AN ASSESSMENT OF THE APPLICATION OF STATISTICAL QUALITY CONTROL IN THE PROVISION OF QUALITY OF SERVICES: A CASE OF KENYA POWER LTD, NAKURU SUB-REGION

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DECLARATION AND APPROVAL

DECLARATION

I declare that this research is my original work and has not been presented for the award of a degree in any other university/institution or for any other purpose.

Signed: .... Date: ....

George Yogo Odongo.
CM11/00713/12

APPROVAL

This research project was been submitted with my approval as the university supervisor;

Signed: .... Date: ....

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DEDICATION

To my wife, Lilian.

This work would not have been possible without your encouragement, support and perseverance.

ACKNOWLEDGEMENTS

I wish to thank The Lord God Almighty for the life and good health he has given me, for without his blessings and the strength I receive daily, I can accomplish nothing. I also wish to express my sincere and deep gratitude to Dr. Christopher Ngacho for all his contribution to this research. He spent countless hours in discussions and many more reading one draft after another. His endeavors have gone a long way in making this work a reality. I also wish to thank the staff of Kenya Power, particularly Eng. Steve Odhiambo for all the support provided. To all the lecturers in my MBA class who were involved in the noble task of imparting knowledge and my student colleagues with whom we spent time together sharing experiences and enriching each other during group discussions. I sincerely thank each one of you. I forget not the staff of the libraries of Egerton University and University of Nairobi for the assistance they accorded. Special thanks go to Milcah Gikunju of The University of Nairobi Repository. To all those who assisted me in one way or another during the programme, your memories will forever remain etched in my mind. May The Almighty God bless and richly reward you.

ABSTRACT

Statistical Quality Control has been widely used in the manufacturing field for decades. It has enabled the use of one or more control charts to control production processes statistically and prevent quality problems without undue delay. However, it is until only recently that SQC has been applied in the services sector. This study applied statistical quality control (SQC) to assess the customer's experience of quality as offered by Kenya Power Ltd. It also sought to determine whether or not the services of the company were in statistical control. The study was designed as a survey. The population consisted of 65,830 customers within Nakuru town and its environs from which four hundred customers were sampled. The sample population was stratified so that 286 were domestic consumers while the remaining 114 were non-domestic consumers. Stratified random sampling was used. The collected data was coded and summarized in the form of tables and entered into the SPSS program. Customers' experiences were obtained and used to draw control charts, which were analyzed. It was found that the customers' experience of service as regards the restoration of supply after settlement of unpaid dues is not in statistical control for both domestic and non-domestic consumers. As regards the disconnection of supply for closed accounts, the service was found to be in statistical control. However the process capability analysis index for the domestic category much higher (1.66) than that for non-domestic consumers (0.1346). As regards the refund of deposit for closed accounts, the service was found to be in statistical control for both categories of users. However, in both categories the process capability analysis index was found to be less than 0.2. Finally, as regards the restoration of supply after unplanned interruptions, the service was found to be out of statistical control for both domestic and non-domestic consumers. These results are a severe indictment of the qualities of service of Kenya Power. The implication for the managers of service processes at Kenya Power is that they must ensure optimal service quality in the firm. In particular, urgent steps must be taken to identify the root cause or causes of special variation that result in service invariability and instability. This study calls for the intensified use of statistical quality control tools in the utility services sector and particularly at Kenya Power, as a means of monitoring quality and production, and enabling the firm to take timely and appropriate action to correct undesirable deviation in production quality.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

BPR	Business Process Reengineering
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IT	Information Technology
KPLC	Kenya Power and Lighting Company Ltd
KNBS	Kenya National Bureau of Statistics
KP	Kenya Power Company Ltd
LCL	Lower Control Limit
R	Range of Data Set
SQC	Statistical Quality Control
TQC	Total Quality Control
TQM	Total Quality Management
UCL	Upper Control Limit
$\bar{X}$	Average of Data Set

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The concept of quality is one that has existed for several decades now though it's concept has metamorphosed with time. In the early twentieth century, quality management meant inspecting products to ensure that design specifications were met. In the intervening periods between the 1940s and 50s, quality became more statistical in nature. Statistical sampling techniques were used to assess quality, and quality control charts were drawn to monitor production processes (Hossain, 2008; Mukherjee, 2012). In the 1960s, the concept took on a broader meaning, thanks to the work of the famous quality gurus in the likes of Feignebaum, Crosby, Ishikawa and Taguchi. Quality began to be viewed as something that encompassed the entire organization and not only the production process. Since all functions were responsible for the quality of a product, all of them shared the costs of poor quality. In the 1970's and 80's, manufacturers in the auto and consumer goods industry of the US lost substantial market share due to foreign competition. These foreign competitors produced lower-priced goods with unmatched superior quality. To survive, companies made far-reaching changes to their quality programs. Consultants were hired and companies instituted intense quality training programs for their employees. Unwittingly, a new concept of quality was emerged. One result is that quality took on a strategic meaning. Successful companies operating in the contemporary world understand that quality provides a competitive advantage. They have further appreciated that by defining quality as meeting or exceeding customer expectations, they place the customer first (Mauch, 2010).

Quality control is even more important in the utility services sector because production and consumption are inseparable, i.e. the customer and the firm interact. Utility services companies include those that provide oil, gas, water, and electricity. One of the most prominent utility service companies in Kenya is Kenya Power. Kenya Power (KP) is responsible for transmission, distribution and retail of electricity throughout Kenya. The company owns and operates the national transmission and distribution grid, and is responsible for scheduling and dispatching electricity to more than two million customers throughout Kenya. The Company's services are targeted at individual and corporate customers and operates through a network of branches in four regions. These are Nairobi, Mount Kenya, Coast and West Kenya (Africa Tech News, 2013).

Kenya Powers' roots can be traced to the defunct East African Power and Lighting Company (EAP&L) which existed back in 1922. EAP&L's mandate covered the East African region since the company had obtained generating and distribution licenses for Uganda and Kenya and had a controlling interest in the Tanganyika Electricity Supply Company Limited (TANESCO). In 1948, the Ugandan Government established The Uganda Electricity Board (UEB) to take over distribution of electricity in the country. Later in 1964, EAP&L sold its majority stockholding in TANESCO to the Government of Tanzania. With its operations confined only to Kenya, EAP&L was renamed The Kenya Power and Lighting Company Limited (KPLC) in 1983. In June 2011, Kenya Power and Lighting Company Limited was rebranded to Kenya Power.

In recent times, many companies have embraced quality management programs to ensure quality control (Njau, 2011). At Kenya Power, the company has instituted initiatives aimed at improving quality services such as business process reengineering (BPR), rebranding and obtain ISO 9000:2000 certification. In addition, it has also come up with Service Delivery Standards and Timelines (Appendix C) for its various services. Amongst many other things, the service delivery charter states that unplanned supply interruption must be restored within eight (8) hours of reporting, reconnection after disconnection to be made within twenty-four (24) hours after payment and construction of a new supply within 3 days after payment. However, despite these endeavors, many customers have consistently centreexpressed dissatisfaction with the quality of service received from Kenya Power (Moraa, Etyang, & Mwabu, 2011).

1.2 Statement of the Problem

One of the key roles of businesses is to attract and retain customers through improved customer satisfaction rates. One of the ways of doing this is by setting and maintaining high quality standards. This will ultimately build consumer confidence. Companies that want to maintain a competitive edge, both now and in the future, have realized that reactive customer interaction services must be replaced by a more proactive approach that recognizes the growing user-centricity of consumer communications networks. In an effort towards this Kenya Power Ltd introduced various quality control measures. Specifically, these include business process reengineering (BPR), rebranding and obtain ISO 9000:2000 certification (Ombui, 2003). In addition, it has also come up with Service Delivery Standards and Timelines for its various services. Amongst many other things, the service delivery charter states that unplanned supply interruption must be restored within eight (8) hours of reporting, reconnection after disconnection to be made within twenty-four (24) hours after payment and construction of a new supply within 3 days after payment. However, despite this endeavors, many customers have expressed dissatisfaction with the quality of service received from Kenya Power (Moraa, Etyang, & Mwabu, 2011; Orumi, 2009; Nyaoga, 2003). Much of these complaints have revolved around delays in reconnection of power after disconnection, delays in restoration of power after interruption of regular supply, and delays in account closure and deposit refund (Moraa, Etyang, & Mwabu, 2011).

It is against this background that this work used statistical quality control tools to assess the services provided by Kenya Power. It adopted the use of statistical quality control in analyzing the quality of service provided by Kenya Power.

1.3 Objectives of the Study

1.3.1 General Objective

The main objective of this work was to carry out an assessment of the quality of services provided by Kenya Power to its customers and find out whether or not the services are in a state of statistical control.

1.3.2 Specific Objectives

The specific objectives were

(i) To assess whether the customers' experience of service as regards the restoration of supply after settlement of unpaid dues is in statistical control.

(ii) To assess whether the customers' experience of service as regards the disconnection of supply for closed accounts is in statistical control.

(iii) To assess whether the customers' experience of service as regards the refund of deposit for closed accounts is in statistical control.

(iv) To assess whether the customers' experience of service as regards the restoration of supply after unplanned interruptions is in statistical control.

1.4 Research Questions

The research questions for this study were;

(i) Is the customers' experience of service as regards the restoration of supply after settlement of unpaid dues, in statistical control?

(ii) Is the customers’ experience of service as regards the disconnection of supply for closed accounts, in statistical control?

(iii) Is the customers’ experience of service as regards the refund of deposit for closed accounts, in statistical control?

(iv) Is the customers’ experience of service as regards the restoration of supply after unplanned interruptions, in statistical control?

1.5 Significance of the Study

Kenya Power Ltd has a clientele of over 2.1 million account holders and several million indirect consumers (Africa Tech News, 2013). By understanding the experiences of its customers about its services and by further understanding whether these services are statistically in control or not, the company can come up with strategies and policies to improve services and boost consumer confidence.

The company’s consumers and members of the general public stand to gain by receiving higher quality and efficient services. The company’s shareholders are also expected to benefit from the study, the single largest of whom is the Government of Kenya with a 49% stake. Others include the National Social Security Fund (NSSF) and other smaller shareholders whose cumulative ownership accounts for the rest of the 51%. Through improved performance, these shareholders stand to gain immensely via increased revenue from dividends.

Future researchers will benefit from the contribution to literature on statistical quality control as applied to the utility services sector.

1.6 Scope and Justification of the Study

Kenya Power is a limited liability company that transmits, distributes and retails electricity to millions of customers throughout Kenya. The company is the national electric utility company, managing electric metering, licensing, billing, emergency electricity service and customer relations. It retails electricity to millions of consumers in the country whose total count as of May 2013 was over 2,100,000 customers (Africa Tech News, 2013). It is further alleged that Kenya Power adds an average of 25,000 new consumers to the grid every month (Africa Tech News, 2013) implying that that figure could be in the region of 2,750,000. The company also conducts its business in four principal regions in Kenyan, namely, Nairobi, Coast, West Kenya, and Mount Kenya (Africa Tech News, 2013).

The scope of this study was Kenya Power customers within Nakuru town and its environs. Nakuru town is located 160 km North West of Nairobi and is the fourth largest urban center in Kenya after Nairobi, Mombasa and Kisumu. It is situated at an altitude of 1,859m above the sea level and it is within the region of the Great Rift Valley. Going by the 2009 census, the population of the town is estimated at 473,288 (KNBS, 2009). The major economic sectors of the Nakuru urban economy are: commerce, industry, tourism, agriculture and tertiary services. The commercial sector in Nakuru contributes about 19% of the economy of the town. Within the Central Business District (CBD), retail activity occupies 26%; wholesale has 10%, the informal sector enterprises 18% of all the commercial activity space. The most dominant forms of business in the Nakuru economy include retail in hardware, general wholesale, outlets for agro-industrial machinery, motor vehicle trade, spare parts and servicing the agro-chemical retail and wholesale outlets. There is a significant network of financial institutions providing banking, insurance and credit services to the business community. The Central Bank of Kenya also recently commissioned a new currency center in Nakuru to serve the more than thirty (30) banks and financial institutions that operate within the town.

The service industry has become increasingly important in our daily lives and global economies, and improving service quality will have a significant social and economic impact (Mauch, 2010). Statistical quality control has provided opportunities to integrate advanced statistical methodologies with system knowledge to better model and control the quality of service systems. In the modern business environment, monitoring and quick detection of abnormal activities has become critical especially in service industries that have complex operation systems and that process huge amounts of data (Nakhai, 2009). This study will shed light on the actual state of services provided by Kenya Power. It will also assist the company to know what their customers think about their services and what improvements may need to be undertaken. Scholars and academicians will benefit from the additional literature on statistical quality control especially as applied to the services industry.

1.7 Limitations of the Study

Since statistical quality control techniques can only uses real-time data, the results may not reflect precisely the current condition of the services offered by Kenya Power Ltd. To obtain the present conditions, the study must be repeated. It is for this reason that statistical quality control has been described as a continuous and ongoing process rather than a one-time event (Oakland, 2008).

1.8 Assumptions of the Study

Given the action taken by the management of Kenya Power, it was deduced that the company is interested in providing efficient and quality services to its customers. It was assumed that the company will be interested in the results of this study and will act on any recommendations that may be made.

1.9 Definition of Terms

Control: Control is a system for measuring and checking or inspecting a phenomenon. It suggests when to inspect, how often to inspect and how much to inspect, how often to inspect. Control ascertains quality characteristics of an item, compares the same with prescribed quality standards and separates defective item from non-defective ones.

Quality: Quality in the context of this study means conformance to specification.

Statistical Control: A variable that continues to be described by the same distribution when observed over time is said to be in statistical control, or simply in control.

