saturation was not reached with the eight interviews that were conducted, the data collected did result in an interesting analysis of how load shedding impacts the retail sector.

The limitations for study 1 were the variations on revenue earned for different days of the week and month. Weekends and month end periods are particularly important in the retail industry as consumers tends to make more purchases during these days. There was a high incidence of load shedding on the weekends as Eskom sought to build up reserve margins on weekends in order to minimise the amount of load shedding during the week. This was

done in an effort to minimise the economic impact of load shedding, but it would have increased the impact on the retail sector. A more accurate implementation of the subjective evaluation methodology would be per retail category and store location as the study indicated that the impact of load shedding varies based on these factors. The sample of data collected in study 2 could also be significantly improved.

Limitations of study 3 were that the data sample could be improved and that the revealed preferences methodology could have been implemented per retail category. The estimate of the total GLA for the South African retail industry was a weak point of study 3 as was the fact that only backup generators were considered as items retailers spent money on in order to mitigate the impact of load shedding.

## **7.5 Recommendations to industry stakeholders**

The first important point to note for industry stakeholders is that load shedding is having a significant impact on the retail sector and that the impact for the most part is drastically negative. This point comes through in the semi-structured interviews. It is evident in study 2 in which the retail sector is estimated to have lost up to 6% of revenue during months with a high incidence of load shedding. It is clear to see in study 3 in the massive bottom line costs sustained by an industry driven on tight margins. Load shedding is a massive problem and the resolution to the current crisis needs to be a top priority for those responsible.

The second insight is that it is possible to quantitatively measure the economic impact that load shedding has. Both quantitative studies showed that the underlying methodologies used were sound and that with a sufficient sample of data and the correct segmentation of the problem, meaningful results could be achieved. Such quantitative studies could be implemented across all industries within South African to obtain a view of the overall economic impact load shedding is having. These results could then be used to measure the effectiveness of investing in new generation capacity to move South Africa out of the current crisis. A true understanding of the costs associated with load shedding would provide a powerful motivator for future investments to ensure it doesn't occur.

The most critical implications of load shedding for retailers are from a revenue and cost perspective. The most significant costs relate to security and the mitigation of load shedding. It is a worrying insight that retailers still experience a loss of revenue due to load shedding despite their best efforts to mitigate the impacts. In a sense load, shedding is too vast a problem for any individual retailer to get around. Opportunities do however exist for retailers

to positively impact their brand by responding proactively to load shedding. There are also counter intuitive circumstances in which load shedding results in a large increase in customers, particularly for the restaurant industry. These opportunities represent a silver lining that retailers can take advantage of in the midst of the current crisis.

Finally, the data suggests that there is a financing shortfall for smaller scale retailers who cannot afford the capital investments required for a generator. Initiatives such as FNB's generator program are targeting this need in the market place, but further financial support is required. Perhaps financing could be arranged by government or through the collaboration of smaller operations.

## **7.6 Recommendations for future research**

A valuable extension of the current research that would be valuable would be to perform the subjective evaluation and marginal cost of backup methodologies per retail category and store location. It would be of interest to compare the impact of load shedding per retail category and would provide valuable insights as to which retailers need the most support in dealing with the current electricity crisis.

It would also be on interest to extend the implementation of these methodologies beyond the retail sector to get a view of how load shedding is impacting other parts of the South African economy.

An investigation into the ability of retailers to mitigate the impact of load shedding would also be of interest. There is a varied response from retailers to the power crisis. Some retailers are well prepared and have invested in backup generation facilities since the 1990's, while others remain with less than 10% of their stores backed up. A study that considered the benefits retailers have achieved from responding proactively to load shedding and sought to understand what means were most effective in mitigating the impact of load shedding would be a valuable resource for all industry stakeholders.

## **7.7 Conclusion**

This current research aims to highlight the impact of load shedding on the South African retail sector. The results show that the impact has been significant and far reaching. In an industry defined by tight margins, the disruptive influence of load shedding has added costs to the bottom line and decreased revenues. The ultimate result has to be a decrease in the profitability of businesses operating in this sector.

