




IDENTIFICATION OF FACTORS ENCOURAGING HOUSEHOLD CONSUMERS TO ENGAGE IN THEFT OF ELECTRICITY IN LUBUMBASHI, DR CONGO

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ABSTRACT

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Fraudulent access to the conventional electricity grid is a serious concern in developing countries. This significantly affects the revenue-generating capacity of their utilities. This article is undertaken to identify the factors encouraging the theft of electricity in Lubumbashi. Based on survey data from various municipalities in the city covering 1211 households based on a simple random sampling plan, the factors responsible for the theft of electricity were identified and ranked in order of importance. Quantitative data were subjected to one-way analysis of variance (ANOVA). In addition, a post hoc test of Tukey was applied at the significance level <5%. Qualitative data were subjected to chi-square tests. In this study, poor enforcement of the law, corruption, SNEL does not fight for the interests of real subscribers, cost of electricity, quality of service and education are the main causes encouraging electricity theft. To combat this situation it is important to put in place policies that integrate these different factors.

Contribution/Originality: This study contributes to the existing literature on the main causes of electricity theft. Other than poverty as an important factor explaining the theft of electricity, this study identifies and ranks other underlying factors in order of importance, including: poor law enforcement, cost of electricity, quality of service and education.

1. INTRODUCTION

Electricity theft is an urgent problem that affects the performance and investment prospects of utilities around the world [1]. While this has minimal effects in some jurisdictions, in others, the theft of electricity greatly affects the variability of the distribution companies [2]. The fraudulent consumption of electricity increases the number of breakdowns on the distribution network by degrading the quality of service [3].

Kumar, et al. [4] in his work in India showed that theft of electricity was a function of the country's policy. In general, we find that the theft of electricity is more widespread in countries where governance is bad [2]. Theft of electricity is a global problem [5]. There is considerable disparity in the rate of electricity theft between developed and developing countries (DCs) [2, 6]. The highest rates are noticed in developing countries Bhattacharyya [7]; Yurtseven [8]. Herdt and Marysse [9] found that 10% of the plots in Kinshasa were fraudulently connected to electricity. Very recently in Lubumbashi [10] has shown that about 20% of households have access to the electricity network of SNEL (National Electricity Company) in a fraudulent way, either by perching on the air network Figure 1 or by connecting with neighbors who are real subscribers of SNEL. Looking at relatively higher flight rates in

DCs, we can index poverty as the explanatory factor. This remains relative in China for example we find a low rate of theft of electricity against a high rate of poverty [8].



Figure-1. Case of the theft of electricity by connecting to the air network in Lubumbashi.

Several authors have identified the determinants underlying the theft of electricity; these factors are different in different countries. In Pakistan, *Jamil and Ahmad* [11] and Brazil, *Mimmi and Ecer* [12] identified electricity prices and income as two variables that affect the theft of electricity; with a negative correlation between income and the theft of electricity. Several authors argue that poverty is the main cause of theft of electricity in developing countries [8]. Others, however, beyond income, identify educational attainment as determinants of electricity theft [1, 13]. Factors other than income must be carefully considered. In this research, beyond the monthly income, other factors encourage households to engage in fraudulent access to electricity are identified and classified. The remainder of this document is structured as follows. In section 2, we present the methodology used and its implementation. Section 3 provides the results and their discussions. We conclude briefly in section 4.

2. METHODOLOGY AND IMPLEMENTATION

2.1. Study Area

The city of Lubumbashi is located at $27^{\circ} 29'S$, $11^{\circ} 41'E$. It is located in the south-east of the Democratic Republic of Congo and is the capital of the province of Upper Katanga (formerly Katanga). Its territory is identical to that of 1957, landlocked in the sub-region of Upper Katanga and still comprises seven communes subdivided into 43 districts, 246 cells and 1368 streets and avenues. Lubumbashi, with a population of about two million is the second most populous city in the Democratic Republic of Congo after Kinshasa. In Lubumbashi the growth rate of the population observed between 2001 and 2008 is 4.1% [14] while the various basic services such as electricity and water have not followed this increase [10]. This rapid growth of the population of Lubumbashi has resulted in the extension of the city and consequently a sharp increase in electricity needs. This is the basis of the overload of the electrical infrastructures which are at the beginning dilapidated [10, 15]. The construction area of the city of Lubumbashi is increasing; the city extends to the periphery [16]. The access rate to the electricity grid is about 62% [15] with a service characterized by long-term and unpredictable power cuts [15, 17].