Statistical Quality Control: Statistical Quality Control (SQC) is a method of quality control that uses statistical methods. It is a production strategy designed to ensure product quality by providing inspectors with tools to help organize technical and statistical data obtained during inspection.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 The Concept of Quality

Quality thinking began with the rise of inspection in the early 1920’s (Garvin, 1998). Though quality is a frequently studied subject in the manufacturing as well as service sectors, there is no universally accepted definition. The definition of quality is subjective, personal and changes from person-to-person, place-to-place, organization-to-organization, situation-to-situation and time-to-time. However, for the purpose of this study, quality is defined as conformance to specifications. In this context, quality measures how well a product, or service meets the targets and tolerances determined by its designers (Feather & Sturges, 2003).

2.2 Historical Background of Quality

For over fifty (50) years now, the principal application domain for statistical quality control has been for process control and improvement in the manufacturing industry (Scordaki & Psarakis, 2005; Nakhai, 2009). The most common process control technique has been control charting. However, the number of applications reported in domains outside of conventional production systems has seen a steady rise over the years. Scordaki & Psarakis (2005) identifies four such application domains. The first of these is in engineering, industrial and environmental applications. The second application area is in healthcare, the third, general service sector application and the fourth, statistical applications. Scordaki & Psarakis (2005) further identified four principal objectives for these application domains. The first objective is to monitor processes where the objective is to watch over and control a process in order to maintain process stability and in many cases to enable process improvement. The second objective is to plan. SPC charts are used to derive effective plans or schedules, particularly for maintenance scheduling. The third objective is in assessing customer satisfaction. SPC charts have been used to assess customer satisfaction in a range of application domains to detect high levels of satisfaction and dissatisfaction. The fourth and final objective is in forecasting. SPC charts are used to generate or optimize a forecasting model.

2.3 Distinctive Characteristics of Service Firms

A question that often arises in the study of service-oriented organizations is, how different is the management of such operations when contrasted with manufacturing firms? In answering this question, Bitran & Lojo, (1993) said that though the basic management principles are the same for both services and manufacturing firms, there are however some distinctive characteristics between service and manufacturing firms. The following attributes of services suggest the need for different skills in the management process; intangibility, perishability, heterogeneity, and simultaneity. Subsequent sub-sections discuss each of these attributes in turn.

2.3.1 Intangibility

As opposed to a product producing firm, service firms usually sell bundles of goods and services, comprising both physical items and intangibles that are both explicit – having sensual benefits, and implicit – having psychological benefits (Roberts, 2005; Ograjenšek, 2002; Bitran and Lojo, 1993). The intangible nature of service products makes it difficult to promote their consumption exclusively on technical grounds. They satisfy customer needs associated with convenience and personal satisfaction, and frequently involve feelings such as anxiety, relief, or joy. These factors are of course, also present in the consumption of tangible goods. However, the physical characteristics of manufactured goods provide some objective measures on which customers can assess their purchases.

2.3.2 Perishability

The fact that most tangible goods have extended life means that they can be stocked and distributed through a network of outlets. Such goods can be produced long in advance of their consumption and stocked at strategic distribution centers (Ograjenšek, 2002; Juneja, Ahmad, and Kumar, 2011; Bitran and Lojo, 1993). In contrast, the intangible nature of services means that they are perishable and cannot be inventoried in the traditional sense. Consequently, managers in service organization are often faced with situations in which their facilities and other assets are idle for long periods, which is very costly.

2.3.3 Heterogeneity

Although technological advancements have created vast opportunities for services to be delivered by machines, not all services can be so delivered. It is still common to encounter services delivered by human being (Heizer, J., and Render, B., 2011; Juneja, Ahmad, and Kumar, 2011; Bitran and Lojo, 1993). Humans, however tend to be inconsistent in their behavior and therefore in the delivery. However, even where there is consistency in delivery, the consumers' experience may be affected by other factors other than those directly attributable to the service provider, such their state of happiness, attitudes etc. This fact therefore creates a major challenge for the managers of quality in service firms.

2.3.4 Simultaneity

A salient feature that is present in all services is that they are produced and consumed at the same time. This characteristic presents a challenge for the manager of quality since the service cannot be inspected before consumption (Ograjenšek, 2002; Heizer, J., and Render, B., 2011; Bitran and Lojo, 1993). If a mistake occurs during delivery, it will be witnessed by the customer and subsequently be very difficult or expensive to correct.

2.4 Measures of Quality in Service Firms

Conformance to quality can be measured based on either or both, internal or external parameters. For internal parameters, the measures of quality have much in common with the well-known measures widely used in the control of manufacturing processes. Measures of external conformance are more complex due to the abstract nature of some of the qualities and due to the subjective reactions of consumers (Doty, 1996). An obvious source of data on external conformance is the cross-section of consumer complaints and claims, although many annoyed consumers will not take the trouble to complain. However, the complaints received do represent a sample of the types of annoyance to which all consumers are subject. A second method of measure of external performance is through solicitation of consumer comments. A typical form of this is the appraisal card made available to consumers in hotel rooms and restaurants. Some companies use the summaries of these cards as the basis for regular management reports. Additionally, some companies design special surveys of customer reaction, through letter questionnaires, telephone contacts and personal interview. The techniques used follow conventional market research practice. Measures of service quality have to date been on an industry-by-industry basis, and this is expected to continue in the near future. Some service companies supplement their regular measures of quality by use of periodic audits. These audits are all pervasive, covering both internal and external aspects of quality (Chandra, 2001).

2.5 Causes of Variation of Quality

Any production process, regardless of how well designed or carefully maintained, will expectedly produce goods of varying quality (Montgomery, 2009; Olatunde, 2009). This variability occurs naturally is healthy and is not indicative of the presence of any underlying problem(s). Such variability, being random, is inherent to a process (Mahesh, and Prabhuswamy, 2010). In the framework of statistical quality control, this natural variability is often called a "*stable system of chance causes*" (Montgomery, 2009). A process that is operating with only chance causes of variation present is said to be in statistical control. It is highly desirable that a process be and remain in statistical control.

The other kind of variability that may occasionally present in the output of a process is due to assignable causes. In general terms, variability due to assignable causes arises from three sources; improperly adjusted or controlled machines, operator errors, or defective raw materials. Such variability is generally large as compared to natural variability and usually represents an unacceptable level of process performance. Sources of variation that are not part of the chance causes are referred to as assignable causes. A process that is operating in the presence of assignable or special causes is said to be an out-of-control process. It is highly undesirable that a process operate statistically out-of-control. Special causes of variation should be eliminated as far as practically possible (Doty, 1996).

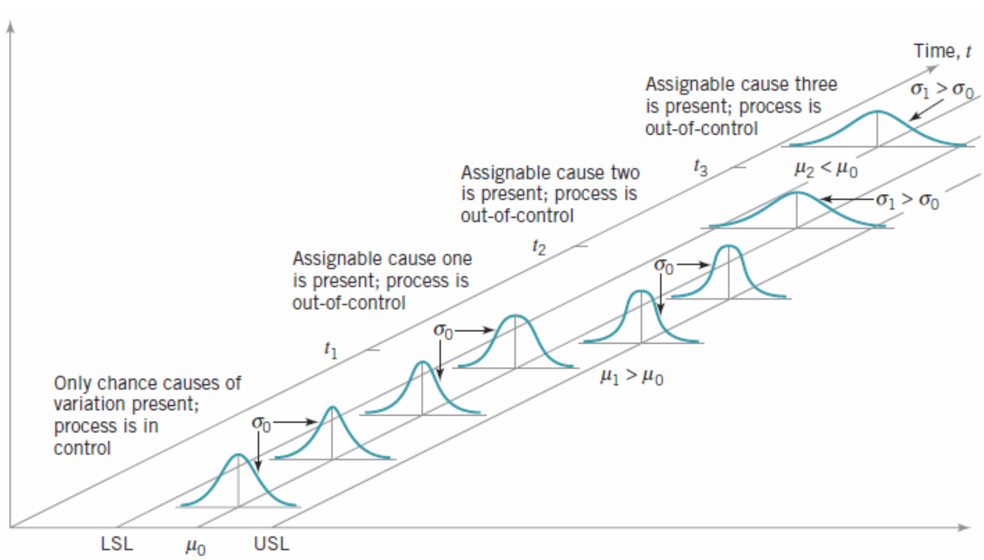

Figure 2.1: Process Quality Characteristics (Adopted: Montgomery, 2009)

Figure 2.1 illustrates these chance and assignable causes of variation. From the figure, it is seen that until time t_1, the process shown in this figure is in control. That is, only chance causes of variation are present. As a result, both the mean and standard deviation of the process are at their in-control values of μ_0 and σ_0 respectively. At time t_1, an assignable cause occurs. The effect of this is to shift the process mean to a new value $\mu_1 > \mu_0$. At time t_2, another assignable cause occurs, resulting in $\mu = \mu_0$, but now the process standard deviation has shifted to a larger value $\sigma_1 > \sigma_0$. At time t_3, there is another assignable cause presents resulting in both the process mean and standard deviation taking on out-of-control values. From time t_1 forward, the presence of assignable causes has resulted in an out-of-control process (Montgomery, 2009).

Processes will often operate in the in-control state for relatively long periods. However, since no process remains stable forever, assignable causes eventually occur, seemingly at random, resulting in a shift to an out-of-control state where a larger proportion of the process output does not conform to requirements. It can be noted from Figure 2.1, that when the process is in control, most of the production will fall between the lower and upper specification limits. However when the process is out of control, a higher proportion of the process lies outside of these specifications (Montgomery, 2009).

2.6 Assumptions Underlying Statistical Quality Control

Statistical quality control is usually seen as being more than just a set of statistical procedures; it also encompasses a set of assumptions about the underlying philosophy of quality management. The first assumption on which the rationale of SPC depends is that important quality characteristics can be and should be measured (Wood, 1994). The risks of failing to measure are obvious in that problems may not be noticed, changes may be brought in without a clear analysis of the situation, and there will be no clear evidence of any improvements. The second assumption is that the aim should be the prevention of problems before they occur, rather than just diagnosing them after they have occurred. The goal should be to improve the future rather than simply measuring the past. There are two reasons for identifying and measuring problems after they have occurred: first to correct the problem (perhaps by scrapping or reworking the component), and second to learn from past performance in order to improve future performance. The aims of SPC fall entirely in the second category. The goal is to improve the process so that – eventually – identifying and correcting errors becomes unnecessary because none exist. This improves quality and reduces waste because the process has improved, and also produces large savings in the amounts which need to be spent on inspection. This argument is as valid in the education industry (for example) as it is in the motor industry: it is not sufficient to identify student errors in order to fail students or correct misunderstandings (i.e. scrap or rework); it is also important to learn from the errors in order to improve the future teaching process and so prevent future errors. Thirdly, wherever possible the analysis should concentrate on the process rather than the output (Wood, 1994). This is likely to be the most effective way of achieving the previous aim. Concentrating on the output is an inefficient strategy because it fails to provide information about which aspects of the production process could be usefully improved, and because of the delay, it may entail. By concentrating on the output rather than the process, a manufacturer of cars for example may, end up with a batch of finished cars all of which have to be scrapped or reworked because of defects in the bodywork. It clearly makes far more sense to monitor each part of the process of manufacture – as it happens – so that problems can be found and remedial action taken immediately to ensure that the problem does not recur. Exactly the same arguments apply to service processes such as education and catering. Lastly, the resources devoted to testing, monitoring and inspection should be as few as possible. This usually means that the amount of data used should be the minimum to achieve the purpose. A common practice for mean and a range control chart, for example, is to use samples of five items only (Wood, 1994). Indeed, a strong case could be made for the claim that it is these principles, and not the techniques themselves, that are the real essence of SQC.

2.7 Statistical Quality Control Techniques

Statistical quality control methods extend the use of descriptive statistics to monitor the quality of the product and process. Using statistical quality control, the amount of variation that is common or normal can be determine. This then makes it possible to monitor the production process to make sure production stays within this normal range. That is, the desire is to ensure the process is in a *state of statistical control.* The most commonly used tool for monitoring the production process is a control chart. Different types of control charts are used to monitor different aspects of the production process.

2.7.1 Control Charts

A control chart (also called process chart or quality control chart) is a graph that shows whether a sample of data falls within the common or normal range of variation. A control chart has upper and lower control limits that separate common causes from assignable causes of variation. The common range of variation is defined by the use of control chart limits. A process is said to be out of control when a plot of data reveals that one or more samples fall outside the control limits (Montgomery, 2009, Oakland, 2008).

The upper and lower control limits on a control chart are usually set at ±3 standard deviations from the mean. If it is assumed that the data exhibits a normal distribution, these control limits will capture 99.73 percent of the normal variation. Control limits can be set at ±2 standard deviations from the mean. In that case, control limits would capture 95.44 percent of the values. Figure 2.2 shows the percentage of values that fall within a particular range of standard deviation.

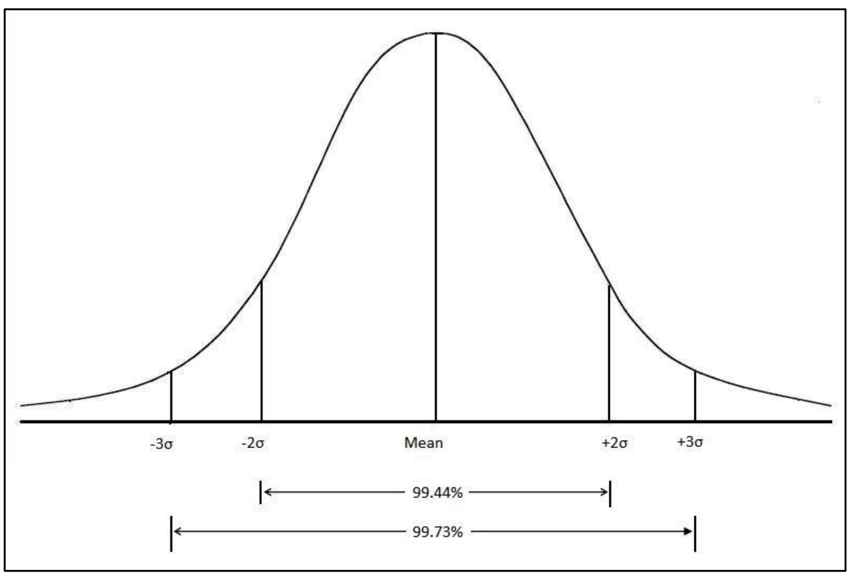

Figure 2.2: Percentage of values captured by different ranges of standard deviation (Adapted: Chandra, 2001)

Looking at Figure 2.2, it can be concluded that observations that fall outside the set range represent assignable causes of variation. However, there is a small probability that a value that falls outside the limits is still due to normal variation. This is called Type I error, with the error being the chance of concluding that there are assignable causes of variation when only normal variation exists (Oakland, 2008, Chandra, 2001). Another name for this is alpha risk (α), where alpha refers to the sum of the probabilities in both tails of the distribution that falls outside the confidence limits. The chance of this happening is given by the percentage or probability represented by the shaded areas of Figure 2.3. For limits of ±3 standard deviations from the mean, the probability of a Type I error is 0.26% (100% – 99.74%), whereas for limits of ±2 standard deviations it is 4.56% (100% – 95.44%).

