

Influence Of Subsidized Connection and Prepaid Metering On Successful Implementation of Slum Electrification Projects in Kenya: A Survey of Kaptebwa Slum in Nakuru County

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Abstract: *Slum electrification in Kenya has always been faced by diverse challenges across the country. These challenges includes, the apathy to pay electricity connection fees, customers billing due to security issues and illegal tapping of electricity from Kenya Power and Lighting Company (KPLC) low voltage lines. KPLC has instituted various interventions to confront these challenges. This study sought to examine the influence of the above interventions on successful implementation of slum electrification. The target population for this study comprises connected residents of Kaptebwa slum. A simple random sampling was used with a sample size of 98. The descriptive and inferential statistics. The Pearson correlation matrix was used to examine the correlation between subsidized connection fee and slum electrification. The results indicated that there was a moderately strong correlation between subsidized connection fee and slum electrification of $r(84) = 0.579$, $p < 0.01$. There was a weak correlation between pre paid metering and slum electrification of $r(84) = 0.499$, $p < 0.0$.*

I. Introduction

Slums exist in almost every country and have become a global phenomenon. A slum is an area that is characterized by poor structural quality of housing, overcrowding, insecure residential status, inadequate access to safe water and inadequate access to electricity and other infrastructure (Bystedt, 2011). Poor communities in and around cities globally are growing rapidly in developing countries, in many cases without any corresponding expansion in national services. The proportion of urban population living in slums was highest in Sub-Saharan Africa (61.7%).

Approximately 35% of Kenya's population lives in urban areas and more than half of urban residents are living in slums. It is expected that the percentage of the population living in urban areas will increase by 50% by 2017, and as a result, the nation is facing the pressure of increased urbanization (Wafula, 2012). Electrification in the slum areas has been a challenge and According to KPLC (2010), about 50% of the urban population in Kenya was electrified.

As part of trying to solve the problem, the Kenya Power was financed through the Kenya Electricity Expansion Project- AF, by the World Bank Group through the International Development Association (IDA) and the Global Partnership for Output Based Aid (GPOBA) that aimed to support the Government's initiatives of ensuring increased electricity access to Kenyans, particularly among low income groups in informal settlement areas (Saliku, 2015). The existing and new distribution transformers were to be optimized through extension of the low and medium voltage network to reach households located in the vicinity of these transformers (Cheseto, 2013). Besides, the Kenya power has subsidized the payments and improved flexibility as well as introduction of new power designs using small transformers, adjusted height of transformers and positioning lower voltage lines below.

Problem Statement

Electricity connection is key in the basic survival and supporting economic development in slum areas. It is also projected that over half of the world population will be living in urban areas by the year 2030. The urban poor mainly reside in slums, however due to their economic ability, slum dwellers have been unable to afford the cost of infrastructure like meters, wires or even pay their electricity bills in a consistent manner, as required. As a result, illegal electricity connections have thrived significantly and have been the key challenge in distribution of electricity in slum areas. Illegal connections not only cause huge losses to power distribution companies, but also pose huge safety dangers to the slum dwellers. In Nakuru Town, Kaptebwa is the largest slum with a population of over 79,480 (Nakuru CIDP, 2013). The problem of illegal connections has been wide spread in slums forcing the Kenya power company to pursue alternative strategies for safer and secure electricity connections in a partnership program between KPC and World Bank through Global Partnership on Output Based Aid (GPOBA) with an aim of connecting over 150,000 slum dwellers.

KPLC instituted diverse measures to confront those challenges. The measures included substituting timber poles to concrete poles, which cannot be easily climbed, constructing low voltage lines above the high

voltage lines stopping low voltage line accessibility by illegal connectors and using small transformers on several poles to step down the voltage to distribution levels for a small number of households. Other measures included, using pre-paid meters, where the garget was installed on the pole instead of the house structure. In plight of the high cost of the electricity connection fee have been subsidized to Ksh 1, 160 with flexible repayment. However, there are no studies carried yet to determine how these initiatives have enhanced electrification in the slums.

