



AN EXPLORATORY STUDY OF EFFECTS OF PREPAID METERING AND ENERGY RELATED BEHAVIOUR AMONG GHANAIAAN HOUSEHOLD

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ABSTRACT

The focus of the study is to examine the effect of a new billing and payment system (prepaid meters) by Electricity Company of Ghana (ECG) on the efficiency of revenue mobilization, its impacts on expenditure of several households groups and the behaviour of the consumers. Based on a survey of 384 households from the Ho municipality in the Volta Region of Ghana, our empirical analysis suggest the utility provider experiences a significant increase in its revenue after the introduction of prepaid metering system. However, the study did not find any difference in the expenditure between single and compound households. Furthermore, there was a strong shift by consumers towards energy conserving attitude and behaviour.

Keywords: Prepaid meter, Behavioural model, Household, Expenditure, Energy, Ghanaian, Revenue, Billing system.

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Contribution/ Originality

This study contributes to the existing literature by extending the effects of the introduction of prepaid meters on expenditure by comparing its effects on single and compound household and also different types of household sizes.

1. INTRODUCTION

Since the emergence of prepaid metering of electricity, the global growth has been steady and gradual in recent years (Tewari and Shah, 2003). For example, a study by Pike estimates that, the installed base of prepaid meters for electricity was over 20m worldwide in 2011. This figure is expected to surpass 23m and 33.7m meters on a global basis by 2012 and 2017 respectively. Thus averaging a relatively modest compound annual growth rate of 9.1% between 2010-2017. Furthermore, the research indicates that more utility agencies worldwide are preparing to launch new prepaid programs or expand the existing prepaid services to a larger customer base (Pike

Research, 2012). Extant literature has enumerated several market drivers compelling governments and utility providers especially in Sub-Saharan countries such as Nigeria, South Africa, and Rwanda etc. to gravitate towards the usage of prepaid meters. For example, Mwaura (2012) identify the reduction of non-technical losses. Other researchers also looked at reduced financial risks, improved customer services, energy conservation, improved operational efficiencies, improved government or corporation revenues and spurring investment in the electricity industry (Ghajar and Khalife, 2003; Tewari and Shah, 2003; Bandyopadhyay, 2008; Khan *et al.*, 2010; Ogujor and Otasowie, 2010; Mwaura, 2012).

In Ghana, prepaid metering was adopted by the country's monopoly power distributor, Electricity Company of Ghana (ECG) among other things to deal with supply side challenges such as reduction in collection expenses, eliminate bad debts, efficient cash flows with an overall aim of improving the financial position of the company. Despite the benefits enumerated by the power provider in convincing consumers in accepting the new policy, paradoxically, anecdotal evidence points to the fact that, majority of consumers have contrary opinion regarding the usage of prepaid meters. For example, consumers complain about having to spend more on electricity after being moved to the prepaid meter. Similarly, consumers in compound houses which share meters complain about having to spend more which to them is unusual than those in single household. Irrefutably, the literature on prepaid metering and its impacts on consumers' expenditure indicates a paucity of scholarly works and understanding of this phenomenon particularly in Ghana since the introduction of the new billing system. This oversight is remarkable given that, as a policy, there is a need for review if its current form is detrimental from the perspectives of the consumer. The only way it can be address is through scholarly investigation. Furthermore, within the marketing literature, a great deal of work has been done regarding payment systems used by consumers to conduct economic exchange. Such payment systems enable consumers to purchase products everywhere, through variety of mediums and at all time. Earlier works of Hirschman (1979); Prelec and Loewenstein (1998) and Bashshur *et al.* (1991) suggest that payment methods affect consumer behaviour and attitudes. Appraisal of the literature however indicates much attention is paid to other payment such as credit cards, debit cards etc. (King and King, 2005; Borzekowski *et al.*, 2008) to the neglect of prepaid meters. Furthermore, behaviour and attitude issues relating to payment methods is under-researched in existing African context compared to developed nations. The deficiency is startling since understanding the extent to which prepaid metering affects household consumption in a developing economy will go a long way to explain consumer or household consumption patterns.

1.1. Present Study

This research aims to provide a better understanding of the effects of introduction of prepaid metering on Ghanaian consumers. Specifically, this paper explores whether there is any significant difference on the type of household and expenditure and size of household and expenditure. Also we would explore whether the consumers spend more on electricity after being moved to the prepaid metering system (or whether there is any significant difference between the

revenue generated by utility companies post the installation of prepaid metering). Additionally, the study would examine consumer behaviour in the usage of electricity after the introduction of prepaid metering systems. This study is important because it will bring to light the total effects of introduction of prepaid metering system on all category of consumers thereby informing more rigorous policy formulation to deal with associated challenges.

