Assessment of the quality of electrical service in industrial sector in Lubumbashi, DR Congo

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Abstract

Keywords:

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Obviously, there is a great analogy between the size of industry and the need for electricity. Overall, large industries have high electricity needs, particularly because of various energy-intensive industrial activities. The main objective of this article was to assess the quality of electrical service in industrial sector in Lubumbashi. The survey covered 60 industries in the city of Lubumbashi out of a total of 125, representing approximately 48%, this percentage thus surveyed makes it possible to say that the sample is representative, exceeding 30%. The different industries have been grouped into 5 following categories: mining industries, food industries, foundries, plastic and semi-industrial.Whatever the type of industry, the connection to the electric grid is the connection mode used at 100%. The use of generators by industries may be justified by the fact that some of these industries experience some hours or even some day of power cuts. To alleviate this situation, the use of generators is a necessity for these industries. Globally, the majority of industrialists describe bad, the quality of the electrical service they use. This perception shows that the consumption needs of manufacturers are far from being met. In the context of an increasing growth of consumption needs in the industrial sector, the repercussions are felt in households where the quality of electricity they use is deteriorating.

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1. Introduction

Electric power is the driving force for the economic development of a country. It facilitates the creation and maintenance industry, promotes trade and services and simplifies communications and transportation systems (Kachelewa et al. 2007; Energy without frontiers, 2008).

Obviously, there is a great analogy between the size of industry and the need for electricity. Overall, large industries have high electricity needs, particularly because of various energy-intensive industrial activities (Benjamin, 2010). However, in Sub-Saharan Africa, the electricity infrastructure is globally old and fragile to the variations of the demand. The report of the World Bank (2008) suggests that the annihilation of lines due to the dilapidated distribution facilities up to 2% of gross national product in many countries in sub-Saharan Africa. Electricity infrastructure is generally obsolete and vulnerable to changes in demand. The lack of investment in the electricity sector, averaging 0.7% of GDP, which explains this inefficient situation (IEA, 2006; BanqueMondiale, 2008).

In Lubumbashi, DR Congo, the electrical service provided by the National Society of Electricity (SNEL) often poses problem in both quality and quantity. Among consumers of electric power SNEL, there are customers High-voltage (VAT) including major mining companies, large consumers of electricity.

And Low Voltage (LV) customers are recruited in semi-industrial activities, including bars, shops, welding houses and craft mills. But, the bulk of the clientele is made up of domestic consumers.

At the global level, the industrial sector accounted for 27% of total energy consumption in 2005 (IEA, 2008). This consumption accounted for 17% of the final total energy consumption of the United Kingdom in 2014 (ECUK, 2015), compared to 25% of energy consumption in France or 1/3 of electricity consumption.

In the last decade, the former province of Katanga has seen an increase in mining companies, demanding more electric power. This implies that the mining companies, as a whole, are demanding powers far greater than the production capacity of the Katanga hydroelectric dams. This strong demand for electricity has meant that the city of Lubumbashi has seen its load reduced to 50 MW, while it needs at least 118 MW to properly serve its subscribers. This explains, to a large extent, the voltage drops and the "load shedding" phenomenon, since the urban network is no longer sufficiently supplied with electricity (Kalenga&Kalambay, 2013). This article verifies the hypothesis that the quality of electricity used in the industrial sector in Lubumbashi is generally good, although it varies according to the type of industry.

2.1. Study area

This study was conducted in Lubumbashi, capital of the province of Upper Katanga in the Democratic Republic of Congo. Lubumbashi, is located at 11 ° 40'latitude and 27 ° 29' longitude, the city was supplied with electricity by the thermal power plants of the UMHK (Union Minière du Haut-Katanga). Actuallyn the rate of access to electricity in Lubumbashi varies according to the different municipalities that make up the city (Banza et al. 2017, Tshibala et al. 2018).

2.2. Methods

2.2.1. Data collection

Among the existing sampling methods, the stratified random method was chosen for this study as it proved more suitable for this industry survey. In addition, the objective of the survey was to obtain estimates of the variables retained at the level of the industries, this type of sampling considered probabilistic provides a representative sample, by the fact that each industry of the place of survey has the same probability to be included in the sample (Vaillant, 2010; Lessard, 2013).