Research Objectives

1. To establish the influence of subsidized connection fees on successful implementation of slum electrification
2. To establish the influence of pre-paid metering on successful implementation of slum electrification

II. Literature Review

The term connection fee is used to denote the amount charged to a consumer to connect to an established distribution network(Scott, 2014). The cost related to connection charge usually covers the estimated costs of materials, labor, and transport needed to make the connection from the nearest pole of the distribution system and along with the costs of inspection of the consumer's premises (Kristiansen, 2015).

The distribution of electricity whether for social or productive uses is a capital-intensive enterprise, and the cost of providing household connection to electricity services can be quite high (Njoroge, 2015). When connection charges are recovered through one-time, up-front fees for new customers, they can constitute a powerful disincentive to people who wish to obtain electricity, no matter how much they might desire the service (Kristiansen, 2015). High electricity connection prices can discourage low-income households that may be able to afford the monthly bills. Ethiopia has connected about 60,000 poor households under the World Bank-funded Electricity Access Rural Expansion Project, GPOBA (Scott, 2014).

According to Saibu (2016), prepayment system refers to the outlay made by a consumer for using a good or service before consumption.

III. Methodology

Research Design

This study utilized the descriptive research design. The descriptive study examines the study phenomenon by addressing who, what, when, where, and how questions.

Study Population

The target population for this study was the slum residents who were connected with electricity within Kaptembwa slums in Nakuru County. According KPLC central rift connectivity report the company connected 5,460 customers at Kaptembwa slums.

Sample and sampling Technique

Simple random sampling without replacement was adopted for this study. Since the entire population is large the research determined the sample size by using a formula by (Nassiuma, 2002). This formula is convenient for large sample sizes. The formula states that:

$$n = (Nc_v^2) / (c_v^2 + (N-1) e^2)$$

Where:

n= Sample size

N= Population

C_v= Coefficient of variation (take 0.5)

e= Tolerance at desired level of confidence, take 0.05 at 95% confidence level

Upon substitution, the sample size would be as follows:

$$n = (5460 * 0.5^2) / (0.5^2 + (5460 - 1) * 0.05^2)$$

n = 98 respondents.

Data Collection Instrument

The questionnaire was used as the data collection instrument.. The reliability of the questionnaire was tested using Cronbach's alpha which indicates the extent to which a set of test items can be treated to be measuring a single latent variable(Kombo & Tromp, 2009).

Data Processing and Analysis

The data analysis was undertaken using SPSS for the analysis of the descriptive and inferential statistics. The descriptive statistics included the means, standard deviations and frequency distributions.

Findings

Relationship between Subsidized Connection Fee and Slum Electrification

Table 1: Frequency Distribution of Subsidized Connection Fee

| The subsidized connection fee have impacted on slum electrification in the following ways; | SA Freq. (%) | A Freq. (%) | U Freq. (%) | D Freq. (%) | SD Freq. (%) |
|--|--------------|-------------|-------------|-------------|--------------|
| The connection fee is easily affordable | 15 (17.9%) | 38 (45.2%) | 18 (21.4%) | 13 (15.5%) | 0 (0%) |
| The level of connections in slum has greatly increased | 34 (40.5%) | 27 (32.1%) | 17 (20.2%) | 6 (7.1%) | 0 (0%) |
| Has Enabled to reduced meter sharing | 21 (25.0%) | 32 (38.1%) | 21 (25.0%) | 10 (11.9%) | 0 (0%) |
| Equitable distribution of electric power in slums | 27 (32.1%) | 31 (36.9%) | 16 (19.0%) | 10 (11.9%) | 0 (0%) |
| Small businessmen can now afford connection fee | 12 (14.3%) | 49 (58.3%) | 14 (16.7%) | 9 (10.7%) | 0 (0%) |
| Equitable distribution of electric power in slums | 27 (32.1%) | 31 (36.9%) | 22 (26.2%) | 4 (4.8%) | 0 (0%) |