2. LITERATURE REVIEW

2.1. History of Billing System for Revenue Collection by Electricity Company of Ghana (ECG)

Revenue collection has long been a bane of ECG under the postpaid system where meters are read, captured and bills are produced. Several methods were engaged over the years by the utility provider in an attempt to ensure efficiency in revenue collection. This ranges from cash offices and pay points, banks, third parties and revenue collectors also called “bonded cashiers”. The bonded cashiers are private individuals who operate in the rural and semi-rural areas where ECG has no pay points or cash offices to collect payments. Even though this strategy to some extent has been successful, they have not been entirely effective in preventing payments evasion, revenue leakages and numerous challenges that consumers face: untimely delivery of bills and crediting of bills paid to customers’ accounts, delivery of bills to wrong person, inconvenience of travelling long distances to make payment (Mensah *et al.*, 2012).

To improve revenue collection and simultaneously solve the myriads of consumer’s problems, ECG turned to prepaid metering system. This system was initially adopted on pilot basis between 1994 and 1995 with the use of “cash power” in parts of SSNIT flats at Sakumono Accra, Tema and Kumasi for residential and commercial consumers with small loads. It was finally introduced in 2005 after several years of testing. Today, this service has been extended to all major cities, metropolis, municipal and districts capitals because of its associated benefits such as reduction in revenue loses and illegal connections, energy conservations etc. to the utility provider. The variety of meters used in Ghana is produced by Ghana Electrometer, the largest single producer of meters in Ghana.

As at 2013 ECG has about 30% of its total customer population using prepaid meters and is in the process of extending it to districts that qualify (ECG, 2013). A new metering technology known as Smart-G is being introduced under a new partnership between Ghana Electrometer and ECG. This meter would enable customers purchase and use power like mobile phone recharge system. With this system ECG would provide scratch cards that can be bought from vendors anywhere, thereby offering the customer comfort and choice in the purchase and consumption of power. It would also improve ECG’s efficiency and cash flow.

2.2. Billing System and Revenue Maximization

Though the aim of every utility provider is to provide efficient service to its clients, in developing countries low-income levels continue to pose a daunting challenge especially in terms of cost recovery (Sualihu and Rahman, 2014). Bill payment and collection efficiency also referred

to as “headline efficiency” which supports adequate service provision according to [Kayaga et al. \(2004\)](#) are generally poor; thus below 50% cost of production in Africa. This inefficiencies in billing and revenue collection are mostly due to (i) incidence of undercharging and overcharging due to billing errors, (ii) creating dissatisfaction among consumers (iii) inefficiencies in the billing system; (iv) failure to establish customer base; (v) irregular bill delivery resulting in non-payment by registered clients ([Chipofya et al., 2009](#)).

[Misra and Kingdom \(2012\)](#) contend that meter reading and billing errors, whether involuntary or resulting from fraudulent practices, should be eliminated by limiting the human handling of data through the adoption of efficient billing systems. In support of [Misra and Kingdom \(2012\)](#), [Ogujor and Otasowie \(2010\)](#) suggests prepaid system ensures adequate and proper billing of customers even though [Oracle \(2009\)](#) is of the view that consumers are not in favour of the prepaid system because of its cost, fairness and health and safety concerns.

However, empirical studies using prepaid meter from several studies shows an improvement in revenues by utility organizations through better billing and collection processes. For example in the water sector, a study by [Kingdom et al. \(2006\)](#) in São Paulo Metropolitan Region of Brazil conclude that Companhia de Saneamento Básico do Estado de São Paulo (SABESP) has greatly increased their revenue by Brazilian reais (R\$) 172m equivalent of US\$ 72m through better metering and billing of certain key customers. A similar study by [Agrawal \(2008\)](#); [Babel and Rivas \(2012\)](#) on Thailand water utility sector provided by Metropolitan Waterworks Authority (MWA) shows an improved revenue to a sustainable level as a result of implementation of new billing and collection practices. As a result of such practices the overall financial performance of MWA was on a positive trend in between 1998 and 2008 ([Rao, 2012](#)). [Babel and Rivas \(2012\)](#) cited in [Rao \(2012\)](#) conclude that such figures indicate the sustainability of utility operations as costs are comfortably covered by revenues. Other countries with notable improvement includes 15% increase in revenue collection in Satkhira, Bangladesh ([World Bank, 2012](#)) and 96% cost recovery in Burkina Faso ([Agrawal, 2008](#)) following the installation of individual water meter.

Regarding electricity, a study by [Casarin and Nicollier \(2008\)](#) among local electricity users indicate that prepaid meters lead to improved consumer welfare and reduction of arrears in accounts receivables, operational and financial costs on the part of the service provider and better allocation of resources for the user. Similarly, a study by [Mwaura \(2012\)](#) in Rwanda about electricity prepayment billing system shows that revenue rose in tandem with the increased number of EPBS enrolment, from US\$ 261,000 in 1996 to US\$ 22.9m in 2008. Other associated benefits discovered include increased and timely revenue collection and improved services delivery to electricity users.

