ASSESSMENT OF THE PERFORMANCE OF THE PREPAYMENT METERING SYSTEM PROJECT IN UMEME LTD

BY

BARBARA NALULE
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DECEMBER 2015
Declaration

I Barbara Nalule, do declare that this is my original work and has never been presented before for the award of a degree in any University.

Signature……………………… Date………………………………………

BARBARA NALULE
Approval

This is to certify that this dissertation has been submitted for examination purposes with our approval as university supervisors.

Signed ........................................

Prof. Joseph Ntayi

Makerere University Business School

Date .................................

Signed ........................................

Eng. Dickinson Turinawe

Makerere University Business School

Date .................................
Dedication

To my Parents Mr. Jonathan Kasule Sebunya, Mrs. Justine Sebunya and to everyone who has contributed in one way or another to make me what I am today by the grace of God.
Acknowledgement

I am grateful to God who has given me wisdom to put this work together and the grace to finish it. I would also like to acknowledge all my lecturers who taught me faithfully to make me better and my Supervisors Prof. Joseph Ntayi and Eng. Turinawe for their professional untiring guidance that they unselfishly gave me, may God continually behold you as the apple of His eye. Finally, I appreciate all the UMEME staff who spared time and included me in the prepaid training programmes as well as my classmates for the knowledge we shared in discussions.
<table>
<thead>
<tr>
<th>Acronym</th>
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<tr>
<td>AMR</td>
<td>Automatic Meter Reading</td>
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<tr>
<td>EPBS</td>
<td>Electricity Prepayment Billing System</td>
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<tr>
<td>ERA</td>
<td>Electricity Regulatory Authority</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<td>RAT</td>
<td>Remote Access Terminals</td>
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<td>UEB</td>
<td>Uganda Electricity Board</td>
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<td>UEDCL</td>
<td>Uganda Electricity Distribution Company Limited</td>
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<td>UEGCL</td>
<td>Uganda Electricity Generation Company Limited</td>
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<td>UETCL</td>
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Abstract

In Uganda as in any other country, elimination of energy losses is an increasing key concern for the players in the utility metering market. The study aimed at examining the level of performance of the Prepayment metering project, challenges of the Prepayment metering system and making suggestions for improving and strengthening the system at UMEME Ltd.

The study adopted both descriptive and qualitative cross sectional survey. A sample of 201 was selected using simple random sampling technique. A pretested questionnaire was used to gather information about the study variables, Frequency counts, percentages, means, standard deviation and factor analysis were generated using SPSS(Statistical Package for Social Scientists) and analyzed. Findings showed that there were extra costs incurred on the project than was budgeted. In addition, despite the systems’ ability to integrate all its components to function, it needs to be enhanced to be able to monitor and control to ensure accuracy is not compromised especially in the metering section by unethical persons. But also care has to be taken when setting tariffs to strike a balance between profitability and affordability for the customers as this in the long run may contribute to reduction in energy losses. It was recommended that management upgrades the technology to a two way token system to make meters intelligent to access information as and when customers load credit, involve community vigilance and most importantly work with the government to have strict enforceable laws with heavy penalties for culprits.
CHAPTER ONE

INTRODUCTION

1.1 Background

The power sector in Uganda has undergone reforms involving the unbundling of the government utility (UEB) into three separate segments for generation, transmission and distribution under ERA regulation (ERA and MoFPED 2008) represented by UEGCL, UETCL and UEDCL entities respectively (Energy policy of 2002). The sector was privatized with the hope that the legal entity that wins the tender is able to reduce losses and increase collection rates, thus forming the basis for reduced tariffs in the long run (Mæstad, 2003). Currently, UMEME Limited is the distribution concessionaire under a 20-year concession agreement signed with UEDCL and is responsible for the upgrade, maintenance and operation of the network as well as revenue collection and customer care.

UMEME started operations using the conventional credit meters to accomplish one of its core activities of revenue collection to achieve its profitability and make a reasonable return to the investors. However apart from the inherent default of extending credit to customers who pay after consumption, the system’s consumption bills issued were estimates necessitating meter readers to confirm the billed amounts at the customers’ premises and involved administrative hurdles of disconnection and reconnection which proved costly not only for the utility but also the customers. In many cases, customers often get wrong bills or abnormally inflated consumption figures and bills were delayed (Mwesigwa, 2013). Power thefts due to illegal connections/unpaid bills, meter by-passing and tampering were the order of the day because the meters were prone to manipulation thus a threat to UMEME (Crested Stocks & Securities 2012). Parsons (2011) attributes the problem of electricity theft to being a culture in Uganda. In a
bid to control the threat of commercial power loss which makes UMEME’s losses the highest in the region at 26.1% of power generated; compared to 17% in Tanzania and 16% in Kenya (Kahigwa, 2013), UMEME invested in the Pre-paid metering technology. To implement the technology, management agreed to undertake a prepayment metering pilot project to operate within the limits of set time, budget and scope. Whilst the scope was adhered to, the budgeted cost of 3.4 million dollars was exceeded and they spent 3.6 million dollars creating an excess of §114,969 dollars an equivalent of 390 million Uganda shillings. More so despite the convenience the system creates for customers, others were unsatisfied on grounds of units running low quickly, inadequate communication and inability to vend due to system failure. The project aims were to improve customer service, increase revenue collections, reduce customer arrears and reduce revenue loss/fraud incidents through enhanced meters and system. Although the technology provided a seamless solution for customer service, revenue collection and arrears recovery gradually, UMEME faces an average monthly energy loss of 11.3% in the piloted area because the meters were tampered with being that they are non intelligent. The dumb Prepayment meters offer one way communication, making it difficult to determine customer periodic consumption, sales reconciliation and losses calculation. The impact of a 1% energy loss on UMEME’s revenue is an equivalent of $3 million dollars’ lost revenue (Financial closure report, 2012). More so an interview with one of the UMEME technicians revealed that during the pilot project, copper wires were used to by-pass the prepaid meters by residents in Kitintale and that other meters were adjusted by some technicians to slow down on the electricity consumed (Personal interview, 14th June 2013). There need to ascertain the performance of the prepayment metering project in UMEME Ltd.
1.2 Statement of the Problem

The desire for having greater control over the distribution of power to eliminate energy losses through improved technology infrastructure (UMEME annual report 2012) remains an increasing key concern. UMEME Ltd seems to have had challenges with the performance of the prepayment metering pilot project which was characterized by an overrun budget cost of 390 million Uganda shillings, unsatisfied customers to some extent, unethical behavior and compromised security of the meter thus causing energy losses. The impact of 1% energy loss is 3 million dollar lost revenue.

1.3 Purpose of the study

The study seeks to examine the level of performance of the prepayment metering project, the challenges of the prepayment metering system and strategies for the improvement of the prepayment metering system in UMEME Ltd.

1.4 Objectives to the Study

a) To examine the level of performance of the prepayment metering project.
b) To examine challenges of the performance of the prepayment metering system project.
c) Make suggestions for strengthening the performance of the prepayment metering system.

1.5 Research questions

a) What is the level of performance of the Pre-payment metering project?
b) What are the challenges of the Performance of the prepayment metering system?
c) How can the performance of the prepayment metering system be improved?
1.6 Scope

The geographical boundaries of the study shall be within Kampala where UMEME piloted the project. The study shall limit itself to the performance of the prepayment metering, factors that affect its security and strategies to improve the system.

1.7 Significance of the Study

i. UMEME has employed the Prepayment metering system to aid it in its bid of reducing energy losses especially commercial losses because they are a threat to the business. Therefore studying on the security of the system and whether it will deliver on the promise is important.

ii. The findings of the study will help the policy makers at UMEME Ltd to design appropriate strategies to improve on the prepayment metering system.

iii. The study will be used by future researchers for further research on prepayment metering system in UMEME Ltd.
CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section of the report presents a review of the literature on the theoretical and conceptual issues linked to Project performance, challenges of the performance of prepayment metering system, and strategies for improving the prepayment metering system.

2.1 Project Performance

Projects are temporary endeavours undertaken to create either a product or service (Ramirez, 2002) and they go through stages like initiation, planning, controlling, implementation and then closure (PMBOK guide, 2000). They usually have defined objectives and ought to have resources to carry out all the tasks required.