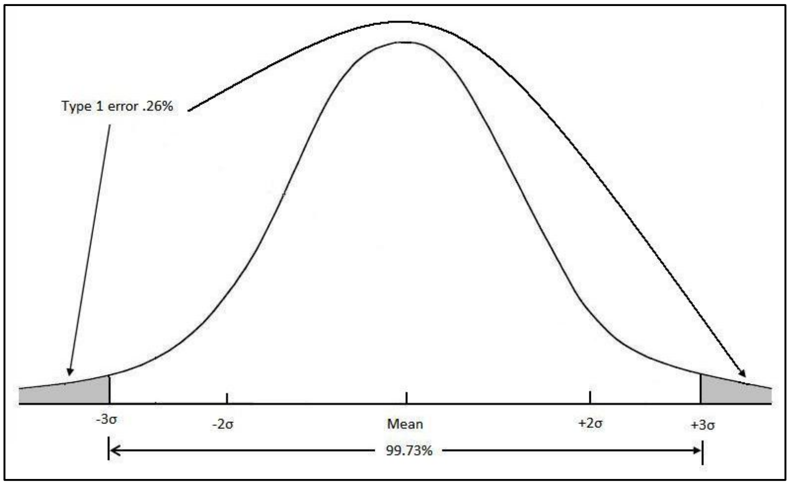

Figure 2.3: Chance of Type 1 error for ±3σ (Adapted: Chandra, 2001)

2.7.2 Pareto Diagram

The Pareto principle was named after the Italian economist who had developed certain mathematical relationships of vital few and trivial many as applied to distribution of wealth. In studying the problems, it can be generally observed that 80% of the problems result from only 20% of the potential causes. The primary purpose and use of Pareto diagrams is to focus improvement efforts on the most important causes by identifying the vital few and trivial many causes. The Pareto Chart indicates identifies problems, prioritizes them and gives in percentages of the total what each presents. Pareto diagrams are mainly applied in sales, production, maintenance, safety and finance.

2.7.3 Histogram.

A histogram is a bar graph which shows the frequency distribution of the data of a group about the central value. The histogram is an important diagnostic tool because it gives a “Birds’-eye-view” of the variation in a data set. A histogram can be used for comparisons of process distribution before and after the improvement action, comparison of different groups and relationship with specification limits.

2.7.4 Cause and Effect Diagram.

A cause and effect diagram (also known as Ishikawa diagram or fishbone diagram) in a pictorial representation of all possible causes which are supposed to influence an ‘‘effect’’ which is under consideration. For every effect there are likely to be several causes. They can be classified under men, methods, materials, machines, policies, procedures, plant etc. These categories are only suggestions. You may use any category that emerges or helps people think creatively.

2.7.5 Check Sheet

A check sheet is a data-gathering format prepared in such a way that the data collection is simplified. The check sheet preparation considers the representatives of the information to be recorded and simplifies the data that is to be actually recorded every time to a mere check work. Check sheets are simply and easy to understand form used to answer the question "how often certain events are happening?" It starts the process of translating into facts.

2.7.6 Scatter Diagram

Scatter diagram is a simple statistical tool to understand in a better way the relationship between two variables. It makes clear whether a relationship exists between two variables and the strength of that relationship.

2.8 Types of Control Charts

Control charts are one of the most commonly used tools in statistical quality control. They can be used to measure any characteristic of a product, such as the weight of a packet of flour, the number of biscuits in a box, or the volume of bottled soda. The different characteristics that can be measured by control charts can be divided into two groups: variables and attributes (Oakland, 2008, Montgomery, 2009)**.** A *control chart for variables* is used to monitor characteristics that can be measured and that have a continuous range of values, such as weight, volume or height. A bottle of Coca-Cola soda soft drink bottling operation is an example of a variable measure since the amount of liquid in the bottles is measured and can take on a number of different values that are non-discrete. On the other hand, a *control chart for attributes* is used to monitor characteristics that have discrete values and that can be counted. Often they can only be evaluated with a simple yes or no type decision. Examples include color, taste, or smell. The monitoring of attributes usually takes less time than that of variables because a variable needs to be measured. An attribute requires only a single decision, such as yes or no, good or bad, pass or fail, acceptable or unacceptable, etc. or counting the number of defects for example the number of broken biscuits in the box. Statistical quality control is used to monitor many different types of variables and attributes.

In the next section, we carry out a review of empirical literature particularly of studies conducted at Kenya Power (formerly KPLC).

2.9 Empirical Literature

The issue of service quality at Kenya Power has been studied by several people at different times using a variety of approaches. Owuor (2007) studied the differences in perception of service quality by customers and managers of the Kenya Power. The research was conducted by the collection of primary data from the customers and managers of the company using a questionnaire based on service quality attributes. The study established that the difference in perception of service quality leads to the existence of various gaps in the provision of quality service by organizations. It was found that managers, have a good idea of what customers expect in terms of service quality. However, the study established that gaps existed in service delivery as measured by customer perception of service quality and management perception of service delivery. It was also found that managers did not believe that the service delivery of KPLC met customer expectations. Similarly, customers perceived that service delivered did not meet their expectations.

Nyaoga (2003) conducted a study with the objectives of determining attributes of importance in evaluation of service quality, evaluating the customer service offered by Kenya Power and Lighting Company, and lastly, to determine whether there exist differences among the different consumer categories. A sample of 100 customers was picked and questionnaires administered to them. Data was collected and analyzed using percentages, means and standard deviations. Analysis indicated that were are many attributes that customers consider important in their evaluation of service quality. These attributes included the ability to offer dependable services, provision of prompt service, ability to solve supply problems correctly the first time, willingness to help customers, promptness in solving complaints, ability to provide services at reasonable cost and accessibility of the service provider. The study found that most respondents were dissatisfied with the service level of the Kenya Power and Lighting Company. According to them, the firm does not have a satisfying customer education program. They decried a high frequency of corrupt practices, high cost of the service, long delays before new constructions are completed after they are paid for, poor availability of staff to address customer queries, and long delays in processing new applications.

Orumi (2009) conducted a study that assessed customer perception about service quality at public organizations; a case of Kenya Power and Lighting Company. The study used the service quality framework (SERVQAL) developed by Parasuraman (1988) to conduct a survey amongst Kenya Power and Lighting Company customers. The attitudes of the customers were tested regarding pre-identified service quality aspects related to provision of electricity. The areas assessed included tangibility, reliability, responsiveness, assurance and empathy. Out of these, the study findings showed that the areas of tangibility and reliability were heavily inconsistent and inadequate. As to whether the staff handled customers with dignity and respect, the study indicated that this was negatively scored. Customers were not happy with the way they were handled because either their dignity was not respected or staff were rude.

Mutua (2010) conducted a study to determine the influence of business process re-engineering (BPR) on customer satisfaction in Kenya Power and Lighting Company Limited. Two hundred and twenty (220) KPLC customers were selected and interviewed out of which, sixty (60) belonged to Nairobi North, seventy four (74) Nairobi West and eighty six (86) Nairobi South. The sample was drawn through proportionate stratified sampling technique. Logistic regression analysis was applied and the results indicated a positive relationship between the KPLC’s products and services and respondents’ gender, level of formal education, age, account held, length of time the account has been in operation and area of residence. However, the most significant was the association between the respondents' residence and the level of satisfaction.

Njoroge (2003) conducted a study about customers’ perception of service quality in a decentralized system in the public utility sector in Kenya: the case of Kenya Power and Lighting Company. Towards this end, samples of different categories of 306 customers were picked and administered with questionnaires that had both semi-structured and Likert matrix questions. The data collected was analyzed using proportions, percentages, means, standard deviations and coefficient of variation. The study found that the received service quality is generally lower than the expected resulting in a relatively high service quality gap of about 18%.

Otiso, Chelangat and Bonuke (2012) also conducted a study on how ICT use improves the quality of customer service at Kenya Power and Lighting Company. Customers were classified into three segment i.e. large power customers who were 20, corporate customers 500 and domestic customers who were 300, totaling to 820. Probability random and stratified random sampling techniques were used to select 10 large power customers, 250 corporate customers and 150 domestic customers for the study sample size. The study used questionnaires and interviews as the research instruments. The correlation analysis indicated that perceived service quality is positively and statistically significant. This implied that as the ICT service delivery increase, so does the customer satisfaction. The study concluded that to enhance customer satisfaction, there is need to increase ICT service delivery at the Kenya Power and Lighting Company.

Ombui (2003) conducted a study which examined the contribution of information technology in business process reengineering at Kenya Power and Lighting Company. The methodology involved the use of a survey and questionnaire administration. The population consisted of selected management groups and employees in the departments of customer service and design and construction who use the various IT systems for customer care and new customer creation. The study found that the contribution of IT to BPR was a key factor in the revolution of business practices at Kenya Power. The results showed a favorable trend towards attributing better service delivery to the period after BPR as compared to before. It was generally shown that IT has significantly contributed to better billing and service quality at Kenya Power.

This review of empirical literature shows that thus far, quality of service studies have primarily been conducted by mainly looking at quality from the consumers' perspective. The major drawback in this is that no consideration is made of how the services are designed to be delivered, resulting in a tilted study. On the converse, this project considered service specification limits and to drew control charts on how they are actually delivered. A determination was made on whether service delivery is in statistical control or not. As evidenced by this review, the use of control charts in evaluating quality of service, especially in the services sector, is one that still needs much research.

2.10 Conceptual Framework

The conceptual framework shown in Figure 2.2 shows that service quality reflects itself in the eyes of the customer.

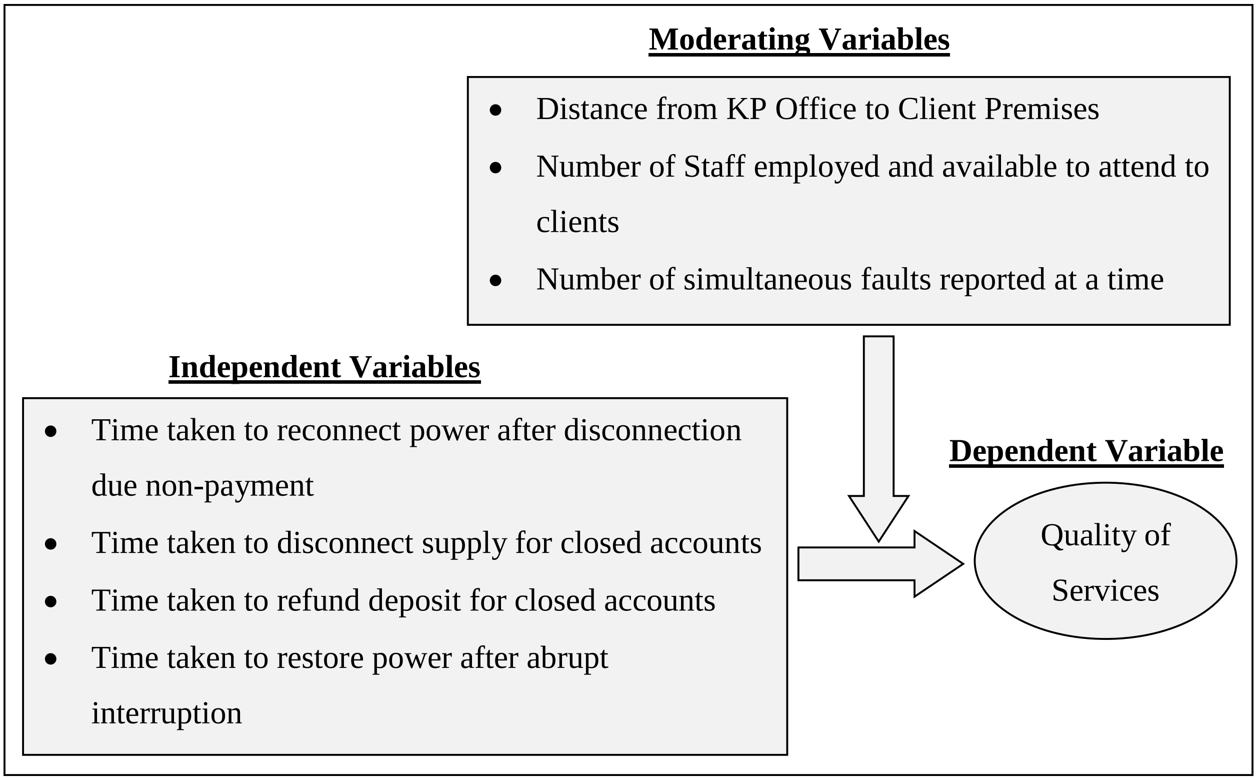

Figure 2.4: The Conceptual Framework (Source: *Researcher's Own*)

The conceptual framework above shows the relationship between the independent variables, moderating variables and the dependent variables. The independent variable are reconnection of power after disconnection due late payment, supply disconnection for closed accounts, deposit refund for closed accounts and restoration of Power after unplanned interruption. The moderating variables Distance from KP Office to Client Premises, Number of Staff employed and available to attend to clients and Number of simultaneous faults reported at a time.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Research Design

The study used survey design. Survey design was found important because it describes an existing observed phenomenon and establishes causal relationships (Kathuri & Pals, 1993). Apart from being an excellent way of gathering large quantitative data, surveys are also an efficient way of getting an insight into people's thoughts, opinions and experiences (Radhakrishna, 2007).