Table 1 shows the analysis of the data with regards to subsidised connection. As shown on the table a total of 53% respondent were in agreement that the connection fee was easily affordable while 18% were uncertain and the least disagreed. On the other hand, 62% of the sample responses were in agreement that subsidized connection fee and slum electrification increased level of connections in the slum. 20.2% of the respondents were uncertain while 39.1% of the respondents disagreed. More respondents, 63.1% agreed that the level of meter sharing had gone down as compared to respondents who disagreed at 11.9% while 25% were uncertain. Most of the respondents 69.0% agreed that there was equitable distribution of power, 19% were uncertain and 11.9%. 72.6% of them agreed that they can now afford connection fee while 10.7% disagreed.

Table 2: Means and Standard Deviation of Subsidized Connection Fee

| | Min | Max | Mean | Std. Dev. |
|--|-----|-----|------|-----------|
| The connection fee is easily affordable | 2 | 5 | 3.65 | 0.95 |
| The level of connections in slum has greatly increased | 2 | 5 | 4.06 | 0.95 |
| The level of illegal connections has gone down | 2 | 5 | 3.76 | 0.96 |
| Equitable distribution of electric power in slums | 2 | 5 | 3.89 | 0.99 |
| Small businessmen can now afford connection fee | 2 | 5 | 3.76 | 0.83 |
| Equitable distribution of electric power in slums | 2 | 5 | 3.96 | 0.88 |

To further gain an understanding on the influence of the subsidized connection fee on the success of slum electrification, the means and standard deviations were calculated on the 4.6. These means indicated that the respondents on average tended to agree that the respective metrics led to the success of the slum electrification at Kaptembwa slums in Nakuru. This is because they had means of between 3.5 and 4.5 while the standard deviations were 0.95, 0.95, 0.96, 0.99, 0.83 and 0.88 respectively which meant that the responses were moderately distributed.

Relationship between Pre-Paid Meter and Slum Electrification

Table 3: Frequency Distributions of Pre Paid Meters on Slum Electrification

| The prepaid meters have impacted on slum electrification in the following ways; | SA Freq. (%) | A Freq. (%) | U Freq. (%) | D Freq. (%) | SD Freq. (%) |
|--|--------------|-------------|-------------|-------------|--------------|
| Easy monitoring of the no number of power units bought | 21 (25.0%) | 35 (41.7%) | 17 (20.2%) | 10 (11.9%) | 1 (1.2%) |
| Improved power reliability | 14 (16.7%) | 35 (41.7%) | 20 (23.85) | 14 (16.7%) | 1 (1.2%) |
| Has enabled me to control electricity consumption according to my financial status | 35 (41.7%) | 26 (31.0%) | 17 (20.2%) | 5 (6.0%) | 1 (1.2%) |
| Has decreased tenant-landlord dispute | 25 (29.8%) | 30 (35.7%) | 18 (21.4%) | 11 (13.1%) | 0 (0.0%) |
| Reduced interruptions of KPLC employees in the premises | 26 (31.0%) | 28 (33.3%) | 21 (25.0%) | 9 (10.7%) | 0 (0.0%) |
| Reduced frequent complains to KPLC offices | 36 (42.9%) | 24 (28.6%) | 1 (1.2%) | 2 (2.4%) | 0 (0.0%) |
| I am able to budget for electricity in advance | 22 (26.2%) | 36 (42.9%) | 17 (20.2%) | 9 (10.7%) | 0 (0.0%) |

The influence of the prepaid meter on the success of slum electrification was analyzed on the table 4.10 where 66.7% of the respondents agreed that prepaid meters had impacted easy monitoring of the number of power units bought, 13.1% of them disagreed and 20.2% of the respondents however were not sure, (58.4%) of the respondents agreed that prepaid meters had improve power reliability, 16.7%, 23.8% were undecided and 17.9% disagreed. 72.7% of the respondents agreed that prepaid meters had enabled them to control electricity consumption, 7.2% rejected the prompt while 20.2% were uncertain.