Project performance has no generally acceptable definition (Lianying, 2013) considering different people attach different meanings to it. What the customer sees as a failure may be viewed as success to the implementer of the project Ramirez, (2002). Crawford (2002) says that project performance exists where the project meets the technical performance, specifications to be performed, and if there is satisfaction concerning the project outcomes. Therefore, successful project performance is measured on the capability to complete the project according to desired specifications, within the agreed budget and time schedule while keeping the customers and other stakeholders delighted (Cella, Dymond, Cooper, & Turnbull, 2007).

Organizations carryout projects to deliver the firm`s strategies and add value (Jugdev & Muller, 2005) in terms of a positive return on investment (Mangione, 2003). Before embarking on any project, the organisation sets out targets at the pre-design stage that it intends to achieve as they guide project implementation and serve as performance measurements(KPMG,1997;Maylor,
Agreeable targets include; scope, time frame, quality, sustainability, cost and any other performance parameters (Sullivan, 2004). These have to be communicated to different stakeholders who may be coming from diverse backgrounds such that the various activities in the project perform as planned. According to Ramsing, 2009 effective communication clarifies on the project what is to be done and communication may be done both formally and informally (Kerzner, 2006). According to Mobey and Parker (2002), to increase the chances of performance of a project, it is important that organizations get to have an understanding of the critical success factors, to systematically and quantitatively assess these critical factors, anticipate possible effects, and then choose appropriate methods of dealing with them. Once identified, the success of the project can then be achieved.

Project failure causes in organisations range from among others poor definition of the objectives, inadequate project schedule, insufficient control and resources, neglecting the people (Young, 2000; Andersen et al., 2004; White, 2006; Young & Jordan, 2008).

2.2 Challenges of the Performance of the prepayment metering project

2.2.1 Security of the Prepayment metering system.

Metering is both a tool for measuring energy supply and sales (Austin, 2002). According to Measurement Canada (2006), Prepayment metering is the trade measurement of electricity which is required to be purchased by a consumer in advance of the consumption of electricity. To facilitate revenue collection, it supports ease of change for both multi-tariff and flat tariff regimes but also comprises of a supporting devise that links the various sales outlets (vendors’) activities with the electricity consumed and amounts paid to the tariff management billing system that reside in the utility’s main frame computers (Kettless, 2004).
It has been identified as an opportunity that specifically addresses service delivery, as well as operational optimization set up among the domestic client sector (UMEME, 2009).

Prepayment metering’s advanced technology is based on systems approach, revenue and maintenance management that is inextricably linked with the operation of the entire system (Energy policy, 2003). The system consists of Prepayment meters with a customer interface connected by a communication wire (Electricity dispenser), Vending machines where the customers can purchase electricity credit and System Master Station that manages the Credit Dispensing Units through the transaction data collected from them (Kettless, 2004).

According to Amit and Mohnish, 2011 a prepaid energy meter behaves like a prepaid mobile phone. It contains a prepaid card analogous to mobile SIM card. The prepaid card communicates with the power utility using mobile communication infrastructure. Once the prepaid card is out of balance, one can top-up the amount to extend the period of electric supply and when the balance is over the supply is automatically cut off by a relay in the electric meter (Khan et al, 2010). The power utility can recharge the prepaid card remotely through mobile communication based on customer requests. ABS Energy Research (2010) states that, there are two types of prepayment meters in use categorized as either one way or two way, referring to the flow of information from the vending machine to the meter and vice versa. The one-way token metering system is one that carries information only from the management system to the meter. Here the management system only has information regarding the purchase pattern of the consumer and not of the actual consumption (Pieter, 2005). Utilities treat these meters as cash registers for their distribution business and they widely disperse them across service areas located on premises not in their control. Over the years, attention has been paid to keeping these cash registers accurate to ensure that they faithfully report the value of the service used by the customer. However, both
the location and the attributes of the cash register make it impossible to guarantee that they cannot be defrauded. According to Pieter (2005) prepayment meters are prone to functional failure and there also exists a sophisticated form of tampering where the consumer causes the meter to slow down or to cause it to stop measuring, but the consumer then still continues to purchase tokens at a reduced frequency in order to evade detection by the management system. In many cases where the prepayment meters were installed, they're not adequately tamper-proofed, and in some cases, were easily by-passed (Horizon Power, 2008). Although the electricity prepayment billing system (EPBS) is being recommended as an appropriate intervention in addressing non-technical losses (Tewari and Shah, 2003; Ghajar and Khalife, 2003), the system by itself is not sufficient to reduce electricity theft but its beneficial in the identification of suspected frauds, meter tampering and low usage of power.

2.2.2 Energy Losses
System losses is one of the most essential power sector indicators especially for developing countries, as it provides information about power system efficiency and overall performance of a power utility in terms of energy that it procures, sells and bills to customers. According to Prasad et al (2009), reducing system losses often provides one of the fastest ways to improve a utility’s financial performance as it has important implications for tariff calculations thus the regulators, governments and public interest groups' interest in monitoring this indicator to support the required fiscal to electricity companies.

The amount of energy not sold represents the loss with the same proportion of revenue uncollected (Utility Policy, 2012). The main components of system losses are technical losses (e.g. heat or copper losses, magnetic losses, or transformation losses) and non-technical losses (e.g. meter failure, meter tampering or fraud, un-metered or illegal connections, or data encryption losses in billing, in other words, commercial losses, metering failures and theft). More
revenue is lost when those with accumulated bills fail to pay for energy utilized and later engage in illegal electricity connections.

UMEME’s transmission and distribution losses are the highest in the region at 26.1% of power generated; compared to 17% in Tanzania and 16% in Kenya (Kahigwa, 2013). The pressure of keeping tariffs at socially desirable levels through regulating them in the face of rising generation costs has created a wedge between keeping tariffs cost-reflective (hence improving the financial solvency of utilities) and keeping rates low to enhance socio-economic development on cheaper energy.

2.2.3 Ethical Behavior
Ethics includes thoughts, language, reasoning and judgment that forms the choices people make in their daily lives that affect their own well-being and that of others (Wassermann, 2000). According to Rafi (2003), ethical behavior is acting in ways that are consistent with what a person and the society consider as being good values like: honesty, fairness and rights of other people.

According to Bowen (2004), all the activities involved at project implementation have an effect on ethical decision making. More so research identified that people management drives project performance more than technical issues do (Scott-Young & Samson, 2004). While Organizations pride in their resources especially the staff, with UMEME it’s also part of its weakness being that fraudulent employees are the ones who steal equipment or facilitate the theft of power by consumers (CSS, 2012). Conflict of interest exists when an individual has the opportunity to take a decision which advances his or her own interest rather than that of the organization (Walker, et al., 2008). According to Soma (2012), money spent on bribing utility employees who cause billing irregularities is less than the money paid for consuming the same amount of
electricity legally. Factors that influence consumers to steal electricity depend upon various local parameters however of these factors, socio-economic factors influence people to a greater extent in stealing electricity. More concisely, some of the major important factors are:

a) Higher energy prices, unemployment or weak economic situation of a consumer.
b) Weak accountability and enforcement of law.
c) Illiterate about the issues, laws and offenses related to the energy theft.
d) Corrupt employees of the utilities who are responsible for billing irregularities.

To overcome the ethical issues in project implementation, an organization should not only have a professional code of conduct but also enforce and demonstrate willingness of the whole organization to commit to the code of ethics (Karande et. al., 2000). According to London and Everingham (2006), although codes may seem to work in theory, they don’t necessarily work in practice because most of the codes of ethics do not address the specific kinds of situations that professionals encounter (Loo, 2002). The achievement of the implementation of the code of ethics in business also has found only partial success (Loo, 2002; Allen & Davis, 1993).

In a bid to run a lean but profitable organization, UMEME set out to shed off as much excess baggage as it could and this led to the outsourcing of various services under their operations like Meter reading, Bill delivery, Disconnections and Reconnections of power among others. According to Lohmann (2000), the rationale for outsourcing is that no company can be effective in solving all tasks. Outsourcing enables the companies to increase efficiency, reduce costs and focus on core business. However, the downside to it include unrealised savings with a potential for increased costs, employee moral problems, overdependence on a supplier, lost corporate
knowledge and future opportunities, and dissatisfied customers (Kremic et al, 2006). More so the company loses control over the resource.

