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Article

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Research paper

The significance of electricity supply sustainability to industrial growth in South Africa



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ABSTRACT

Objective: The South African business environment is characterized by supply uncertainties, which have large economic implications on the country's capacity to achieve its industrial goals. South Africa's industrial decline and falling economic growth is directly associated with decreasing electricity sustainability, as the industrial sector is the main economic contributor to South Africa's GDP. This study aimed at indicating the nexus of electricity supply and industrial growth in South Africa and to appraise the effects of unsustainable supply on industrial operations. The study also assessed industrial and administrative efforts towards sustainable supply of electricity for industries. **Methods:** The empirical research utilized a quantitative research design. The study geography was focused in the Gauteng and North West provinces of South Africa. A purposive-convenience sampling was utilized. However, quota-sampling guidelines were considered in targeting actual participants. Enterprises across the service, manufacturing and mining industries were sampled. Descriptive and Bivariate statistics were performed. **Findings:** Results reflected unsustainable electricity supply for the industrial sector and the poor sustainability has an impact on the industrial growth in South Africa. Results also note that most enterprises is challenge in instituting mitigation strategies such as Small, Micro, Medium Enterprises (SMME's) across industries. The phenomenon tends to impact electricity intensive and non-electricity-intensive industries differently. **Conclusions:** The public sector should apply the good governance framework to ensure policies that will priorities electricity supply sustainability to industries. Enterprises are also advised to institute mitigation mechanisms.

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1. Introduction

From the importance of electricity in general, Kenny (2015) (p. 1) maintains that the service is one of the most important new technologies of the 21st century. It changed the world extremely and mostly for the better. It is now the stamina of every modern economy. Ahmad and Othman (2014) point out that electricity is the most demanded necessity currently in the world, in general. The global industrial applications of electricity have been advanced rapidly with industries utilizing large amounts of electrification for generating power to all technologies that are needed for production. Olufemi (2015) says industrial growth is vital since industrialization is responsible for manufacturing consumer and capital goods which tend to create the necessary stimulation for the development of other sectors of the economy. Aladejare (2014) mentions that accurate supplies of modern electricity for the commercial sector now signify high

economic prominence of a country. The decreasing trend of electricity supply in South Africa has placed Eskom (South Africa's public electricity provider) in a difficult position as reserves have also decreased (Khobai et al., 2017). Eskom has now taken to intensify rationing of the electricity supply in an attempt to minimize the imbalance between electricity supply and consumption, threatening a breakage of the grid system.

Load-shedding occurrences are now a predictable certainty in the future. Though the current electricity conservation strategy is necessary, conservation worsened the effects on economic growth for an economy with an industrial sector that is energy reliant (Adebola, 2011). Eskom faces huge technical and financial constraints in order to turnaround the tough electrification situation. Most productive sectors have been experiencing extreme decline in growth. The South African business environment is seriously constrained owing to unsustainable electricity supply for operations (Von Ketelhodt and Wöcke, 2008). Index points on Figs. 1 and 2 reflect the decline of key business industries and business confidence respectively.

Even though the electricity supply was fairly stable in 2015 and part of 2016, there is no assurance that Eskom can keep

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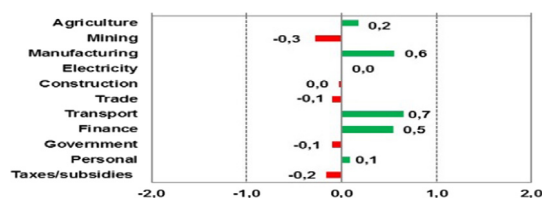


Fig. 1. Key industrial sector decline in South Africa (Trading economics, 2019).

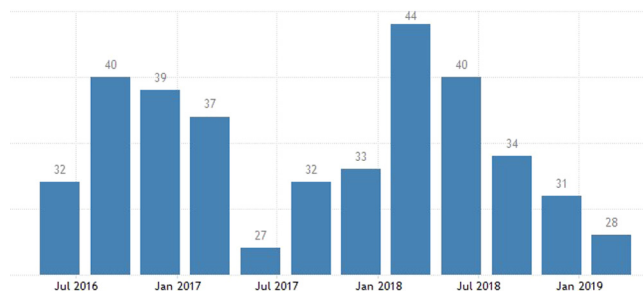


Fig. 2. South Africa business confidence (Statistics South Africa, 2018).

up with the ever-increasing constraints on power supply (Albert, 2015). This study aimed at indicating the nexus of electricity supply and industrial growth in South Africa. It further appraise the effects of unsustainable supply on industrial operations. The study also assessed industrial mitigation strategies against supply disruption and administrative efforts towards sustainable supply of electricity for industries.

The study create industrial consciousness on the imperative role of electricity to operational success and business opportunities. Suppliers and administrators will also gain essential facts that could be utilized to ensure fair energy access and security for industries. The following questions arose:

- What is the importance of electricity and the current competence of electricity supply for industries?
- How does ineffective supply affect organizations potential for meeting up new business pressures and demands?
- What measures can be implemented to ensure electricity supply sustainability for industries?

Target organizations from different industries provided important insight regarding the research questions through a comprehensive questionnaire. Important implications have been recommend.

2. Literature review

This section will present a brief discussion on the contribution of electrical energy to industrialization.

2.1. The contribution of electrical energy to industrial evolution

Industrial growth or industrialization is the deliberate and sustained application and the combination of appropriate technology, infrastructure, managerial expertise, and other important resources in the production of output (Olufemi, 2015). The structural transformation of economies from traditional to modern economies, driven by high-productivity industrial manufacturing activities, has been a defining feature of economic development (Naudé and Szirmai, 2012) (p. 20).

Attigah and Mayer-Tasch (2016) (p. 4) state that of all modern energy types, electricity is the most undisputable category that is

much considered in the strategic objectives of industrial growth. Electricity grid system was designed in the image of the “First Industrial Revolution”, with the grid modelled, to enable mass production and to attain economies of scale. Electricity was a key contributor during the “Second Industrial Revolution” by the last quarter of the 19th century and the beginning of the 20th century. The revolution was pioneered by electrical generation, the transformation of the chemical industry and the advancement of the internal combustion engine (Zhanga et al., 2017). In this 21st century industrial age, development remains relevant for developing countries trying to catch up with more advanced economies and to provide increasing standards of living for their populations. Industrialization is a catalyst that accelerates the pace of structural transformation and diversification of economies, enabling a country to fully utilize its factor endowment for its sustenance (Olufemi, 2015).

Jucker et al. (0000) (p. 3) states that industrial and economic growth for all developing economies is strongly dependent on the supply levels of electrical energy and access to reliable supplies of electricity. Electrical energy savings have a direct impact on the bottom line of industrial plants and commercial businesses (Jucker et al., 0000) (p. 5). Isaksson (2016) (p. 1) agrees that the most direct role of electrical energy is that it serves as the main input to industrial production. A world without electricity amounts to non-mechanized production. Unreliable supplies of electricity disrupt production, and voltage fluctuations negatively affect the durability of machinery. As electricity cannot be economically stored on a large scale, an electricity supply system has to be designed for the maximum expected demand to be able to sustain industrial activities (Aoki et al., 2016).

2.2. Electricity supply sustainability and industrial growth

Mzini and Muhiya (2014) state that energy is a central feature for the United Nations (UN) Sustainable Development Goals (SDGs). The UN SDGs in general has an ambitious and transformational vision for the globe striving for a world where the environment of humans and other species are safe, resilient and sustainable. The 7th goal drive for the need to sustainable energy for social and economic activities. The goal advises economies to prioritize on access to reliable, affordable, modern and efficient use of energy to attain social and economic growth (United Nations, 2015) (p. 3).