2.2. Methodology

To identify and rank in order of importance the factors explaining the theft of electricity, the qualitative research methodology was used. These were mainly interviews and reading the existing literature. The heads of households were interviewed with an open questionnaire and gave the reasons why different households engage in

the practice of electricity theft. The question was: What do you think is the reason that motivates people to steal electricity?

To identify the factors responsible for the theft of electricity, the Likert scale was used allowing inter-household households to give their perception of the impact of the selected variables on the theft of electricity. The variables selected are: cost of electricity, unemployment, quality of electricity service, poverty, corruption, poor enforcement of the law against theft of electricity, education and SNEL struggling not for the interests of consumers. On a Likert scale of 1 to 5 (strongly disagree, disagree, neutral, agree and strongly agree) [18-20] household heads were asked to choose how they agreed with the reasons listed as contributing to the theft of electricity.

2.3. Sample Constitution

The size of the sample taken must be representative of the population surveyed [21]. To determine the sample size, we were guided by Barlett, et al. [22] they argue that the accuracy and quality of the research will be influenced by inappropriate, insufficient or excessive sample sizes. The estimation table constructed by Krejcie and Morgan [23] has been widely used by researchers to estimate the sample size [20, 24] and the following formula (1) is used:

$$S = X^2 NP (1-P) / d^2 (N-1) + X^2 P (1-P) \quad (1)$$

Where:

S = required sample size; X^2 = chi-square value for a degree of freedom at the desired level of confidence; N = size of population; P = proportion of the population (assumed to be 0.50); d = the degree of precision expressed as a proportion (0.05).

Krejcie and Morgan [23] used the formula above to construct a table to determine the sample size at 1 degree of freedom (dof). This method is effective and representative of the chosen population [20].

Very recently [10] has shown that in Lubumbashi the access rate to the SNEL network is about 62%, while 20% of the population has access to electricity via this network fraudulently. In 2017, the number of households in Lubumbashi is close to 230000, which gives 142600 the number of consuming households. This brings us to a target population (20% consumer) of around 28520.

In the framework of this work we had 7 observations (7 municipalities) this leads us to 6 dof ($k-1$) and a 95% confidence interval. X^2 6dof = 12,592 [25]. The margin of error is 5% using formula (1) and a 95% confidence interval. This led to a sample of 1208. We take the sample size to 1211 (for the 7 communes of Lubumbashi) to allow us to have 173 households per municipality and thus include as many households with the socio-economic level varied.

2.4. Household Selection

In Lubumbashi, most households are grouped and sometimes several households are in the same plot with different financial conditions. In this case each household was separately surveyed. Random sampling will be retained for data collection. The "Random Number Generator" application was used for surveys [26]. This app selects a range of homes in a group of 1 to 100. House number 1 was the first on the right side and number 2 was the first on the other side of the road.

2.5. Data Processing

The survey data was extracted and encoded in binary form using the Excel software. After coding, the data were subjected to a one-way analysis of variance (ANOVA) in order to highlight the differences between the means of the communes. In addition, a post hoc test of Tukey was applied to determine the difference between the means of

the result with 5% significance threshold [27, 28]. ANOVA helped to differentiate the average from different variables. R 2.15 and Past software will be used for statistical analysis.

3. RESULTS AND DISCUSSION

Consumers are then classified into the domestic and commercial categories Table 1. In this table 1023 respondents were household consumers and 188 were commercial consumers, accounting for 84% and 16% respectively of the total number of consumers surveyed.