3.2 Target Population and Study Area

The target population consisted of electricity consumers within Nakuru Town and its environs who hold domestic and non-domestic accounts for the duration of the study. As of August 2013, the total number of such accounts was 65,830 (Source: Kenya Power Database) distributed as follows.

Table 3.1: Distribution of consumer accounts by type in Nakuru Town Area

Types of Account	Total Number
Domestic Consumers	47,149
Non-domestic Consumers	18,681
Total	**65,830**

(Source: Kenya Power Database, August 2013)

3.3 Sampling Design

Stratified sampling was used. For the purpose of the study, domestic and non-domestic consumers living in and around Nakuru County were used in the study. Stratified sampling was used to obtain samples from each of the two categories of users as shown in Table 3.1. The following formula discovered by Krejcie & Morgan (1970) was used to calculate the sample size.

$$\text{Sample Size} = \frac{(\text{Z.Score})^2 \times \text{StdDev} \times (1 - \text{StdDev})}{(\text{margin of error})^2}$$

The Z-Score and the confidence interval were selected as 1.96 and ± 5% respectively. A Z-Score of 1.96 corresponds to a confidence level of 95%. The standard deviation is difficult to determine before the study is conducted but a safe choice of 0.5 is made for the sake of moving the study forward (Kothari, 2004). With this, the sample size was obtained to be 384.16, but was rounded up to the nearest hundreds, i.e. 400. The distribution of this sample across each stratum as follows.

Table 3.2: Stratification of Sample Population

Types of Account	Total Number	Percentage (%)	Sample
Domestic Consumers	47,149	71.6	286
Non-domestic Consumers	18,681	28.4	114
Total	**65,830**	**100**	**400**

(Source: Kenya Power Database, August 2013)

Accordingly, the sample sizes for the domestic and non-domestic consumers were 286 and 114 respectively.

3.4 Data Collection

This study utilized both primary and secondary data. Primary data was captured by way of questionnaires consisting of closed-ended questions. It was tested for reliability and validity using the translation validity method. With this, a test was done for both face and content validity. The questionnaire was then piloted on about 10% (40) of the target respondents. Of these, 29 were domestic consumers and the rest (11) non-domestic. The feedback was used to correct the questionnaire, which was subsequently administered to the envisaged sample. The questionnaires were hand delivered to houses of the electricity consumer and collected afterwards after they were filled up.

Secondary data was collected from existing data to support the primary data. Specifically, the procedure of developing control charts, tables of constants and formulas used were obtained in this manner.

3.5 Data Analysis

In order to facilitate data analysis the filled up questionnaires were checked for completeness, consistency and clarity. The responses were coded by assigning numerical values to each. This made them quantitative for ease of capture by the computer. The coded data was summarized in forms of tables and entered into the SPSS program. The demographic profile of the respondents was analyzed using frequency tables and graphs. Samples of five respondents in each category were randomly clustered. The mean value and range for each cluster was calculated and used to draw control charts. The charts were drawn using SPSS version 20. Specifically Range (R) and

Mean ($\bar{X}$) charts were drawn. The Range (R) and Mean ($\bar{X}$) charts were selected because they have the ability to tell apart variation due to assignable causes from random causes of variation. In addition to identifying of out-of-control processes, control charts can be used to identify trends and reduce overall system variability.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents findings of the study that was conducted to assess of the quality of services of Kenya Power using statistical quality control. The study was carried out in Nakuru town and its environs. A stratified sample of 400 was selected. Of these, 286 were domestic consumers and 114 were non-domestic consumers. Questionnaires were randomly issued and responses obtained.

Information on the demographic distribution of the respondents and an analysis of the various variables of interest have been included. Control charts used in the assessment of the customer's experience of quality service provision have also been included. The objectives of this study were to assess whether or not the four services provided by Kenya Power were in statistical control. These were restoration of supply after settlement of unpaid dues, disconnection of supply for closed accounts, refund of deposit for closed accounts and restoration of supply after unplanned interruptions.

Both Range (R) Charts and Mean charts ($\overline{X}$-bar chart) were used for each quality attribute. The mean ($\overline{X}$-bar) chart showed the variation in a process by plotting the actual mean values of a set of sample data. Each set of sample data consisted of multiple observations of the process that is under assessment. The data was plotted against the background of the mean of all the samples taken and the upper and lower control limits for the data. These limiting bounds are each three-sigma limits, meaning that almost all (99.73%) of the variation in the process is expected to fall within a six-sigma limit. Sigma, represented by the Greek symbol σ, is the standard deviation of a distribution. The range chart (R-chart) is similar to the mean chart in having upper and lower (three-sigma) control limits, but the data plotted for each sample is now the range between the largest and the smallest value in the sample. By plotting the range of values, variation within each sample is more apparent. Signals from a mean chart or range chart to detect processes that are out of control was done by identifying outliers, shifts, trends, or cycles (Oakland, 2008, Montgomery, 2009).

An outlier is any data point that is above the Upper Control Limit (UCL) or below the Low Control Limit (LCL) i.e. any point that is beyond $\pm 3\sigma$. Because the control limits are calculated from the probability theory, an outlier is highly unlikely in a process with only common cause variation.

A shift is when a process generates nine points in a row on the same side of the centerline. While this may be possible, it is highly unlikely. A shift indicates a shift in the mean. This is a strong indicator that the process has changed and warrants investigation.

A trend is defined as six consecutive points, each higher than the previous point or six consecutive points, each lower than the previous point. It indicates a special cause with a gradual effect.

Fourteen consecutive points that alternate up and down signal repeating patterns, also called cycles (Oakland, 2008, Montgomery, 2009). This pattern signals cyclical change in the process that is repetitive and certainly warranting investigation.

4.1 Response Rate

A total of four hundred (400) questionnaires were issued. Four hundred responses were obtained. Table 4.1 shows the findings.

Table 4.1: Response Rate of the Study

Distributed	Received	Response Rate
400	400	100 %

(Source: Research Data)

From the above table, a response rate of one hundred percent (100%) was achieved. This due to the fact that the questionnaires delivered and collected by hand. This implies that all questionnaires that were issued were subsequently collected. Additionally, all spoilt questionnaires, for example those that were completed by individuals coming from outside Nakuru county, were replaced. These measures guaranteed this high response rate.

Krejcie & Morgan (1970) determined that for a population of between 500,000 to 1,000,000 a minimum sample of three hundred and eighty four (384) is sufficiently representative. This means that the sample size of four hundred (400) is representative enough given that the population is about 65,830 as shown in table 3.1.

4.2 Demographic Information on the Respondents

The first item on demographics information sought was on the gender distribution of the respondents. This demographic analysis is only relevant for consumers who hold domestic accounts since non-domestic consumers are non-human entities and as such have no gender. The respondents' responses are presented in Table 4.2.

Table 4.2: Distribution of respondents by gender

Gender	Frequency	Percent
Male	170	59.4
Female	116	40.5
Total	**286**	**100.0**

(Source: Research Data)

The study found out that most of the domestic customers of Kenya Power in Nakuru and its environs were men at 59.4% while women were about 40.5%.

4.3 Distribution of Sampled Consumers in and around Nakuru

The respondents were asked to indicate in which ward of Nakuru County, their electricity was installed. The analysis was done first for domestic consumers and then for non-domestic consumers. Table 4.3 shows how the sampled domestic consumers are distributed across the wards of Nakuru County.

Table 4.3 shows that a majority or 20.6% of the sampled domestic consumers reside in Njoro. This was followed by Nakuru East at 10.1%. Kihingo and Lanet wards, which tied at 9.4%, came in third.

Table 4.3: Geographic distribution of sampled domestic consumers

Ward	Frequency	Percent
Bahati	11	3.8
Dundori	0	0.7
Elburgon	5	1.7
Flamingo	1	0.3
Kabatini	26	9.1
Kaptembwo	2	0.7
Kihingo	27	9.4
Lanet/Umoja	27	9.4
London	9	3.1
Mau Narok	5	1.7
Mauche	12	4.2
Menengai	7	2.4
Menengai West	21	7.3
Molo	4	0.3
Nakuru East	29	10.1
Njoro	59	20.6
Rhoda	9	3.1
Shabaab	23	8.0
Turi	8	2.8
Maili Sita	1	0.3
Free Area	1	0.3
Total	**286**	**100.0**

(Source: Research Data)

Table 4.4 shows how the sampled non-domestic consumers who were sampled were distributed across the wards of Nakuru County.

Table 4.4: Geographic distribution of sampled non-domestic consumers

Ward	Frequency	Percent
Bahati	2	1.8
Biashara	22	19.3
Flamingo	2	1.8
Kabazi	7	6.1
Kapkures	2	1.8
Kaptembwo	2	1.8
Kihingo	6	5.3
Lanet/Umoja	5	4.4
Lare	2	1.8
Mau Narok	2	1.8
Mauche	1	0.9
Menengai	2	1.8
Menengai West	2	1.8
Nakuru East	5	4.4
Nesuit	2	1.8
Njoro	40	35.1
Rhoda	1	0.9
Shabaab	1	0.9
Subukia	4	3.5
Turi	1	0.9
Waseges	1	0.9
Free Area	1	0.9
Mukungugu	1	0.9
Total	**114**	**100**

(Source: Research Data)

Table 4.4 shows that 35.1% of the sampled non-domestic consumers were located in Njoro. This was followed by Biashara and Kabazi wards with 19.3% and 6.1% respectively.

4.4 Duration of Operating the Electricity Account

The respondents were also asked to indicate for how long they had operated an account with Kenya Power. The analysis was done first for domestic consumers and then for non-domestic consumers. Table 4.5 shows the results for the sampled domestic consumers.

Table 4.5: Duration of Operating the Electricity Account in domestic consumers

	Frequency	Percent
Less than 1 year	29	10.14
1 - 4 years	78	27.27
5 - 10 years	87	30.42
11 - 15 years	51	17.83
16 - 20 years	27	9.44
Over 20 years	14	4.90
Total	**286**	**100.0**

(Source: Research Data)

Table 4.5 shows that a majority of domestic consumers or 30.2% have operated their accounts for between 5 to 10 years.

Table 4.6: Duration of Operating the Electricity Account in non-domestic consumers

	Frequency	Percent
Less than 1 year	21	18.1
1 - 4 years	45	38.8
5 - 10 years	42	36.2
11 - 15 years	7	6.0
Over 20 years	1	0.9
Total	**116**	**100.0**

(Source: Research Data)

Table 4.6 shows for how long the sampled non-domestic consumers have operated their electricity accounts. It shows that a majority of non-domestic consumers (38.8%) have operated their accounts for between 4 to 5 years. This could also correspond with the number of years these business entities have been in existence. It also shows that 36.2% of the sampled non-domestic consumers have operated their accounts for between 5 to 10 years.

4.5 Disconnection for late settlement of outstanding bills

The respondents were asked to indicate if their accounts have ever been disconnected for late settlement of outstanding bills. The analysis was done first for domestic consumers and then for non-domestic consumers. The responses are presented in Table 4.7.

Table 4.7: Disconnection for late settlement of outstanding bills in domestic consumers

	Frequency	Percent
Yes	193	56.7
No	148	43.4
Total	**341**	**100.0**

(Source: Research Data)

The responses show that 56.6% of domestic consumers have had their accounts disconnected for late payment of outstanding bills. This means that only 43.3% of the domestic customers pay their electricity bills on time. The responses for non-domestic consumers are presented in Table 4.8.

Table 4.8: Disconnection for late settlement of outstanding bills in non-domestic consumers

	Frequency	Percent
Yes	46	39.7
No	70	60.3
Total	**116**	**100.0**

(Source: Research Data)

Table 4.9: Sub-grouping of the responses in domestic consumers

	Observations								Mean	Range
Cluster 1	45	45	7	14	45	7	4	7	21.8	41
Cluster 2	45	7	45	4	7	14	14	45	22.6	41
Cluster 3	7	45	45	14	14	14	7	45	23.9	38
Cluster 4	45	4	14	45	45	4	14	7	22.3	41
Cluster 5	45	7	7	14	45	14	4	45	22.6	41
Cluster 6	14	7	45	7	14	45	14	7	19.1	38
Cluster 7	45	45	14	45	45	7	4	7	26.5	41
Cluster 8	4	45	7	14	45	45	14	7	22.6	41
Cluster 9	45	45	14	90	7	14	4	45	33.0	86
Cluster 10	14	4	4	7	4	14	14	7	8.5	10
Cluster 11	45	45	45	14	7	14	45	45	32.5	38
Cluster 12	45	4	14	45	90	7	4	4	26.6	86
Cluster 13	14	4	45	7	4	4	7	90	21.9	86
Cluster 14	7	4	7	4	7	7	14	45	11.9	41
Cluster 15	45	7	4	90	45	90	45	45	46.4	86
Cluster 16	7	4	4	14	45	4	90	7	21.9	86
Cluster 17	14	14	45	4	4	14	45	7	18.4	41
Cluster 18	90	45	7	45	7	45	4	4	30.9	86
Cluster 19	90	7	90	90	45	4	45	45	52.0	86
Cluster 20	45	14	14	14	7	14	7	7	15.3	38
Cluster 21	4	14	7	7	7	7	4	14	8.0	10
Cluster 22	45	14	14	45	45	7	45	14	28.6	38
Cluster 23	4	7	14	45	45	7	7	45	21.8	41
Average									**24.30**	**51.35**

(Source: Research Data)

4.6 Restoration of supply after payment of outstanding dues

The respondents were asked to indicate how long after settling outstanding bills was power restored to them. Analysis was done for each category of consumers that is domestic and non-domestic. The results are presented in the subsequent sub-sections.

4.6.1 Restoration of supply after payment of outstanding dues: domestic consumers

In order to study the sample variability in domestic consumers, the data was randomly clustered into sets of eight as shown in Table 4.9.