General consensus among researches is that relationship exists between industrial electricity consumption, economic growth and development (Abokyi et al., 2018). Mawejje and Mawejje (2016) summarized the different hypothetical views that have arisen on the relationship between electricity consumption and economic growth:

- the growth hypothesis where causality is one-way from electricity consumption to output growth
- the conservation hypothesis in which causality rather runs from output growth to electricity consumption
- the feedback hypothesis in which a two-way causality exists between electricity consumption and output growth
- the neutrality hypothesis in which no causality exists between electricity consumption and output growth.

Important findings to the aforementioned views has been investigated by authors such as Akinlo (2008), Odhiambo (2009), Payne (2009), Odhiambo (2010) and Mawejje and Mawejje (2016). The sub-Saharan Africa (SSA) region has been found to have a unique relationship between electricity consumption and economic growth. Investigation in eleven SSA countries found a significant positive relationship between electricity consumption

and economic growth (Akinlo, 2008). Odhiambo (2010) conducted a similar investigation on three SSA countries and the findings concur to Akinlo (2008). The growth in economic activities has been on a decline in the SSA region considering that its electricity capacity is fragile and not relative to demand. In addition, a significant proportion of countries in the region are highly energy intensive. There have been renewed commitment by most of the governments to transform and expand electricity generation and supply to ensure security of demand.

Despite the recent awareness on the contribution of electricity supply sustainability to the growth of economic activities, there is limited research conducted on the agenda. Developments to electricity production and supply will lead to improved consumption per capita (Mawejje and Mawejje, 2016). Industrial and enterprise survey has concurred that electricity constraints is the primary obstacle to industrial and enterprise performance (Mawejje, 2013). Asafu-Adjaye (2000) investigated the drivers of industrial productivity in Singapore and Indonesia and found that there is causativeness between electricity supply and economic growth. Asafu-Adjaye allude that electricity adequacy is an indispensable component of industrial productivity. The relationship between energy supply and industrial growth is complex and can be elaborated upon from different angles. The most important is the volume effect, which determines different tendencies in the production level of economic activities based on the quantity of energy supplied (Nkomo, 2006) (p. 77).

Research findings for the relationship between electricity supply and economic growth is inconclusive. There are studies where authors have concluded that electricity supply actually influences economic growth (Sarker, 2010; Nnaji et al., 2013), while some contradict this finding by disputing that economic growth instead, influence electricity supply (Lean and Smyth, 2010; Bayraktutan et al., 2011). Thus, conducting this study in the South African context is important as it provides a different approach on assessing the influence of electricity supply on industrial growth through the opinion from industries themselves.

2.3. Electricity supply sustainability and industrial growth in South Africa

Industrial electricity supply and consumption is recognized as an instantaneous indicator of a country's economic progress (Zhanga et al., 2017). The industrial sector has been experiencing a severe decline mainly from shocks resulting from shortages of electrical energy (Fedderke, 2014) (p. 6). Electricity is an essential input for production in South Africa, hence an important factor for the competitiveness of the country's industrial performance (Inglesi and Blignaut, 2012). There is a significant relationship between electricity and economic growth in South Africa (Bah and Azam, 2017). However, there is scarcity in existing research on the role of electricity supply and the growth in economic activities in South Africa. Khobai et al. (2017) is a unique study that significantly investigated the causality between economic activities and electricity supply in South Africa. The empirical research used a multivariate framework to determine co-integration between electricity supply and economic growth. The ARDL testing showed that there is long-run relationship and the VECM testing showed that causality exist between variables. The findings imply that industrial priorities such as production and competitiveness of South African industries in the local and international markets significantly rely on sustainable electricity supply (Khobai et al., 2017).

Inglesi (2010) projected that Eskom, the national parastatal, who is in charge of the administration of about 96 percent of South Africa's electricity, will experience a long term lack of capacity in the generation and reticulation of electricity in general.

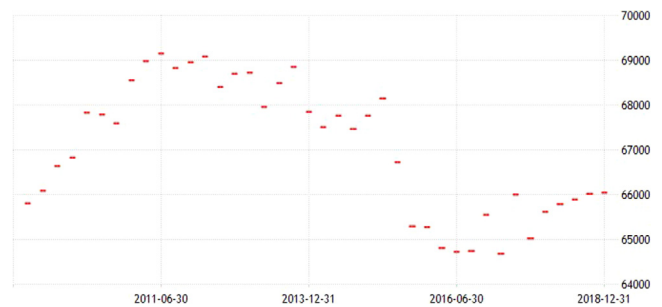


Fig. 3. South African GDP from utilities from 2014 to 2017 (Trading Economics, 2018).

The prediction has been true ever since load shedding first hit South Africa from April 2008 (Oxford, 2015) (p. 12). Businesses have been battling to deal with its impacts. The power supply has been on a short leash as Eskom fights to manage an ageing grid, and alongside steadily increasing consumer demand. Eskom recently warned the public to be prepared for planned and unplanned blackouts all over the country until 2021. This will generally incur damaging effects on the economy at large. Eskom agrees that the constraints on the power system and especially the issue of supply and demand is not likely to end if sufficient capacity to meet required demand remains pending (Oxford, 2015) (p. 12). Severe deficiency in electricity capacity has precipitated frequent load shedding, leading to low business confidence (Kumo et al., 2016) (p. 4). The South African business sector is extremely concerned about the short to medium term power crisis (James, 2015) (p. 1).

South Africa's insufficient and unstable electricity supply lead to increased input costs and difficult industrial relations, affecting the performance of business enterprises and their investment plans. The economy is seriously constrained with the impact of insufficient and unreliable electricity supply (Industrial Development Corporation, 2015) (pp. 2–8), (Hedden, 2015) (p. 7). Low electricity supply immensely affected the production chain, causing a sharp contraction in major industries such as mining, manufacturing and service industries, lowering the economic growth (Statistics South Africa, 2015) (p. 2). The economic impact of load shedding in 2015 alone was equivalent to the loss of an entire industry (Carew, 2015) (p. 16). Chris Yelland, a South African energy expert, gave a press release on the estimated cost of blackouts on the South Africa economy. Yelland points out that Stage 1 load shedding resulting in 10 h of blackouts per day for 20 days a month results in losses of 20 billion ZAR per month. Using the same parameters, Stage 2 load shedding costs the economy 40 billion ZAR per month and Stage 3 was estimated to have a cost of 80 billion ZAR per month (Van der Nest, 2000) (p. 1). Mike Schussler presented a different view on an interview by Biz4Afrika in August 2015, highlighting that load shedding on industries cost the economy 15 to 20 million ZAR for every five hours of lights out. Eskom has just implemented stage 4 (March 2019) in which certain regions in the country go over 18 h a day without electricity. This slow industrial growth is also felt in the utility industry. GDP from utilities has been on a constant decrease since the first quarter of 2014. Fig. 3 reflects past indexes in millions.