Table-1. Type of consumer in % in the different municipalities.

Municipalities	Type of consumer		Total
	Domestic	Commercial	
Annexe	128	45	173
	74%	26%	100%
Kamalondo	152	21	173
	88%	12%	100%
Kampemba	145	28	173
	84%	16%	100%
Katuba	159	14	173
	92%	8%	100%
Kenya	128	45	173
	74%	26%	100%
Lubumbashi	159	14	173
	92%	8%	100%
Ruashi	152	21	173
	88%	12%	100%
Total	1023	188	1211
	84%	16%	100%

There are three types of consumers namely consumers with a prepaid, postpaid Figure 2 and non-metered Table 2 counter. At the city level, 9% of households had a prepaid counter, 43.7% a post-paid meter and 53% did not have a meter.

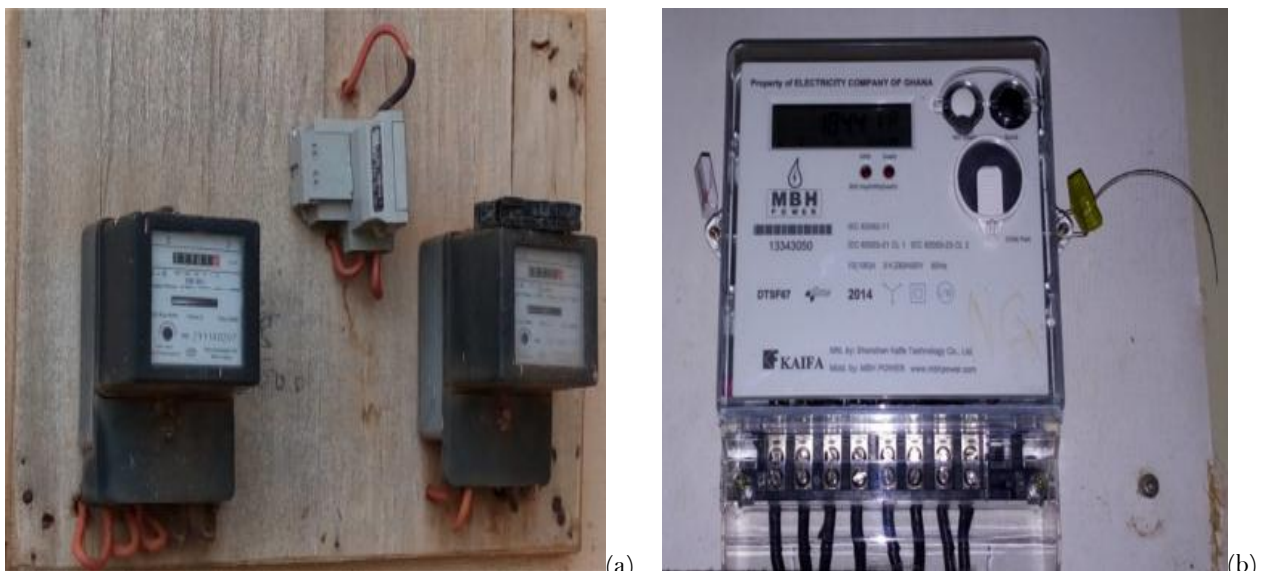


Figure-2- a. postpaid analog meter; b. Digital prepaid meter.

Table-2. Type of meter in % in the different municipalities.

Municipalities	Type of meter			Total
	Prepaid	Postpaid	Without meter	
Annexe	0	7	166	173
	0.0%	4%	96%	100%
Kamalondo	0	156	17	173
	0.0%	90.2%	9.8%	100%
Kampemba	0	35	138	173
	0.0%	20%	80%	100%
Katuba	0	0	173	173
	0.0%	0.0%	100%	100%
Kenya	3	101	69	173
	2%	58%	40%	100%
Lubumbashi	31	72	70	173
	18%	41.6%	40.4%	100%
Ruashi	3	159	11	173
	2%	92%	6%	100%
Total	37	530	644	1211
	3%	43.7%	53%	100%

Several electricity consumers in Lubumbashi share the same meter, either in the same plot or in nearby neighborhoods. According to [Table 3](#), out of a total of 1211 households, 252 households representing 21% used a single counter, while 959 households representing 79% used a common counter. The report is often not known and often also the owner of the meter does not contribute to the bill.