The mean of means was calculated to be 24.3 and the mean range was 51.35. The R chart shown in Figure 4.1 was subsequently drawn.

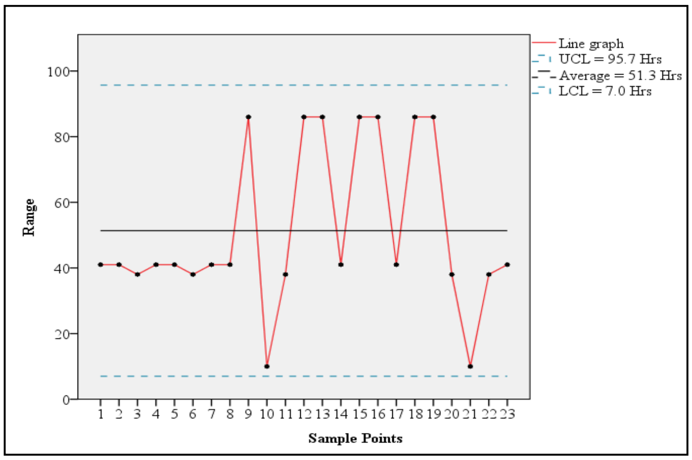

Figure 4.1: R Chart on Restoration of supply (domestic)

The Range Chart showed that there were no outliers, trends or cycles. However it can be seen that curve almost form a shift at its' beginning since eight points are all below the center line. The within-sample variability was constant. The mean chart shown in Figure 4.2 was also drawn. It showed that the process is not under statistical control since samples 15 and 19 are outliers.

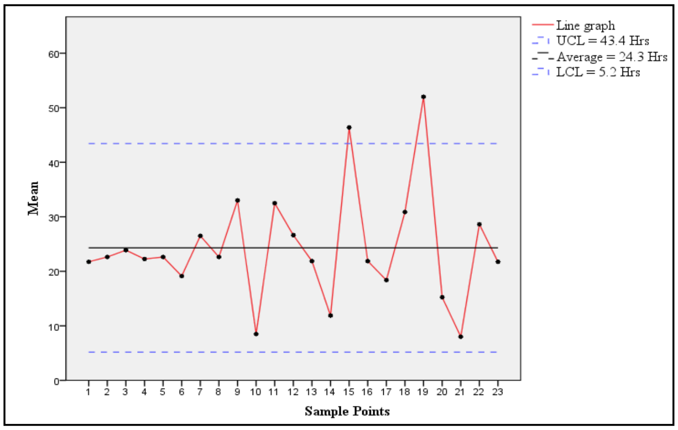

Figure 4.2: Chart on the restoration of supply (domestic)

Table 4.10: Sub-grouping of the responses in non-domestic consumers

	Observations			Mean	Range
Cluster 1	14	45	14	24.3	31
Cluster 2	14	45	45	34.7	31
Cluster 3	7	4	14	8.3	10
Cluster 4	45	14	14	24.3	31
Cluster 5	4	7	7	6.0	3
Cluster 6	7	45	7	19.7	38
Cluster 7	7	7	7	7.0	0
Cluster 8	45	14	4	21.0	41
Cluster 9	45	7	45	32.3	38
Cluster 10	7	7	14	9.3	7
Cluster 11	4	7	14	8.3	10
Cluster 12	7	7	4	6.0	3
Cluster 13	4	4	4	4.0	0
Cluster 14	45	14	4	21.0	41
Cluster 15	4	7	4	5.0	3
Average				**15.42**	**19.13**

(Source: Research Data)

4.6.2 Restoration of supply after payment of outstanding dues: non-domestic consumers

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of three as shown in Table 4.10.

The mean of means was calculated to be 15.42 and the mean range was 19.13. The Range Chart shown in Figure 4.3 was subsequently drawn.

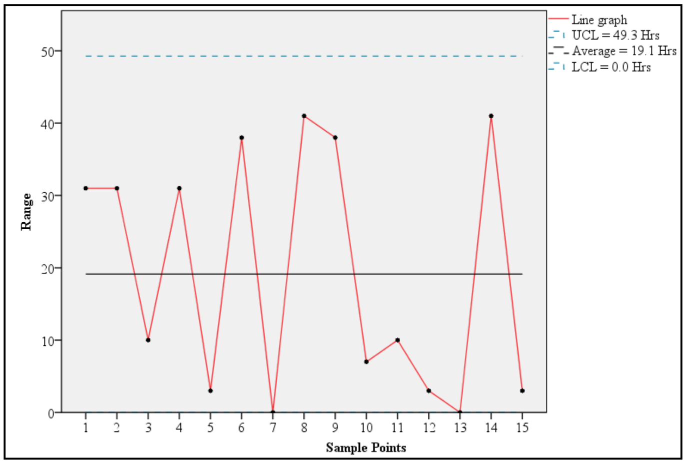

Figure 4.3: R Chart on restoration of supply (non-domestic)

The Range Chart shows that there are no outliers, shifts, trends or cycles. Thus, the sample variability is in control. The Mean chart was subsequently drawn as shown in Figure 4.4.

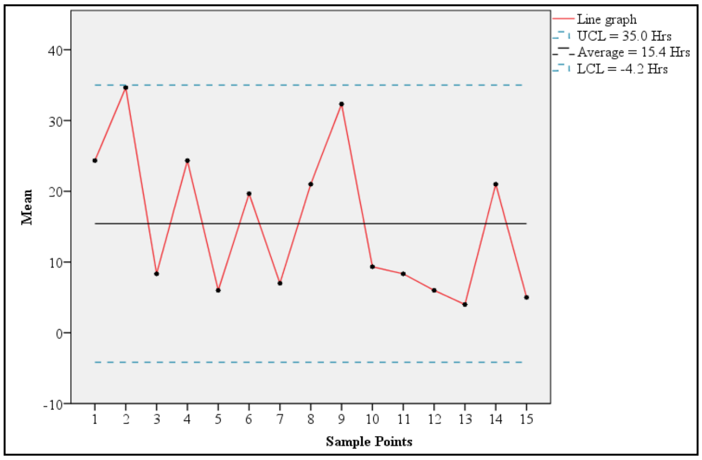

Figure 4.4: $\overline{X}$ Chart on the restoration of supply (non-domestic)

The mean chart shows that there are no outliers, shifts, trends or cycles. Thus, this quality attribute is in statistical control.

A process capability analysis was further carried out. The following formula was used.

$$\text{Process capability index, } C_{pk} = \frac{(UCL - LCL)}{6\sigma} = \frac{(24 - 0.0)}{6 \times 11.28} = 0.3546$$

The standard deviation, σ was estimated from the mean range using the formula

$$\text{Standard deviation, } \sigma = \frac{\text{Mean Range}}{d_2} = \frac{19.1}{1.69} = 11.28$$

Since the process capability analysis (C_p), was calculated to be less than one, it was therefore concluded that this process does not have the ability to meet the design specifications or customer tolerance limits.

4.7 Disconnection of supply after termination of supply agreement

The respondents were asked to indicate how long, after the termination of the supply agreement was power disconnected from the premises. Analysis was done for each category of consumers, that is domestic and non-domestic. The results are presented in succeeding sub-sections.

4.7.1 Disconnection of supply after termination of supply agreement: domestic consumers

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of four as shown in Table 4.11.

Table 4.11: Sub-grouping of the responses in domestic consumers

	Observations				Mean	Range
Cluster 1	10	10	10	10	10.0	0
Cluster 2	45	10	10	10	18.8	35
Cluster 3	10	5	5	45	16.3	40
Cluster 4	10	5	10	45	17.5	40
Cluster 5	45	1	1	1	12.0	44
Cluster 6	45	1	5	10	15.3	44
Cluster 7	5	5	90	90	47.5	85
Cluster 8	5	45	1	90	35.3	89
Cluster 9	45	90	5	10	37.5	85
Cluster 10	90	45	90	10	58.8	80
Cluster 11	10	5	90	10	28.8	85
Cluster 12	45	1	5	5	14.0	44
Average					**25.96**	**55.92**

(Source: Research Data)

The mean of means was calculated to be 25.96 and the mean range was 55.92. The Range chart shown in Figure 4.5 was subsequently drawn.

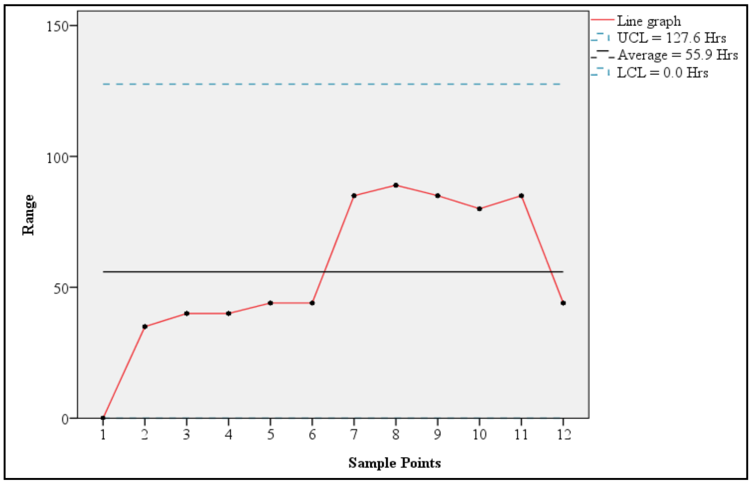

Figure 4.5: Range Chart on supply disconnection (domestic)

The Range chart showed that there were no outliers, shifts, trends or cycles. The sample variability exhibited no variation that could be attributed to special causes. The mean ($\bar{X}$) chart shown in Figure 4.6 was also drawn.

It showed that there were no outliers, shifts, trends or cycles. Thus, this particular attribute is in statistical control because both the range and mean charts suggest that the process is in control.

A process capability analysis was then carried out as shown below.

$$\text{Process capability index, } C_{pk} = \frac{(UCL - LCL)}{6\sigma} = \frac{(24 - 0.0)}{6 \times 14.45} = 0.2768$$

The standard deviation, σ was estimated from the mean range using the formula

$$\text{Standard deviation, } \sigma = \frac{\text{Mean Range}}{d_2} = \frac{29.75}{2.059} = 14.45$$

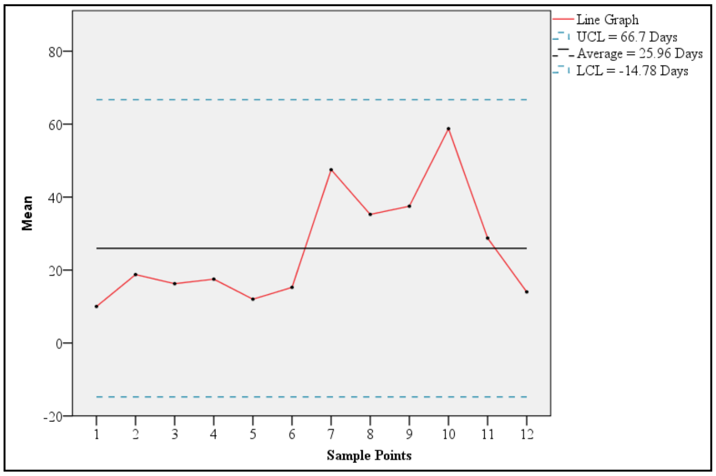

Figure 4.6: $\overline{X}$ Chart on the supply disconnection (domestic)

Since the process capability analysis (C_p), was calculated to be less than one, it was therefore concluded that this process does not have the ability to meet the design specifications or customer tolerance limits.

4.7.2 Disconnection of supply after termination of supply agreement: non-domestic users

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of three as shown in Table 4.12.

Table 4.12: Sub-grouping of the responses in domestic consumers

	Observations			Mean	Range
Cluster 1	1	10	45	18.7	44
Cluster 2	10	90	5	35.0	85
Cluster 3	10	45	1	18.7	44
Cluster 4	5	5	5	5.0	0
Cluster 5	5	1	45	17.0	44
Cluster 6	90	5	10	35.0	85
Average				**21.6**	**50.3**

The responses showed that very few non-domestic consumers have had the opportunity to apply for termination of the supply agreement. This could be explained by the fact that very few businesses find the need to relocate after they are established. The mean of means was calculated to be 21.6 and the mean range was 50.3. The Range chart shown in Figure 4.7 was drawn.

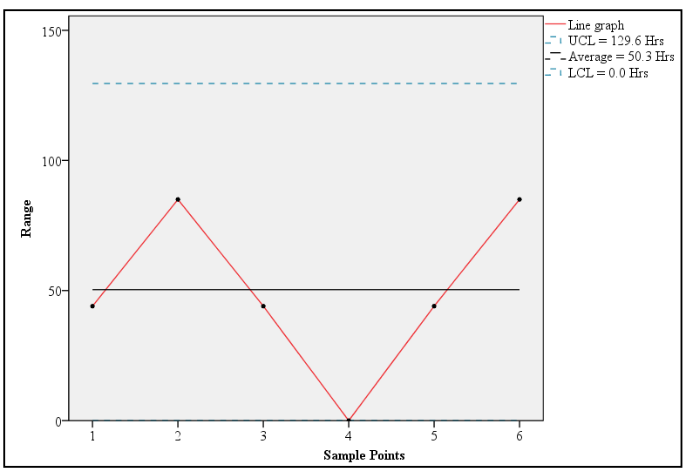

Figure 4.7: Range Chart on Supply disconnection (non-domestic)

It showed that there were no outliers, shifts, trends or cycles. Thus, the sample variability is in control. The mean chart, shown in Figure 4.8, was subsequently drawn.