2.2.4 Customer Satisfaction

Kamara (2000) describes the ‘customer’ as a body that incorporates the interests of prospective users and other interest groups. These groups of people or each individual whose involved in a project, have different needs and expectations thus it is very unsurprising that they interpret project success in their own way of understanding (Cleland & Ireland, 2004). According to Kotler (10th edition), satisfaction is a person’s feelings of pressure or disappointment resulting from product’s perceived performance (outcome) in relation to his/her expectations. Therefore customer satisfaction can be defined as how well a contractor meets the customer’s expectations, and the quality on the project can be regarded as the fulfilment of expectations (Barrett 2000). The significance of customer satisfaction, and its use for evaluating the quality from the customer’s perspective, have been emphasised by many authors (Barret 2000; Torbica and Stroh 2001; Maloney 2002; Yasamis et al. 2002).

And Nicholas (1989) concluded that, the satisfaction of the key project stakeholders, including the customer, was the overriding measure of project success, with stakeholders being satisfied if their quality-related criteria are met. More recent research also arrives at the same conclusion (Wateridge, 1995; Atkinson, 1999; Tukel and Rom, 2001). However, this according to Ruuska (1996) is possible if there be exchange of information intended to create an understanding amongst project stakeholders. Baker (2007) also agrees that ineffective communication contributes up to 95% of project failures.

According to Elenbaas (2000), project success is about communication. Gronroos (2001) emphasises that organisations ought to put in perspective what the customers wishes regarding how they want to be treated are; the service or physical product has to fit the customer’s internal
value-generating processes. In this survey, the views of the two groups of project owners regarding contractor’s performance differed in all areas. The results highlight the need to design the service product from the customer’s perspective. Typically, customers were satisfied with the contractor’s abilities to cooperate and the skills of the contractor’s workers and supervisors, whereas low satisfaction could be identified in the items related to quality assurance and handover. According to this survey, a common feature of the low satisfaction items is that they come out in later phases of the project. This result could indicate that the contractor and customer have not planned the completion stage, or that it has been poorly designed. It could also indicate that there is a problem in managing schedules, which also requires mutual co-operation between parties.

Acceptance is a stage in project implementation that must be managed like any other factor. Locus (2009) as an implementation strategist, discusses the importance of user participation in the early stages of a system development as a way of improving the likelihood of later acceptance and therefore performance. User participation occurs when users are assigned project roles and tasks, which lead to a better communication of their needs and help, which in turn ensures that the system is implemented successfully (Shenhar, A.J., Tishler, A., Dvir, D., Lipovetsky, S. and Lechler, T. 2002). In the long run, what really counts is whether the parties associated with, and affected by, a project are satisfied.

2.3 Suggestions for improving the Prepayment metering system

The prepayment metering technology can be improved in conjunction with tasks that reduce energy losses. According to Prasad et al (2009), the following is a list of strategies and tools that have proven useful in reducing System losses:
i. Improve energy accounting and auditing: not as a one off exercise but carrying it out on a regular basis.

ii. GIS/GPS-based inventory of all distribution infrastructures, such as poles and transformers. All customer GPS coordinates should be picked and referenced to the meter GPS.

iii. Special legislation to reduce electricity theft together with the strict enforcement of laws has been found to be a very effective mean to reduce system losses in some utilities, such as in Andhra Pradesh, India as presented in several energy seminars at the World Bank and through the view point publication of the World Bank.

iv. The Conversion to High Voltage Distribution System has had many benefits for the effective operation of the utility as it reduces technical losses and non-technical losses by making it much more difficult to bypass the meter or connect directly to the network.

v. Improve metering: Use of intelligent or smart meters is recommended as this will help in enhancing the security of the metering system, in reconciling sales and revenue collected and in the determination of loss figures.

2.3.1 Remote access topologies
Power companies often install remote-reporting meters specifically to enable remote detection of tampering, and specifically to discover energy theft according to Hill and Hayes, Landis + Gyr, (2010). It should be obvious by now that meters alone, do not provide adequate levels of revenue protection. The add-on nature of remote access capabilities exploits the communication facilities inherent in the meter design and more significantly, allows the remote access products to be installed, maintained, upgraded and replaced without the knowledge of, or inconvenience to the consumer. Furthermore, the commercial justification of the remote access equipment can be independently assessed and motivated depending on the level of tampering prevalent within a
specific community. This benefits the revenue protection practitioner as the investment into such equipment can be made long after the initial electrification of the sites, and it can be adjusted periodically if necessary, to match the degree of tampering known to exist at a point in time. An example of the communication technology is Remote access terminals (RAT) whose primary purpose is to provide an access path to the data in a prepayment meter, for auditing and revenue protection.

2.3.2 Smart meters
The change to smart power meters is useful to stop energy theft. According to ABS Energy Research (2010), Smart meters use new technology and communication systems to capture complex energy use information and transmit the information as it happens, or almost as it happens. As opposed to ‘dumb’ meters (prepayment meters or AMR), ‘smart’ meters have one over-riding characteristic which is a two-way communications that gives service providers more information whilst at the same time enabling them to transmit commands back to the meter, for example, to cut off or restrict supply. These include using online monitoring to look at your bills (UK Power Limited, 2012). By using the rich, real-time data and the command capability provided by ‘smart’ meters across the business; utilities can achieve a host of benefits of lower operational costs.

2.4 Conclusion
In conclusion, Project performance ‘s success is measured majorly on achievement of working with the agreed budget, time line, scope and other parameters established, short of that makes the project unsuccessful. Secondly Prepayment metering technology may address service delivery, however, Prepayment meters are not smart enough to measure actual consumption and report back to the utility systems in real time. Although they may contain tamper mechanisms these only identify energy losses if energy audits are carried out by the utility. Thus, inadequate meters
coupled with unethical behavior will continue to cause energy losses that translate in revenue loss if they go unchecked with mechanisms suggested to improve the system.
CHAPTER THREE
METHODOLOGY

3.1 Introduction
This section presents the research methods used to carry out the study. It covered the research design, study population, sampling design, sample size, sources of data, data collection instruments, reliability and validity measurement of variables and data analysis.

3.2 Research Design
The researcher used both descriptive and qualitative cross sectional research survey design. This yielded sufficient data that enabled the researcher to achieve the objectives of the study.

3.3 The Study Population
The study comprised an aggregate population of 10,140 staff and customers of UMEME Ltd. To obtain appropriate detail on the system's operation, Kitintale where the system was first piloted was considered because audits on meters installed and consumption analysis is over two years.

3.4 Sample Size
A sample of 201 respondents was selected from a population of 10,140 comprising of 40 prepayment metering officers of UMEME Ltd and 161 customers basing on a table for determining sample size developed by Krejcie & Morgan (1970). This sample size was considered to be adequate to provide enough accurate data to base decisions on the findings with confidence.

3.5 Sampling Design and Procedure
The researcher employed simple random sampling technique to select participants in the study. Data was collected directly from the respondents by administering the questionnaires.
3.6 Data Sources
The researcher used both the primary and secondary sources of data. The Primary source was from generated responses of selected respondents and the secondary source was reviewed documented Literature; Journals, articles, reports from UMEME that are relevant to the study.

3.7 Data Collection Instrument
Primary data was collected from respondents using administered questionnaire, anonymity condition was adhered to create trust with respondent in order to get salient findings. The questionnaire was designed according to the objectives and variables employed in this study. The respondents filled the questionnaire at their own convenience and responses to some of the questions were anchored on a five (5) point Likert. Pre-testing was conducted using Questionnaires before the actual surveying.

3.8 Measurement of Variables
The main instrument for data collection was a questionnaire comprising of both open ended and closed ended questions. It was used on staff to give their opinions and views about the appropriateness of the Prepayment metering technology, ethical behavior and high electricity rates' effect on power revenue losses in UMEME. The researcher used a 5- Likert scale to score the items in the questionnaires as below;


3.9 Data Reliability and Validity
Reliability in the research instrument was assessed by using the Cronbach’s alpha coefficient (Cronbach, 1951). Alpha coefficient of 0.7 or higher for individual test variable will show that the instrument is adequate (Nunnally & Bernstein, 1994).
Table 1; Reliability and validity values

<table>
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<tr>
<th>Variable</th>
<th>Anchor</th>
<th>Cronbach Alpha</th>
<th>Content Validity Index</th>
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<tr>
<td>Performance of the prepayment Metering Project</td>
<td>5 Point</td>
<td>.759</td>
<td>.835</td>
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<tr>
<td>The Challenges of Prepayment Metering System</td>
<td>5 Point</td>
<td>.725</td>
<td>.750</td>
</tr>
<tr>
<td>Suggestions for Strengthening the Performance of the Prepayment Metering System</td>
<td>5 Point</td>
<td>.773</td>
<td>.875</td>
</tr>
</tbody>
</table>

Results above are a reflection that the research questionnaire was not only valid but reliable as well. It is clear that the Cronbach Alpha coefficient and the Content Validity Index were well above 0.7000 yet the limit for this is 0.500.