Table-3. User Type of meter in%.

Municipalities	Meter usage type		Total
	Single user	Multiple users	
Annexe	3	170	173
	2%	98%	100%
Kamalondo	35	138	173
	20%	80%	100%
Kampemba	31	142	173
	18%	82%	100%
Katuba	0	173	173
	0,0%	100%	100%
Kenya	27	146	173
	16%	84%	100%
Lubumbashi	59	114	173
	34%	66%	100%
Ruashi	97	76	173
	56%	44%	100%
Total	252	959	1211
	21%	79%	100%

[Table 4](#) presents the average of responses collected from household heads on the reasons for theft of electricity. Respondents disagreed that poverty and unemployment were the main causes of the theft of electricity. These variables had an average of 2.62 and 2.3. The weak enforcement of the law against the theft of electricity (3.81) is the main cause for which people steal electricity. Bribery, averaging 3.76, is the second reason consumers are stealing electricity. SNEL employees and accredited agents cooperate with households to steal electricity in exchange for money. SNEL does not fight for the interests of legal subscribers, it is only interested in establishing new rates this statement is ranked third with an average of 3.7. With an average of 3.6, electricity prices are the fourth reason why consumers engage in theft of electricity. Respondents criticized electricity tariffs and the predominantly flat-rate mode of charging of 53% of households surveyed that do not have a meter [Table 2](#) and respondents agree that it is one of the main causes of the theft of electricity. In Lubumbashi, the work of [Banza \[15\]](#)

showed that electricity billing was a source of conflict between domestic users and the distribution system operator. The author has also shown that this billing is done in a lump sum manner. This forces subscribers to pay for the consumption of fraudsters and losses in the distribution network. And in general, it is the poor and honest consumers who pay the consequences [29]. This was at the root of the attacks and vandalism of public utilities by people because of the anger provoked by what they called extremely high bills [15, 20]. The quality of service of SNEL was also criticized by the respondents. Power outages and voltage level variation persist, affecting consumers' uses, with some consumers losing their devices as a result of these variations. Due to the poor quality of electricity, consumers cannot use electricity to work efficiently. Respondents rate the poor quality of electrical service and the lack of education in fifth place with an average of 3.4, which is another reason why consumers are involved in the theft of electricity.

Table-4. Rand average reasons for the theft of electricity.

Reason	N	Minimum	Maximum	Average	Standard-deviation
Cost of electricity	1211	1	5	3.6	1.3
Unemployment	1211	1	5	2.3	0.9
Quality of electrical service	1211	1	5	3.4	1.3
Poverty	1211	1	5	2.62	1.11
Corruption	1211	1	5	3.76	1.26
Poor application of the law against the theft of electricity	1211	1	5	3.81	1.28
SNEL does not fight for the interests of consumers	1211	1	5	3.7	1.4
Education	1211	1	5	3.4	1.3

Figure 3 shows that the rate of illegal access to the network was decreasing with the increase in monthly income.