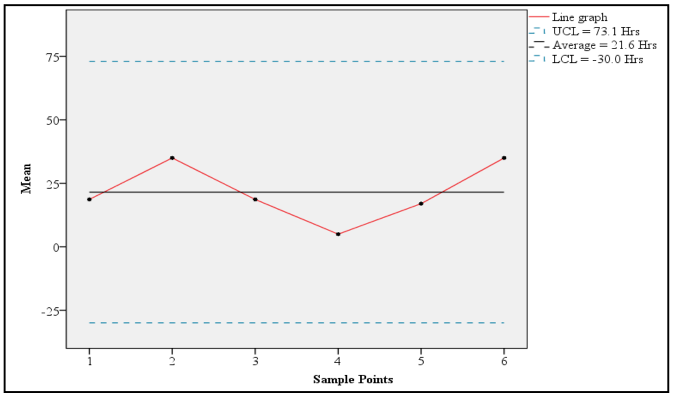

Figure 4.8: $\bar{X}$ Chart on Supply disconnection (non-domestic)

It showed that there were no outliers, shifts, trends or cycles. Thus, this particular attributed is in statistical control.

A process capability analysis was then carried out. It was calculated as follows.

$$\text{Process capability index, } C_{pk} = \frac{(UCL - LCL)}{6\sigma} = \frac{(24 - 0.0)}{6 \times 29.71} = 0.1346$$

The standard deviation, σ was estimated from the mean range using the formula

$$\text{Standard deviation, } \sigma = \frac{\text{Mean Range}}{d_2} = \frac{50.3}{1.69} = 29.71$$

Since C_p has been calculated to be less than one, it was concluded that this process does not have the ability to meet the design specifications.

4.8 Processing of deposit refund after termination of supply agreement

The respondents were asked to indicate how long, after termination of the supply agreement, was a refund of deposit done. An analysis was done for each category of consumers that is domestic and non-domestic. The results are presented in succeeding sub-sections.

4.8.1 Processing of deposit refund: domestic consumers

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of four as shown in Table 4.13.

Table 4.13: Sub-grouping of the responses in domestic consumers

	Observations				$\bar{X}$	Range
Cluster 1	10	5	5	10	7.5	5
Cluster 2	45	5	10	1	15.25	44
Cluster 3	10	1	5	10	6.5	9
Cluster 4	5	5	10	10	7.5	5
Cluster 5	10	1	1	45	14.25	44
Cluster 6	45	5	1	1	13	44
Cluster 7	1	5	30	30	16.5	29
Cluster 8	1	5	45	1	13	44
Cluster 9	10	5	5	1	5.25	9
Cluster 10	5	45	5	5	15	40
Cluster 11	1	10	10	45	16.5	44
Cluster 12	5	5	45	5	15	40
Average					**12.10**	**29.75**

(Source: Research Data)

The mean of means was calculated to be 12.10 and the mean range was 29.75. The Range chart shown in Figure 4.9 was subsequently drawn.

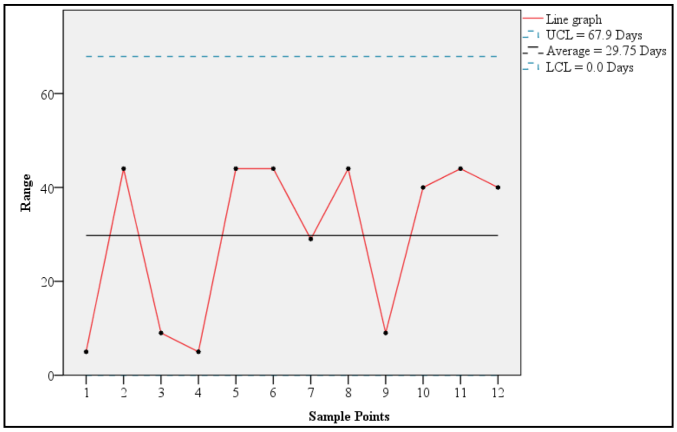

Figure 4.9: R Chart on Deposit refund (domestic)

The Range Chart showed that there were no outliers, shifts, trends or cycles. The sample variability exhibited no variation that could be attributed to special causes. The mean ($\bar{X}$) chart shown in Figure 4.10 was also drawn.

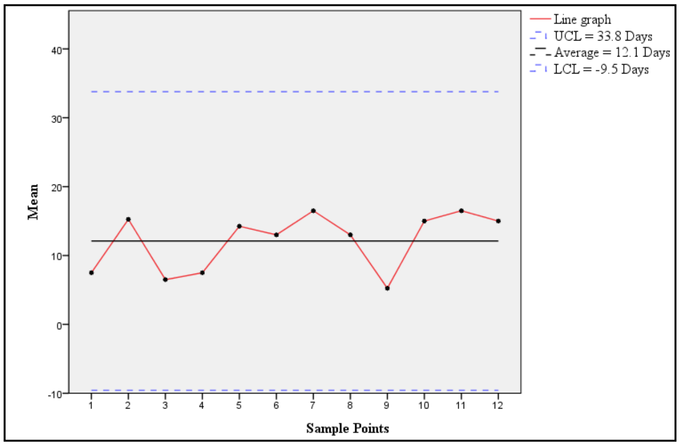

Figure 4.10: Mean Chart on Deposit refund (domestic)

It showed that there were no outliers, shifts, trends or cycles. Thus, this particular attributed is in statistical control. A process capability analysis was then undertaken as below.

$$\text{Process capability index, } C_{pk} = \frac{(UCL - LCL)}{6\sigma} = \frac{(14 - 0.0)}{6 \times 14.47} = 0.1613$$

The standard deviation, σ was estimated from the mean range using the formula

$$\text{Standard deviation, } \sigma = \frac{\text{Mean Range}}{d_2} = \frac{29.8}{2.06} = 14.47$$

Since C_p has been calculated to be less than one. It is therefore concluded that this process does not have the ability to meet the design specifications.

4.8.2 Processing of deposit refund: non-domestic consumers

Since it was found that very few non-domestic consumers had the opportunity to apply for disconnections, it followed that very few have also had to process a refund of deposit. The explanation given earlier can also explain this state and that is that businesses rarely relocate once established. What is more common for business entities is the opening of new branches.

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of three as shown in Table 4.14.

Table 4.14: Sub-grouping of the responses in non-domestic consumers

	Observations			Mean	Range
Cluster 1	5	30	45	26.7	40
Cluster 2	5	30	10	15.0	25
Cluster 3	45	5	1	17.0	44
Cluster 4	1	5	5	3.7	4
Cluster 5	1	45	10	18.7	44
Cluster 6	45	5	10	20.0	40
Average				**16.83**	**32.83**

(Source: Research Data)

The mean of means was calculated to be 16.83 and the mean range was 32.83. The Range chart shown in Figure 4.11 was drawn.

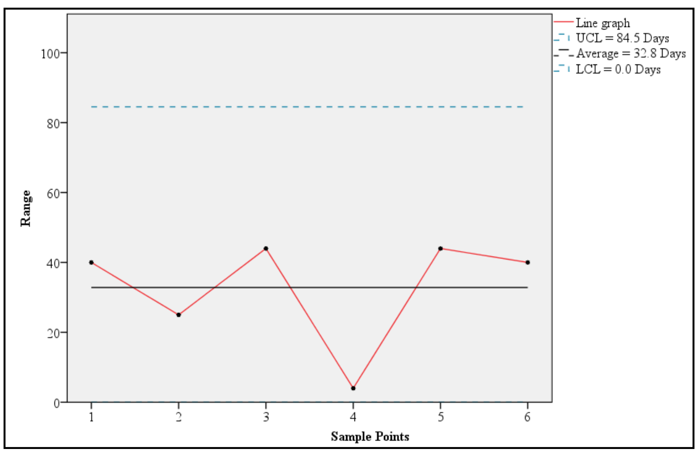

Figure 4.11: Range Chart on deposit refund (non-domestic)

The R chart showed that there were no outliers, shifts, trends or cycles. The sample variability exhibited no variation that could be attributed to special causes.

The Mean chart shown in Figure 4.12 was also drawn.

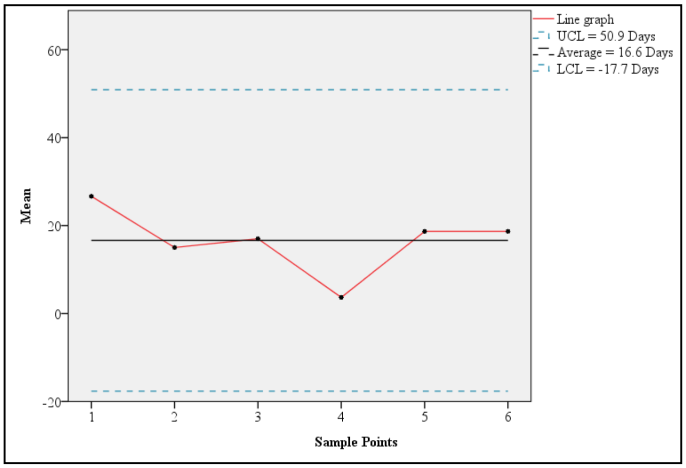

Figure 4.12: Mean Chart on Deposit refund (non-domestic)

It showed that there were no outliers, shifts, trends or cycles. Thus, this particular attributed is in statistical control. A process capability analysis was subsequently carried out as follows.

$$\text{Process capability index, } C_{pk} = \frac{(UCL - LCL)}{6\sigma} = \frac{(14 - 0.0)}{6 \times 19.37} = 0.1205$$

The standard deviation, σ was estimated from the mean range using the formula

$$\text{Standard deviation, } \sigma = \frac{\text{Mean Range}}{d_2} = \frac{32.8}{1.69} = 19.37$$

Since C_p has been calculated to be less than one, it was therefore concluded that this process does not have the ability to meet the design specifications or customers tolerance limits.

4.9 Action taken during unplanned power interruption

The respondents were asked to indicate what action, if any, they take when an unplanned power outage occurred. An analysis was done for each category of consumers that is domestic and non-domestic.

4.9.1 Action taken during unplanned power interruption: domestic consumers

The responses for domestic consumers are shown in Table 4.15. The table showed that as many as 62% of domestic consumers take no action during an unplanned power interruption. Only 36.8% call Kenya Power. About 1.1% call a local electrician to look up the problem.

Table 4.15: Action taken by domestic consumers in event of unplanned interruption

	Frequency	Percent
Report to Kenya Power	98	36.8
Do nothing	165	62.0
Call a local electrician	3	1.1
Total	**266**	**100.0**

(Source: Research Data)

4.9.1 Action taken during unplanned power interruption: non-domestic consumers

The responses for non-domestic consumers are shown in Table 4.16.

Table 4.16: Action taken by non-domestic consumers in event of unplanned interruption

	Frequency	Percent
Report to Kenya Power	43	52.4
Do nothing	37	45.1
Call a local electrician	2	2.4
Total	**82**	**100.0**

(Source: Research Data)

The table showed that as many as 52% of domestic consumers inform Kenya Power company during unplanned power interruption. About 45.1% take no action and simply wait for supply to resume. 2.4% of the respondents call a local electrician to look up the problem.

These results indicates that non-domestic consumers are more averse to unplanned power outages than domestic consumers are. This is because 52.4% of non-domestic consumers report power outages as compared to only 36.8% of domestic consumers. This may be due to the fact that for business installations, electricity supply may be critical in their production processes. A majority of domestic consumers, about 62% simply do nothing when a black out occurs.

4.10 Causes of an unplanned power interruption

The respondents were asked to indicate whether they get to know the causes of unplanned power outages when they occurred. An analysis was done for each category of consumers that is domestic and non-domestic. The results are presented in succeeding sub-sections.

4.10.1 Causes of an unplanned power interruption: domestic users

The responses for domestic consumers are shown in Table 4.17.

Table 4.17: Causes of unplanned Power interruptions as reported by domestic consumers

Cause	Frequency	Percent
System/transformer malfunction	82	30.8
Fallen tree	37	13.9
Vandalism	12	4.5
Trees falling on lines	25	9.4
Don't know	110	41.4
Total	**266**	**100.0**

(Source: Research Data)

The respondents reported that 30.6% of supply interruptions are caused by transformer malfunction followed by fallen trees at 13.9%. About 41.1% of the respondents who reported a supply interruption were not told the cause and therefore did not know.

4.10.2 Causes of an unplanned power interruption: non-domestic users

The responses for non-domestic consumers are shown in Table 4.18.

Table 4.18: Causes of unplanned Power interruptions reported by non-domestic consumers

	Frequency	Percent
System/transformer malfunction	21	25.6
Fallen tree	10	12.2
Vandalism	7	8.5
Trees falling on lines	7	8.5
Don't know	37	45.1
Total	**82**	**100.0**

(Source: Research Data)

The respondents reported that 25.6% of supply interruptions are caused by transformer malfunction followed by fallen trees at 12.2%. About 45.1% of the respondents who reported a supply interruption were not told the cause.

4.11 Time taken to restore supply after an unplanned power interruption

The respondents were also asked to indicate how much time Kenya Power typically takes to restore supply after an unplanned power interruption. An analysis was done for each category of consumers that is domestic and non-domestic. The results are presented in succeeding sub-sections.

4.11.1 Restoration of supply after unplanned interruptions: domestic users

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of eight as shown in Table 4.19.