SARB (2016) (p. 1) points out that economic growth has decelerated markedly since 2011 due to the dropped in the industrial sector. It is the most sluggish pace of expansion since the Great Recession and such only experienced last during the emerging-market crisis of 1998. The disappointing growth outcome has been mostly traceable to shocks from the electricity crisis (South African Reserve Bank, 2016) (p. 1). Business confidence reached

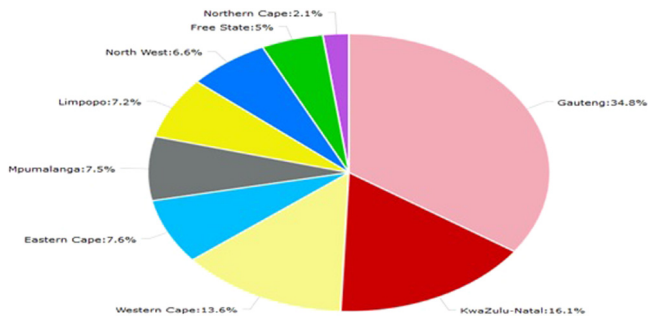


Fig. 4. Provincial GDP contribution to the South African economy (Statistics South Africa, 2018).

a 24 year-low in historical perspective by the first quarter of 2016. Several rating agencies have also downgraded the country's credit rating, which has had a negative impact on the outlook of the country as an investment destination. J.P. Morgan has already announced that it will be removing South Africa from its investment grade emerging market bond indexes following the downgrades (Bloomberg, 2017) (p. 20). The failure of electricity administrators' to recognize the growing threat about electricity supply sustainability has cost the country billions of ZAR and it is yet to incur the country's economy the harshest financial loss should there be any occurrence of blackouts ahead (Oxford, 2015) (p. 12).

3. Material and methods

The research design used in this study was the quantitative research design. Quantitative design highlights and situates the researcher in the empirical world and connected the research questions to data (Punch, 2009) (p. 112).

The Gauteng and the North West province was the considered geography for participating industries. Conducting empirical research in Gauteng was based on its provincial economic strength and its role as the stamina of the South African economy, contributing over 34.8% of the national GDP (category B2⁶/A5/Metrose). The North West province was selected since it was necessary to also target a provincial location with a slow-paced economic growth. The North West economy is among the lowest contributors to the economic growth with a GDP of just 6.6% (category A⁷/secondary cities). This is reflected on Fig. 4.

The research focused on the administrative and economic capital of each sampled province. In the North West province (Mafikeng the administrative and Rustenburg the economic capitals) were targeted, while (Pretoria the administrative and Johannesburg the economic capitals) were target cities for the Gauteng province. Moreover, Johannesburg and Rustenburg are ranked amongst the fastest growing economic cities in Africa. The investigation considered the industrial sectors that are the nucleus towards industrial development in South Africa. The target industries include mining, manufacturing and commercial services. Industrial development corporation (Industrial Development Corporation, 2013) (p. 6–7) assessed the economic trends from 1994 and outlined that the commercial, manufacturing and mining industries have been the spine of the South African economy. Considering the diversity of industries in both size and assortment, data was collected from selected sectors of sampled industries as follows: Commercial Services (financial institutions and supermarkets retailing), Manufacturing (construction and chemicals business) and Mining (mineral miners and mine purification businesses).

North-West Province		Gauteng Province	
City	City status	City	City status
Mafikeng	Provincial administrative capital	Pretoria	Provincial administrative capital
Rustenburg	Provincial economic capital	Rustenburg	Provincial economic capital

Manufacturing		Mining		Commercial	
Construction		Mineral deposits		Supermarkets	
NWP	25	NWP	25	NWP	25
Gauteng	25	Gauteng	25	Gauteng	25
Total	50	Total	50	Total	50
Chemicals		Mine purification		Financials	
NWP	25	NWP	25	NWP	25
Gauteng	25	Gauteng	25	Gauteng	25
Total	50	Total	50	Total	50

300 participants	
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Fig. 5. Summary of population and sampling.

The purposive-convenience sampling was used in targeting participating enterprises. Purposive sampling was employed to target employees with reliable information on the operationalization of an enterprise. Through convenience sampling, an adequate participatory size was obtained. However, the quota sampling guidelines were utilized to enable a proportionate representation of each target industrial sector. It was considered acceptable that 100 enterprises should represent each industry. Participants per sector were considered to be 50 accumulating to a total sample of 300. A total of 223 questionnaires were obtained from the fieldwork. It should be noted that empirical research only targeted the mining industry in the North West, due to limited mining activities in the Gauteng province. Mining in the North West is responsible for over 60% of total mining in South Africa. However, three large mining conglomerates (Anglo Gold, Ashanti Gold and Impala Mines) solely conduct over 70% of mining activities in the area. This account for a low representation of the mining industry in the empirical research.

Data was analysed using the IBM Standard Package Social Science research (SPSS). Descriptive statistics were performed and results are based on frequencies, percentages, means (M) and standard deviation (SD). Bivariate analyses were also conducted to determine sectoral and provincial comparison of sample industries.

A description of data collection is reflected on Fig. 5. The following section presents the results of our research.

4. Results

The data collection employed close-ended questionnaires with defined categories to examining the effect of low electrical power supply on the industrial growth in South Africa. The IBM Statistical Package for Social Science statistics version 23 as prescribed by SPSS Inc. (2016) was used in analysing data.

4.1. Descriptive results of electricity supply and industrial operations

This section of data presentation and interpretation will discuss results based on frequencies, percentages, means and standard deviation. Fig. 6 reflects the total participants per sampled province. Results reflect that Gauteng province contributes to 55.6% of the total sample. The North West province contribute to 44.4% of the sample.

Fig. 7 reflects the outcome from the different sampled sectors per industry. The supermarket and construction, chemicals and financial sectors were the most represented industries with a total of 36.8%, 23.8%, 18.8% and 18.4% respectively. The mining industry was the least represented with 2.7% in total.

Fig. 8 reflects the responses of participants' profile. Owners and managers were the majority of participants adding up to

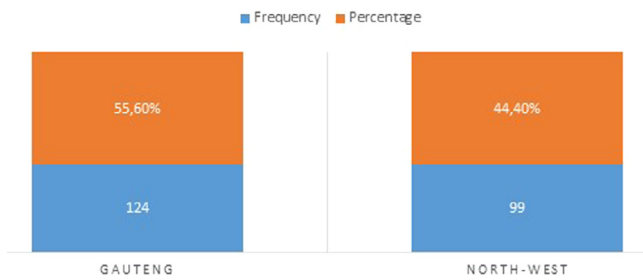


Fig. 6. Participants per sampled province.

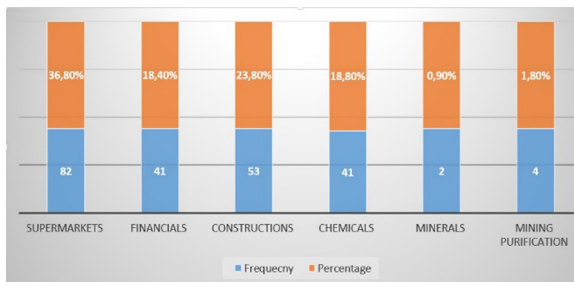


Fig. 7. Participants per sectors.

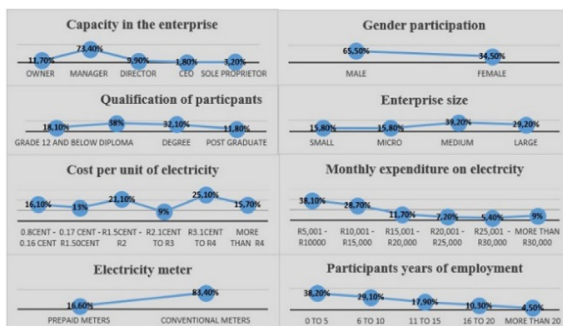


Fig. 8. Participants' profile.

a total of 85.1%. Most participants have been employed from 0 to 5 years (38.2%) and from 6 to 10 years (29.1%). Medium sized enterprise's representation contributes 39.2% of the participants. Most enterprises spends between 5 to 10 thousand ZAR on monthly electricity purchases. 84.4% of the participants utilize the conventional metring system as opposed to prepaid metres.