Alongside issue of efficiency in revenue generation, [Kettless \(2004\)](#) states that the prepayment system has been used in the United Kingdom (UK) for more than 80 years and that the system developed as a way of dealing with bad debts. However, [Tewari and Shah \(2003\)](#) and [O’Sullivan et al. \(2014\)](#) argues that it also affords customers the opportunity to avoid the build-up of debt which would be the case in the post-paid billing system.

Based on this evidence we hypothesized that:

H₁: the new billing system (prepaid meters) is positively related to improving revenue position of the utility provider.

H₂: there is no significant difference in expenditure on the type of household after the introduction of new billing system (prepaid meters)

H₃: there is no significant difference in expenditure on the size of household after the introduction of new billing system (prepaid meters)

A review of the literature demonstrate lack of research on hypothesis H₂ and H₃. This study also aims to focus and explore the two relationships.

2.3. Theoretical Framework

Significant area of theory used to explain household energy use are models of behavioural change. Though these behavioural models tend to differ broadly by concepts, theory, and applications (Axsen and Kurani, 2012) they are necessary to understand what consumers do, and why they do so. Behaviour in this sense is not the consumption of energy in itself but rather a consequent of behaviours such as turning the lights off or buying more efficient household appliances (Becker *et al.*, 1981). For this study we zero in on behaviours which relate to direct energy requirements such as curtailment behaviours (Dwyer *et al.*, 1993; Abrahamse *et al.*, 2005). The sociotechnical approach of behavioural change was adopted for this study. The sociotechnical model argues that there is a close relationship between behaviours and infrastructure i.e. energy infrastructure (e.g. smart grids) (Shove, 2010). The sociotechnical models go beyond how people's dispositions and behaviours are influenced by others and propose that objects and technologies have an inbuilt tendency to cause the user to behave in certain ways (Guy, 2006). Different objects or technologies tend to work together in technological systems which then permit or encourage certain behaviours and lifestyles. These lifestyles in turn create the need for further technologies to reinforce the lifestyle. This is why the idea is called 'sociotechnical. This approach acknowledges the active role that metering technology has in mediating the relationship between energy suppliers and households (Akrich, 1994). This idea also supports the view that metering of energy consumption though complex, can influence the energy behaviour of consumers and lead to a conserving behavioural effect (Graham and Marvin, 1994; Hand *et al.*, 2005; Stephenson *et al.*, 2010; Brunner *et al.*, 2012) and also act as a "gatekeeper" to utilities (Marvin *et al.*, 1999). Thus the socio-technical perspective suggests we should understand behaviour as the outcome of a mutually reinforcing system of technologies, ideas, behaviours and institutions.

3. METHODOLOGY

The work involved a survey of both single and compound households within the Ho Municipality. The choice of the municipality is based on the fact that it is one of the cities where every household has been fitted with prepaid meter system. Two types of quantitative techniques were used for the study. Firstly, descriptive approach was used to obtain basic information on biodata, prepaid metering and to explain consumer behaviour after the introduction of the prepaid meter (Punch, 2005; Jackson, 2009; Saunders *et al.*, 2012). Secondly, cross-section design was

employed to determine intergroup difference on types of household and household size regarding expenditure on energy (Wohlwill, 1970; Miller, 1998; Kraemer *et al.*, 2000). A total of 384 households were selected from an estimated household population of 4,090 using convenient sampling technique. This approach is to help the researchers select the most accessible subjects and it is least costly in terms of time and effort (Marshall, 1996; Oisin, 2007). The sample size was determined using computed table based on 95% level of certainty or significance (Krejcie and Morgan, 1970). Structured questionnaire was used to collect primary data for the study. The questionnaire was divided into four (4) sections: Section A covers the biographic data of head of households surveyed. Section B covers the basic information on prepaid metering; Section C examines the energy or electricity expenditure of the households. Here a minimum of six months average values of consumer's last year's post-paid bill and first year's prepaid bill were recorded. Section D involves ten (10) questions which cover consumer's awareness and usage of energy saving techniques. Twenty questionnaires were administered in a day by five (5) well trained research assistants in July 2014 mostly in the evening where head of households are present. All questionnaires sent to the field were retrieved and found to be useful for analysis. This represents 100% response rate. Subsequently, the questionnaires were coded and keyed into the SPSS version 22.0 for analysis. Two main methods were engaged in data analysis. Respondent's demographic data, basic information on prepaid meter and consumer behaviour after usage of prepaid metering were assessed using percentage values. Differences between amount spent using post-paid and prepaid meter was assessed using paired sample statistic (t-test for dependence). For differences between compound and single household unit, the author used t-test for independence and one-way anova test for comparison between household sizes. All tests were based on p value of 0.05. Data has a score of Skewness (0.125) and Kurtosis (0.248) after checking for normality.