65.5% agreed to have decreased tenant-landlord disputes, 21.4% were undecided and 13.1% disagreed. The numbers that agreed that there were reduced KPLC employees' interruptions in their premises were 64.3%, 27.0% disagreed and 25% of the respondents were undecided on the matter. 71.5% of the respondents agreed 1.25 were undecided and 2.4% disagreed that there were reduced frequent complaints to KPLC offices. On the other hand, 68.1% of the respondents agreed that they were able to budget for electricity in advance, 20.2% were not sure while 10.7% disagreed.

Table 4: Means and Standard Deviations of Pre Paid Meters

| | Min | Max | Mean | Std. Dev. |
|--|-----|-----|------|-----------|
| Easy monitoring of the no number of power units bought | 1 | 5 | 3.77 | 0.99 |
| Improved power reliability | 1 | 5 | 3.56 | 1.00 |
| Has enabled me to control electricity consumption according to my financial status | 1 | 5 | 4.06 | 0.99 |
| Has decreased tenant-landlord dispute | 2 | 5 | 3.82 | 1.01 |
| Reduced interruptions of KPLC employees in the premises | 2 | 5 | 3.85 | 0.99 |
| Reduced frequent complains to KPLC offices | 1 | 5 | 3.87 | 0.89 |
| I am able to budget for electricity in advance | 2 | 5 | 3.85 | 0.94 |

In order to gain further understanding of the influence of the prepaid meters on the success of the slum electrification process, the means and standard deviations were calculated as per the table 4.10 and were. 3.77, 3.56, 4.06, 3.82, 3.85, 3.87, and 3.85 respectively and 0.99, 1.00, 0.99, 1.01, 0.99, 0.89, and 0.94 respectively. Analyzing the means the respondents on average tended to agree with the prepaid metrics having an influence on the success of slum electrification aspects. On the other hand, the standard deviations showed that there was lack of consensus on the aspects of improved power reliability and decreased tenant-landlord dispute due to standard deviation of above 1.0.

Slum Electrification

Table 5: Frequency Distribution of Slum Electrification

| | SA Freq. (%) | A Freq. (%) | U Freq. (%) | D Freq. (%) | SD Freq. (%) |
|--|--------------|-------------|-------------|-------------|--------------|
| Has resulted to Legal slum electricity connections | 23 (27.4%) | 34 (40.5%) | 14 (16.7%) | 13 (15.5%) | 0 (0.0%) |
| Flexible power consumption | 17 (20.2%) | 36 (42.9%) | 18 (21.4%) | 13 (15.5%) | 0 (0.0%) |
| Brought safe electricity to slum | 32 (38.1%) | 29 (34.5%) | 17 (20.2%) | 5 (6.0%) | 1 (1.2%) |
| Equitable distribution of electric power in slums | 21 (25.0%) | 45 (53.6%) | 12 (14.3%) | 6 (7.1%) | 0 (0.0%) |
| Improved electric power reliability | 23 (27.3%) | 43 (51.2%) | 10 (11.9%) | 8 (9.5%) | 0 (0.0%) |

The slum electrification was examined as shown on the table 5. As per the table up to 67.9% of the respondents believe that diverse interventions on slum electrification have resulted in legal slum electricity connections, while 15.5% disagreed and 16.7% were unsure. On the other hand, 63.1% of the respondents agreed that interventions in slum electrification led to flexible power consumption, 15.5% of them disagreed and 21.4% were uncertain, Slum intervention strategies was not appreciated by 7.2% who disagree that it had brought safety to the slums, 72.6% of the respondents however agreed while 20.2% were uncertain. More than a half mark (78.6%) of the respondents agreed that slum electrification had brought about equitable distribution of electric power in slums, 7.1% of them disagreed. 14.3% of the respondents were undecided. In the context of the improved power reliability as a result of slum electrification, 78.5% agreed, 9.5%, disagreed while 11.9% were uncertain.