Table 1 presents results for participants' opinions to the importance of electrical energy as an energy source for business operations. Participants' opinions are further reflected with Means (M) and Standard Deviations (SD). The majority of the participants gave a positive response that electrical energy is the main energy source (M = 4.43, SD = 0.65). Participants agreed that electricity disruptions affect their production levels (M = 4.39, SD = 0.76). The majority of the participants agreed that consistency in electricity is necessary for business growth (M = 4.50, SD = 0.70).

Table 2 reflects results for electricity supply sufficiency to industries. The majority of the enterprises felt that electricity supply volumes are not sufficient to meet business demand (M = 2.37, SD = 1.17). Participants tend to disagree regarding being optimistic on future electricity consistency (M = 2.43, SD = 1.13). The majority of participants tend towards agreeing that South Africa are operating in an energy crisis environment (M = 3.42, SD = 1.27).

Table 3 presents results on the assessment of electricity inconsistency and economic downturn on business performance from 2007. The majority of the participants agreed that electricity inconsistency had affected business performance since 2007 (M = 3.73, SD = 1.02). The majority of the participants also agreed that economic downturn had affected business performance as of 2007 (M = 3.78, 1.02). Results reflect that electricity consistency is eminent for economic growth as supported in the literature review.

Table 4 contains operational vulnerability results. Results reflect that a total of 84.3% agreed that production reliability is affected (M = 4.13, SD = 0.76). A total of 66.8% agreed that equipment damages had been experienced in their enterprise due to inconsistency in electricity supply (M = 3.68, SD = 0.95). Sixty-four point six percent (64.6%) of participants agreed that electricity inconsistency has contributed towards a reduced workforce in their enterprises (M = 3.55, SD = 1.10). A total of 77.6% agreed that production deadlines had been influenced negatively by electricity inadequacy (M = 3.92, SD = 0.93). A total of 75.3% agreed that electricity inconsistency affected employees motivation to work (M = 3.86, SD = 0.91). A total of 71.8% and 75.8% of participants agreed that working hours are reduced due to electricity inadequacy and disruptions (M = 3.75, SD = 0.91) and (M = 3.89, SD = 0.95) respectively.

A total of 72.2% agreed that electricity supply inadequacy has caused a decline in product range (product line decline) (M = 3.77, SD = 0.92). Seventy-one point six percent (71.6%) and 69.9% respectively agreed that electricity supply inadequacy has affected communication technology infrastructure (M = 3.86, SD = 0.93) and loss of data (M = 3.73, SD = 0.99). A total of 75.1% agreed that electricity inadequacy has a negative effect on investment possibilities in the industry (M = 3.86, SD = 0.99). Seventy-four point three percent (74.3%) and 70.5% agreed that electricity inadequacy has affected the financial markets in the short term (M = 3.79, SD = 0.88) and long term and (M = 3.89, SD = 0.98) respectively. A total of 66.6% agreed that there have been losses of direct investments due to electricity uncertainty (M = 3.64, SD = 1.12). A total of 72.5% agreed that electricity cost has a significant effect on enterprises' profit margins (M = 3.82, SD = 0.97). A total of 71.6% agreed that electricity price increases are been spiralled down to enterprises (M = 3.85, SD = 0.98).

4.2. Descriptive results on strategies used for minimizing power inconsistency

Table 5 presents descriptive statistics for the electricity inconsistency mitigation programmes section. Results reflect that participants felt neutral tending to agree that their enterprises have an adequate understanding of electricity crisis management (M = 3.47, SD = 1.17). Participants also tend towards being neutral that enterprises have successfully implemented electricity crisis management programmes (M = 2.84, 1.24). Respondents felt neutral tending towards disagreeing that alternative electricity generating system has been adopted successfully (M = 2.65, SD = 1.24). More than half of the participants noted that alternative power sources are not capable of solving shortfalls of the grid (M = 2.43, SD = 1.13). Participants mostly disagree to have acquired investors to sponsor energy mitigation plans (M = 2.24, SD = 1.07). Participants disagree that trade unions and business forums are involved in stabilizing electricity supply to the industrial sector (M = 2.17 and SD = 0.96) and (M = 2.42 and 1.09) respectively.

Table 6 presents outcomes for industrial electricity intensity control. Respondents were neutral towards the importance of industrial electricity efficiency to the public sector (M = 3.19, SD = 1.24). The respondents were neutral towards the statements, electricity distribution programmes have been introduced

Table 1
Importance of electrical energy to industries.

Statements	Scale points	Percentage	Mean	Standard deviation
1. Electrical energy is mainly used as energy source	Strongly disagree	0.1%	4.43	0.65
	Disagree	2.2%		
	Neutral	2.2%		
	Agree	45.7%		
	Strongly agree	49.8%		
2. Electricity disruptions has a negative effect on your company's production levels	Strongly disagree	0.4%	4.39	0.76
	Disagree	2.2%		
	Neutral	7.6%		
	Agree	37.7%		
	Strongly agree	52%		
3. Consistency in electricity supply is necessary for your business growth	Strongly disagree	0.4%	4.50	0.70
	Disagree	2.2%		
	Neutral	2.7%		
	Agree	35.9%		
	Strongly agree	58.7%		

Table 2
Supply sufficiency to industries.

Statements	Scale points	Percentage	Mean	Standard deviation
1. Electricity supply volumes is sufficient to meet business demand	Strongly disagree	22.4%	2.37	1.17
	Disagree	44.8%		
	Neutral	13.9%		
	Agree	10.8%		
	Strongly agree	8.1%		
2. Your organization is optimistic about future consistency in electricity supply	Strongly disagree	19.3%	2.43	1.13
	Disagree	44.4%		
	Neutral	16.1%		
	Agree	13.9%		
	Strongly agree	6.3%		
3. Currently in South Africa, businesses are operating in an energy crisis environment	Strongly disagree	8.1%	3.42	1.27
	Disagree	20.6%		
	Neutral	16.1%		
	Agree	31.4%		
	Strongly agree	23.8%		

Table 3
Business performance.

Statements	Scale points	Percentage	Mean	Standard deviation
1. Your business growth (linked to performance) has declined since 2007 due to instability of electricity supply	Strongly disagree	4.5%	3.73	1.02
	Disagree	9.9%		
	Neutral	13.1%		
	Agree	53.2%		
	Strongly agree	19.4%		
2. Your business growth (linked to performance) has declined since 2007 due to the general economic downturn	Strongly disagree	3.6%	3.78	1.02
	Disagree	10.4%		
	Neutral	12.6%		
	Agree	51.4%		
	Strongly agree	22.1%		

successfully to stabilize intensity in high demand industries ($M = 3.00$, $SD = 1.26$), as well as electricity distribution programmes, have been introduced successfully to stabilize intensity in low demand industries ($M = 2.77$, $SD = 1.12$). Respondents tend toward feeling neutral in the conservation of available power that has become a major focal point in business strategies ($M = 2.61$, $SD = 1.23$). Participants disagreed that organizations take part in efficiency programmes such as (statement 4a): reducing electricity consumptions ($M = 2.38$, $SD = 1.21$), (statement 4b): emission control ($M = 2.35$, $SD = 1.11$) and (statement 4c): facing-off energy-intensive activities ($M = 2.55$, $SD = 1.24$).

Respondents tend to disagree that electricity administrators levy penalties (statement 5a) and ensure administration of penalties (statement 5b), to non-compliance of efficiency control policies ($M = 2.51$, $SD = 1.05$) and ($M = 2.30$, $SD = 0.98$) respectively. Opinions tend towards disagreeing that there is a general

corporate awareness towards the efficient use of electricity in enterprises ($M = 2.53$, $SD = 1.14$). Participants disagreed tending towards neutral on (statement 7a), that enterprises' attitude towards energy control is positive ($M = 2.53$, $SD = 1.14$) and tend to be neutral on (statement 7b), that enterprises' attitude towards energy control is negative ($M = 2.91$, $SD = 1.24$). Opinions were neutral respectively for (statement 8), the importance to control industrial energy consumption ($M = 3.26$, $SD = 1.12$) and (statement 9), administrators efficiency on establishing emission guidelines ($M = 3.47$, $SD = 1.21$).

