Electricity Theft in Kampala and Potential ICT Solutions

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Abstract. Electricity theft is the main source of non-technical losses in electricity distribution utilities. This paper presents data from an ongoing research to study the causes of electricity theft in Kampala, Uganda and people's response to the efforts being made to reduce it. Our study reveals that electricity theft in Kampala is largely due to economic reasons and corruption within the utility company. It confirms that people perceive electricity theft as the utility's problem and are not willing to report electric theft suspects. We propose ICT technologies to encourage consumer participation in reducing electricity theft.

Keywords: Energy · Electricity distribution · Electricity theft · Non-technical losses · ICT · Mobile applications · Consumer participation

1 Introduction

Electricity distribution utility companies world over are grappling with electricity theft [1–6]. Due to electricity theft, utilities are losing an estimated $25 billion annually [2], with some being driven to bankruptcy [1, 3]. Electricity theft makes it difficult for the utilities to plan for the grid leading to power black outs [2]. The unavailability and irregularity of power caused by an unstable grid slows down the economy because industries and businesses cannot operate profitably [7, 8], and in some cases, public services like transportation, telecommunication and health cannot function normally. In addition, innocent lives are lost due to fires and electrocution brought about by unprotected illegal connections and unprofessional electrical terminations [9, 10].

Electricity theft is complex problem that requires thorough study [1, 11]. In this paper we present our findings on a study of electricity theft in Kampala, Uganda and make some recommendations. The rest of this paper is organized as follows: in Sect. 2 we briefly highlight the problem and efforts towards reducing it. Section 3 mentions related work, while Sect. 4 explains the study approach. In Sect. 5 we present the findings of the research which we briefly discuss in Sect. 6. Section 7 contains the recommendations and we conclude in Sect. 8.

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2 Problem Definition

Theft of electricity in Uganda is a problem resulting into losses of $30 million annually for UMEME Ltd, the main electricity distribution utility [12]. The utility company launched a campaign against electricity theft, starting with installation of prepaid meters [13] and aerial bundle conductors in 2011, and media campaigns in 2013 to 2014. The media campaigns through radio, television and billboards, lasting for six months to one year, encouraging people to desist from stealing electricity and to report suspects. The installation of prepaid meters and aerial bundled conductors will go on until 2018 [14]. Additionally, efforts are being made to tighten the laws against electricity theft [15]. Given the complex nature of the factors that lead to electricity theft, Smith [1] recommends that before any action is taken against electricity theft it is crucial that the problem be understood and a multi-disciplinary approach taken. This research was undertaken to understand the reasons why Kampala residents engage in electricity theft and therefore design additional approaches to curb it.

3 Related Work

Previous work has been done to identify factors that lead to electricity theft, focusing on one or two factors at a time. Smith [1] related electricity theft to governance and corruption and found that electricity theft is a major problem in countries with weak structures and poor governance. Steadman [3] considered the connection between electricity theft, economic factors and crime. Her work reveals that demand for electricity stays the same regardless of the price and that electricity theft is higher when the cost of living is high than when it is low. Mimmi et al. [16] studied the socio-economic factors that lead to theft in the peri-urban slum dwellers of Brazil. They find that the quality of power supply and feelings of being discriminated against by the utility, lack of access to electricity connections, home businesses and poor energy efficiency practices all contribute to electricity theft. Winther [6] looked at the relational nature of the problem and found that people were forced to comply to payment of electricity bills due to fear of social pressure rather than technology and formal law. Faisal and Ahmed [5] carried out an economic investigation of electricity theft and concluded that people only steal electricity if the perceived benefits are more than the risks.

4 Methodology

We conducted a descriptive research to understand electricity theft from the consumers' perspectives. Random stratified sampling was used to ensure that we capture a representative sample of domestic and commercial consumers. Industrial consumers where not willing to participate so they were left out. Electricity theft is a sensitive issue and we feared that respondents would become suspicious thinking we are spies from the utility company. Consequently, we feared that asking respondents whether or not they had participated in electricity theft would make them defensive. Therefore we reasoned that since the reasons that would make someone consider stealing electricity are the

same reasons that would cause someone to actually do it, we interviewed respondents as potential electricity thieves, regardless of whether they had done it before or not. We also asked respondents to report actual cases of electricity theft bearing in mind that these could be their own cases. Fortunately we were able to get some respondents who where open enough to admit that they had done it. The main data collection tool was a survey questionnaire that had a mixture of open ended and closed question. For an entire population of 331,337 consumers in Kampala, we used a margin of error of 5 %, a confidence interval of 95 %, and a response distribution of 50 %, the sample size was 384 [17]. Here we present results from 167 respondents.