The content Validity Index (CVI) was acquired as a result of computing the ratio;

\[
CVI = \frac{\text{Number of Relevant statements}}{\text{Total Number of statements}}
\]

This was done for each of the study variables and the results are in Table 1. This means that the items in the study measured what they were intended to measure.

3.10 Data management and analysis

Data was compiled, sorted, edited, coded and entered into the computer and analyzed using SPSS (Statistical Package for Social Scientists) to generate frequency counts, percentages, means, standard deviation and factor analysis was used to examine the performance of prepayment metering system, the factors that affect the control over power losses that translate to lost revenue and strategies of improving the prepayment metering system in UMEME. Interpretations and conclusions of the findings were made according to the objectives of the study.
3.11 Ethical considerations
In order to ensure ethical research principals, the researcher obtained an introductory letter from Makerere University Business School and sought permission to undertake the research in UMEME Ltd. The instrument that was used to collect data was delivered and collected by the Researcher after being filled by the respondent. The research was purely academic. Confidentiality and anonymity of the respondents was strongly guarded.

3.12 Study challenges
- The costs of conducting the Research were high in terms of finances and time.
- It’s less likely that the respondents would participate and answer completely when confronted with the lengthy questionnaire.
- Respondents feared and some were unwilling to answer the questionnaire thinking that the information would be used to disclose what actually is happening and in turn used to sue them accordingly.
- The researcher encountered difficulties in getting all the required information for the study due its sensitivity
CHAPTER FOUR

PRESENTATION AND INTERPRETATION OF FINDINGS

4.0 Introduction
This section captures the background attributes of the sample but also presents the findings of the study and their interpretation generated from collected data according to the following study objectives:

- To examine the level of performance of the prepayment metering project.
- Challenges of the performance of the prepayment metering system.
- Make suggestions for improving the prepayment metering system in UMEME Ltd.

4.1 Background Information
This comprises the background characteristics like the categories of respondents, gender, age and the education level of the persons who participated in the study.

4.1.1 Respondent Categories
The results in the table 1 below indicate the categories of the respondents that participated in the study.

Table 2; Categories of Respondents

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Valid</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>40</td>
<td>19.9</td>
<td>19.9</td>
</tr>
<tr>
<td>Customers</td>
<td>161</td>
<td>80.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>201</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary data

The results in the table 1 above reveal that of the total sample of 201 respondents, 40 were employees while 161 were customers.
4.1.2 Highest level of Education

The results in the table 2 show the distribution levels of education among the respondents. This was presented using frequencies and percentages.

Table 3; Qualifications of Respondents

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>Categories</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Employees</td>
<td>Customers</td>
</tr>
<tr>
<td>Certificate</td>
<td>Frequency</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Percentages</td>
<td>2%</td>
</tr>
<tr>
<td>Diploma</td>
<td>Frequency</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Percentages</td>
<td>4.5%</td>
</tr>
<tr>
<td>Degree</td>
<td>Frequency</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Percentages</td>
<td>11.4%</td>
</tr>
<tr>
<td>Professional</td>
<td>Frequency</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Percentages</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>Frequency</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Sample %</td>
<td>19.9%</td>
</tr>
</tbody>
</table>

Source: Primary data

Results show that, most respondents were Degree Holders (50.7%) of which 23 were employees while 79 were customers. Followed by diploma (17.5%) of which 9 were employees while 26 were customers. Next were certificate Holders (16.4%) of which 4 were employees while 29 were customers. And lastly the professionals constituted 15.4% of which 4 were employees while 27 were customers. The education levels in the sample are an indication that the respondents were fairly educated and could easily fill the questionnaires with the guidance of the researcher.
4.1.3 Gender

The results in table 3 show the distribution of the gender of the respondents. This is presented using frequencies and percentages.

**Table 4; Gender of Respondents**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Categories</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Employees</td>
<td>Customers</td>
</tr>
<tr>
<td>Male</td>
<td>Frequency</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Percentage</td>
<td>12.4%</td>
</tr>
<tr>
<td>Female</td>
<td>Frequency</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Percentage</td>
<td>7.5%</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Sample %</td>
<td>19.9%</td>
</tr>
</tbody>
</table>

*Source: Primary data*

The findings showed that most of the respondents were Female (51.8%) of which 15 were employees while 89 customers and the Male comprised (48.2%) of which 25 were employees while 72 were customers.
4.1.4 Age

The table below shows the various age brackets of the respondents who participated in the research. This is presented using frequencies and percentages.

Table 5: Age of Respondents

<table>
<thead>
<tr>
<th>Age Brackets</th>
<th>Categories</th>
<th>Total</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Employees</td>
<td>Customers</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>20 - 29 yrs</td>
<td>Frequency</td>
<td>25</td>
<td>18</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Valid Percentage %</td>
<td>12.4%</td>
<td>9%</td>
<td>21.4%</td>
</tr>
<tr>
<td>30 - 39 yrs</td>
<td>Frequency</td>
<td>14</td>
<td>84</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Valid Percentage %</td>
<td>7%</td>
<td>41.7%</td>
<td>48.7%</td>
</tr>
<tr>
<td>40 - 49 yrs</td>
<td>Frequency</td>
<td>1</td>
<td>54</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Valid Percentage %</td>
<td>0.5%</td>
<td>27%</td>
<td>27.5%</td>
</tr>
<tr>
<td>50 yrs &amp; Above</td>
<td>Frequency</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Valid Percentage %</td>
<td>2.4%</td>
<td>2.4%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Frequency</td>
<td>40</td>
<td>161</td>
<td>201</td>
</tr>
<tr>
<td></td>
<td>Sample %</td>
<td>19.9%</td>
<td>80.1%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: Primary data

From the above table, the findings reveal that most of the respondents were between the age bracket of 30-39(48.7%) of which 14 were employees and 84 customers, followed by the age bracket of 20-29 (21.4%) of which 25 were employees and 18 were customers, then 40-49(27.4%) of which 1 was an employee and 54 customers and lastly 50 & above (2.4%) of which all were customers.

4.2 To examine the level of performance of the prepayment metering project

This section presents results on the level of performance of the prepayment metering project by UMEME Ltd. The level of performance explained five factors accounting for 66.166% of the variance. These factors are Accessibility (36.857), Timeliness (14.269), monitoring and control (5.497), accuracy (4.905) and cost (4.638). Details are summarized in table 5.
Table 6: Level of Performance of the Prepayment metering Project

<table>
<thead>
<tr>
<th></th>
<th>Accessibility/Convenience</th>
<th>Timeliness Monitoring and control</th>
<th>Accuracy</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>It integrates the Electricity dispenser, vending system and the master station.</td>
<td>.749</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It uses a disposable token that is specific to the meter.</td>
<td>.601</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The system enables loading credit for electricity within the comfort of one’s home.</td>
<td>.628</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customers’ inability to vend due to vending system failure.</td>
<td>.743</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The project was commenced on time.</td>
<td>.663</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The entire prepayment system functions in real time to keep customers on supply.</td>
<td>.771</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity is paid for before consumption</td>
<td>.747</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer can print own bill as and when desired.</td>
<td>.501</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>They are online based and give Utilities control in real time of all consumer energy use.</td>
<td>.859</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Their network makes it easier to quickly detect and correct trouble on a power line.</td>
<td>.896</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The utility system can disconnect supply remotely in case of energy theft.</td>
<td>.826</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening a terminal cover triggers tamper mode, that can only be reset by a system generated token.</td>
<td>.563</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manipulators cause the meter to register less energy consumption leading to losses.</td>
<td>.797</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Meter has an audit trail of the all the activities it performs</td>
<td>.672</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra costs were experienced on the project</td>
<td>.764</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eigenvalues</td>
<td>4.423</td>
<td>1.712</td>
<td>1.319</td>
<td>1.177</td>
</tr>
<tr>
<td>Variance%</td>
<td>36.857</td>
<td>14.269</td>
<td>5.497</td>
<td>4.905</td>
</tr>
<tr>
<td>Cumulative %</td>
<td>36.857</td>
<td>51.126</td>
<td>56.622</td>
<td>61.527</td>
</tr>
<tr>
<td>Mean</td>
<td>4.003</td>
<td>4.296</td>
<td>3.363</td>
<td>3.811</td>
</tr>
<tr>
<td>SD</td>
<td>.695</td>
<td>.693</td>
<td>.676</td>
<td>.993</td>
</tr>
</tbody>
</table>

Source: Primary data

The measurement items in table 5 were anchored on a five point likert scale with 1=Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree and 5= Strongly Agree. The results with means
close to 1 or 2 show Disagreement while those close to 4 or 5 show Agreement with the issue being raised. In between, results with means close to 3 revealed uncertainty about the concept raised and thus required improvement of the issue at hand.