4.3. Bivariate results of sectoral and provincial comparison on factors

The Cronbach Alpha test was first conducted to determine the internal consistency of coefficients and to evaluate items

Table 4
Operational vulnerabilities by supply inconsistency.

Statements	Scale points	Percentage	Mean	Standard deviation
1. Your organization's production reliability is affected negatively by inadequate electricity supply	Strongly disagree	0.4%	4.13	0.76
	Disagree	2.7%		
	Neutral	12.6%		
	Agree	51.6%		
	Strongly agree	32.7%		
2. Your organization has experienced industrial equipment damages due to inconsistent electricity supply	Strongly disagree	3.1%	3.68	0.95
	Disagree	8.5%		
	Neutral	21.5%		
	Agree	50.7%		
	Strongly agree	16.1%		
3. Electricity supply inconsistency contributed towards a reduced workforce (labour) in your organization	Strongly disagree	4.9%	3.55	1.10
	Disagree	16.6%		
	Neutral	13.9%		
	Agree	48%		
	Strongly agree	16.6%		
4. Production deadlines have been influenced negatively by electricity supply inadequacy	Strongly disagree	1.3%	3.92	0.93
	Disagree	9.4%		
	Neutral	11.7%		
	Agree	51.1%		
	Strongly agree	26.5%		
5. Electricity inconsistency has a negative effect on employee motivation levels in your organization	Strongly disagree	1.80%	3.86	0.91
	Disagree	8.1%		
	Neutral	14.8%		
	Agree	52.9%		
	Strongly agree	22.4%		
6.a. Productive working hours are being reduced due to electricity supply inadequacy	Strongly Disagree	2.7%	3.75	0.91
	Disagree	7.6%		
	Neutral	17.9%		
	Agree	55.2%		
	Strongly agree	16.6%		
6.b. Productive working hours are being reduced due to electricity supply disruptions	Strongly disagree	2.2%	3.89	0.95
	Disagree	8.1%		
	Neutral	13.9%		
	Agree	50.2%		
	Strongly agree	25.6%		
7. Electricity supply inadequacy caused a decline in your product range (product lines closure, etc.)	Strongly disagree	1.8%	3.77	0.92
	Disagree	9.9%		
	Neutral	16.1%		
	Agree	53.8%		
	Strongly disagree	18.4%		
8.a. Electricity supply inadequacy had a negative influence on communication technology infrastructure in your organization	Strongly disagree	2.7%	3.86	0.93
	Disagree	7.2%		
	Neutral	13.5%		
	Agree	55%		
	Strongly disagree	21.6%		
8.b. Electricity supply inadequacy resulted in a loss of data in your organization	Strongly disagree	3.6%	3.73	0.99
	Disagree	9%		
	Neutral	17.6%		
	Agree	50.5%		
	Strongly disagree	19.4%		
9. Electricity supply inadequacy has a negative effect on investments possibilities in your industry	Strongly disagree	3.2%	3.86	0.99
	Disagree	8.1%		
	Neutral	13.6%		
	Agree	49.8%		
	Strongly disagree	25.3%		
10.a. Electricity supply inadequacy has a negative effect on financial market behaviour in your industry in the short-term	Strongly disagree	2.3%	3.79	0.88
	Disagree	7.2%		
	Neutral	16.2%		
	Agree	58.1%		
	Strongly disagree	16.2%		

(continued on next page)

scored in the multiple answer categories (Cronbach, 1951). Reliability exists if there is a transverse consistency on measurement forms (Sharma, 2016). For an exploratory study such as this, reliability >0.5 and <0.7 is good. However, reliability is considered as very good or excellent if it is >0.7 . Due to the several dynamics relating to what should be accepted as a reliable Alpha for analysis, values of 0.5 or above will be sufficient (Field,

2014) (pp. 708–709) states that. The one-way Analysis of Variance (ANOVA), T-test, Spearman rank correlation was performed for sectors on variables. The ANOVA test was conducted to assess whether or not there are differences in the opinions within the different business categories (supermarkets, financials, construction and chemicals) and the different industrial business size classifications (small, micro, medium and large) for sampled

Table 4 (continued).

Statements	Scale points	Percentage	Mean	Standard deviation
10.b. Electricity supply inadequacy has a negative effect on financial market behaviour in your industry in the long-term	Strongly disagree	2.3%	3.87	0.98
	Disagree	8.1%		
	Neutral	17.1%		
	Agree	45%		
	Strongly disagree	27.5%		
11. Your company has lost direct investment possibilities due to electricity uncertainties	Strongly disagree	6.8%	3.64	1.12
	Disagree	9.9%		
	Neutral	16.7%		
	Agree	45.9%		
	Strongly agree	20.7%		
12. Electricity cost has a significant effect on profit margins in your organization	Strongly disagree	3.6%	3.82	0.97
	Disagree	6.3%		
	Neutral	17.6%		
	Agree	50%		
	Strongly agree	22.5%		
13. Electricity price increases are being spiralled down to the final consumer (business's)	Strongly disagree	3.2%	3.85	0.98
	Disagree	6.3%		
	Neutral	18.9%		
	Agree	45.9%		
	Strongly agree	25.7%		

Table 5
Organizational electricity inconsistency mitigation programmes.

Statements	Scale points	Percentage	Mean	Standard deviation
1. Your organization have an adequate understanding of electricity crisis management programmes (e.g. alternative power sources)	Strongly disagree	7.2%	3.47	1.17
	Disagree	18.5%		
	Neutral	10.8%		
	Agree	47.3%		
	Strongly agree	16.2%		
2. Electricity crisis management programmes have been successfully implemented in your organization	Strongly disagree	10.8%	2.84	1.24
	Disagree	40.5%		
	Neutral	15.3%		
	Agree	20.3%		
	Strongly agree	13.1%		
3. Alternative electricity generating systems (for example solar power and generators) have been adopted successfully	Strongly disagree	18.9%	2.65	1.24
	Disagree	35.1%		
	Neutral	17.1%		
	Agree	19.80%		
	Strongly agree	9%		
4. The organization's alternative power systems is capable of solving any form of grid short-fall	Strongly disagree	18.9%	2.43	1.13
	Disagree	47.3%		
	Neutral	10.4%		
	Agree	18.5%		
	Strongly agree	5%		
5. Your organization have been able to acquire investors to sponsor your energy mitigation programmes	Strongly disagree	25.7%	2.24	1.07
	Disagree	43.7%		
	Neutral	14%		
	Agree	14%		
	Strongly agree	2.7%		
6. Trade unions are involved with the stabilizing of electricity supply (strategic discussions with suppliers)	Strongly disagree	26.1%	2.17	0.96
	Disagree	42.3%		
	Neutral	21.2%		
	Agree	9%		
	Strongly agree	1.4%		
7. Commercial business forums are involved with the stabilizing of electricity supply (strategic discussions with suppliers)	Strongly disagree	19.4%	2.42	1.09
	Disagree	41.9%		
	Neutral	20.7%		
	Agree	13.1%		
	Strongly agree	5%		

industries. Effect sizes were used to determine the practical significant differences that might exist as suggested by Ellis and Steyn (2003). Effect sizes >0.2 , >0.5 and >0.8 reflect small, medium and large differences respectively. These can also be referred to as practically non-significant, practically visible and practically significant differences respectively.