Of the167 consumers that participated in the research, 60 % where domestic consumers while 40 % were commercial. Among the domestic consumers, 61 % had prepaid meters, and 31 % had ordinary meters while the commercial consumers had an equal number of prepaid and ordinary meters. 61 % of the respondents were male while were 39 % female.

5 Findings

We presented respondents with some of the reasons for electricity theft based on literature, asking them to tick all the reasons they find applicable. Figure 1 shows their responses. The Y-axis shows the percentage of respondents who ticked a particular reason. The significant reasons from left to right on the X- axis, are lack of money, high electricity tariffs, corruption within the utility, weak laws against electricity theft. Other reasons included ignorance, arrogance and the opinion that the previous utility had more affordable electricity.

The respondents were presented some attitudes of people while they are using illegal electricity and we asked which one they agreed with, ticking all applicable. The responses presented in Fig. 2 with the Y-axis representing the percentage and X-axis the attitudes. 50 % selected "why should I pay if I can avoid it", "Some people do it and

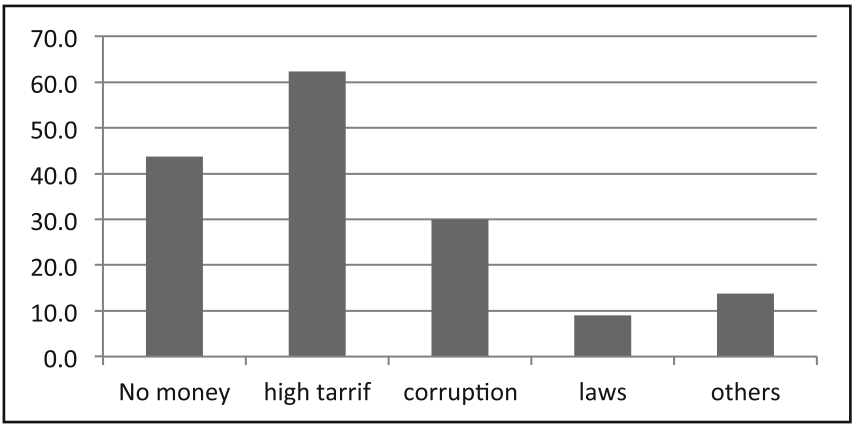

Fig. 1. Motivations for electricity theft

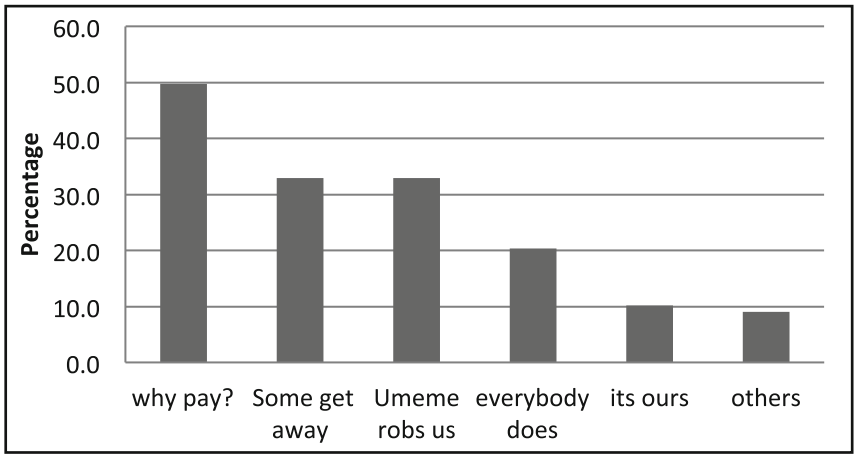

Fig. 2. Attitudes that encourage electricity theft

get away with it" and "UMEME robs us so we should rob them too" each had 33 %. 20 % agreed with "Everybody is doing it" and 10 % "it is our electricity why pay?" while 9 % had other responses.

We asked respondents who bears the cost for stolen electricity. 40 % respondents think that the cost is only borne by the utility, 28 % by paying consumers and 22 % think the cost is shared by the utility and the consumers. These results are represented in Fig. 3A.