The results of study 1 are captured in a model which highlights the major pain points experienced by the retail industry due to load shedding. The results of study 2 indicate that R13.72 billion rand was lost in revenue for the first six months of 2015. The results of study 3 indicate that a conservative estimate of R716 million has been invested by retailers in backup generation power during the same period.

It is hoped that these results will be of value for industry stakeholders in dealing with the crisis and will provide powerful motivation to ensure the correct measures are taken to keep lights on.

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## Appendix A: Interview consent form

Dear Sir or Madam

The current research is part of a GIBS MBA thesis and will contribute an independent and reliable estimate of the impact of load shedding on the South African retail sector.

The methodology for this study consists of the following three components:

1. Survey of managers at retail outlets to understand the impact of load shedding at the individual store level.
2. Collecting information from head office to understand the monthly costs of providing backup generation per square meter.
3. Qualitative interviews with financial and operations managers to understand the impact of load shedding on the business as a whole.

I would like to invite you to participate in this research. I would like to interview about the impact that load shedding is having on your business. Our interview should last about 15 minutes. Your participation is voluntary and you can withdraw at any time without penalty. I will be recording the interview in order to accurately capture all the information you share.

All data will be kept 100% confidential and there will be no mention of any company name in the results of this research.

If you have any concerns, please contact me or my supervisor. Our details are provided below.

<b>Researcher</b>	<b>Supervisor</b>
Name: Ariel Goldberg Email: 445023@mygibs.co.za Phone: 082 998 7122	Name: Solomon Moyo Email: ss.moyo@gmail.com Phone: 073 774 2553

Signature of participant:

Date:

Signature of the researcher:

Date:

## Appendix B: Questionnaire

Dear research participant

The current research is part of a second year MBA thesis and will contribute an independent and reliable estimate of the cost of load shedding to the South African retail sector

I would like to invite you to participate in this survey. All data is 100% confidential. The survey will take you no more than 10 minutes to complete and there are no costs to you. Your participation is voluntary and you can withdraw at any time without penalty. By completing the survey, you indicate that you voluntarily participate in this research.

If you have any concerns, please contact me or my supervisor. Our details are provided below.

<b>Researcher</b>	<b>Supervisor</b>
Name: Ariel Goldberg Email: 445023@mygibs.co.za Phone: 082 998 7122	Name: Solomon Moyo Email: ss.moyo@gmail.com Phone: 073 774 2553

### Page 1

Q1: Have you ever experienced load shedding while your store was open without any backup generators?

- Yes
- No

### Page 2

Please think of a particular load shedding incident that you experienced

Q2: Please describe what time in the day the load shedding started and ended and on which day of the week it occurred

For example: from 1pm to 5pm on a Monday

Q3: Please describe how your business was impacted by that load shedding incident

Q4: Please estimate the percentage of your daily revenue that was lost on that day

### Page 3

Q5: Does your retail outlet use backup generation facilities?

- Yes
- No

#### Page 4

Q6: Do you manage your own backup generators or are they provided as a service?

- Manage
- Provided as a service

Q7: Please estimate the monthly costs of having backup generators and explain how you estimate this

Q8: Please describe which parts of your store are powered by the backup generators during load shedding

Q9: What percentage of your store do the backup generators power?

#### Page 5

Please help us put your answers into context by answering the following questions concerning your retail outlet

Q10: What is the total area in square meters of the retail outlet that you manage?

- $< 50m^2$
- $50 - 100m^2$
- $100 - 200 m^2$
- $200 - 300m^2$
- $400 - 800m^2$
- $800 - 1600m^2$
- $1600 - 3200m^2$
- $3200 - 5000m^2$
- $> 5000m^2$

Q11: Which shopping mall or neighbourhood and province is the retail outlet that you manage based? (eg. Sandton City or Illovo, Gauteng)

Q12: Please select whichever category best describes the retail outlet that you manage:

- General dealers

- Food, beverages and tobacco in specialised stores
- Pharmaceuticals and medical goods, cosmetics and toiletries
- Textiles, clothing, footwear and leather goods
- Household furniture, appliances and equipment
- Hardware, paint and glass
- All other retailers

Q13: How many full time employees work at the retail outlet that you manage?