4.2.1 Accessibility/convenience
Accessibility (Mean=4 and Standard deviation=0.695) had four elements of priority to explain it as a component of the study variable. The elements’ results revealed that the prepayment metering system's operation is integrated to facilitate accessibility in form of communication amongst the individual elements of the whole system. This implying that prepayment metering is a system made up of subsystems each with its own goals to achieve. That's to say the meter records how much electricity is consumed by the consumer from the total produced by the utility, the master station ensures the customer has the correct amount of electricity sold to him through the vending machine and administers the whole system. The meter has an interface to the customer for managing the transfer of credit to the meter and to display the credit status. The customers’ inability to purchase from the vending system the disposable tokens (embedded in them units of electricity equivalent to their money worth) not only causes an inconvenience but also denies them access to the service. The system can either be addressable meaning that tokens are personalized to one meter and therefore can't be used to credit another meter or non-addressable.

4.2.2 Timeliness
Timeliness (M=4.3 and SD=.695) is explained by four measurement items. The findings show that, the project commenced on time and the customers in the pilot area had to pay for electricity by buying tokens before they consume the service. The system's proper performance is dependent on functioning in real time as in, the system's meter behavior with a prepaid card is
likened unto the way a prepaid mobile phone works with a mobile SIM card. Once the card is out of balance, the supply is automatically cut off by a relay in the meter. More so, the utility can enable the customer to recharge remotely through mobile communication based on customer requests as well as giving them the option of timely printing their own bill.

4.2.3 Monitoring and control

The study showed that Monitoring and control (M=3.4 and SD=.676) is explained by three items. The results revealed uncertainty of the system to monitor and control in real time the consumers' energy use and to quickly detect as well as correct trouble on a power line simply because prepayment systems are categorized as either one-way or two-way. In the one way, information flows from the vending machine to the meter while in the two-way information flows in both directions. In the later, the meter returns information such as average daily consumption, peak demand etc as part of the purchase cycle whereby data is transferred from as intelligent token devise( electronic token key.smart card). Each time a new token is purchased, the vending outlet downloads the feedback data. However, this method is dependent on the customer's purchasing cycle, which may vary and thus provide no immediacy for the utility.

4.2.4 Accuracy

From the study, the three items under accuracy (M=3.8 and SD=.993) were used to explain the study variable. The results tended to agree that although the meters have an audit trail; manipulators still cause the meter to register less energy consumption leading to losses. The implication of this is that the meters are not robust with inbuilt sensor trigger alarm reporting mechanisms to the utility management system in case the physical security features are overridden. More so, the terminal cover trigger tamper mechanism is only operable if there is
supply on the grid and can be compromised incase of no supply because then the meter won’t go into tamper mode.

4.2.5 Cost
Results revealed uncertainty in regard to the cost component (M=3.132 and SD 1.012) of the level of the performance of the prepayment metering system. The implication of this is that little information in relation to the cost of the project was known by the respondents thus the need to improve communication in this area.

4.3 Challenges of the Performance of Prepayment metering system
This section presents results on the factors affecting the prepayment metering system of UMEME Ltd. The challenges of the system explained five factors accounting for a 62.001% of the variance. These factors are Accountability (38.68%), Ethical conduct (7.225%), Energy revenue losses (6.011%), Tariff/Investment (5.474%) and security of the metering system (4.643%). Details are summarized in table 6.
Table 7; Challenges of the Prepayment metering system

<table>
<thead>
<tr>
<th>Accountability</th>
<th>Ethical conduct</th>
<th>Energy Revenue losses</th>
<th>Tariff/Investment</th>
<th>Security of the metering system</th>
</tr>
</thead>
<tbody>
<tr>
<td>.719</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.694</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.601</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The User interface and the Meter are the property of UMEME Ltd.

Meter pole installation gives the customer an excuse to deny responsibility for fraud. Accountability mechanisms need to be strengthened to address the irregularity.

Technicians abuse their position in the field while interacting with customers. Customers bribe technicians to tamper with meters so that they pay less. Acceptance of an advantage constitutes improper performance of activities.

The energy not sold represents the loss with the same proportion of revenue uncollected. Energy theft generally translates into power revenue losses for UMEME Ltd. They occur when meters are manipulated, malfunctioning, not read and by direct tapping.

High tariffs reflect the cost of energy but are affordable by the low income earners. Domestic users' tariffs are high because of the investments in infrastructure.

The meter is mounted on a pole outside user’s premise for utility staff easier access. Disconnection is done by the meter and reconnection if a token is loaded.

<table>
<thead>
<tr>
<th>Eigen values</th>
<th>4.251</th>
<th>1.589</th>
<th>1.322</th>
<th>1.204</th>
<th>1.021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance%</td>
<td>38.68</td>
<td>7.225</td>
<td>6.011</td>
<td>5.474</td>
<td>4.643</td>
</tr>
<tr>
<td>Cumulative %</td>
<td>38.68</td>
<td>45.873</td>
<td>51.884</td>
<td>57.358</td>
<td>62.001</td>
</tr>
<tr>
<td>Mean</td>
<td>3.756</td>
<td>4.218</td>
<td>3.505</td>
<td>3.151</td>
<td>3.864</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.655</td>
<td>0.750</td>
<td>0.647</td>
<td>0.684</td>
<td>1.046</td>
</tr>
</tbody>
</table>

*Source: Primary data*
The measurement items in table 6 were anchored on a five point likert scale with 1=Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree and 5= Strongly Agree. The results with means close to 1 or 2 show Disagreement while those close to 4 or 5 show Agreement with the issue being raised. In between, results with means close to 3 revealed uncertainty about the concept raised and thus required improvement of the issue at hand.

4.3.1 Accountability

Items of this component (M=3.756 and SD=0.655) tended to agree that the User Interface and the Meter are the property of UMEME Ltd which is responsible for their installation, one at the user premises while the meter is placed on a pole outside user premise. The Meter pole installation gives the customer an excuse to deny responsibility for fraud since the user has no control over activities outside his premises; thus accountability mechanisms need to be strengthened to address the irregularity. The implication of this is that, customers already had meters which they had applied and signed for with different terms and conditions and during the project implementation the concern seemed to rest on replacing the old meters rather than also encompassing the thought of having the customers sign other terms in which authority for accountability is passed on by UMEME Ltd.

4.3.2 Ethical conduct

Under Ethical conduct (M=4.218 and SD=0.750) three elements explained the study variable. And the results revealed that, integrity is compromised when one accepts an advantage and in most cases the activities one is required to perform are done haphazardly contrary to how they are supposed to be done. This is because the person who gives the advantage requires the tasks to be carried out in his favour such that he benefits from consuming electricity but at a tariff rate
lower than the one charged by the utility. The tariff rate reviews are not favourable for the low income earners who find it cheaper to bribe technicians for a one off transaction to enjoy the service at a relative price thus Technicians' abusing their position when they accept the customer's offer.

4.3.3 Tariff/investment

Results under this component (M=3.151 and SD=.684) revealed uncertainty in regard to whether tariffs reflect the cost of energy but are affordable for the low income earners. This is because various factors including investments in infrastructure constitute the cost of energy but on top of these factors, on a quarterly basis, adjustments of the increase or decrease of the fuel prices, inflation and local currency depreciation are made to the cost. The implication is that, for every capital investment, operating costs etc made in the prevailing economic conditions, UMEME factors in these expenditures while setting the tariff to come up with a commensurate required rate of return spread throughout a specific period until the time of the next review. The pricing is not to make the service affordable but rather to enable the going concern of UMEME Ltd by retaining a return on their investments.

4.3.4 Energy revenue losses

Results tended to agree that, amongst the three elements listed under this component (M=3.505 and SD=0.647) energy theft translates into power revenue losses. This is because in most cases UMEME is unable to collect the revenues’ equivalent of power losses from culprits whose meters are manipulated, malfunctioning, not read and or who consume electricity by direct tapping. In conclusion, energy not sold represents the loss with the same proportion of revenue uncollected. The implication of this is that electricity cannot be stored, as it’s received from
transmission, it’s sent to the grid for consumption and the difference between what was received and that used is the energy loss that has no trace of having been sold.