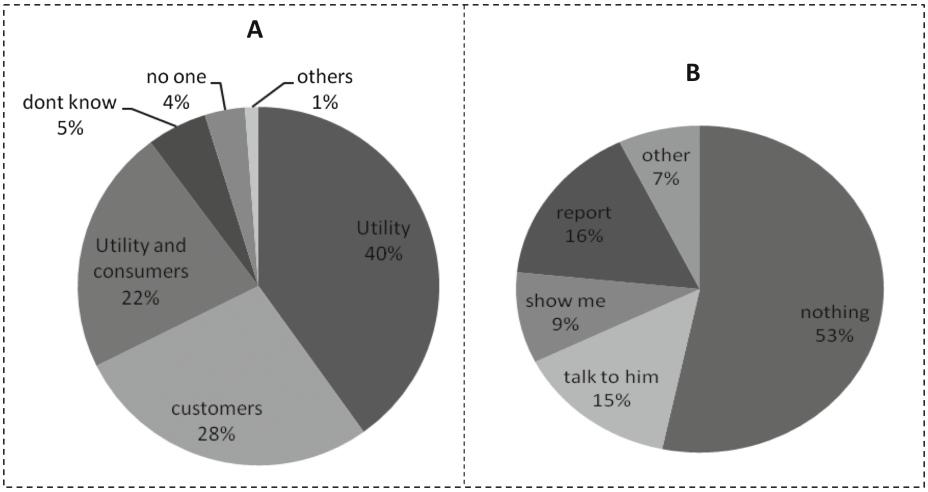

Fig. 3. A shows the responses to who bears the cost of electricity and 3B has the reactions in case of knowledge of electricity theft.

Like earlier mentioned, we wanted to know how effective the utility's efforts to encourage the public to report cases of theft were. Therefore we asked them what they would do in case they saw their neighbor stealing electricity. 53.4 % said they would do nothing, 16.2 % they would report to the authorities, 14.4 % would talk to the person taking the illegal electricity advising them to stop, 9.0 % would ask to be shown how to do the same and 7.2 % other reactions. These are shown in Fig. 3B.

Lastly, on a scale of 0–5 where; 0 is totally disagree, 5 is totally agree, we asked the respondents how much they agreed with statements concerning their attitude towards electricity theft, their relationship with the utility and the legal system as pertains to electricity theft. We find that 59 % totally agree that illegal use of electricity is a bad habit. 54 % totally agree that utility staff are major contributor to electricity theft and 51 % are sure the utility's campaign against theft will not compel them report illegal use. Much as 42 % are aware of the legal consequences of illegal use, 46 % totally disagree that the law is strong enough to prevent people from stealing electricity. These are shown in Fig. 4.

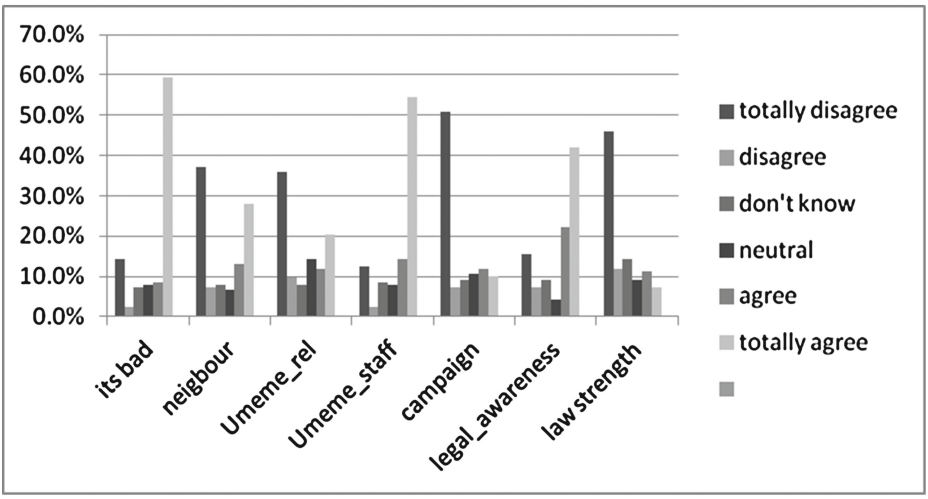

Fig. 4. Responses to general attitudes.

6 Discussion of Results

Results in Fig. 4 show that people within Kampala view electricity theft as a bad habit, however that they are forced into by the high electricity tariffs and the ever increasing cost of living (Fig. 1). Much as the laws against electricity theft are not strong enough (Fig. 4), Fig. 1 shows that this weakness is not a major contributor to theft. On the other hand, corrupt utility employees play a major role in facilitating the process of electricity theft (Figs. 1, 2 and 3). Additionally, Fig. 3 shows that Ugandans don't have the sense of entitlement to electricity as was the case in South Africa [18], and just as trust in the authority's fairness has been found to be a great factor in tax compliance [19, 20], it is also a factor here albeit to a small degree.

Quantification of the cost of electricity theft to both the consumers and the utility is critical for electricity theft reduction. This estimation requires accurate calculation of technical and non technical losses and then a clear identification of all the sources of electricity theft. A report on a study of energy losses [21] placed the 2009 technical losses at 15.1 % and thus concluded that the non technical loss for 2010 which had a total loss of 30 % was 14.9 %. As of September 2014, total energy losses were at 21.6 % from 24.3 % in 2013 [22]. Preliminary findings suggest that in 2012, a 1 % loss cost the country 12 billion Uganda shillings [23]. This study is still ongoing and more definitive results on the economic impact of o electricity theft will be published in a subsequent report.