- 1-5
- 5-10
- 10-20
- 20 - 40
- More than 40

Finish

## Appendix C: Information Request to Retailer Head Office

Dear Sir or Madam

The current research is part of a GIBS MBA thesis and will contribute an independent and reliable estimate of the impact of load shedding on the South African retail sector.

The methodology for this study consists of the following three components:

1. Survey of managers at retail outlets to understand the impact of load shedding at the individual store level.
2. Collecting information from head office to understand the monthly costs of providing backup generation per square meter.
3. Qualitative interviews with financial and operations managers to understand the impact of load shedding on the business as a whole.

I would like to invite your company to participate in this research by sharing data on the costs of providing backup generation to stores. Your participation is voluntary and you can withdraw at any time without penalty.

All data will be kept 100% confidential and there will be no mention of any company name in the results of this research.

If you have any concerns, please contact me or my supervisor. Our details are provided below.

<b>Researcher</b>	<b>Supervisor</b>
Name: Ariel Goldberg Email: 445023@mygibs.co.za Phone: 082 998 7122	Name: Solomon Moyo Email: ss.moyo@gmail.com Phone: 073 774 2553

Signature of participant:

Date:

Signature of the researcher:

Date:

## Appendix D: List of initial open codes

- Lighting
- Top of mind issue for executives
- Operations-Stop trading
- Affect-Large
- Fixed costs remain but lose time for sales
- Investments in UPS
- Positive impact due to proactive response
- Increased competitiveness of company
- Cost-There is a cost impact
- Category of retailer
- Increased equipment damage
- Bought portable lighting as backup
- Cost per kWh much higher from backup power
- Buying behaviour changes
- Criminals targetting stores during load shedding
- Development of new competencies within the company
- Operations-Payment-Cash
- Generators not designed for load shedding conditions
- Displaying merchandise
- Stores stop trading
- UPS damage
- Loss of stock
- Estimates of impact done within company
- Equipment maintenance
- ATMs are often down
- Affect-Minimal
- Foot traffic
- Increased preparedness of company
- Cant make credit card payments
- Operations-Ability to supply offerings limited
- Duration of load shedding incident
- Security CCTV
- Inconvenience for customers
- Increased opportunities for business as a result of load shedding
- Revenue-Demand for related offerings limited
- Minor negative impact
- Operational diesel costs
- Very expensive
- Revenue-Customer traffic
- Point of sales
- Affect-Medium
- Operations-Payment
- Shopping centers
- Decreased ability to deal with work load
- Minor investment made to mitigate load shedding
- Investment in generators
- Sales predominantly towards the end of the day
- Time based element
- Operations-Tills
- Scale of retailer - can be make or break
- Complex management of backup systems
- New procedures to deal with load shedding
- Security sensormatic
- Revenue-Time Related
- Very difficult to measure some impacts
- Staff training during load shedding
- Cost of backup services has increased due to the huge demand
- Smaller scale retailers unable to make investment
- Increased Operational expenses
- Capital cost of generators
- Limited services provided by malls
- Limited offering
- No Communications

- Load shedding schedules can differ depending on whether supply is from Eskom or Municipality
- Issues despite having backup in place
- Operations-Communications
- Sensormatic systems don't work
- Invest in more expensive but secure option
- Costs-Assets lost
- Negatively impacted systems
- Load shedding adds complexity to normal business operations
- Revenue-Revenue impact
- Security-Vulnerable to outside thieves
- Operations-Employees don't get paid
- Being well prepared
- Generator maintenance
- Security stock theft
- Broader energy industry is becoming more innovative
- Smaller scale retailers unable to make investment
- Eventually costs will be passed on to the consumer
- Lost time
- Investments in new systems that are more suitable to the environment created by load shedding
- Response to load shedding - Still lose despite being prepared
- Customers leave baskets unprocessed
- Increased energy efficiency and negotiations with Eskom
- Customers don't come back
- Prioritisation of stores for backup
- Operations-Lighting
- Increased operational work load
- Equipment damage
- Temporarily rent a generator
- Resigned acceptance of load shedding in South Africa
- Need to be paid but are unproductive during load shedding
- Loss in revenue despite fixed costs
- Equipment not designed for load shedding conditions
- Business-Margins
- Increased friction of doing business
- Percentage of stores backed up
- Unqualified companies providing backup services
- Running on backup power
- Operations-Alternatives to electricity
- Customer loyalty retention
- Widespread
- Large decrease in foot traffic
- The cold chain
- What needs to be backed up affects the cost of backup
- Phased investments approach
- Challenging conditions in the market
- Increased stress and pressure on staff
- Operations-Customers go to competition
- Low downside risk to brand damage as load shedding is a universal problem
- Poor quality of power supply
- Operations-Backup insufficient
- Not all costs are fixed
- Customers do come back
- Significant negative impact
- Time is significant factor
- Generator damage
- Availability of goods is not impacted
- Revenue-Customers returning
- Business-Technology dependant business
- Loss of orders via phone/internet
- Environment-Retail environment
- Notification of load shedding

