FACTORS INFLUENCING THE ADOPTION OF THE KENYA POWER COMPANY COMPACT FLUORESCENT LAMPS IN NAIROBI COUNTY, KENYA

BY

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DECLARATION

This research project report is my own original work and has not been presented for a degree in this or any other university.

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DEDICATION

This project is dedicated to my wife, Naomi and our children Adrian and Alicia. Your support, assistance and understanding are the reason that this study was completed in time.

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ABSTRACT

Energy efficient Compact Fluorescent Lamp (CFL) fixtures are becoming commonly available in the marketplace for homeowners as they replace traditional incandescent lamps. The replacement of incandescent bulbs with energy efficient lamps in houses would certainly reduce the electrical energy use and power demand; however, would also affect the space heating and space cooling energy needs. The unit cost of different sources of energy also plays a key role in identifying the potential retrofit measures. The lighting energy use accounts for about 5% to 8% of the annual utility costs in Kenya. Kenya Power Company has embarked on a project to replace incandescent lamps with CFLs which are expected to benefit about one million Kenya Power customers. The project is expected to reduce domestic customers' power consumption by 130 megawatts (MW) during peak hours and is also expected to be a revenue source for Kenya Power as it seeks to get a share of the rapidly growing carbon trade industry. The project has been registered as a Clean Development Mechanism (CDM) project, with the firm set to sell the Certified Emission Reductions (CERs) generated by the project. This study therefore sought to evaluate factors influencing the adoption of the Kenya Power project on compact fluorescent lamps (CFL). The study findings suggest that there exist grounds to report strong influence of proper time management, costs, training and information on the adoption of the CFL project. The study also revealed aspects of cost, time management, training and information that had complementary and contrasting effects on the project while establishing a correlation between these factors and the adoption of the project. The study then suggests several areas of study that open themselves up for future exploration.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Artificial lighting is necessary for most of our domestic and commercial activities once darkness falls and sometimes even before nightfall. This is achieved mainly through the use of electric lighting (utilizing incandescent bulbs) in urban areas and traditional fuel-based lamps (kerosene, and other flammable sources) in areas without access to mains electricity. Domestic and industrial lighting used worldwide is responsible for 1,900 million tonnes of CO_2 a year meaning that the potential for reduction in green-house gas (GHG) emissions is enormous (Hulme 2013).

It is estimated that around 40% of future global energy demand for lighting could be mitigated by switching to more energy efficient lamps (Energy savers 2009). The shift from inefficient incandescent lamps to energy efficient compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs) would cut world lighting energy demand significantly, saving countries, businesses and households considerable sums in reduced electricity bills. (It is estimated that a 13W CFL produces the same lighting effect as a 60W incandescent lamp an efficiency increase of over 400%) (Hulme 2013).

Few actions could reduce carbon emissions as cheaply and easily as the phase-out of inefficient incandescent lighting. However, by themselves, market forces are not sufficient to achieve the rapid transformation needed in the lighting market to respond to the climate change challenge. Instead, a multi-stakeholder global partnership is required to support countries as they embark upon efficient lighting transformation programmes. With its unparalleled global network, UNEP provides leadership by inspiring and enabling nations to prioritise efficient lighting and reap the benefits of lowered energy costs. Whereas activities aimed at phasing out inefficient technologies have been introduced in recent years in a number of countries, experience indicates that global coordination is required to assist countries as they embark upon efficient lighting transformation programmes. Support is also necessary to provide countries with the required know-how to make the transition successful, both in terms of the economic gains and the associated reduction of GHG emissions (Coaton and Marsden 1997).

A number of countries and regions in the world have initiated successful steps in order to move towards efficient lighting. In 2009, the EU banned the production and sale of traditional incandescent bulbs of 100 watts or more, a decision that eliminates production of about 32 million tonnes of CO_2 a year. Together with energy efficiency regulations, the ban will save about €11 billion a year (US$15.3 billion). In Australia, where the legislation of efficiency standards will result in a ban on incandescent bulbs this year, more than 30 terawatt hours (TWh) of electricity and 28 million tonnes of GHG emissions are expected to be saved between 2008 and 2020. With the above activities as examples of what is possible, the UNEP *en.lighten* initiative has seized the opportunity to lead the engagement with developing and emerging countries, governments and the private sector to achieve a global market transformation to efficient lighting.