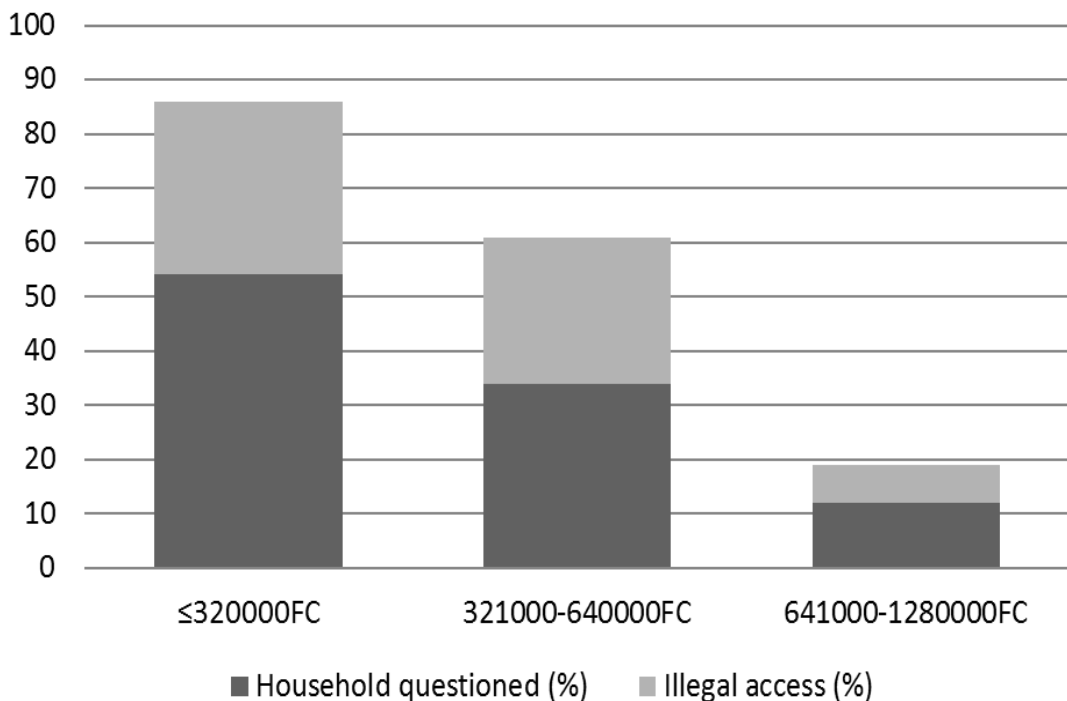


Figure-3. Link between illegal network access and monthly income (1600FC = \$ 1).

In this study the main reasons why people commit theft of electricity are classified as follows: poor law enforcement, corruption, SNEL does no fight for the interests of real subscribers, high electricity prices, poor quality of electrical service and education. Unemployment is concomitant with the poverty of the populations. These are not major factors but they also contribute to the theft of electricity.

Smith [2] shows in his work in South Asia that poverty are the main factor in the theft of electricity by consumers. This assertion is not sustainable in Lubumbashi for this study; this is corroborated by Yurtseven [8] and Yakubu, et al. [20]. In Lubumbashi, we sometimes notice consumers of the commercial type who are not poor are connected to several lines of the distribution network fraudulently.

This study shares with Smith [2] the same view that the theft of electricity is caused by corruption. This study also corroborates the statement of Jamil and Ahmad [11] by Mutebi, et al. [30] and Yakubu, et al. [20] corruption is a factor favoring the theft of electricity. On the other hand, the study does not share the point of view of Yakubu, et al. [20] according to which the lack of education level of the population was not among the main reasons for the theft of electricity. Theft of electricity is at the root of many security issues such as electric shocks, electrocution and fire Depuru, et al. [6]; Banza [10]. According to Banza [10] the lack of education of the population means that it ignores the risk it incurs by engaging in this type of practice of stealing electricity.

4. CONCLUSION

Increasing rates of electricity theft in developing cities, including Lubumbashi, need to be curbed. It is therefore imperative to understand the causes that motivate people to engage in theft of electricity in order to implement improvement solutions. In Lubumbashi it was found poor enforcement of the law, corruption, SNEL does not fight for the interests of real subscribers, cost of electricity, quality of electrical service and education are the main causes of theft electricity. Unemployment is concomitant to poverty also incite people to engage in theft of electricity. This leads us to believe that the causes of the theft of electricity are country-specific with corruption as a common factor for developing countries. Policies to combat the theft of electricity should incorporate the cost and quality of the electrical service provided. This will allow the country households correctly their bills. This work opens a door to future work, we are already thinking of developing a technical system to detect and extract evidence of theft of electricity to prosecute offenders.

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