The data used in this study comes from field surveys of local industries. The complete list of local industries has been obtained at the FPI (Fund for the Promotion of Industry). From this list a categorization was performed according to the methodology recommended by Eberhard (2013). Each industry category in the industrial sector is analyzed separately and then combined in a comprehensive sector assessment (Brodyanski et al., 1994). The survey covered 60 industries in the city of Lubumbashi out of a total of 125, representing approximately 48%, this percentage thus surveyed makes it possible to say that the sample is representative, exceeding 30%. The different industries have been grouped into 5 following categories: mining industries, food industries, foundries, plastic and semi-industrial. The first category included all industries processing or processing minerals. The food industry category included all biscuits, breweries and all other industries producing various food products. The foundry category included all industries manufacturing various metal parts (Eberhard, 2013), and finally the semi-industrial category included bars, shops, welding houses and craft mills (Kalenga&Kalambay, 2013).

2.2.2. Statistics

Based on the survey data, we entered a database using the Excel software. The statistical analyzes were performed with the Minitab 16 software by applying an analysis of the variance (ANOVA) according to the different types of industries.

3. Results

3.1. Number of hours and days of load shedding

Figure 1 shows the number of hours of load shedding per day and the number of break days per week. As a result, the number of days and hours of load shedding are functions of the types of enterprises. Mining companies benefit from an average electrical service without interruption. The mining industries benefit from an almost interrupted electrical service, in contrast to semi-industries where the number of hours of interruption is higher. However, the number of load shedding days observed in foundries is not synonym of entire day without power, but an average of 4 hours. In addition, the food industries and plastics industries benefit from an intermediate quality compared to the number of days and cut-off hours of other industries.
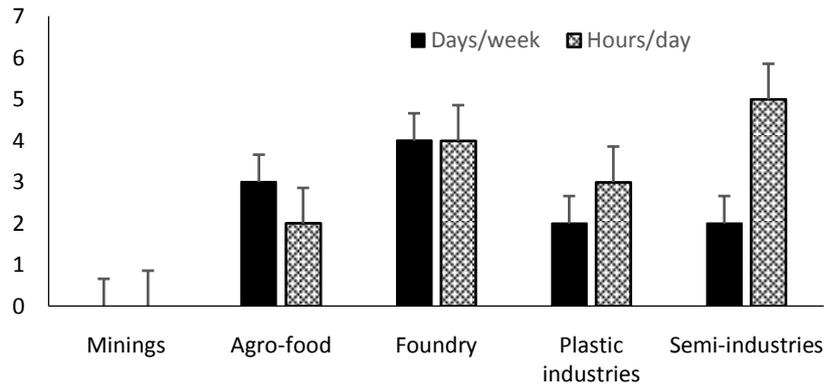
Figure 1. Number of hours and days of load shedding by industry type

3.2. Number of power lines

The maximum number of power lines that an average local industry uses is 3. The mining, food processing and smelting industries have more lines than the plastics and semi- industries (two lines on average). The need for electrical energy and the fear of running the risk of load shedding by having a single power line are the main reasons why all industries have more than one power line (Figure 2).
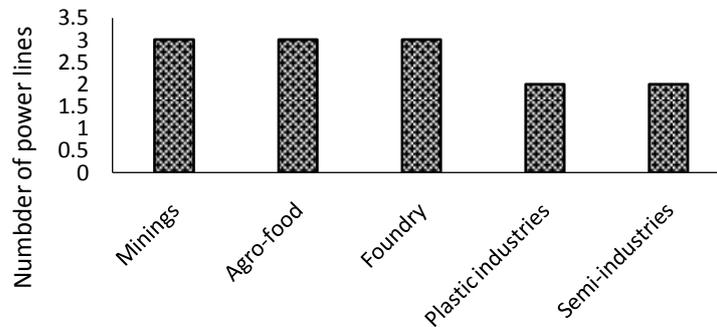