There is a growing need globally to find ways to reduce energy use. The US Energy Information Administration (EIA) has estimated that up to 19% of global electricity is used by lighting which makes lighting a significant sector in electricity use worldwide (EIA 2006). The need to reduce energy use and protect the environment in Europe has led to legislative measures such as the Ecodesign Directive (EU 2009a). The directive and its regulations do not ban any technology as such but rather regulate energy efficiencies and levels of mercury which cause some technologies to be phased out from the European markets. One of the technologies facing a phase-out is the use of incandescent lamps in domestic and industrial use.

In developed countries the energy consumed for lighting in terms of the total electrical energy consumption may be relatively small in percentage but the actual amount is large. In industrialized countries, electrical energy consumption for lighting ranges from 5% (Belgium and Luxembourg) to 15% (Denmark, Japan, and the Netherlands) of total electricity consumption (Mills 2002). Martikainen found that lighting consumes 16% of all electricity consumption within the EU and more than 20% in North America (Martikainen 2009). It is important to mention that lighting represents 20% of the residential electricity consumption in the 12 new member states of the EU and a significant amount of electricity, accounting for around 18.3 TWh/year (Bertoldi & Atanasiu 2007). About 238 TWh of electricity was consumed in the USA for residential lighting in 2005. Member countries of Organization for Economic Co-operation

and Development (OECD) consumed 372 TWh. The number of lamps per household in OECD countries varies from 10.4 (Greece) to 43 (USA) (Waide 2010).

The present state of electrical energy availability in many developing countries is far from an adequate level to supply the needs of all of the population. Only about 24% of the people living in sub-Saharan Africa had access to electricity in 2000. Electrical supply networks in these countries are connected mainly to the urban and peri-urban areas. In the rural and more remote areas of these countries, only 2% - 5% of the population has access to electricity. In countries such as Brazil, Bangladesh, India, Morocco, and South Africa 20% - 30% of the rural population have access to electrical supply networks with some higher grid connection. The rest of the people (without access to mains electricity) mainly use liquid fuels (kerosene) for lighting (Halonen 2010). It is good news that the electrification rate in the developing countries has been continuously increasing during the past few decades. The situation is improving day by day. In most developing countries people consume electricity mainly for lighting purposes. So, lighting consumes the largest amount of total electrical energy in these countries. The amount can be as high as 86% (Tanzania) of the total electricity production (Mills 2002). On the other hand, the dominant light source in domestic lighting is the inefficient incandescent lamp. This indicates that there is a large energy saving potential in these countries if these lamps can be replaced with energy efficient CFLs (Mills, 2002).

Electrical energy maintains the standard of our living and economy. Lack of electricity is largely unexpected in today's society. The earlier situation of over capacity has decreased and the balance between supply and demand is becoming narrower day by day, with the reserve capacity of fossil fuel decreasing. For these reasons, the situation is not expected to remain the same because of the growth of the world population and the resultant growth of demand due to economic growth and rising living standards. In both developed and developing countries, electricity consumption per capita is increasing. The imbalanced tug-of-war between the population growth and electrification may result in an increase in the number of people without access to electricity (Mills 2002). World-wide energy demand is projected by the World Energy Council to be at least double that of its present level by the year 2050. Most of this growth and much of the increase in energy consumption will occur in developing countries (Europa 2009b).

One of the most interesting and quickly developing lighting technologies to replace old technologies is solid state lighting (SSL), especially light emitting diodes (LED). Until recently, LED technology has not provided suitable solutions for private users, decision makers or investors, due to insufficient luminous efficacies and high investment costs. LED technology, however, is developing at a quick pace. Low investment in energy efficient technologies is often identified as a result of the 'energy efficiency gap' (Jaffe and Stavins, 1994a; Weber, 1997). This term attempts to capture the slow diffusion of profitable energy efficient technologies that fail to achieve market success. The energy efficiency gap is described in terms of market failures and barriers, indicating that the investors do not choose energy technologies although they are cost effective. In addition, it could be argued that consumer decisions do not respond to the model of rational choice behaviour. Early work done by Lutzenhiser (1994) spotted evidence of lack of economic rationality in consumer decisions to forego some obviously energy efficient measures (Lutzenhiser, 1994).