- Pilferage
- Costs come off the bottom line
- Not impacted due to sufficient backup generation in place
- Security-Fraud
- Increase in sales due to trading when competitors are not
- Gas cooking
- Cost-Employees need to be paid despite load shedding
- Operations-Employees added pressure
- Impact was very significant
- Load shedding can impact the survival of a business
- Decrease in sales not severe
- Increased power efficiency
- Business-Customer unhappy
- Upset customers
- Slow response
- Decrease in sales - severe impact
- Severe cost
- Depends on particular store and type of mall
- Were investments worthwhile
- Business not prepared
- Appealing pull factor for malls to attract stores
- Strategic decisions
- Increased efficiencies
- Increased vigilance

## Appendix E: Hour of the week CDF data

Table 31. Detail behind CDF showing PDRPLH distributed across day of the week and hour of the day combined

Day	Hour	Sample size	Average of PDRLPH	StdDev of PDRLPH	Min of PDRLPH	Max of PDRLPH
<b>Monday</b>	09-10	1	15%	-	15%	15%
	10-11	1	15%	-	15%	15%
	11-12	2	9%	8%	3%	15%
	12-13	2	9%	8%	3%	15%
	13-14	3	38%	54%	3%	100%
	14-15	2	13%	4%	10%	15%
	15-16	4	10%	7%	0%	15%
	16-17	4	10%	7%	0%	15%
	17-18	1	15%	-	15%	15%
<b>Tuesday</b>	10-11	2	5%	0%	5%	5%
	11-12	2	5%	0%	5%	5%
	12-13	1	5%	-	5%	5%
	13-14	2	4%	2%	3%	5%
	14-15	5	12%	8%	3%	23%
	15-16	5	12%	8%	3%	23%
	16-17	5	12%	8%	3%	23%
	17-18	5	11%	8%	0%	23%
	18-19	3	8%	7%	0%	13%
	19-20	1	13%	-	13%	13%
20-21	1	13%	-	13%	13%	
<b>Wednesday</b>	09-10	1	5%	-	5%	5%
	10-11	2	6%	2%	5%	8%
	11-12	2	6%	2%	5%	8%
	12-13	2	6%	2%	5%	8%
	13-14	2	6%	2%	5%	8%
	14-15	5	6%	3%	3%	10%
	15-16	4	6%	5%	3%	13%
	16-17	4	6%	5%	3%	13%
	17-18	4	6%	5%	3%	13%
<b>Thursday</b>	10-11	2	4%	2%	3%	5%
	11-12	3	8%	7%	3%	15%
	12-13	6	10%	5%	3%	15%
	13-14	5	9%	5%	3%	13%
	14-15	4	14%	1%	13%	15%