4. RESULTS

4.1. Profile of Respondents

Table 1 shows that (235) 61.2% of the respondents were male and (212) 55.2% being married. Approximately (102) 26.6%, (118) 30.7% and (97) 25.3% of the respondents are aged between 46-55 years, 26-35 years and 36-45 years respectively. In terms of education, (197) 51.3% of the respondents held either diploma or undergraduate certificate and (90) 23.4% had completed senior high school education. In relation to the number of people who lived within a household, 190 (49.5%) are within 1-5 group, followed by 148 (38.5%) who lived within 5-10 household size. The remaining 46 (12%) lived in household occupied by more than 11 individuals. About 193 (50.3%) of the respondents have been using prepaid meter for between 3-4 years. Ninety-three (24.2%) within 1-2 years and 76 (19.8%) beyond five years. Finally, majority of the households, 215 (56%) lived in a compound house and the remaining 169 (44%) in single house occupancy.

Table-1. Demographic Data

| Gender | Freq | % | Marital Status | Freq | % |
|----------------------|------|------|---|------|------|
| Male | 235 | 61.2 | Single | 168 | 43.8 |
| Female | 149 | 38.8 | Married | 212 | 55.2 |
| | | | Widow/Widower | 4 | 1 |
| Age | Freq | % | Level of Education | Freq | % |
| 18-25 yrs | 56 | 14.6 | No Formal Education | 16 | 4.2 |
| 26-35 yrs | 118 | 30.7 | Basic | 31 | 8.1 |
| 36-45 yrs | 97 | 25.3 | Senior High | 90 | 23.4 |
| 46-55 yrs | 102 | 26.6 | Diploma/Undergraduate | 197 | 51.3 |
| 56+ yrs | 11 | 2.9 | Masters/PhD | 38 | 9.9 |
| | | | Others | 12 | 3.1 |
| Household Size (HHS) | Freq | % | How Long resp. have been on Prepaid Meter | Freq | % |
| 1-5 | 190 | 49.5 | Less than 1 year | 22 | 5.7 |
| 5-10 | 148 | 38.5 | 1-2 years | 93 | 24.2 |
| 11+ | 46 | 12 | 3-4years | 193 | 50.3 |
| | | | Above 5years | 76 | 19.8 |
| | | | Type of Household Unit | Freq | % |
| | | | Compound House | 215 | 56 |
| | | | Single House Occupancy | 169 | 44 |

Source: July, 2014

4.2. Household Expenditure on Energy/ Revenue Generated by Utility Provider Pre and Post Prepaid Meter

Table 2 shows results from a paired sample t-test conducted to evaluate the impact of prepaid metering on the expenditure made by household on electricity units /revenue generated by the utility provider post prepaid meter. There results indicate a statistical significant increase in the expenditure of unit consumed/increase in the revenue generated by utility company before (M=31.95, SD=39.485) and after the installation of prepaid meter (M = 56.93, SD = 63.845), t (383) =-13.351, p<0.000 (two tailed). The mean increase in expenditure/revenue is 24.98 with a 95% confidence interval ranging from -28.66 to -21.30. The eta square statistics (0.32) indicate a large effect size.

Table-2. Paired Sample Test of Household Expenditure on Energy

| Paired Samples Statistics | | | | Paired Samples Test | | | | |
|---------------------------|-------|-----|--------|---------------------|---------|--------|---------|-----------------|
| | Mean | N | SD | | Mean | SD | t | Sig. (2-tailed) |
| Pair A | 31.95 | 384 | 39.485 | Pair 1- A-B | -24.980 | 36.666 | -13.351 | .000 |
| B | 56.93 | 384 | 63.845 | | | | | |

Source: July, 2014 *p<0.05

A = Average of at least six month of consumers' last year expenditure using post-prepaid meter.

B= Average of at least six month of consumers first year expenditure using pre-prepaid meter.

4.3. Difference between Electricity Expenditure and Household Type

An independent t-test was conducted to compare impact of prepaid metering on the expenditure of units consumed by single and compound households. Even though the evidence from Table 3 indicates that the expenditure of compound household on unit consumption is

higher compared to single household units by a mean difference of 5.19, there was no statistical significant difference in the expenditure of compound household (M=59.21, SD=75.84) and single household (M=54.02, SD=44.17), $t(382) = 0.79$, $p < 0.430$ (two tailed), with a 95% confidence interval ranging from -7.73 to 18.10. The eta square statistics (0.001) indicate a small effect size.