In fact, one can argue that the approach of economic rationality is inadequate to properly reflect technological consumer preferences. Investment costs are only part of a great variety of variables that frame and drive energy-related consumer's investment decisions. For instance, design, comfort, equipment's brand, timing, functionality, reliability, learning, marketing, environmental awareness, etc., are likely to influence the decision about an energy-technology choice/purchase. From the societal point of view e.g. environment, the investment outcome is likely to be unsatisfactory so there is a great need in public policy to better understand consumer investment decisions in the context of energy use (Adato 2008).

In Kenya, consumption of lighting energy has steadily grown. Electricity used for household lighting is 2.4 TWh/a. This is nearly one fourth of total household electricity consumption, when electric heating is not included (Adato 2008). Outdoor lighting uses up to 0.8 TWh/a (Sippola 2012) and office lighting around 0.7 TWh/a (Pohjolainen 2000). Household, outdoor and office lighting account for almost 5% of total Kenyan electricity consumption. The Ecodesign Directive and regulations force the Kenyan counties to invest in new outdoor lighting solutions, and private consumers must decide which light source they will use to replace incandescent lamps. Little information is available on the potential of compact fluorescent lamps in saving energy and

reducing CO2 emissions in Kenyan households, as previous research has mainly focused on conventional incandescent lamps. It should be noted that a previous study indicates that CFL bulbs may have an effect on power supply quality when used in a mixed installation with incandescent bulbs due to substantial harmonic distortions and a low power factor (Ndungu, Nderu and Ngoo, 2012).

The government, in conjunction with Kenya Power, distributed 3.3 million free energy saving bulbs in a countrywide exercise in the year 2013. The project, implemented under the Clean Development Mechanism's (CDM) efficient lighting programme entailed replacement of ordinary bulbs (incandescent lamps) with compact fluorescent lamps (CFLs) which benefited about one million Kenya Power customers**.** Selected target customers for the project included low income households and Kenya Power's Stima Loan (revolving fund) customers in various parts of the country, who got a maximum of four bulbs. Kenya Power hoped that the project will help reduce demand for electricity as CFLs use less electricity, and consequently reduce power bills for customers. The project was expected to reduce demand for electricity from domestic customers and nationally help save 130 MW especially during evening peak demand (Macharia, 2013)

According to Kenya Power, reduction of peak demand will consequently mitigate climate change through reduction of greenhouse gas emissions estimated at 117,000 tons of carbon dioxide per year. The exercise was implemented as the second phase of the company's 2010 'Badilisha Bulb' campaign which involved retrofitting 1.25 million CFL bulbs in exchange with incandescent bulbs (Macharia, 2013)

During the project implementation, Kenya Power carried out an awareness campaign to sensitise customers on the need to conserve energy by using available energy efficiently. The entire project including distribution and retrofitting exercise in all regions where the power utility operates was estimated to cost Sh1.3 billion. The project was financed jointly by the Government of Kenya and the French Development Agency (AFD).

1.2 Statement of the problem

There is a growing need globally to find ways of reducing energy usage. The EIA (2006) has estimated that up to 19% of global electricity is used by lighting which makes lighting a significant sector in electricity use worldwide. The need to reduce energy use and protect the environment in Kenya led to Kenya Power entering into a contract with Standard Bank Plc to develop the Clean Development Mechanism (CDM) project and sell the Certified Emission Reductions (CERs) generated by the project.

The CFL project aimed at helping to supply more consumers with the same installed electricity production capacity through slowing down electricity demand growth. So, energy conservation is needed to ensure the essential supply of energy required for boosting both economic development and people's quality of life, as well as protecting the environment. Energy conservation through energy efficiency in homes is essential to reach that goal. Energy efficiency measures related to lighting are cost-effective and can offer a better opportunity to increase the security and reliability of energy supply in the future. The most effective measure is to use energy saving lamps in lighting. Replacement of energy inefficient incandescent lamps with efficient compact fluorescent lamps can be one of the most effective ways to make buildings energy efficient (Hulme 2013).