4.3.5 Security of the Metering system

Under security of the metering system (M=3.864 and SD=1.046) as a challenge of performance, results tended to agree with the capabilities of the meter and the reason why it’s placed outside user's premise. The meter is a cash register of the utility system and direct visible access may deter unauthorized persons from tampering with it thus accurately measuring the energy consumption. More so, the meter continuously receives electricity supply irrespective of whether or not the customer has credit but via a cable communication between the meter and a user interface, instructions are received by the meter. These may be to allow the flow of electricity to the consumer load when credit is purchased or to disconnect when it is utilized.

4.4 Suggestions for improving the prepayment metering system

This section presents results on the strategies of improving the prepayment metering system at UMEME Ltd. The strategies to improve the system explained three factors accounting for 69.322% of the variance. These factors are intensive field monitoring 10.561%, advanced infrastructure 48.320%, and Legal and ethical compliance 10.441%. Details are summarized in table 7.
Table 8; Strategies for Improving the Prepayment metering system

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Advanced Infrastructure</th>
<th>Intensive field monitoring/auditing</th>
<th>Legal and ethical compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion to High Voltage distribution system avoids losses.</td>
<td>.716</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of smart/Intelligent meters enhances the security of the metering system.</td>
<td>.835</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of the two-way token to read data to and from the meter to the management system.</td>
<td>.706</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensure right pricing of electricity that is affordable to the market</td>
<td>.595</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounting and Auditing ensures energy availed and utilized is within permissible limits.</td>
<td>.788</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community has to be involved in the fight against electricity theft.</td>
<td>.732</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourage whistle blowing with rewards for the whistleblower.</td>
<td>.791</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Code of ethics should address the specific situations that professionals encounter.</td>
<td>.664</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Eigen values | 2.416 | 1.056 | 1.044 |
| Variance %   | 48.320 | 10.561 | 10.441 |
| Cumulative % | 48.320 | 58.881 | 69.322 |
| Mean         | 4.209 | 3.903 | 3.964 |
| SD           | 0.736 | 0.708 | 1.028 |

Source: Primary data

The measurement items in table 7 were anchored on a five point likert scale with 1=Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree and 5= Strongly Agree. The results with means close to 1 or 2 show Disagreement while those close to 4 or 5 show Agreement with the issue being raised. In between, results with means close to 3 revealed uncertainty about the concept raised and thus required improvement of the issue at hand.
4.4.1 Intensive field Monitoring/Auditing;
Results under this component (M=3.903 and SD=0.708) tended to agree that giving the community rewards for whistle blowing and engaging accounting system could improve the prepayment metering system. The campaign for whistle blowing comes with a reward that is a motivation to keep one alert and report any suspicious individuals. In the event that the hunch is right UMEME saves on the losses as a result of tampering and replacement cost of an item that could have been vandalized. The effectiveness of the campaigns is revealed when the utility carries out active field audits. These enable the company to obtain actual consumption which is compared to energy supplied to the grid or per transformer (transformer metering) in a designated area to produce sales, consumption and energy loss reports on which decisions are based.

4.4.2 Using Advanced Technology recommendations
Results of this component (M=4.209 and SD=0.736) revealed that, the use of smart/intelligent meters enhances the security of the metering system because of ease of the communication feature technical specification inbuilt in the meter. The feature enables direct communication between the meter and the management system in real time. In addition, conversion to High Voltage distribution system allows low current to flow through the lines which makes direct tapping very difficult thus increasing the authorized connection which in turn improve revenue from the metering system. Further, the use of the two-way intelligent token to read data to and from the meter to the vending system provides information from the audit trail in the meter which could be useful for the utility as well as save on the cost of the active field audits. Lastly, the right pricing of electricity that is affordable to the market is subjective to a number of factors one being ensuring that the utility earns a return on its investments. And since the company is a
monopoly although it has a government entity as a regulator, consumer’s alternatives to electricity may not be comfortable solutions to go with thus paying the price levied by the utility.

4.4.3 Legal and ethical compliance
Results of this component (M=3.964 and SD=1.028) tended to agree that professionals bound by the Code of ethics that addresses the specific situations professionals encounter are conscious of the repercussions spelt out in the event that they commit the felony. This makes them employable because they value the profession.

4.5 Qualitative Data
As regards how energy supplied in the area and that consumed by the customers on prepaid system is obtained; Some of the respondents said that the quantity of energy supplied in an area is obtained through transformer metering while others said that metering is per feeder. One of the respondents specifically pointed out that the HV line supplying the area is the one that is metered. However, on the account of determining how the actual consumer energy is obtained, the response was that, the purchases made by the customer’s electricity equivalent in units is the customer’s actual consumption. While others mentioned use of a portable test kit to enable data download thus providing meter consumption data.

On the issue of the systems that could be put in place to identify and minimize energy losses, some respondents said that use of an intelligent meter with bi-directional communication could adequately resolve the situation. Others were of the view that, regular and active field audits would be more efficient in identifying as well as minimize energy losses.
The mechanism in place to ensure that prepaid meters accurately measure the energy consumption to prevent energy losses include; Testing of the meters to ascertain proper calibration before they are put to use in the field. Secondly, mounting of the meter on the pole outside consumer's premise in away deters tampering because the whole community will now be viewing the pole if one who isn't a technician was to climb it with the intent of stealing power.

Lastly the recommendations that could be implemented to strengthen the existing mechanisms include; Engaging Parliament to enact heavy penalties for culprits who are caught stealing or aiding the theft of electricity.
CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction
This chapter presents the discussions, conclusions and recommendations of the findings in relation to the study objectives. It is divided into four sections; Discussions of findings, Conclusions, Recommendations and Areas for further studies. These sections were guided by the study objectives which focused on examining the level of performance of the prepayment metering project, challenges of the performance of the prepayment metering system and strategies of improving the prepayment metering system. They are based on the findings presented in the previous Chapter.

5.2 Discussion of the results

5.2.1 To examining the level of performance of the prepayment metering project
From the factor analysis results in the previous chapter, it was observed that the performance of the prepayment metering project is comprised of five main components which are accessibility, timeliness, monitoring & Control, Accuracy and cost. These components have been indicated in order of decreasing capacity to account for the level of performance in the prepayment metering project.

5.2.1.1 Accessibility/Convenience
Results showed the high ranged factor as being the system´s ability to integrate the electricity dispenser (meter), vending system (sale points) and master station (utility management system). This implies that tokens sold at the various sales points are generated by the utility management system and are at the same time recognized by the meter when one is loading the units. Therefore various components of the prepayment metering system have to be up and
running if the system is to deliver on its functionality as a whole. This is in agreement with earlier studies by Tewari and Shah (2003) where it was established that the prepayment metering solution is an advanced technology which inextricably links the operation of the entire system. The factor that ranked low under accessibility is that the system uses a disposable token that is specific to the meter. This is in agreement with Energy (2003) studies that, showed that a token with a numeric strip of paper with of 20 digits number is a disposable and concurs with UMEME (2009) that Tokens dispensed will contain a unique number specific to the pre-payment meter installed.

5.2.1.2 Timeliness
Under this results showed that the entire system functions in real time to keep customers on supply of electricity. This implies that if the customer’s credit is utilized over the weekend, he doesn’t have to wait for the UMEME’s offices to open on weekdays to buy units, but rather can use the mobile or internet platforms to buy credit inform of units, load them on the user interface and the meter will supply electricity. This is consistent with the studies by Nysscheu (2010) that showed that communication between the different components of the prepayment metering system is enabled by an efficient internet connection. Prepayment has become the payment method of choice for mobile phone and similar services (Oracle, 2009). The least factor under this component was the ability of the customer to print own bill as and when desired. This is in an agreement with one of the benefits listed of the prepayment metering having automated record keeping (Power Division, 2011). Thus retrieving bills is easier by a customer even without the Utility´s help.
5.2.1.3 Monitoring and control

Here, the factor with the highest ranking was that the prepayment metering’s network makes it easier to quickly detect and correct trouble on a power line. This enhances performance levels because the customers are served better using evolved mechanisms that use internet to remotely communicate with each other for better decision making. This is optimised if the meter is intelligent because it facilitates information flow from the meter to the utility and vice versa. This is in agreement with the studies K. Peter, (2011) depicting the meter has as having two-way communication capability. Austin (2002) confirms that sophisticated meters record all consumer transactions and allow utilities to monitor items such as consumer purchase patterns, determine energy load requirements, reconcile to bulk metering devices, detect non technical losses and plan maintenance of their systems. Simpson (1996) agrees that utilities are turning to two way communication to provide better and more efficient services for their customers. The least factor was that the utility system can disconnect supply remotely in case of energy theft. The Prepaid Meter has an in built terminal cover tamper detector which if opened, the meter switches off supply, goes into tamper mode and can only be re-set by a tamper re-set token generated from the master station. However, this is only effective if there is supply of electricity on the grid (Financial closer report, 2012).