Day	Hour	Sample size	Average of PDRLPH	StdDev of PDRLPH	Min of PDRLPH	Max of PDRLPH	
	15-16	3	14%	1%	13%	15%	
	16-17	3	14%	1%	13%	15%	
	17-18	4	10%	7%	0%	15%	
	18-19	1	0%	-	0%	0%	
Friday	08-09	1	5%	-	5%	5%	
	09-10	2	4%	2%	2%	5%	
	10-11	6	5%	3%	0%	8%	
	11-12	6	5%	3%	0%	8%	
	12-13	5	5%	3%	2%	8%	
	13-14	6	6%	3%	2%	10%	
	14-15	5	19%	24%	2%	60%	
	15-16	5	8%	5%	2%	15%	
	16-17	5	8%	5%	2%	15%	
	17-18	4	8%	5%	2%	15%	
	18-19	1	8%	-	8%	8%	
	07-08	1	9%	-	9%	9%	
	08-09	1	9%	-	9%	9%	
	Saturday	09-10	6	19%	7%	9%	30%
		10-11	12	20%	11%	9%	50%
11-12		17	23%	16%	3%	70%	
12-13		12	18%	10%	3%	40%	
13-14		11	17%	9%	3%	40%	
14-15		8	17%	14%	3%	50%	
15-16		2	11%	6%	7%	15%	
16-17		2	11%	6%	7%	15%	
17-18		3	11%	4%	7%	15%	
18-19		3	7%	4%	3%	12%	
19-20		3	7%	4%	3%	12%	
20-21		3	7%	4%	3%	12%	
21-22		1	12%	-	12%	12%	
Sunday		09-10	2	10%	11%	2%	18%
		10-11	3	14%	11%	2%	23%
	11-12	3	14%	11%	2%	23%	
	12-13	3	14%	11%	2%	23%	
	13-14	2	12%	14%	2%	23%	
	15-16	1	10%	-	10%	10%	
	16-17	1	10%	-	10%	10%	
	17-18	1	10%	-	10%	10%	
	18-19	1	10%	-	10%	10%	
	19-20	1	10%	-	10%	10%	

## Appendix F: Sample of hourly load shedding data derived from Eskom's twitter handle

Table 32. An extract of a single weekend of the hourly load shedding data derived from the Eskom's twitter handle

Date	Day of the week	Hour of the day	Stage 1	Stage 2	Stage 3
14Feb2015	Sat	07-08			
14Feb2015	Sat	08-09		08-09	
14Feb2015	Sat	09-10		09-10	
14Feb2015	Sat	10-11		10-11	
14Feb2015	Sat	11-12		11-12	
14Feb2015	Sat	12-13		12-13	
14Feb2015	Sat	13-14		13-14	
14Feb2015	Sat	14-15		14-15	
14Feb2015	Sat	15-16		15-16	
14Feb2015	Sat	16-17		16-17	
14Feb2015	Sat	17-18		17-18	
14Feb2015	Sat	18-19		18-19	
14Feb2015	Sat	19-20		19-20	
14Feb2015	Sat	20-21		20-21	
14Feb2015	Sat	21-22		21-22	
14Feb2015	Sat	22-23			
15Feb2015	Sun	07-08			
15Feb2015	Sun	08-09		08-09	
15Feb2015	Sun	09-10		09-10	
15Feb2015	Sun	10-11		10-11	
15Feb2015	Sun	11-12		11-12	
15Feb2015	Sun	12-13	12-13		
15Feb2015	Sun	13-14	13-14		
15Feb2015	Sun	14-15	14-15		
15Feb2015	Sun	15-16	15-16		
15Feb2015	Sun	16-17	16-17		
15Feb2015	Sun	17-18	17-18		
15Feb2015	Sun	18-19	18-19		
15Feb2015	Sun	19-20	19-20		
15Feb2015	Sun	20-21	20-21		
15Feb2015	Sun	21-22	21-22		
15Feb2015	Sun	22-23			

## Appendix G: Results of the trading hours survey

Table 33. Results of the trading hours survey

Day	Hour	% Retailers Open	% Restaurants Open
Monday	07-08	2	2
Monday	08-09	10	10
Monday	09-10	100	100
Monday	10-11	100	100
Monday	11-12	100	100
Monday	12-13	100	100
Monday	13-14	100	100
Monday	14-15	100	100
Monday	15-16	100	100
Monday	16-17	100	100
Monday	17-18	90	100
Monday	18-19	36	100
Monday	19-20	5	100
Monday	20-21	3	100
Monday	21-22	0	100
Tuesday	07-08	2	2
Tuesday	08-09	10	10
Tuesday	09-10	100	100
Tuesday	10-11	100	100
Tuesday	11-12	100	100
Tuesday	12-13	100	100
Tuesday	13-14	100	100
Tuesday	14-15	100	100
Tuesday	15-16	100	100
Tuesday	16-17	100	100
Tuesday	17-18	90	100
Tuesday	18-19	36	100
Tuesday	19-20	5	100
Tuesday	20-21	3	100
Tuesday	21-22	0	100
Wednesday	07-08	2	2
Wednesday	08-09	10	10
Wednesday	09-10	100	100
Wednesday	10-11	100	100
Wednesday	11-12	100	100
Wednesday	12-13	100	100
Wednesday	13-14	100	100