The T-test analyses the difference between the means scores derived from the participants from two sampled provinces. The effect size explains practical differences between the means of sampled clusters. Values >0.2 , >0.5 and >0.8 reflect a small, medium and large effect sizes respectively. The Spearman rank correlation was used to measure the strength of an association

Table 6
Industrial electricity intensity control.

Statements	Scale points	Percentage	Mean	Standard deviation
1. Electricity efficiency within your industry is important to the public sector (NERSA/DME).	Strongly disagree	9%	3.19	1.24
	Disagree	23.9%		
	Neutral	23.9%		
	Agree	25.2%		
	Strongly agree	18%		
2.a. Electricity distribution control programmes have been introduced successfully to stabilize intensity in high demand industries	Strongly disagree	12.2%	3.00	1.26
	Disagree	29.3%		
	Neutral	18.5%		
	Agree	26.1%		
	Strongly agree	14%		
2.b. Electricity distribution control programmes have been introduced successfully to stabilize intensity in low demand industries	Strongly disagree	11.3%	2.77	1.12
	Disagree	36%		
	Neutral	23.4%		
	Agree	22.5%		
	Strongly agree	6.8%		
3. Conservation of available power has become a major focus in your business strategy	Strongly disagree	18%	2.61	1.23
	Disagree	39.2%		
	Neutral	17.1%		
	Agree	15.3%		
	Strongly agree	10.4%		
4.a. Your organization takes part in efficiency programmes such as reducing electricity consumption	Strongly disagree	26.6%	2.38	1.21
	Disagree	37.8%		
	Neutral	12.6%		
	Agree	17.1%		
	Strongly agree	5.9%		
4.b. Your organization take part in programmes such as instituting guidelines toward emission control	Strongly Disagree	23.4%	2.35	1.11
	Disagree	41%		
	Neutral	17.1%		
	Agree	14%		
	Strongly agree	4.5%		
4.c. Your organization take part in efficiency programmes such as facing-off energy intensive operational activities	Strongly disagree	23.9%	2.55	1.24
	Disagree	30.6%		
	Neutral	18.9%		
	Agree	19.4%		
	Strongly agree	7.2%		
5.a. Administrators (Eskom. NERSA);levy penalties in cases of non-compliance to efficiency control policies	Strongly disagree	15.8%	2.51	1.05
	Disagree	40.5%		
	Neutral	24.3%		
	Agree	15.8%		
	Strongly agree	3.6%		
5.b. Administrators (Eskom. NERSA);ensure administration in cases of levy to non-compliance to efficiency control policies	Strongly disagree	21.2%	2.30	0.98
	Disagree	42.8%		
	Neutral	21.6%		
	Agree	14%		
	Strongly agree	0.9%		
6. There is a general corporate awareness towards efficient use of electricity	Strongly disagree	18.5%	2.53	1.14
	Disagree	39.2%		
	Neutral	18.9%		
	Agree	18%		
	Strongly agree	5.4%		
7.a. The general organization attitude towards energy control is positive	Strongly disagree	12.6%	2.91	1.24
	Disagree	32.9%		
	Neutral	18%		
	Agree	24.3%		
	Strongly agree	12.2%		
7.b. The general organization attitude towards energy control is negative	Strongly disagree	8.6%	3.26	1.12
	Disagree	16.3%		
	Neutral	26.2%		
	Agree	38%		
	Strongly agree	10.9%		
8. Controlling industrial energy consumption is important	Strongly disagree	5.4%	3.47	1.21
	Disagree	22.5%		
	Neutral	14.4%		
	Agree	35.1%		
	Strongly agree	22.5%		
9. Administrators have established guidelines towards emission control	Strongly disagree	16.7%	2.60	1.14
	Disagree	38.3%		
	Neutral	18.5%		
	Agree	21.6%		
	Strongly agree	5%		

Table 7
Reliability test results.

Variables	Cronbach's Alpha
Electrical energy importance	0.75
Supply sufficiency	0.7
Operational vulnerabilities	0.81
Business performance	0.76
Mitigation control programmes	0.74
Intensity control programmes	0.74

between business size, monthly expenditure of electricity and cost per unit of electricity.

The Spearman rank coefficient also indicates if a practical significant relation exists between business size, monthly expenditure of electricity and cost per unit of electricity. A coefficient >0.1 , >0.3 and >0.5 represents a small, medium and large relationship respectively. The Chi-square test was employed to identify if an association exists between sectors and monthly expenditure on electricity and cost per unit of electricity. Chi-square analysis identifies if two categorical variables are independent (no relationship) (Turner, 2014) (p. 2). The Cramer's value was used to indicate practical significant associations (effect size differences). A coefficient <0.05 indicates a significant statistical relation. Cramer's values of >0.1 , >0.3 , >0.5 indicates small, medium and large associations respectively.

A p-value < 0.05 reflects that a significant statistical difference exists. The p-values are reported for completeness sake, but will not be interpreted since a non-probability sampling procedure was used and not probability sampling, thus statistical inferences conclusions cannot be drawn.

Table 7 reflects reliability test for all constructs as indicated by the sections of the questionnaire. Results show that the Cronbach's Alpha for all factors was deemed reliable with a result of 0.7 and above for all factors.

Table 8 reflects results of the ANOVA for sectors. Results indicate effect sizes are tending towards medium for chemicals and financials sectors (0.44) and construction and financial sectors (0.41) for mitigation control. This imply respondents from the chemical sector tend to disagree ($M = 2.36$, $SD = 0.90$), while respondents from the financial sector ($M = 2.77$, $SD = 0.56$) tend towards neutral with statements on mitigation. Respondents from the construction sector tend more towards neutral ($M = 2.50$, $SD = 0.65$) contrasting the financial sector that tends towards neutral. Effect size differences indicating medium tending towards large is reflected between sectors for supply sufficiency construct. The financial and supermarket sectors reflect an effect size of 0.67, with financial sector tending towards agree on supply sufficiency (statement 3) ($M = 3.98$, $SD = 0.85$) and supermarket sector tend towards neutral ($M = 3.13$, $SD = 1.25$).

The chemical and supermarket sectors reflect an effect size of 0.61, with respondents from the chemical sector tending towards agreeing ($M = 3.90$, $SD = 1.19$), unlike the supermarket sector that tend towards neutral. The construction and finance sectors reflect an effect size of 0.62, with respondents from the construction sector tending towards neutral ($M = 3.09$, $SD = 1.41$), unlike the financial sector with responses tending toward agreeing. The chemical and construction sectors indicate an effect size of 0.57, as respondents from the chemical sector tend to agree on the statement, while construction respondents tend towards neutral. Intensity control reflects medium tending towards large (0.69) for chemicals and financials. The respondents from the chemical sector disagreed with the statements regarding intensity control ($M = 2.46$, $SD = 0.62$). The respondents from the financial sector in general felt neutral ($M = 2.89$, $SD = 0.34$).

Table 9 reflects the results of the ANOVA for the different enterprise size classifications. Results reflect small tending towards medium for supply sufficiency between large and small

enterprises (0.48), medium and small (0.44) and large and micro (0.44).

Results reflect medium effect sizes for mitigation control between large and small enterprises (0.53) and between large and micro enterprises (0.55). Large enterprises tended toward neutral ($M = 2.76$, $SD = 0.70$), while small enterprises tended toward disagreeing on the construct ($M = 2.39$, $SD = 0.65$). Micro enterprises tended towards disagree ($M = 2.37$, $SD = 0.68$), unlike large enterprises that tends more towards neutral. Intensity control also reflects medium effect sizes between large and small enterprises (0.54) and also for large and micro businesses (0.55). Large enterprises tend towards being neutral ($M = 2.85$, $SD = 0.56$), while small businesses are tended more towards disagree ($M = 2.54$, $SD = 0.48$). Micro enterprises reflect to be tending more towards disagree ($M = 2.54$, $SD = 0.56$), unlike large enterprises that tend towards neutral.