Table-3. Independent T-Test Results on Differences between Expenditure on Electricity and Type of Household (Compound & Single Household Unit)

| Group Statistic | | | | Independent T-test | | | |
|-----------------|-------|-----|--------|-----------------------------|-----------------|------|-----------------|
| | Mean | N | SD | | Mean Difference | t | Sig. (2-tailed) |
| Compound House | 59.21 | 215 | 75.841 | Equal variance assumed | 5.183 | .789 | .430 |
| Single House | 54.02 | 169 | 44.169 | Equal variances not assumed | 5.183 | .838 | .403 |

Source: July, 2014 *p<0.05

4.4. Difference between Electricity Expenditure and Household Size

A one-way between groups analysis of variance was conducted to explore the impact of household size on electricity expenditure. Participants were divided into three (3) groups according to the number of people within a compound. (Group 1:1-5; Group 2: 6-10 and Group 3: 11+). Evidence from Table 4 indicates there was a statistical significant difference at $p < 0.05$ level for the three household size: $F(2, 380) = 6.07$, $p = 0.003$. Furthermore, the actual difference between the mean score between the groups is big. Thus 10.5, 35.75 and 25.7 between groups 1&2, groups 1 &3 and groups 2&3 respectively. The effect size calculated using the eta value was very negligible at 0.03.

Table-4. One-Anova Test of Differences between Household Size and Expenditure on Electricity

| One-way Anova Statistic | | | | Anova Test | | | | | |
|---------------------------------|---------|----------|--------|------------|----------------|-------------|-----------|-------|------|
| HHS | N | Mean | SD | | SS | MS | F | Sig. | |
| 1-5 | 190 | 48.77 | 35.030 | | Between Groups | 48205.341 | 24102.670 | 6.070 | .003 |
| 6-10 | 148 | 58.82 | 85.988 | | Within Groups | 1512986.794 | 3971.094 | | |
| 11+ | 46 | 84.52 | 65.683 | | Total | 1561192.135 | | | |
| Total | 384 | 56.93 | 63.845 | | | | | | |
| Multiple Comparisons- Tukey HSD | | | | | | | | | |
| (I) HHS | (J) HHS | MD (I-J) | Sig. | | | | | | |
| 1-5 | 6-10 | -10.053 | .314 | | | | | | |
| | 11+ | -35.753* | .002 | | | | | | |
| 6-10 | 1-5 | 10.053 | .314 | | | | | | |
| | 11+ | -25.701* | .043 | | | | | | |
| 11+ | 1-5 | 35.753* | .002 | | | | | | |
| | 6-10 | 25.701* | .043 | | | | | | |

Source: July, 2014 *p<0.05

Since the sample sizes of the household size are unequal, LSD hoc test was used to reveal the differences in the reported expenditure in the households. Post-hoc comparisons using the Tukey HSD test indicated the mean score for Group 1 (M=48.77, SD= 35.03) was significantly different from Group 3(M=84.52, SD=65.68). Similarly, there is a significant difference between mean score of Group 2 (M=58.82, SD=85.98) and Group 3 (M=84.52, SD=65.68). However, Group 1 did not differ from Group 2.

4.5. Awareness and Usage of Energy Saving Techniques

The results regarding awareness and usage of energy saving techniques are shown in table 5. It is evident from the table that respondents are aware of all the energy saving techniques. Furthermore, the most used technique by the households study is switching off lights when leaving the house (90.1%) followed by turning lights off when leaving a room (87.2%). The least used technique is designation of rooms as night hangout rooms for the family (48.7%). A further probe to ascertain reasons behind use of energy saving techniques reveals that almost all respondents indicated the used of prepaid metering has revealed their actual expenditure compared to postpaid meters. This has informed them as to the appropriate ways to conserve energy and reduce cost of utility.

Table-5. Awareness and Usage of Energy Saving Techniques

| Energy Saving Techniques | Aware | | Ever used it | |
|--|-------|------|--------------|------|
| | Yes | No | Yes | No |
| 1) Switching off your lights when you leave your house | 98% | 1.8% | 90.1% | 9.9% |
| 2) Turning lights off when leaving the room | 96.7 | 3.1% | 87.2 | 12.8 |
| 3) Switch off lights excepts security lights in home when not in use | 95.1 | 4.9 | 80.7 | 19.3 |
| 4) Switch off appliances on the wall when not in use | 95.6 | 4.4 | 73.4 | 26.6 |
| 5) Boil only as much water with a pot or kettle that is needed | 93.8 | 6.3 | 56.5 | 43.5 |
| 6) Iron clothes in bulk | 93.2 | 6.8 | 63.8 | 36.2 |
| 7) Designate few rooms as night hangout rooms for your family | 89.9 | 10.1 | 48.7 | 51.3 |
| 8) Use energy efficient bulbs | 94 | 6 | 72.9 | 27.1 |
| 9) Unplug or disconnect all gadgets when not in use | 94 | 6 | 72.7 | 23.3 |
| 10) Replace your appliances with energy efficient models | 94.8 | 5.2 | 69.3 | 30.7 |