5.2.1.4 Accuracy

Results showed that, Manipulators cause the meter to register less energy consumption leading to losses ranked the highest and Opening a terminal cover triggers tamper mode, that can only be reset by a system generated token ranked the lowest factor in determining the level of performance. If the metering devise has a lope hole that can be exploited by unscrupulous people then, this affects the performance of the prepayment metering. The tamper detector is only effective when there is supply implying that when accessed without supply of electricity then the
meter can be tuned to register less energy consumption. This is emphasized by Horizon Power (2008) that states that, in many cases were the prepayment meters were installed, they're not adequately tamper-proofed, and in some cases, were easily by-passed.

5.2.1.5 Cost
Results revealed that, there were extra costs that were experienced on the project. This in itself affects the performance of the prepayment metering project because resources to be utilized on the project are budgeted and to exceed the budget hinders the project’s success. This finding agreed with studies by Stamatia (2012) where it was established that the performance of a project is measured as the ability to complete the project according to desired specifications, within the specified budget and time schedule (Cella, Dymond, Cooper, & Turnbull, 2007).

5.2.2 Challenges of the performance of the prepayment metering system
From the factor analysis results in the previous chapter, it was observed that the challenges of performance of the prepayment metering system comprised of five main components which are accountability, ethical conduct, energy revenue losses, tariff/investment and security of the metering system.

5.2.2.1 Accountability
Results revealed that, the user interface and the meter being the property of UMEME Ltd ranked the highest factor under this component. This is consistent with UMEME (2009) descriptive studies that showed that the prepaid meters purchased will be a property of UMEME. However, the Meter is installed on the pole outside user premises yet at the same time UMEME claims ownership of it, makes accountability difficult incase the meter has been tampered with. As much as the meter supplies electricity to the user yet it's not in his control to monitor especially if
there are a couple of meters on the pole. Accountability mechanisms need to be strengthened to address the irregularity ranked low.

5.2.2.2 Ethical conduct
Under this component, the factor that ranked highest was that there is conflict of interest amongst the workers with the company goals and the least was that Technicians abuse their position in the field while interacting with customers. Conflict of interest occurs when puts his need first irrespective of the organization's rules that govern their work. This is evident in technicians who take bribes from customers to perform their jobs contrary to what the organization employed them to satisfy their own needs. The findings are consistent with the study that conflict of interest exists when an individual has the opportunity to take a decision which advances his or her own interest rather than that of the organization (Walker, et al., 2008). And in agreement with the findings by Soma (2012), that revealed that utility employees are bribed to cause billing irregularities.

5.2.2.3 Energy revenue losses
Results revealed that, energy theft generally translates into power revenue losses for UMEME Ltd ranked high and the energy not sold represents the loss with the same proportion of revenue uncollected ranked low. This is in conformity with the study by Ghajar and Khalife (2003) and Utility Policy (2012) which showed that the amount of energy purchased and not sold includes electrical energy lost through theft, which could be in form of illegal connections, fraud or non-payment of bills.
5.2.2.4 Tariff/Investment
The results revealed that, there were two factors that challenged the prepayment metering system under this component. High ranked being that the High tariffs reflect the cost of energy but are not affordable by the low income earners and the least being that Domestic users' tariffs are high because of the investments in infrastructure. This consistent with the findings by ERA (2006), which showed that in Tariff setting, a tariff structure provides for cost reflective tariff for each customer group and also provides consumers with fair and reasonable price structures consistent with maintenance of a financially and operationally secure electricity supply system. This implying that the pricing of electricity may not necessarily be affordable for the user but keeps the utility financially sound.

5.2.2.5 Security of the prepayment metering system
Results revealed that, the meter is mounted on a pole outside user´s premise for utility staff easier access. This is also a mechanism to deter other persons from accessing the meter and if they did it would be in full view of the community around. This is in agreement with the findings that, the metering part of a split prepaid meter is at the top of a tall pole and that though tampering would be done in full view, it's often impossible to tell the difference between a utility staff member performing maintenance duties on a pole top, and a revenue theft syndicate member bypassing the meter thus the visibility of the meter tampering activity is not a great deterrent (R Hill and H J Hayes, Landis + Gyr, 2010). The least factor was that disconnection is done by the meter and reconnection if a token is loaded. This is in conformity with the findings by Khan et al (2010) that, supply of electricity is automatically cutoff by a relay in the prepaid meter and to extend the supply one has to top-up before the units get finished.
5.2.3 Strategies of improving the prepayment metering system.
From the factor analysis results in the previous chapter, it was observed that the strategies of improving the prepayment metering system is comprised of three main components which are Advanced infrastructure, intensive field monitoring and legal ethical compliance.

5.2.3.1 Advanced infrastructure
Results in the order of the highest revealed that, Use of smart/Intelligent meters enhances the security of the metering system. This is in conformity with the finding that, smart meters improve metering security in reconciling sales and revenue collection and in determining of loss figures (Prasad et al, 2009). And ensuring right pricing of electricity that is affordable to the market ranked low. If this is not adhered to, illegal consumption of power is given leeway. This is consistent with the finding that Sharp fluctuations in prices result in deviant consumer behaviour and increase the level of theft (ERA, 2006).

5.2.3.2 Intensive field monitoring
Results in descending order revealed that, encouraging whistle blowing with rewards for the whistleblower and involving community in the fight against electricity theft would greatly improve the system. The community can be engaged through sensitization campaigns of preservation of electricity infrastructure. This is in conformity with Antmann (2009) studies of setting direct and open contact with communities, their leaders, and the authorities involved to create awareness about the fact that electricity is a commercial good with a price and that electricity consumption should be rationalized and efficient.
5.2.3.3 Legal and ethical compliance
Results showed that, the code of ethics should address the specific situations that professionals encounter in the field so as to enhance the ethic standards. This gives a guide to the professionals of what is required of them in various aspects of their duties however most codes don’t spell situations out. This is in conformity with studies that revealed that most codes of ethics do not address the specific kinds of situations that professionals encounter (Loo, 2002) and in agreement with Sims (1992) findings that, professional codes influence the ethical climate.

5.2.4 Qualitative data
Results also indicated that the, energy supplied in the area and that consumed by the consumers on prepaid system can be obtained through transformer or feeder metering and use of portable meter readers respectively. This is in conformity with the financial report (2012) that says that a portable test kit is used to download data on consumption. And transformers which feed HVDs lines provide better accountability resulting in accurate and reliable energy accounts on sustainable basis (Ankita et al, 2012).

5.3 Conclusion
In general, the findings of the study revealed that, the implemented project's system has the ability to integrate all its components to function as a whole by using an efficient internet connection by credit units and payments are effected. However, remote monitoring mechanism can only be effective when the meter is enhanced to be intelligent and its tamper detector's shortcomings addressed to activate even when there isn't supply as will completely deter manipulators. Lastly for a project to be considered successful, it has to fit within its budget which wasn’t the case. In addition the system had challenges of the metering part drawing attention on accountability considering the meter is outside the user premise yet its owned by UMEME thus
in cases of bypassing who takes the blame. More so the ethical conduct of the employees and customers showed that if not attended to, issues of energy revenue losses seemed to stem from it coupled with the tariff/investment component. Lastly, the meter disconnecting and reconnecting if the token is loaded coupled with its being on the top of the electric pole proved not to be deterrent for tampering activity. As a result of the above some of the strategies for improving the system evolved around, advancing the infrastructure, intensive field monitoring and legal ethical compliance. That is to say, enhancing the prepayment metering system to be smart, right pricing of electricity, campaigns with rewards for whistle blowers in the community engaged and employing professionals

5.4 Recommendations
Basing on the above findings, the study recommends the following for improving the system in UMEME Ltd;

Management should put in place the two-way token metering system that carries information from the management system to the meter as well as from the meter to the management system. This will enable the UMEME obtain actual consumption of the energy utilized by the customers being that the meter is intelligent thus facilitating accurate billing.