Table 10 contains the results of the independent T-test when considering the construction on sector per province.

For the chemical sector, operational vulnerability (0.76) and intensity control (0.51) reflect large and medium effect sizes respectively. The operational vulnerability construct reflects that respondents from Gauteng tended towards ($M = 3.74$, $SD = 0.50$) while respondents from North West agreed, tending towards strongly agree ($M = 4.12$, $SD = 0.45$). Load shedding statistics for 2014 to 2015 concur that there were more lights cut in the North West province compared to Gauteng in the mentioned period. The intensity control construct reflects that respondents from Gauteng tend towards neutral on statements ($M = 2.63$, $SD = 0.47$) while respondent from North West tend to disagree ($M = 2.26$, $SD = 0.73$). For the supermarket sector, supply sufficiency reflect a large effect size of 0.94 for Gauteng ($M = 2.72$, $SD = 1.28$) and North West ($M = 3.93$, $SD = 0.71$).

The large difference reflects that participants tend towards neutral in Gauteng, while participants in the North West agreed to the statements. For the financial sector, the importance of electrical energy reflects a medium effect size (0.59). Gauteng tend towards strongly agree ($M = 4.62$, $SD = 0.48$) and North West tend towards agree ($M = 4.33$, $SD = 0.35$). Effect sizes tending towards large, reflect for supply sufficiency (0.61), operational vulnerability (0.71) and business performance (0.61). Respondents tend towards agreeing for supply sufficiency for Gauteng ($M = 3.73$, $SD = 0.88$), while respondents from North West tend towards strongly agree ($M = 4.26$, $SD = 0.73$). Operational vulnerability reflects that respondents from Gauteng tend towards agree ($M = 3.62$, $SD = 0.41$) and respondents from North West agree ($M = 3.92$, $SD = 0.41$). Business performance reflect that respondents from Gauteng tend towards neutral on statements ($M = 3.40$, $SD = 1.15$) while respondents from North West tend to agree ($M = 4.11$, $SD = 0.58$). For the construction sector, operational vulnerability reflects medium effect size (0.52) as responses for Gauteng tend towards agreeing on statements ($M = 3.62$, $SD = 0.61$), while respondent from North West tended a little stronger towards agreeing ($M = 3.93$, $SD = 0.51$).

Table 11 presents correlation results. Results reflect a positive correlation, tending towards medium, between cost per unit of electricity and monthly expenditure on electricity ($r = 0.24$). A positive correlation tending towards large exist for business size and electricity monthly spending ($r = 0.48$). Thus, it indicates that large enterprises will spend more on electricity compared to smaller enterprises.

Table 12 reflects the Chi-square test between industry and monthly expenditure on electricity. Results also reflect a small association effect (Cramer's V (CV) = 0.19).

Table 13 reflects the Chi-square test between industry and cost per unit of electricity. Results reflect a medium tendency toward large effect size (CV = 0.37). This indicates that industrial energy pricing per unit cost is regulated across different industrial sectors in South Africa.

Table 8
ANOVA test for industrial sector on constructs.

Factors	Business categories	Mean	Standard deviation	ANOVA p value	Welch p value	Effect sizes		
						Super market with...	Financial with...	Construction with...
Importance of electrical energy	Supermarket	4.54	0.48	0.04	0.08	0.13	0.31	0,23
	Financials	4.48	0.44					
	Construction	4.26	0.71					
	Chemicals	4.42	0.61					
Supply sufficiency	Supermarket	3.13	1.25	<0.01	<0.01	0.67	0,62	0,57
	Financials	3.98	0.85					
	Construction	3.09	1.41					
	Chemicals	3.90	1.19					
Operational vulnerability	Supermarket	3.81	0.43	0.49	0.51	0.11	0,05	0,22
	Financials	3.76	0.43					
	Construction	3.78	0.57					
	Chemicals	3.91	0.51					
Business performance	Supermarket	3.71	0.90	0.82	0.80	0.01	0,11	0,00
	Financials	3.72	0.99					
	Construction	3.83	1.04					
	Chemicals	3.83	0.68					
Mitigation control	Supermarket	2.65	0.68	0.04	0.05	0.16	0,41	0,15
	Financials	2.77	0.56					
	Construction	2.50	0.65					
	Chemicals	2.36	0.90					
Intensity control	Supermarket	2.71	0.47	0.01	<0.01	0.39	0,33	0,32
	Financials	2.89	0.34					
	Construction	2.67	0.66					
	Chemicals	2.46	0.62					

Table 9
ANOVA test for enterprise size on factors.

Factors	Business categories	Mean	Standard deviation	ANOVA p value	Welch p value	Effect sizes		
						Small with...	Micro with...	Medium with...
Importance of electrical energy	Small	4.34	0.59	0.51	0.50	0.29	0.18	0.14
	Micro	4.51	0.50					
	Medium	4.41	0.58					
	Large	4.49	0.60					
Supply sufficiency	Small	2.09	0.91	0.02	0.03	0.00	0.24	0.25
	Micro	2.09	0.95					
	Medium	2.36	1.13					
	Large	2.71	1.40					
Operational vulnerability	Small	3.74	0.45	0.76	0.75	0.09	0.11	0.10
	Micro	3.79	0.47					
	Medium	3.84	0.49					
	Large	3.79	0.51					
Business performance	Small	3.88	0.65	0.56	0.51	0.05	0.10	0.10
	Micro	3.84	0.87					
	Medium	3.75	0.92					
	Large	3.63	1.06					
Mitigation control	Small	2.39	0.65	0.01	0.01	0.02	0.40	0.14
	Micro	2.37	0.68					
	Medium	2.66	0.71					
	Large	2.76	0.70					
Intensity control	Small	2.54	0.48	0.01	0.01	0.01	0.34	0.20
	Micro	2.54	0.56					
	Medium	2.73	0.57					
	Large	2.85	0.56					

5. Conclusions

The study has critically examined the significance of electricity supply to industrial growth in general. The objectives were to determine the importance of electricity and the current competence of electricity supply for industries, assessing the effects of ineffective supply on organizations potential to meet new business pressures and demands, and to recommend reliable and applicable measures with capabilities for ensuring electricity supply sustainability for industries.

The importance of electricity to businesses, supply sufficiency, operational vulnerability and business performance were used to measure the aggregate relations.

The value added contribution of the research emerges from the fact that enterprises noted important hindrances to industrial electricity supply.

Objective 1: Enterprises responded that electrical energy is very important for their operations. Despite the importance, sufficiency remains problematic. Enterprises tend to disagreed that supply sufficiency levels are adequate. Enterprises are also of

Table 10
T-test results when considering the constructs on sector per province.