Figure 2. Number of power lines by type of business

3.3. Connection to the network and use of electric generators

Figure 3 shows the percentage of industries directly connected to the electricity grid and those using electric generators as a palliative source of the lack of electricity. It follows that: regardless of the type of industry, the connection to the SNEL grid is the basic connection mode (100%). Regarding the use of generators. It is proven in Figure 3 that most industries use electric generators. However, all foundries use personal generators to compensate for the lack of service provided by SNEL. As for the plastic and semi-industrial industries, the results reveal that only 20 and 21.7% of these industries use personal generators.
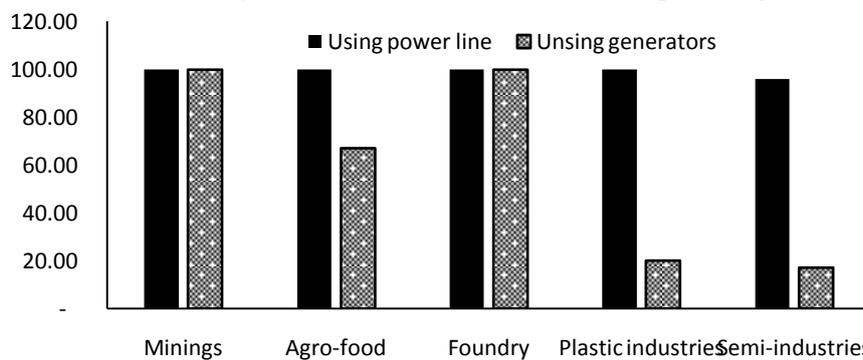

Figure 3. Network connection and use of personal generators

3.5. Variation in charge rate and voltage drop

Figure 4 shows the variation of the charge rate (in percentage) and the voltage drop. The observation of the results obtained after analyzes shows that the charge rate varies between 56, 61% and 107 %. It is obvious that the average load rate for the mining industries is the lowest, i.e. 56, 61%. The load factor higher than

100% as observed in the plastic and semi-industrial industries shows that these industries are overloaded. In addition, the voltage drop is lower for the foundry industries, the agro-food and mining plastic and semi-industrial industries.
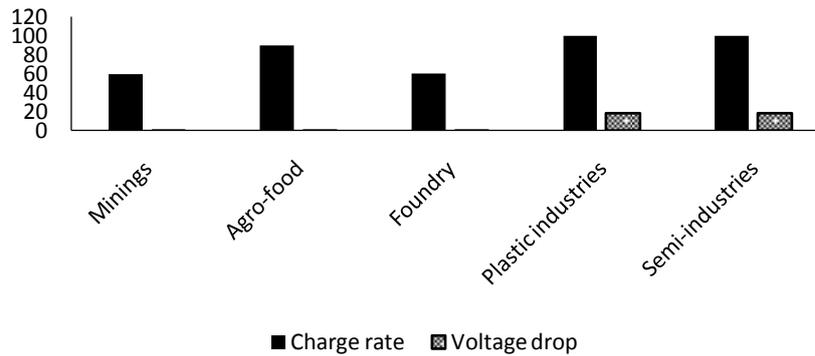

Figure 4. Variation in charge rate and voltage drop according to the types of industries

Table 1 presents the different levels of assessment of the electrical service by the industrialists. As a result, the mining industry appreciates the quality of service. On the other hand, foundries are not satisfied with the quality of service they receive. According to industry perception, only semi - industrials have a high percentage with poor quality followed by foundries and plastics industries. On average, the majority of the industrial sector describes the quality of the electrical service provided by SNEL as bad. Only 13.34% of industries are satisfied with the electrical service provided by SNEL.

Table 1 also shows the industry's perception of the quality of electrical service provided by SNEL. As a result, the majority of industries (68.33%) rated the quality of service provided by SNEL as bad. Only 13.34% of the industries that qualify as good the quality of the service which they benefit.

Table 1. Perception of the quality of electrical service by industrialists

Industries	Number of industries	Investigation				Enrollment (%)			
		good	Average	bad	Very bad	good	Average	bad	Very bad
Minier	2 (3,33%)	1	1	0	0	1, 67	1, 67	0	0
Food	18 (30%)	2	5	11	0	3, 33	8, 33	18, 33	0
Foundry	5 (8, 33%)	0	0	5	0	0	0	5 , 33	0
Plastic	13 (21,67%)	1	2	9	1	1, 67	3, 33	15	1, 67
Small industry	22 (36,67%)	4	2	16	0	6, 67	3, 33	26, 67	0
	60 (100%)	8	10	41	1	13,34	16, 67	68, 33	1, 67

4. Discussion

The study of the quality of energy supply in the industrial sector was based on the following parameters: The number of days of shedding per week and the number of shedding hours per day, the charge rate, the voltage drops and the perception of the industry s on the causes of disruption of electricity supply.