Management should continuously carryout active regular field audits if it so chooses to continue to operate the dumb meters (none-intelligent meters) as this also facilitates accurate billing.

Management should employ professionals in the company who are governed by the code of ethics such that when they involve themselves in acts which are unethical, they are dismissed from the practice indefinitely.
Management should also work with the government of Uganda to enact laws with heavy penalties for individuals who engage in electricity theft. This will deter both the employees and customers in collusion to steal electricity to refrain from the exercise.

Management and government should come up with a strategy to make electricity rates affordable to all the domestic users especially the low income earners. As this will reduce electricity theft since the money the Customers use to bribe technicians to tamper with their meters to register less energy consumption will be sufficient to purchase electricity legally.

Management ought to motivate their employees, put in place strong accountability measures as well as ensuring refresher courses on ethical issues are undertake by their staff on a quarterly basis. More so, sensitization campaigns about ethical issues amongst the customers should aired on radio and any media outlet. To educate them on illegality of practices of energy theft and the penalties involved (once the bill is enacted).

Dressing meters in the meter box with a screws and seals which are signed off with the user of the meter as means of handing the responsibility of accountability to him/her incase of tampering issues.

Lastly, community should be involved in the fight against power theft. This can be encouraged by putting a reward for anyone who whistle blows on any within the community engaged in electricity theft.

5.5 Areas for further research
With the increasing advancement in technology, research should be conducted in the area of on-line credit theft of credit units from the prepaid platform vending system.
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Appendix 1: Questionnaire

MAKERERE UNIVERSITY BUSINESS SCHOOL

This questionnaire intends to collect information to assess the performance of prepayment metering system piloted by UMEME in the central region of Uganda. The information you provide will be treated with utter most confidentiality and used for academic purposes only.

Thank you for contributing towards the success of this research.

SECTION A: Social Demographic Profile of Respondents.
1. What is your gender? Male      Female

2. In which age group do you belong?
20-29  1  30-39  2  40-49  3  50 and above  4

3. Which level of education do you have?
Certificate  1  Diploma  2  Degree  3  Professional  4  others specify............

SECTION B

On a scale of 1-5, express your opinion on the performance of the metering system. where; 1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree 5 = Strongly Agree. Please tick (√) in the most appropriate box.

<table>
<thead>
<tr>
<th>The level of Performance of the prepayment metering project</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 The voltage supply from the meter to the consumer load is controlled by the contactor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2 Opening a terminal cover triggers tamper mode that can only be reset by a system generated token.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Tampering with a terminal cover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Manipulators cause the meter to register less energy consumption leading to losses.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4 The Meter has an audit trail of the all the activities it performs</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5 Field audits are needed to obtain actual energy consumption.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Accessibility/Convenience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 It integrates the Electricity dispenser, vending system and the master station.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8 It uses a disposable token that is specific to the meter.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9 The system enables loading credit for electricity within the comfort of one´s home.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10 The customer interface unit enable customers to monitor and control usage</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11 Customers´ inability to vend due to vending system failure.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Timeliness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 The project was commenced on time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13 The entire prepayment system functions in real time to keep customers on supply.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Electricity is paid for before consumption</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Customer can print own bill as and when desired.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Dumb meters make periodic consumption reports, sales reconciliation and losses calculation difficult.</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cost**

| 17 | The budget cost was adhered to throughout the whole project. | 1 2 3 4 5 |
| 18 | Extra costs were experienced on the project | 1 2 3 4 5 |
| 19 | There was project rework that was costly | 1 2 3 4 5 |
| 21 | The one way token avails information on the purchase pattern of the consumers. | 1 2 3 4 5 |
| 22 | The units purchased in a month vary on the same amount paid. | 1 2 3 4 5 |

**Monitoring and control**

| 23 | They have a two way communication system for monitoring and control purposes. | 1 2 3 4 5 |
| 24 | They are online based and give Utilities control in real time of all consumer energy use. | 1 2 3 4 5 |
| 25 | Their network makes it easier to quickly detect and correct trouble on a power line. | 1 2 3 4 5 |
| 26 | The utility system can disconnect supply remotely in case of energy theft. | 1 2 3 4 5 |
| 27 | The system identifies cases of energy theft through consumption analysis reports. | 1 2 3 4 5 |

**Challenges of the Performance of Prepayment metering system**

**Accountability**

| 28 | The user interface and Meter are the property of UMEME ltd. | 1 2 3 4 5 |
| 29 | UMEME field staff easier access to the meter makes them liable for any meter tampering. | 1 2 3 4 5 |
| 30 | Meter pole installation gives the customer an excuse to deny responsibility for fraud. | 1 2 3 4 5 |
| 31 | It's difficult to balance energy because there is no integration of the transformer and prepayment. | 1 2 3 4 5 |
| 32 | Acceptance of an advantage constitutes improper performance of activities. | 1 2 3 4 5 |
| 33 | Accountability mechanisms need to be strengthened to address the irregularity. | 1 2 3 4 5 |

**Ethical conduct**

| 34 | Employees and contractors perform their duties with honesty. | 1 2 3 4 5 |
| 35 | Technicians abuse their position in the field while interacting with customers. | 1 2 3 4 5 |
| 36 | Customers bribe technicians to tamper with meters so that they pay less. | 1 2 3 4 5 |
| 37 | There is conflict of interest amongst the workers with the company goals. | 1 2 3 4 5 |
| 38 | The act of electricity theft is attributed to being a culture in Uganda. | 1 2 3 4 5 |

**Tariff/Investment**

| 39 | The system supports tariff and monthly fixed charges to be changed with ease. | 1 2 3 4 5 |
| 40 | High tariffs reflect the cost of energy but are affordable by the low income earners. | 1 2 3 4 5 |
| 41 | Domestic users' tariffs are high because of the investments in infrastructure. | 1 2 3 4 5 |
| 42 | High power tariffs are due to fuel prices, inflation, and local currency depreciation. | 1 2 3 4 5 |
| 43 | Energy losses are inclusive in the composition of the tariff levied on consumers. | 1 2 3 4 5 |

**Energy Revenue losses**

| 44 | The energy not sold represents the loss with the same proportion of revenue uncollected. | 1 2 3 4 5 |
| 45 | Energy theft generally translates into power revenue losses for UMEME Ltd. | 1 2 3 4 5 |
| 46 | They occur when meters are manipulated, malfunctioning, not read and by direct tapping. | 1 2 3 4 5 |
| 47 | The viability of an electricity utility depends upon the minimization of energy losses. | 1 2 3 4 5 |
| 48 | Data on energy losses is beneficial if revenue protection action can be taken based on it. | 1 2 3 4 5 |

**Security of the metering system**

| 49 | It’s a non intelligent meter that uses a one-way token |
The Meter’s terminal cover tamper detector is effective when there is electricity supply.

The meter is mounted on a pole outside user’s premise for utility staff easier access.

Disconnection is done by the meter and reconnection if a token is loaded.

Improper calibration and illegal de-calibration of meters causes energy losses.

Suggestions for improving the prepayment metering system

Legal and ethical compliance

The Code of ethics should address the specific situations that professionals encounter.

There should be strict enforcement of laws with maximum penalties for culprits.

Intensive field monitoring/auditing

Carrying out active regular field audits manages losses and fraud.

Accounting and Auditing ensures energy availed and utilized is within permissible limits.

Community has to be involved in the fight against electricity theft.

Encourage whistle blowing with rewards for the whistleblower.

Advanced Infrastructure

Conversion to High Voltage distribution system avoids losses.

Use of smart/Intelligent meters enhances the security of the metering system.

Use of the two-way token to read data to and from the meter to the management system.

Ensure right pricing of electricity that is affordable to the market.

64. Considering that the prepaid management system captures the purchase patterns of consumers rather than actual consumption, in the piloted area of Kitintale, how is energy supplied in the area and that consumed by the customers on prepaid system obtained?

........................................................................................................................................

65. With the continued energy losses UMEME is facing, what mechanisms/ systems can be put in place to identify and minimize energy losses?

........................................................................................................................................

66. What mechanisms/ systems are in place to ensure that prepaid meters accurately measure the energy consumption to prevent energy losses?

........................................................................................................................................

67. What are the suggestions or recommendations that could be implemented to strengthen the existing mechanisms?

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