Factors	Province	Mean	Standard deviation	Levene's p value	Effect sizes
Chemical sector					
Importance of electrical energy	Gauteng	4.33	0.72	0.30	0.28
	North-West	4.53	0.44		
Supply sufficiency statement	Gauteng	3.64	1.32	0.12	0.44
	North-West	4.22	0.94		
Operational vulnerability	Gauteng	3.74	0.50	0.01	0.76
	North-West	4.12	0.45		
Business performance	Gauteng	3.72	0.81	0.26	0.30
	North-West	3.97	0.46		
Mitigation control	Gauteng	2.55	0.70	0.16	0.38
	North-West	2.14	1.09		
Intensity control	Gauteng	2.63	0.47	0.06	0.51
	North-West	2.26	0.73		
Supermarket sector					
Importance of electrical energy	Gauteng	4.59	0.51	0.26	0.25
	North-West	4.46	0.41		
Supply sufficiency statement	Gauteng	2.72	1.28	<0.01	0.94
	North-West	3.93	0.71		
Operational vulnerability	Gauteng	3.74	0.40	0.04	0.43
	North-West	3.94	0.47		
Business performance	Gauteng	3.63	0.98	0.30	0.22
	North-West	3.85	0.73		
Mitigation control	Gauteng	2.75	0.65	0.08	0.38
	North-West	2.47	0.71		
Intensity control	Gauteng	2.74	0.42	0.34	0.19
	North-West	2.64	0.55		
Financials sector					
Importance of electrical energy	Gauteng	4.62	0.48	0.03	0.59
	North-West	4.33	0.35		
Supply sufficiency statement	Gauteng	3.73	0.88	0.04	0.61
	North-West	4.26	0.73		
Operational vulnerability	Gauteng	3.62	0.41	0.02	0.71
	North-West	3.92	0.41		
Business performance	Gauteng	3.40	1.15	0.02	0.61
	North-West	4.11	0.58		
Mitigation control	Gauteng	2.64	0.54	0.13	0.48
	North-West	2.92	0.56		
Intensity control	Gauteng	2.93	0.39	0.38	0.24
	North-West	2.84	0.25		
Construction sector					
Importance of electrical energy	Gauteng	4.08	0.91	0.07	0.38
	North-West	4.42	0.42		
Supply sufficiency	Gauteng	2.16	1.14	<0.01	1.55
	North-West	3.93	1.08		
Operational vulnerability	Gauteng	3.62	0.61	0.04	0.52
	North-West	3.93	0.51		
Business performance	Gauteng	3.54	1.29	0.04	0.44
	North-West	4.10	0.67		
Mitigation control	Gauteng	2.57	0.65	0.45	0.21
	North-West	2.43	0.66		
Intensity control	Gauteng	2.68	0.59	0.95	0.01
	North-West	2.67	0.73		

Table 11
Correlation results.

Factors	Measurements	Business size	Monthly expenditure on electricity	Cost per unit of electricity	Conclusions
Business size	Coefficient Sig.	1.00	0.48 0.00	0.15 0.02	A positive significant correlation exists for both spending and income
Monthly expenditure on electricity	Coefficient Sig.	0.48 0.00	1.00	0.24 0.00	A positive significant correlation exists for spending and no correlation exist for income
Cost per unit of electricity	Coefficient Sig.	0.15 0.02	0.24 0.00	1.00	A negative significant correlation exists between spending on electricity and monthly income

Table 12
Chi-square test for industries and monthly expenditure on electricity.

Chi square test			Symmetric measures		
	df	Sig.		Values (effect size)	Sig.
Pearson	15	0.04	Phi	0.34	0.04
Likelihood ratio	15	0.02	Cramer's V	0.19	0.04
Linear-by-linear association	1	<0.001			

Table 13
Chi-square test for industries and cost per unit of electricity.

Chi square test			Symmetric measures		
	df	Sig.		Values (effect size)	Sig.
Pearson	15	<0.001	Phi	0.65	<0.001
Likelihood ratio	15	<0.001	Cramer's V	0.37	<0.001
Linear-by-linear association	1	<0.001			

the opinion that business growth has declined due to unstable electricity supply. Unreliable electricity supply (extensive periods with supply shortfall) over the course of several years in South Africa is characterized with load-shedding occurrences as a predictable certainty for the future (Doyle, 2015) (p.22).

Objective 2: Enterprises agreed that business operations have been vulnerable due to inconsistency in electricity supply. Enterprises have experienced impacts such as loss of productive working hours, production deadlines and equipment damages. Results also reflect that the poor supply sustainability affect different business sectors and types differently. The impact also vary in the provincial level.

Objective 3: Despite the uncertainty of electricity security, enterprises still fail to prioritize relevant mitigation strategies, pertaining to a productive continuation during electricity interruptions. There is also limited governance on industrial electricity intensity in order to attain industrial efficiency. Suppliers and administrators have not implement sufficient measures that can contribute to industrial electricity supply sustainability. The literature review notes that electrical energy sustainability is primarily for industrial growth and advancements of economic activities. Measures for improvement are being discussed in the next section.

The implications of this research can be divided into two potentially interested groups: company leaders and national decision-makers. The first group should search for possibilities of increasing the level of energetic independence from the national supplier of electricity (e.g. by investing into alternative sources of energy, such as photovoltaic panels Moraes Toledo et al., 2010, biogas Tumusiime et al., 2019 tidal power and innovative electricity storage Uihlein and Magagna, 2016, etc.). Industries can significantly enhance electricity independence by direct liaison with the IPP industry. This liaison should lead to direct benefits and the potential of alternative electricity generation. NERSA should further be empowered to restructure licencing procedures for IPPs. As the South African business environment is characterized with uncertainties on energy security, it is important for industry stakeholders to establish a microgrid to reduce the impact of low supply of electrical power. This action should further prevent disruptions during industrial activities. The second group should consider to increase the efficiency of national electricity producers and distributors. The Integrated Resource Plan (IRP), which is the adopted roadmap for South Africa's energy future should be considered as a point of departure. The plan refers to capacity improvement technology, with limited references to the "how" capacity can be enhanced with such technologies. There

is also limited inclusion on grid planning needs in the resource plan. Connecting IPPs to the grid will be a challenge for grid planners, should the government continue to rely on the current IRP, for long-run energy planning. The South African government ...should consider consulting with Central and Eastern European countries – who have overcome similar infrastructural issues in the past.

The structural implementation guidelines should aim to strengthen the international competitiveness of industries, especially by forcing the electricity suppliers to ensure fair energy access, security and sustainability. Insufficient energy supply for industrial operations will significantly impact on industrial competitiveness and consequently industrial growth. Electrical energy adequacy has a direct impact on the bottom-line of industrial plants and commercial businesses (Jucker et al., 0000) (p. 5). To ensure substantial energy savings, consumption control should be effective across all sectors in the economy. Industrial technological efficiency improvement measures, are key strategy towards minimizing environmental pollution (Lee et al., 2013) (p. 189). The public sector should apply the good governance framework to ensure policies are effectively implemented and stakeholders adhere to compliance requirements on efficiency and intensity control. It is important to proceed by addressing the lack of motivation to practise energy control by industries. Scheme fostering heavy sanctions should be instituted to ensure compliance. In general, the government and the industry needs to engage on developing industrial growth, supported by electricity supply.

The main limitation of the presented research is its territorial coverage, which is limited to South Africa. Other African countries face electricity shortages as well. Nevertheless, due to the relatively high level of economic development of South Africa, the country constitutes a model case for presenting the vulnerability of developing economies to low sustainability of energy supply. When compared to its growth in former time periods, it provides also a comparative perspective on the devastating impact on electricity shortages to the business environment.

Future research should concentrate on searching for financially efficient and sustainable means of restoring the continuity of electricity supply and energy adequacy for South African business entities (as e.g. in Bushnell, 2005; Singh and Mishra, 2018; Uncertainty, 0000; Lara-Arango et al., 2017). At the same time a thorough audit of real possibilities of sustainability of real economic and infrastructural performance of the national electricity provider, Eskom, should be initiated and implemented. Its results should be presented for crosscheck and debate to the general scientific public (e.g. with use of the triangulation approach) and further analysis. When these necessary steps are fulfilled, a countrywide complex restructuring plan should be proposed for political and business decision-makers. Only such an approach can assure a restitution of the electricity infrastructure into a long-term sustainable functioning state.

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