Table 4.19: Sub-grouping of the responses in domestic consumers

	Observations								Mean	Range
Cluster 1	5	9	3	9	9	9	11	5	7.5	8
Cluster 2	3	5	3	5	5	7	3	11	5.3	8
Cluster 3	3	9	5	5	11	9	9	9	7.5	8
Cluster 4	11	3	11	11	11	5	11	5	8.5	8
Cluster 5	3	9	11	11	5	11	11	7	8.5	8
Cluster 6	9	11	7	7	7	11	11	9	9.0	4
Cluster 7	9	11	5	3	5	9	7	3	6.5	8
Cluster 8	11	5	11	9	11	5	9	11	9.0	6
Cluster 9	3	11	1	7	11	5	11	11	7.5	10
Cluster 10	11	5	9	11	5	5	5	7	7.3	6
Cluster 11	3	3	7	9	5	11	9	11	7.3	8
Cluster 12	9	3	3	11	11	5	9	5	7.0	8
Cluster 13	11	7	11	7	3	11	11	5	8.3	8
Cluster 14	1	3	11	9	3	3	7	3	5.0	10
Cluster 15	11	11	11	9	5	7	11	11	9.5	6
Cluster 16	9	1	3	3	9	11	3	11	6.3	10
Cluster 17	3	9	50	30	11	5	11	11	16.3	47
Cluster 18	11	7	50	50	3	5	5	30	20.1	47
Cluster 19	3	7	5	3	7	9	5	7	5.8	6
Cluster 20	7	5	11	1	50	11	5	11	12.6	49

Cluster 21	7	5	3	7	5	7	50	1	10.6	49
Cluster 22	7	5	30	7	11	1	11	30	12.8	29
Cluster 23	5	30	30	1	3	30	9	5	14.1	29
Cluster 24	30	9	11	11	50	50	50	3	26.8	47
Cluster 25	11	5	5	30	1	5	30	11	12.3	29
Cluster 26	9	1	11	3	11	11	11	7	8.0	10
Cluster 27	11	11	11	7	3	5	5	3	7.0	8
Cluster 28	11	7	7	11	9	7	7	9	8.5	4
Cluster 29	1	3	3	11	11	11	9	11	7.5	10
Cluster 30	11	11	11	7	11	11	3	9	9.3	8
Cluster 31	5	5	7	9	11	11	3	5	7.0	8
Average									**9.62**	**16.26**

(Source: Research Data)

The mean of means was calculated to be 9.62 and the mean range was 16.26. The Range chart shown in Figure 4.13 was subsequently drawn.

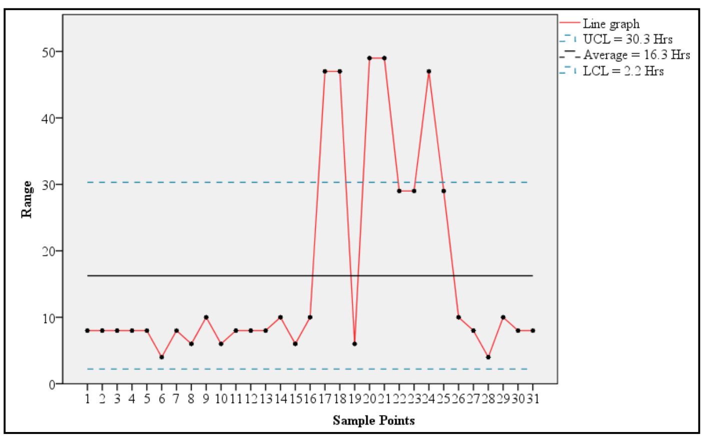

Figure 4.13: Range Chart on Restoration of supply after unplanned interruptions (domestic)

The Range Chart showed that not only are the first 16 sample points on one side of the mean but samples 16, 17, 20, 21 and 24 are outliers. The within-sample variability was not constant. Thus the range chart indicates that the process is not in statistical control. The Mean ($\bar{X}$) chart was then drawn as shown in Figure 4.14.

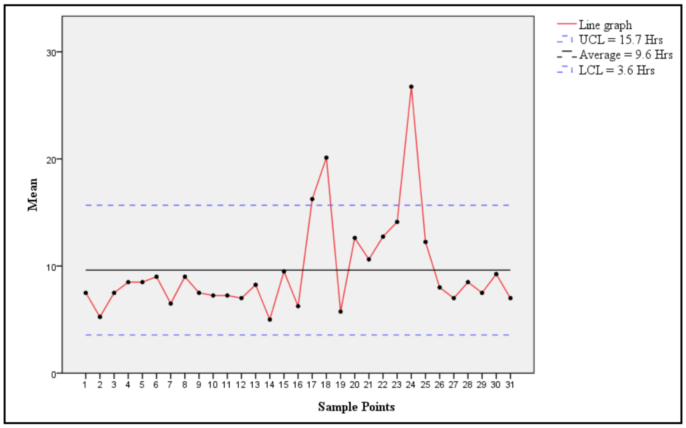

Figure 4.14: Mean Chart on Restoration of supply after unplanned interruptions (domestic)

It can be seen that the first sixteen consecutive sample points are all below the centerline. This is a clear indication that the process is not in statistical control. In addition, samples 18 and 24 are outliers. As with the Range chart we conclude that the process is not in statistical control.

4.11.2 Restoration of supply after unplanned interruptions: non-domestic users

In order to study the sample variability in non-domestic consumers, the data was randomly clustered into sets of three as shown in Table 4.20.

The mean of means was calculated to be 10.52 and the mean range was 10.91. The Range chart shown in Figure 4.15 was subsequently drawn.

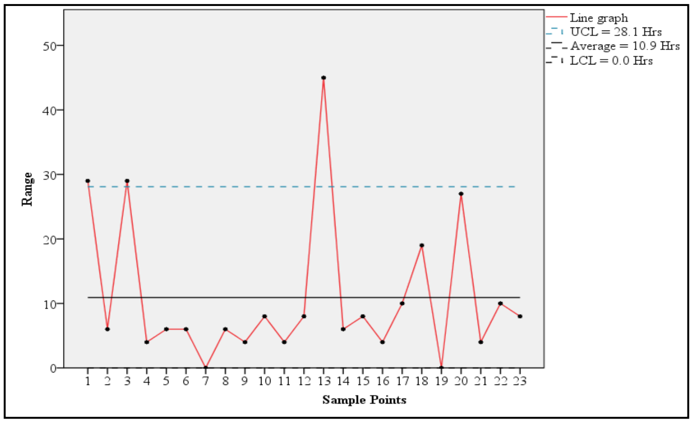

Figure 4.15: Range Chart on Restoration of supply after unplanned interruptions (non-domestic)

The Range Chart showed that sample points 1, 2 and 13 are outliers. The within-sample variability was not constant. In addition, samples 4 to 12 created a shift. Thus, the range chart indicates that the process is not in statistical control.

Table 4.20: Sub-grouping of the responses in non-domestic consumers

	Observations			Mean	Range
Cluster 1	9	30	1	13.3	29
Cluster 2	3	5	9	5.7	6
Cluster 3	30	7	1	12.7	29
Cluster 4	7	11	11	9.7	4
Cluster 5	5	11	11	9.0	6
Cluster 6	11	11	5	9.0	6
Cluster 7	11	11	11	11.0	0
Cluster 8	11	5	11	9.0	6
Cluster 9	9	9	5	7.7	4
Cluster 10	11	7	3	7.0	8
Cluster 11	5	7	9	7.0	4
Cluster 12	11	5	3	6.3	8
Cluster 13	5	50	11	22.0	45
Cluster 14	5	11	5	7.0	6
Cluster 15	3	5	11	6.3	8
Cluster 16	11	11	7	9.7	4
Cluster 17	3	11	1	5.0	10
Cluster 18	30	11	30	23.7	19
Cluster 19	30	30	30	30.0	0
Cluster 20	5	3	30	12.7	27
Cluster 21	7	11	11	9.7	4
Cluster 22	11	1	1	4.3	10
Cluster 23	3	9	1	4.3	8
Average				**10.52**	**10.91**

(Source: Research Data)

The Mean ($\overline{X}$) chart shown in Figure 4.16 was also drawn.

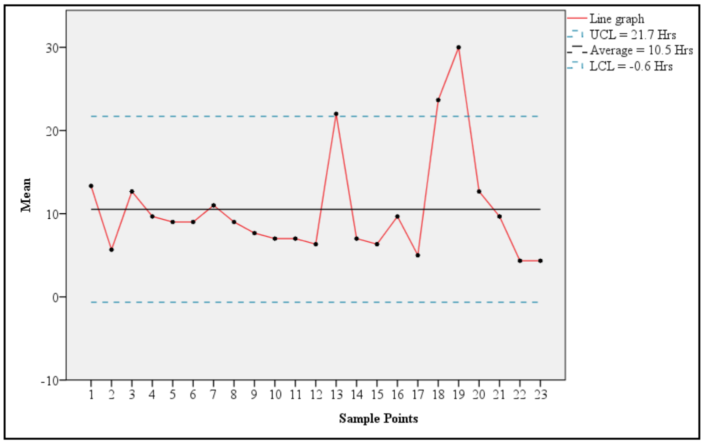

Figure 4.16: Mean Chart on Restoration of supply after unplanned interruptions (non-domestic)

From this diagram, it is seen that samples points 13, 18 and 19 are outliers. It is therefore concluded that the process is not in statistical control. Hence, no process capability analysis was carried out.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of the Findings

This study applied statistical quality control (SQC) to assess the customer's experience of quality as offered by Kenya Power Ltd. As the first objective was to assess the customers' experience of service as regards the restoration of supply after settlement of unpaid dues, and determine whether or not is in statistical control. The analysis done for domestic consumers showed that this service is not in statistical control. The analysis done for non-domestic consumers showed that this service is in statistical control. However, when a process capability analysis was carried out, it was found that the process had a very low ability to meet the designed tolerance limits since the process capability was only 0.3546.

A similar analysis was carried out to find out the statistical state of the customers' experience of service as regards the disconnection of supply for closed accounts. Analysis was done for both domestic and non-domestic consumers. For the domestic consumers, the analysis showed that the process was in statistical control. In addition, the process capability was calculated to be 0.2768 which implied that the process had a low ability to meet the designed tolerance limits. For the non-domestic consumers, both the Range and Mean charts showed that the processes were in statistical control, albeit with a very small process capability of 0.1346. This means that the process has a low ability to meet the designed tolerance limits.

With regard to the customers' experience of service as regards the refund of deposit for closed accounts, analysis was done for the two consumer categories. For the domestic consumers, both the range and mean charts showed that the process was in statistical control. In addition, the process capability was calculated to be 0.1613, which implied that the process had a low ability to meet the designed tolerance limits. For the non-domestic consumers, both the range and mean charts showed that the processes was in statistical control, albeit with a very small process capability of 0.1205. This means that the process has a low ability to meet the designed tolerance limits.

Lastly, with regard to the restoration of supply after unplanned interruptions, the service is not in statistical control for both the domestic and non-domestic consumers.

5.2 Conclusions

This study made the following findings as regards the state of the services of Kenya Power. As to whether the customers' experience of service as regards the restoration of supply after settlement of unpaid dues is in statistical control, it was found not to be in statistical control. This can be interpreted in two ways; one that Kenya Power has too many domestic consumers and is therefore unable to satisfy them or that the company has preferential treatment towards non-domestic consumers.

With regard to the disconnection of supply for closed accounts, the process was found to be in statistical control for both domestic and non-domestic consumers. However, it that in processes the process capability was low at 0.2768 for domestic consumers and 0.1346 for non-domestic consumers. When the two figures are compared to each other, they seem to suggest that Kenya Power loses much revenue from domestic consumers than from non-domestic consumers. The company may therefore have a policy to disconnect closed account for domestic consumers immediately upon request to prevent loss of revenue. Since this is the only objective that is in control for both domestic and non-domestic consumers, it can also be deduced that this process is critical to the operations of the company and is therefore monitored keenly.

With regard to refund of deposit for closed accounts, the process was found to be in statistical control for both domestic and non-domestic consumers. Even though the process capability was found to be very weak, it meant the accounts department strives to refund clients money as soon as they can.

As regarding the restoration of supply after unplanned interruptions, the service was found not in statistical control for both domestic and non-domestic consumers. This could mean that the company's' repair and maintenance department is overwhelmed. The number of human and capital resources may also be inadequate for the amount of work.

5.3 Recommendations and Possible Areas for Future Work

Results have indicated that the quality of services of Kenya Power are not as good as perhaps they should be. It appears that the measures to guarantee quality such the ISO certification are not yet effective. This means that the management of Kenya Power has a lot more to do to ensure optimal service quality in the firm. In particular, urgent steps must be taken to identify the root causes of service instability. Furthermore, the management of Kenya Power must make a commitment to understand and reduce all process variation as much as possible. They must also provide the staff with the tools and training to recognize when stability does not exist. As Wood (1994) noted, the costs of quality is greatest in the service sector. This means that SQC is even more beneficial in the utility service sector where an opportunity to impress a customer presents itself only once.

Control charts, also known as Shewart charts, have been shown to be very useful in monitoring quality not only in a traditional industrial process but also in non-industrial setting. The two most common techniques are mean charts and range charts. These two parameters when used in conjunction with the central limit theory provide an effective means of monitoring productivity and ensuring quality. Control charts are important because they prevent unnecessary adjustments to stable processes. They can tell when everything is working well and as such prevents any unnecessary changes such processes. This is consistent with the "if it isn't broken, don't fix it" philosophy. Control charts also provide information about process capability. They provide information about the value of important process parameters and their stability over time. This allows an estimate of process capability to be made. This information is of tremendous benefit to product and process designers. We therefore strongly advocate for the intensified use of statistical quality control tools in the utility services sector and particularly at Kenya Power, as a means of monitoring quality and production, and enabling the firm to take timely and appropriate action to correct undesirable deviation in production quality.

In future, this study can be extended to major urban centers such as Nairobi or Mombasa. An investigation can also be made to determine the extent to which Kenya Power can employ statistical quality control as a measure to detect and curb non-technical electricity losses and additionally to establish the factors that influence such losses in the company.

REFERENCES

Africa Tech News, (2013). Focus: 'Kenya Power Company now freezes new power connections. Business, [internet] 26 June. Available at: http://ictville.com/2013/05/kenya-power-company-now-freezes-new-power-connections/ [Accessed 22 September 2013].

Bitran G.R., and Lojo, M., (1993). A Framework for Analyzing Service Operations. *European Management Journal*, 11(3), pp. 271-282

Chandra M.J., (2001). *Statistical Quality Control*. CRC Press LLC

Doty, L.A., (1996). *Statistical Process Control*. Industrial Press Inc., U.S.

Feather, J. and Sturges, P. (2003). *International Encyclopedia of Information and Library Science*. 2nd Ed.. Routledge; London.

Garvin, D.A. (1998). *Managing Quality – The Strategic and Competitive Edge*. The free press. New York.

Heizer, J., and Render, B., (2011). *Operations Management*, 10th edition. Pearson, New Jersey.