It turns out that in the industrial sector in Lubumbashi, the number of time s and days of shedding depends of industries such. According to the types of industries, it is observable that the mining industries benefit from an uninterrupted electrical service unlike other industries. This observation implies that the mining sector is an economically key sector in the region. In addition, these industries connected to high voltage power grids are e very consumer's energy and proper functioning implies a permanent electricity supply. The consequences of this high demand for electricity are reflected in households that benefit less and less from good quality service. As for semi-industrial companies, the results show that the quality of the electricity supply in this type of company is bad compared to other types of industries. This would be justified by the fact that most semi-industrial users are connected to the low-voltage grid, which suffers frequent interruptions (Banza et al., 2016). Yet, industry is an essential sector in that it is a "modern" economic activity for developing countries and thus promotes economic development. This link between industry and economic growth has, moreover, been empirically observed worldwide since the 1950s (Rodrik, 2008, 2009). Although there are power cuts in the industrial sector, the situation in the residential sector is still worse, as

shown by Banza et al. (2017). The number of hours of load shedding in some parts of the city easily reaches 20 (Banza et al., 2017). Some newly-built neighborhoods live naturally in the dark. It is also reported by Kalenga&Kalambay (2013) that the strong demand for electricity has meant that the city of Lubumbashi has seen its load reduced to 50 MW, while it needs at least 118 MW to properly serve its subscribers. This explains, to a large extent, the voltage drops and the "load shedding" phenomenon, since the urban network is no longer sufficiently supplied with electricity.

With regard to the number of power lines used by the industries, the results show that the mining industries, the food industry and the foundries benefit from an average of three power lines per industry. The lowest number of lines is 2 for the plastic and semi-industrial industries. This situation shows that no industry takes the risk of being connected to a single power line. The lack of confidence created by the sometimes un-programmed cuts encourages industries to connect to more than one power line. This situation was also observed in the residential sector in the same region by Banza et al. (2017). A relationship can be established between the number of lines supplying a given industry and the number of hours and days of load shedding per day and per week, respectively. The question of the need for consumption is also evident at this stage as the mining industries have a higher number of the line, reflecting the high electricity needs and explains the absence of cuts in these types of industries.

Whatever the type of industry, the connection to the electric grid is the connection mode used at 100%. However, these results reveal that 100% of industries use an electric generator. The use of generators by industry, can be justified by the fact that some of these industries are experiencing a few hours or even a day of electricity cuts. To alleviate this situation, the use of generators is a necessity for these industries. Other industries are even connected to the Zambian interconnection power grid (ZESCO) in order to fill the service gap provided by SNEL. The number of semi-industrial generators using the generator in the event of an electrical failure is only 21.70 %. This means that 78, 30% of the industry's semi depend entirely on power lines SNEL and despite the shedding frequency which amounts to 5 hours per day, 2 days per week on average. This situation shows that these companies benefit from a poor quality of electrical service.

With regard to the load rate and the voltage drop within the industries, the observation of the results obtained after analysis shows that the charge rate varies between 56. 61% and 107 %. It is obvious that the average load rate for the mining, smelting and agro-food industries is the lowest. This discharge rate exceeding 100% reveals the overload problem in some industries. In addition, the voltage drop is lower for the mining and smelting industries but higher for small industries. Industries with multiple power lines experience a relatively low voltage drop.

Overall, the assessment of the quality of the electrical service rendered by SNEL in the industrial sector is poor. Most industries, although benefiting from several power lines and fewer switch-off days, are still dissatisfied compared to their need for consumption. In the context of the strong population growth in the city of Lubumbashi, which is leading to increased electricity needs and increasing demand from the industrial sector, it is necessary to put in place mediating policies to avoid deterioration that is becoming increasingly worrying. the quality of electrical service in both sectors.

5. Conclusion

The consumption and quality of electrical energy in the industrial sector in Lubumbashi has differing degrees according to the type of industry. It results from the results of the investigations in the industrial sector in Lubumbashi, the number of time s and shedding days depend on the type of industries. However, these numbers are relatively low in this industrial sector compared to the load shedding frequency observed in the residential sector in Lubumbashi. Whatever the type of industry, the connection to the electric grid is the connection mode used at 100%. The use of generators by industries may be justified by the fact that some of these industries experience some hours or even some day of power cuts. To alleviate this situation, the use of generators is a necessity for these industries. Globally, the majority of industrialists describe bad, the quality of the electrical service they use. This perception shows that the consumption needs of manufacturers are far from being met. In the context of an increasing growth of consumption needs in the industrial sector, the repercussions are felt in households where the quality of electricity they use is deteriorating. Effective measures should be taken to spare Lush households from suffering the consequences of industrial electricity dissatisfaction.

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