Table 6: Means and Standard Deviations of Slum Electrification

| | Min | Max | Mean | Std. Dev. |
|--|------|------|------|-----------|
| Has resulted to Legal slum electricity connections | 2.00 | 5.00 | 3.79 | 1.01 |
| Flexible power consumption | 2.00 | 5.00 | 3.67 | 0.97 |
| Brought safe electricity to slum | 1.00 | 5.00 | 4.02 | 0.96 |
| Equitable distribution of electric power in slums | 2.00 | 5.00 | 3.96 | 0.82 |
| Improved electric power reliability | 2.00 | 5.00 | 3.96 | 0.81 |

In order to gain an in-depth understanding of the slum electrification, the means and standard deviations of the slum electrification were calculated. The means were 3.79, 3.67, 4.02, 3.96 and 3.96 respectively. On the other hand, the standard deviations of were 1.01, 0.97, 0.96, 0.82 and 0.81 respectively.

Inferential Statistics

The inferential statistics were examined through use of the correlation analysis and multiple linear regression.

Correlation Analysis of Subsidized Connection Fee

The Pearson correlation matrix was used to examine the correlation between subsidized connection fee and slum electrification. The results indicated that there was a moderately strong correlation between subsidized connection fee and slum electrification of $r(84) = 0.579$, $p < 0.01$.

Table 7: Correlation Analysis of Subsidized Connection

| | Slum Electrification |
|----------------------------------|-----------------------------|
| Subsidized Connection Fee | .579** |

** . Correlation is significant at the 0.01 level (2-tailed).

The results are consistent with the findings of other scholars. The distribution of electricity whether for social or productive uses is a capital-intensive enterprise, and the cost of providing household connection to electricity services can be quite high (Njoroge, 2015). When connection charges are recovered through one-time, up-front fees for new customers, they can constitute a powerful disincentive to people who wish to obtain electricity, no matter how much they might desire the service (Kristiansen, 2015). High electricity connection prices can discourage low-income households that may be able to afford the monthly bills. This is because, in practice, high bills are not such an obstacle, because the cost of alternatives generally used, such as kerosene oil, candles and batteries, are comparable to most grid-supplied electricity tariffs for small consumers. The main obstacle is the high up-front charges the consumer has to pay for a grid connection. These include the cost of house wiring and the connection charge payable to the utility (Kawa, 2013).

Table 8: Pre Paid Metering

The Pearson correlation matrix was used to examine the correlation between pre paid metering and slum electrification. The results indicated that there was a weak correlation between pre paid metering and slum electrification of $r(84) = 0.499$, $p < 0.01$ as illustrated in table 4.15.

Correlation Analysis of Subsidized Connection

| | Slum Electrification |
|----------------------|-----------------------------|
| Prepaid meter | .499** |

** . Correlation is significant at the 0.01 level (2-tailed).

The significance of the prepayment system on the subsidized connection was also noted in diverse countries across the world. For example, Lange (2008) state results of a survey conducted among local electricity users indicated that prepaid meters lead to increase in welfare. They also indicate that the advantages of the system are linked to the reduction of arrears in accounts receivables and of operational and financial costs on the part of the service provider and to a better allocation of resources for the user (Kitungu, 2014). Scott (2014) did a cost benefit analysis of prepaid meters in South Africa and found it possible to identify the change in aggregate welfare resulting from the adoption of the prepayment system as well as in each of the groups concerned.

IV. Conclusions

The study concluded that the subsidized connection fee had statistically significant influence on the successful implementation of slum electrification. The statistical significance of the subsidized connection fee with the slum electrification lies with the poverty levels that is prevalent in slum areas. Most slum dwellers lack the financial capacity to pay the electricity connection at the market rate and therefore the subsidization of the connection fee leads to an increase in customers seeking electricity connection.

The study found that the pre paid metering had no significant influence on the successful implementation of slum electrification. One of the reasons that attributed to this was the fact that a majority of the slum dwellers were not in a position to pay up the electricity token after the initial tokens had been used as well as challenges with the KPLC team in ensuring that all the pre paid meters are vending.

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