Hossain M.M. (2008). *Development of Statistical Quality Control: Evolution or Revolution?*. Available at: www.decisionsciences.org/Proceedings/DSI2008/docs/196-3623.pdf [Accessed 4 September 2013]

Juneja, D., Ahmad, S., and Kumar, S., (2011). Adaptability of Total Quality Management to Service Sector. *International Journal of Computer Science & Management Studies*, Vol. 11, Issue 02, pp 93-98

Kathuri, J.N., and Pals, D.A. (1993). Introduction to Educational Research. Njoro: Egerton University Press.

Kenya National Bureau of Statistics, (2009). Facts and Figures.

Kothari, C.R., (2004), *Research Methodology, second edition*. New Age International Publication, New Delhi.

Krejcie and Morgan. (1970). "Determining Sample Size for Research Activities". *Educational and Psychological Measurement*, No30, pp. 607-610.

Li, J. and Tsung, F., (2013). *Statistical Quality Control for the Service Sector*. Available at: www.statistics.gov.hk/wsc/IPS091-P2-S.pdf [Accessed 15 September 2013]

Mahesh, B.P. and Prabhuswamy, M.S., (2010). Process variability reduction through SPC for quality improvement. *International Journal for Quality Research*, 4(3), pp. 193-203.

Mauch, P.D., (2010). Quality Management: Theory and Application. CRC Press.

Montgomery, D.C., (2009). *Introduction to Statistical Quality Control*, Sixth Edition. John Wiley & Sons, Inc.

Moraa, S.O., Etyang, M. and Mwabu G. (2011). The demand for Energy in the Kenyan Manufacturing Sector. *The journal of Energy and Development*, 34 (2), pp. 265-276.

Mukherjee, A., (2012). Services Sector in India: Trends, Issues and Way Forward. World Economic Outlook.

Mutua, J.W., (2010). *The influence of business process re-engineering on customer satisfaction in Kenya Power and Lighting Company Limited*. Master's Thesis. University of Nairobi.

Nakhai, B., (2009). The challenges of six sigma in improving service quality. *International Journal of Quality & Reliability Management*. Vol. 26 No. 7, pp. 663-684

Njau, E.W., (2011). *An investigation of factors affecting performance appraisal in Kenya Power. MBA*. Nairobi. Kenyatta University.

Njoroge, J.K., (2003). *Analysis of customer perception of service offered by Kenya power and lighting company ltd in Mount Kenya Region: The Case of Kenya Power and Lighting Company Limited*. Master's Thesis. University of Nairobi

Nyaoga, P., (2003). *Analysis of customer perception of service offered by Kenya power and lighting company ltd in Mount Kenya Region*. Master's Thesis. University of Nairobi.

Oakland, J., (2008). *Statistical Process Control*, sixth edition. Butterworth-Heinemann

Ograjenšek, I., (2002). Applying Statistical Tools to Improve Quality in the Service Sector. Available at: www.stat-d.si/mz/mz18/ograjen.pdf [Accessed 8 September 2013]

Olatunde, A.A., (2009). On the Importance of Statistical Process Control in Health Care. *Research Journal of Medical Sciences*, Vol: 3, Issue: 2, pp 87-90.

Ombui, J.M., (2003). *Contribution of Information Technology in Business Process Reengineering the case of Kenya Power and Lighting Company*. Master's Thesis. Egerton University.

Orumi, N.H., (2009). *An assessment of customer perception about service quality at public organizations. (A Case Study of the Kenya Power and Lighting Company LTD)*. Master's Thesis. University of Nairobi.

Otiso, K.N.; Chelangat, D.; Bonuke, R.N., (2012). Improving the Quality of Customer Service through ICT Use in the Kenya Power and Lighting Company. *Journal of Emerging Trends in Economics & Management Sciences*, Vol. 3 Issue 5, pp461.

Owuor, M.O. (2007). *Differences in perception of service quality by customers and managers of the Kenya Power and Lighting Company Ltd*. Master's Thesis. University of Nairobi

Radhakrishna B. R. (2007). Tips for Developing and Testing Questionnaires/Instruments. *Journal of extension. Vol. 45* No. 1, pp. 363-364

Roberts, L., (2005). Applying statistical process control in a Service Environment. Available at: www.r2assoc.com/SPC%20in%20a%20Service%20Environment.pdf [Accessed 7 September 2013]

Sargut, K.U., (2003). *Application of Statistical Process Control to Software Development Processes via Control Charts*. Master's Thesis. The Middle East Technical University.

Scordaki, A., and Psarakis, S. (2005). Statistical process control in service industry an application with real data in a commercial company. In *Proc. 7th Hellenic European Conference on Computer Mathematics and Its Applications*.

Uhusiano, (2010). Service Delivery Standards and Timelines on services at Kenya Power and Lighting Company. Available at: http://misterfix.wordpress.com/2010/04/14/service-delivery-standards-and-timelines-on-services-at-kplc/ [Accessed 1 October 2013]

Wood, M., (1994). Statistical Methods for Monitoring Service Processes. *International Journal of Service Industry Management*, 5(4), pp. 53-68.

APPENDICES

APPENDIX A: LETTER OF INTRODUCTION

George Yogo Odongo,
Department of Accounting, Finance and Management Science,
Egerton University,
P.O. Box 536 – 20115,
Egerton.

May 1, 2014.

Dear Respondent,

<u>RE: LETTER OF INTRODUCTION</u>

I am a postgraduate student enrolled for the Master of Business Administration Degree in the Faculty of Commerce of Egerton University. I am undertaking an educational research titled "***An Assessment of the Application of Statistical Quality Control in the Provision of Quality of Services: A Case of Kenya Power Ltd, Nakuru Sub-Region".*** You have been selected as one of the key respondents. I kindly request you to fill the questionnaire attached to the best of your knowledge and as accurately as possible.

The information you will provide is purely for academic purposes and will be treated with utmost confidentiality. In no way will your name or that of your organization appear anywhere in the final report. Therefore, do not write your name or that of your organization in any part of the questionnaire.

Thank you in advance for your valuable contribution

Yours faithfully,

George Y. Odongo

<u>MBA Candidate</u>

APPENDIX B: QUESTIONNAIRE

Instructions:

- **You have been randomly selected to fill the following questionnaire. Kindly do so to the best of your knowledge and as accurately as possible. Mark your selection by placing a tick √ in the appropriate box.**
- **All information provided will be treated as confidential and purposely made for academic requirements only.**

1. What is your Gender? ☐ Male ☐ Female
2. Do you have an electricity account with Kenya Power? ☐ Yes ☐ No
3. If your answer to (2) is Yes, in which ward of Nakuru county is your electricity installed?

   ☐ Bahati ☐ Barut ☐ Biashara ☐ Dundori ☐ Elburgon

   ☐ Flamingo ☐ Kabatini ☐ Kabazi ☐ Kapkures ☐ Kaptembwo

   ☐ Kihingo ☐ Kivumbini ☐ Lanet/Umoja ☐ Lare ☐ London

   ☐ Mau Narok ☐ Mauche ☐ Menengai ☐ Molo ☐ Menengai West

   ☐ Nakuru East ☐ Nesuit ☐ Njoro ☐ Rhoda ☐ Shabaab

   ☐ Sirikwa ☐ Solai ☐ Subukia ☐ Turi ☐ Waseges

   ☐ Other (Specify) ____
4. If you have an electricity account, for how long have you operated this account?

   ☐ less than 1 yr ☐ 1 - 4 yrs ☐ 5-10 yrs ☐ 11-15 yrs ☐ 16-20 yrs

   ☐ over 20 yrs ☐ Not applicable ☐ Other (Specify) ____________________

   ____
5. If you have an electricity account, what is your account usage type?

   ☐ Domestic ☐ Non-Domestic ☐ Other (Specify) ________________________

   ____
6. If you have an electricity account, has it ever been disconnected for non-payment of an outstanding bill? ☐ Yes ☐ No ☐ Not applicable

   ☐ Other (Specify)____

7. If your answer to (6) above is Yes, how long (in hours) did Kenya Power take to restore supply after you paid outstanding dues? ☐ 4 hours ☐ 7 hours ☐ 14 hours

   ☐ 45 hours ☐ Not applicable ☐ Other (Specify) ____________________________

   ____

8. Have you ever applied for the closure of an electricity account? ☐ Yes ☐ No

9. If your answer to (8) above is Yes, how long (in hours) did it take Kenya Power to disconnect supply to the meter?

   ☐ within an hour ☐ 5 hours ☐ 10 hours ☐ 45 hours ☐ Not applicable

   ☐ Other (Specify) ____

   ____

10. If your answer to (8) is Yes, how long (in days) did it take to process deposit refund?

    ☐ within a day ☐ 5 days ☐ 10 days ☐ 45 days ☐ Not applicable

    ☐ Other (Specify) ____

11. In your regular consumption of electricity, have you experienced power outages?

    ☐ Yes ☐ No ☐ Not applicable

12. If your answer to (11) above is Yes, what action do you typically take?

    ☐ Report to Kenya Power ☐ Do nothing ☐ Not applicable

    ☐ Other (Specify) ____

13. If you do report to Kenya Power, what were you informed was the cause of the outage?

    ☐ System/ transformer malfunction ☐ Fallen pole ☐ Vandalism

    ☐ Trees falling on lines ☐ Don't know ☐ Not applicable

    ☐ Other (Specify) ____

    ____

14. How long (in hours) did it take Kenya Power to rectify the fault?

    ☐ within 1 hr ☐ 2-3 hrs ☐ 4-5 hrs ☐ 6-7 hrs ☐ 8-9 hrs

    ☐ 10-11 hrs ☐ Not applicable ☐ Other (Specify) ____________________

    ____

APPENDIX C: SERVICE DELIVERY STANDARDS AND TIMELINES ON SERVICES OF KENYA POWER (KP) LTD

KP has come up with standards that have clear time lines on their various services as follows:

Quotation after application of Supply

- requiring meter only – 7 days
- requiring low voltage extension (metered at 230V) – 14 days
- requiring medium voltage extension & or transformer (metered at 400V) – 28 days
- requiring connection at high voltage (metered at 11KV, 33KV, 66KV) – 45 days

Construction period after payment

- requiring meter only – 3 days
- requiring low voltage extension (metered at 230V) – 14 days
- requiring medium voltage extension & or transformer (metered at 400V) – 45 days
- requiring connection at high voltage (metered at 11KV, 33KV, 66KV) – To be agreed

Reconnection after disconnection

- reconnection for non-payment – within 24 hours

Account closure and deposit refund

- disconnection on request for account closure – within 24 hours
- deposit refund upon closure of account – within 14 days

Unplanned Supply Interruption

When:

- System / transformer malfunction – up to 8 hours
- Trees falling on lines – up to 8 hours
- Fallen pole – up to 10 hours
- Vandalism – to be agreed

Customer queries

- Query/ complaint in writing – resolution / response within 7 days
- Other queries & complaints (walk-ins, emails, phone) – resolution / response within 7 days

Approximate connection cost for low voltage requirements

- Customers within 600 meters from transformer (single phase) – KES 35, 000
- Customers within 600 meters from transformer (three phase) – KES 45, 000

APPENDIX D: TABLE OF CONTROL CHART CONSTANTS

	X-bar Chart Constants		for sigma estimate	R-Chart Constants		S-Chart Constants	
Sample Size = m	A_2	A_3	d_2	D_3	D_4	B_3	B_4
2	1.880	2.659	1.128	0	3.267	0	3.267
3	1.023	1.954	1.693	0	2.574	0	2.568
4	0.729	1.628	2.059	0	2.282	0	2.266
5	0.577	1.427	2.326	0	2.114	0	2.089
6	0.483	1.287	2.534	0	2.004	0.030	1.970
7	0.419	1.182	2.704	0.076	1.924	0.118	1.882
8	0.373	1.099	2.847	0.136	1.864	0.185	1.815
9	0.337	1.032	2.970	0.184	1.816	0.239	1.761
10	0.308	0.975	3.078	0.223	1.777	0.284	1.716
11	0.285	0.927	3.173	0.256	1.744	0.321	1.679
12	0.266	0.886	3.258	0.283	1.717	0.354	1.646
13	0.249	0.850	3.336	0.307	1.693	0.382	1.618
14	0.235	0.817	3.407	0.328	1.672	0.406	1.594
15	0.223	0.789	3.472	0.347	1.653	0.428	1.572
16	0.212	0.763	3.532	0.363	1.637	0.448	1.552
17	0.203	0.739	3.588	0.378	1.622	0.466	1.534
18	0.194	0.718	3.640	0.391	1.608	0.482	1.518
19	0.187	0.698	3.689	0.403	1.597	0.497	1.503
20	0.180	0.680	3.735	0.415	1.585	0.510	1.490
21	0.173	0.663	3.778	0.425	1.575	0.523	1.477
22	0.167	0.647	3.819	0.434	1.566	0.534	1.466
23	0.162	0.633	3.858	0.443	1.557	0.545	1.455
24	0.157	0.619	3.895	0.451	1.548	0.555	1.445
25	0.153	0.606	3.931	0.459	1.541	0.565	1.435

APPENDIX E: FORMULAE FOR CALCULATING CONTROL CHART LIMITS

RANGE CHART

Upper Control Limit (UCL) $= D_4\overline{R}$

Center Line $= \overline{R}$

Lower Control Limit (LCL) $= D_3\overline{R}$

where $\overline{\overline{X}}$ Average of the sample means

$\overline{R}$ Average range of the samples

D_3 & D_4 Factors obtained from table of control chart constants (Appendix D)

MEAN CHART

Upper Control Limit (UCL) $= \overline{\overline{X}} + \left(\frac{3}{d_2\sqrt{n}}\right)\overline{R} \quad = \overline{\overline{X}} + A_2\overline{R}$

Center Line $= \overline{\overline{X}}$

Lower Control Limit (LCL) $= \overline{\overline{X}} - \left(\frac{3}{d_2\sqrt{n}}\right)\overline{R} \quad = \overline{\overline{X}} - A_2\overline{R}$

where $\overline{\overline{X}}$ Average of the sample means

$\overline{R}$ Average range of the samples

A_2 & d_2 Factor obtained from table of control chart constants (Appendix D)

n Sample size