<b>Wednesday</b>	14-15	100	100
<b>Wednesday</b>	15-16	100	100
<b>Wednesday</b>	16-17	100	100
<b>Wednesday</b>	17-18	90	100
<b>Wednesday</b>	18-19	36	100
<b>Wednesday</b>	19-20	5	100
<b>Wednesday</b>	20-21	3	100
<b>Wednesday</b>	21-22	0	100
<b>Thursday</b>	07-08	2	2
<b>Thursday</b>	08-09	10	10
<b>Thursday</b>	09-10	100	100
<b>Thursday</b>	10-11	100	100
<b>Thursday</b>	11-12	100	100
<b>Thursday</b>	12-13	100	100
<b>Thursday</b>	13-14	100	100
<b>Thursday</b>	14-15	100	100
<b>Thursday</b>	15-16	100	100
<b>Thursday</b>	16-17	100	100
<b>Thursday</b>	17-18	90	100
<b>Thursday</b>	18-19	38	100
<b>Thursday</b>	19-20	7	100
<b>Thursday</b>	20-21	5	100
<b>Thursday</b>	21-22	0	100
<b>Friday</b>	07-08	2	2
<b>Friday</b>	08-09	10	10
<b>Friday</b>	09-10	100	100
<b>Friday</b>	10-11	100	100
<b>Friday</b>	11-12	100	100
<b>Friday</b>	12-13	100	100
<b>Friday</b>	13-14	100	100
<b>Friday</b>	14-15	100	100
<b>Friday</b>	15-16	100	100
<b>Friday</b>	16-17	100	100
<b>Friday</b>	17-18	92	100
<b>Friday</b>	18-19	59	100
<b>Friday</b>	19-20	16	100
<b>Friday</b>	20-21	11	100
<b>Friday</b>	21-22	0	100
<b>Saturday</b>	07-08	2	2
<b>Saturday</b>	08-09	13	13
<b>Saturday</b>	09-10	100	100

<b>Saturday</b>	10-11	100	100
<b>Saturday</b>	11-12	100	100
<b>Saturday</b>	12-13	100	100
<b>Saturday</b>	13-14	97	100
<b>Saturday</b>	14-15	97	100
<b>Saturday</b>	15-16	97	100
<b>Saturday</b>	16-17	93	100
<b>Saturday</b>	17-18	43	100
<b>Saturday</b>	18-19	21	100
<b>Saturday</b>	19-20	7	100
<b>Saturday</b>	20-21	5	100
<b>Saturday</b>	21-22	0	100
<b>Sunday</b>	07-08	2	2
<b>Sunday</b>	08-09	10	10
<b>Sunday</b>	09-10	95	95
<b>Sunday</b>	10-11	100	100
<b>Sunday</b>	11-12	100	100
<b>Sunday</b>	12-13	100	100
<b>Sunday</b>	13-14	95	100
<b>Sunday</b>	14-15	80	100
<b>Sunday</b>	15-16	59	100
<b>Sunday</b>	16-17	51	100
<b>Sunday</b>	17-18	11	100
<b>Sunday</b>	18-19	5	100
<b>Sunday</b>	19-20	3	100
<b>Sunday</b>	20-21	3	100
<b>Sunday</b>	21-22	0	100

## Appendix H: Ethical Clearance Confirmation

**Gordon Institute  
of Business Science**  
University of Pretoria

Dear Ariel Goldberg

Protocol Number: **Temp2015-01507**

Title: **The economic cost of load shedding: The case of South African retailers**

Please be advised that your application for Ethical Clearance has been APPROVED.

You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

Adele Bekker