Source: July, 2014

5. DISCUSSIONS CONCLUSIONS AND IMPLICATIONS

As found in other studies (Mwaura, 2012; World Bank, 2012; Miyogo *et al.*, 2013), the findings from this study demonstrate an increase in revenue collection by the utility provider after the installation of prepaid meters. The significant increase in revenue is not surprising since

the new billing system eliminates majority of activities which happen under the postpaid system normally leads to loss of revenue to the utility provider. For example delayed payment of bills by customers leading to accumulation of lots of bad debts, provision of estimated bills to customers etc.

The t-test for independent analysis reveals that the expenditure by household type on units consumed is not different. This finding is quite interesting given the complaint of consumers within compound households. Perhaps their perception may be explained by the frequency with which they buy units compared to single household units. The frequency of purchase causes them to lose the benefits of subsidies provided for low income groups. It may also be due to the fact that in most of this compound houses the individuals are not many. However, it underline the importance of prepaid metering system in providing fairness in payment for what is consumed compared to the postpaid system.

On the difference between electricity expenditure and household size the study showed a significant difference among the categories of household sizes examined. These finding are not surprising since the more individuals within household, the more the demand for utility and expenditure needed to meet such demand.

Finally, respondents are aware of the energy saving techniques and their usage is high among the respondents. Furthermore, the behaviour adopted by consumers is consistent with most common behavioral changes noted in literature: thus energy preservation (Tewari and Shah, 2003; McKenzie, 2013; O'Sullivan *et al.*, 2014). Users of prepaid meters are said to be more conscious of usage of electricity, often tying consumption to sustainability of electricity units available. According to a study undertaken in Ontario, Canada, 25% of the sampled electricity-users used about 20% less energy than they were using under the metering-and-billing system because the display segment of the prepayment meter made them aware of what they were using, which resulted in energy-saving adjustments (Casarin and Nicollier, 2008). This actions by the consumers at the end would help reduce overall energy demand in the country, lessen the pressure on government for the need for immediate generation increases.

6. CONCLUSION

The purpose of this study was to evaluate the effects of prepaid meters on the efficiency of revenue collection by the utility company, determine whether there were differences in the expenditure of compound and single household and different household sizes and finally behaviour of consumers of energy.

The study shows that there has been significant increase in the revenue position of utility provider by a mean difference of 24.98. This finding suggests the ability of prepaid metering to readily make funds available to the utility supplier (ECG) for investment in important projects compared to the post-paid metering system which was bedeviled with low revenue collection. Management must therefore deliberately and consciously take steps to connect all customers to prepaid meters in order avoid the challenges of revenue leakage.

Even though the nation's utility regulatory authority, Public Utility Regulatory Commission (PURC) introduced two tariffs structure (lifeline tariff and flat rate tariff) to cater for vulnerable residential groups, which are mostly found in compound houses with large household sizes. The findings from the study further reveal that the expenditure on utility varies with the size of household. This implies that majority of them are not enjoying the subsidies being provided for the vulnerable groups. For this category of consumers to benefit from the intended purpose of the subsidy, government and the utility provider must expand the constituents of the subsidy to include frequency of purchase, a factor which inadvertently is working against them enjoying the subsidy. However, for compound and single households, the findings exhibit fairness in terms of expenditure on units consumed. Another significant conclusion from the study is that the emergence of prepaid metering system has made consumers conscious of their expenditure, consequently, compelling them to adopt/exhibit the needed energy saving behaviours with the aim of regulating the consumption pattern to manage cost. The judicious consumption of energy by customers through the use prepaid meters should have led to the surplus energy for ECG due to change in behaviour. This should be a welcome news for both government and the utility provider who are currently faced with energy deficit in a face of waste from consumers. To ensure energy sustainability government must in addition to other energy efficiency programs push the agenda of prepaid metering since it is self-regulatory.

This study is limited by the fact that it considered only energy expenditure and behaviour of households. Future studies should lay emphasis on the commercial energy users and more households in other cities. Furthermore, because convenience sampling was used, caution should be exercised in generalizing the finding. The data for the analysis was gathered from field survey instead of relying on secondary data from ECG, the institution in-charge of sale of power to consumers. Field survey data was used due to bureaucratic tendency of the agency involved. Further research in the area should exploit the possibility of using secondary data from ECG.