Whereas the cost of electricity theft is borne by both the utility and consumers [11], the consumers tend to perceive it as only the utility's problem as evidenced by their unwillingness to report theft. Those who were not willing to report thought it was none of their business, or feared the wrath of the neighbors, or did not want to affect their relationships. Others simply wondered what they would stand to benefit from reporting.

7 Proposed System

The utility company is making progress in fighting electricity theft, however more could be achieved if consumers where more involved. Indeed Winther [6] and Faisal and Jamil [5] advocate that a bottom-up approach that relies on the public to curb the problem is needed. Since this research has revealed that consumers are reluctant to report theft, we recommend the following interventions that hopefully might result into increased consumer participation:

(i) **Communicating the Cost of electricity theft to consumers:** In order to generate public interest in electricity theft we recommend that the cost of theft to consumers be made explicit. Studies have shown that display of consumption information on home display units of smart metering consumers, results into efficient energy use [17]. We hope that if the predicted increase in tariffs based on prevailing levels of theft is communicated via SMS or as part of phone application, consumers will see the need to report theft.

(ii) **Applications for collecting theft tips:** Utility companies need applications to effectively collect and manage electricity theft tips. These could take the form of a web and smart phone applications. These applications will provide consumers with a template of the necessary information required.

(iii) **Applications for evaluating and managing electricity theft tip information:** Electricity tips will generate a huge amount of data that would need to be stored and managed by a database. Additionally, tips are prone to being inaccurate and the utilities usually have no way of selecting which tip is true or false. There is a need for an intelligent decision support system that supports the utility in deciding which tips to follow up on. This will reduce wastage of resources on inaccurate tips.

For the aforementioned interventions to be achieved a system for electricity theft monitoring is needed. We propose a system to proactively engage consumers in reporting electricity theft by:

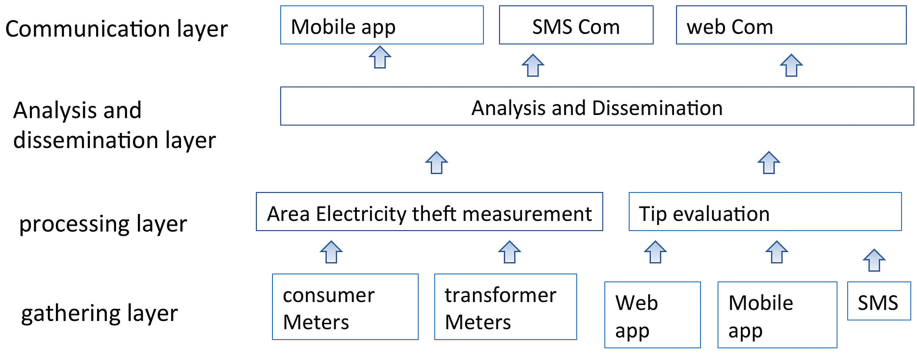

Fig. 5. High-level architecture of proposed system

- Communicating to consumers the electricity lost through electricity theft in their locality and its cost implication in terms of tariff increase.
- Providing user friendly platforms for consumers to report electricity theft, corruption by utility employees, and other performance issues like power black outs.
- Monitoring the trend of electricity theft, number of tips, the accuracy and usefulness of tips, and quality power supplied.

The system shown in Fig. 5, has a four layer architecture that consists of :

1. Information gathering layer: This has the field equipment for measuring electricity consumption at both consumer premises and transformer. It also has consumer applications for reporting electricity theft suspects, utility electricity theft related corruption, electricity supply complaints.
2. Information processing layer: process information from the meters and tips. It is at this layer that electricity theft is measured and the accuracy of tips provided is ascertained.
3. Information analysis and dissemination layer: It combines all the information, analyses and generates reports. In addition it customizes messages for communication on the three platforms; smart phone application, website and SMS.
4. Communication layer: this layer is ensures that there is feedback to consumers by ensuring that communication is passed on by SMS, on the website and the smart phone application.

8 Conclusion

Understanding what causes electricity theft is very crucial if a lasting solution is to be got. In this paper we have studied electricity theft in Kampala, Uganda and have found that electricity theft in Kampala is largely due to economic reasons and corruption within the utility company. We have also highlighted some of the utility's efforts and discussed public response to them. We find that, people consider electricity theft as the utility's problem and are not willing to co-operate. To increase the public's involvement

in curbing electricity theft, we propose a system and provide it's high-level architecture. The proposed system is based on making the cost of electricity theft explicit to the consumers, improving transparency between utility and consumer, provision of user friendly platforms of communication and ensuring the tips provide accurate information. An in-depth study of the utility efforts is still ongoing; the findings will be used to improve upon the proposed system.

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