REFERENCES

- Abrahamse, W., L. Steg, C. Vlek and T. Rothengatter, 2005. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, 25(3): 273–291.
- Agrawal, P., 2008. Performance improvement planning: Developing effective billing and collection practices', field note 44119, water and sanitation program. South Asia: World Bank.
- Akrich, M., 1994. The description of technical objects. In Bijker, W.E. and J. Law (Eds). *Shaping technology/building society: Studies in sociotechnical change*. Massachusetts: MIT Press.
- Axsen, J. and K.S. Kurani, 2012. Social influence, consumer behavior, and low-carbon energy transitions. *Annual Review of Environment and Resources*, 37(1): 1-30.
- Babel, M.S. and A. Rivas, 2012. Chapter 22: Bangkok, Thailand' in Chiplunkar, A. K. Seetharam, and C.K. Tan. (Eds). *Good practices in urban water management: Decoding good practices for a successful future*. Asian Development Bank and National University of Singapore.
- Bandyopadhyay, K., 2008. User acceptance of prepayment metering systems in India. *International Journal of Indian Culture and Business Management*, 1(4): 450-465.

- Bashshur, R.L., C.A. Metzner and A.B.C. Worden, 1991. Consumer satisfaction with group practice, the cha case. A Paper Presented at Medical Care Section of the American Public Health Association at the Ninth Annual Meeting in San Francisco, California.
- Becker, L., J.C. Seligman, R.H. Fazio and J.M. Darley, 1981. Relating attitudes to residential energy use. *Environment and Behaviour*, 13(5): 590-609.
- Borzekowski, R.E. Kiser and S. Ahmed, 2008. Consumers' use of debit cards: Patterns, preferences, and price response. *Journal of Money, Credit, and Banking*, 40(1): 149-172.
- Brunner, K.M., M. Spitzer and A. Christanell, 2012. Experiencing fuel poverty. Coping strategies of low-income households in Vienna/Austria. *Energy Policy*, 49: 53-59.
- Casarin, A. and A.L. Nicollier, 2008. Prepaid meters in electricity: A cost-benefit analysis. IAE Working Paper Series, IAE Business School, Austral University. Available from <http://www.sandiego.edu> [Accessed 07/04/2014].
- Chipofya, V., Z. Hoko and C. Gustaff, 2009. An assessment of effective metering and billing as a water demand management tool. The case of area 49 in Lilongue, Malawi. In M. Schouten, E. Hes, & Z. Hoko (Eds). *Innovative practices in the African water supply and sanitation sector*. Stellenbosch: Sun Media Stellenbosch. pp: 99-110.
- Dwyer, W.O., F.C. Leeming, M.K. Cobern, B.E. Porter and J.M. Jackson, 1993. Critical review of behavioural interventions to preserve the environment - research since 1980. *Environment and Behaviour*, 25(3): 275-321.
- ECG, 2013. Proposal for review in distribution service charge. Electricity Company of Ghana. Available from http://www.purc.com.gh/purc/sites/default/files/Tariff_proposal_for_2013_ECG.pdf.
- Ghajar, R.F. and J. Khalife, 2003. Cost/benefit analysis of an AMR system to reduce electricity theft and maximize revenues for electricite du Liban. *Applied Energy*, 76(1): 25-37.
- Graham, S. and S. Marvin, 1994. Cherry picking and social dumping: Utilities in the 1990s. *Utilities Policy*, 4(2): 113-119.
- Guy, S., 2006. Designing urban knowledge: Competing perspectives on energy and buildings. *Environment and Planning C: Government and Policy*, 24(5): 645-659.
- Hand, M., E. Shove and D. Southerton, 2005. Explaining showering: A discussion of the material, conventional, and temporal dimensions of practice. *Sociological Research Online*, 10(2): 1-13.
- Hirschman, E.C., 1979. Differences in consumer purchase behavior by credit card payment system. *The Journal of Consumer Research*, 6(1): 58 - 66.
- Jackson, S.L., 2009. *Research methods and statistics: A critical thinking approach*. 3rd Edn., Belmont, CA: Wadsworth.
- Kayaga, S., R. Franceys and K. Sansom, 2004. Bill payment behaviour in urban water services in Uganda. An empirical data from Uganda. *Journal of Water Supply: Research and Technology-Aqua*, 53(5): 339-349.
- Kettless, P.M., 2004. *Prepayment metering systems for the low income group*. London: PRI Ltd.
- Khan, H.R., F.A. Tanzim, V. Sreeram and H.C. Iu, 2010. A prepaid smart metering scheme based on WiMAX prepaid accounting model. *Smart Grid and Renewable Energy*, 1(2): 63-69.

- King, A.S. and J.T. King, 2005. The decision between debit and credit: Finance charges, float, and fear. *Financial Services Review*, 14(1): 21-36.
- Kingdom, B., R. Liemberger and P. Marin, 2006. The challenge of reducing non-revenue water (NRW) in developing countries. How the private sector can help: A look at performance-based service contracting. *Water Supply and Sanitation Sector Board Discussion Paper Series, Paper No. 8.* World Bank.
- Kraemer, H.C., J.A. Yesavage, J.L. Taylor and D. Kupfer, 2000. How can we learn about developmental processes from cross-sectional studies, or can we? *American Journal of Psychiatry*, 157(2): 163–171.
- Krejcie, R.V. and D.W. Morgan, 1970. Determining sample size for research activities. *Educational and Psychological Measurement*, 30(3): 607-610.
- Marshall, M.N., 1996. Sampling for qualitative research. *Family Practice*, 13(6): 522-525.
- Marvin, S., H. Chappells and S. Guy, 1999. Pathways of smart metering development: Shaping environmental innovation. *Computers, Environment and Urban Systems*, 23(2): 109–126.
- McKenzie, M., 2013. Prepayment meters and energy efficiency in indigenous households. A Report for the Bushlight Centre for Appropriate Technology.
- Mensah, J.K.A., M.K. Ahegbebu and Asabere, 2012. Development of an information and communication technology (ICT)-driven business model for the utility sector. *International Journal of Information and Communication Technology Research*, 2(5): 402-428.
- Miller, S.A., 1998. *Developmental research methods*. 2nd Edn., Upper Saddle River, NJ: Prentice-Hall.
- Misra, S. and W. Kingdom, 2012. India: Improving urban water supply and sanitation service provision. Lessons from business plans for Maharashtra, Rajasthan, Haryana and international good practices. World Bank and Ministry of Urban Development, India.
- Miyogo, C.N., S.O. Nyanamba and G.N. Nyangweso, 2013. An assessment of the effect of prepaid service transition in electricity bill payment on KP customers. A Survey of Kenya Power, West Kenya Kisumu.
- Mwaura, F., 2012. Adopting electricity prepayment billing system to reduce non-technical energy losses in Uganda: Lesson from Rwanda Utilities Policy.
- O'Sullivan, K.C., H.E. Viggers and P.L. Howden-Chapman, 2014. The influence of electricity prepayment meter use on household energy behaviour. *Sust Cities and Soc.* Available from <http://dx.doi.org/10.1016/j.scs.2013.10.004>.
- Ogujor, E.A. and P.O. Otasowie, 2010. The impact of the pre-paid meter on revenue generation in Nigeria. *The Pacific Journal of Science and Technology*, 1(1): 138–142.
- Oisin, T., 2007. Process tracing and elite interviewing: A case for non-probability sampling. *Cambridge Journal Online*, 40(4): 765-772.
- Oracle, 2009. Serve prepaid customers without prepayment meters. Oracle white paper. Available from <http://www.oracle.com/us/industries/utilities/046584.pdf> [Accessed 10/03/2013].
- Pike Research, 2012. AMI managed services: Executive summary. Available from www.navigantresearch.com.

- Prelec, D. and G. Loewenstein, 1998. The red and the black: Mental accounting of savings and debt. *Marketing Science*, 17(1): 4 - 28.
- Punch, K.F., 2005. *Introduction to social research. Quantitative and qualitative approaches*. 2nd Edn., London: Sage.
- Rao, S., 2012. *Impact of municipal billing systems on revenue collection (GSDRC Helpdesk Research Report)*. Birmingham, UK: Governance and Social Development Resource Centre, University of Birmingham.
- Saunders, M., P. Lewis and A. Thornhill, 2012. *Research methods for business students*. 6th Edn., Harlow: Pearson Educational Limited.
- Shove, E., 2010. Beyond the ABC: Climate change policy and theories of social change. *Environment and Planning A*, 42(6): 1273-1285.
- Stephenson, J., B. Barton, G. Carrington, D. Gnoth, R. Lawson and P. Thorsnes, 2010. Energy cultures: A framework for understanding energy behaviours. *Energy Policy*, 38(10): 6120-6129.
- Sualihu, M.A. and M.A. Rahman, 2014. Payment behaviour of electricity consumers: Evidence from the greater Accra region of Ghana. *Global Business Review*, 15(3): 477-492.
- Tewari, D.D. and T. Shah, 2003. An assessment of South African prepaid electricity experiment, lessons learned, and their policy implications for developing countries. *Energy Policy*, 31(9): 911-927.
- Wohlwill, J.F., 1970. Methodology and research strategy in the study of developmental change. In L. R. Goulet and P. B. Baltes (Eds). *Life-span developmental psychology: Research and theory*. New York: Academic Press. pp: 149-91.
- World Bank, 2012. *Installation of individual water meters increases revenue collection by 15 Per cent in Bangladesh*.

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