Electric lighting is a major energy consumer. Energy savings are possible using energy efficient equipment, effective controls, and careful design. Using less electric lighting reduces heat gain, thus saving air-conditioning energy and improving thermal comfort. Electric lighting design also strongly affects visual performance and visual comfort by aiming to maintain adequate and appropriate illumination while controlling reflection and glare. Thus energy efficient lighting fixtures offer substantial potential for reducing the electrical power consumption, energy use and wastage.

Energy efficient compact fluorescent lighting fixtures are becoming more commonly available in the marketplace for homeowners. The replacement of incandescent bulbs with energy efficient lamps in houses is certain to reduce the electrical energy use and power demand. The unit cost of different sources of energy also plays a key role in identifying the potential retrofit measures. The lighting energy use accounts for about 5% to 8% of the annual utility costs in Kenya. The

purpose of this study was to evaluate the factors affecting the adoption of the Kenya Power project on Compact Fluorescent Lamps (CFLs).

1.3 Purpose of the study

The purpose of the study was to examine the factors influencing the adoption of the Kenya Power Company compact fluorescent lamps project with reference to Nairobi County.

1.4 Objectives of the study

The objectives of the study were:

1. To determine how cost affected the Kenya Power Compact Fluorescent Lamp project.
2. To determine how time affected the Kenya Power Compact Fluorescent Lamp project.
3. To determine how training affected the Kenya Power Compact Fluorescent Lamp project.
4. To establish whether information affected the Kenya Power Compact Fluorescent Lamp project.

1.5 Research questions

The study was guided by the following research questions:

1. How does cost affect the Kenya Power Compact Fluorescent Lamp project?
2. How does time affect the Kenya Power Compact Fluorescent Lamp project?
3. How does training affect the Kenya Power Compact Fluorescent Lamp project?
4. How does information affect the Kenya Power Compact Fluorescent Lamp project?

1.6 Research hypothesis

The research hypotheses for this study were as follows:

1. Cost effect on the adoption of Kenya Power compact fluorescent lamp project

Null hypothesis (H_0): There is no relationship between cost and the adoption of the Kenya Power company compact fluorescent lamps.

Alternative hypothesis (H_1): Cost has an effect on the adoption of compact fluorescent lamps.

2. Time effect on the adoption of Kenya Power compact fluorescent lamp project

Null hypothesis (H_0): Time management in project planning and execution has no effect on the adoption of the Kenya Power company compact fluorescent lamps.

Alternative hypothesis (H_1): Time management in project planning and execution has a direct effect on the adoption of compact fluorescent lamps.

3. Training effect on the adoption of Kenya Power compact fluorescent lamp project

Null hypothesis (H_0): Staff and consumer training have no implication on the adoption of the Kenya Power company compact fluorescent lamps.

Alternative hypothesis (H_1): Training of Kenya Power staff and consumers have a direct bearing on the adoption of compact fluorescent lamps.

4. Information effect on the adoption of Kenya Power compact fluorescent lamp project

Null hypothesis (H_0): There is no effect of information on the adoption of the Kenya Power company compact fluorescent lamps.

Alternative hypothesis (H_1): Information on CFLs has a direct effect on the adoption of compact fluorescent lamps.

1.7 Significance of the study

The study was expected to contribute to the in-depth understanding of the need to use the Compact Fluorescent Lamps (CFL) in the country since the replacement of incandescent lamps with energy efficient lamps in houses would reduce the electrical energy use and peak power demand.

The findings will be of immense importance to the government through the Ministry of Energy, NEMA, KenGen and Kenya Power since the study would shed light on the effects of substituting the incandescent lamps currently being used in the country with compact fluorescent lamps. In addition to the above, the study will be useful to stakeholders, financiers, and investors in formulating and planning areas of intervention and support.

The findings of the study will particularly be useful in providing additional knowledge to existing and future institutions on Kenya Power Compact Fluorescent Lamps (CFL) project. This

will expand knowledge on the project and also identify areas of further study. The study will also be a source of reference material for future researchers on related topics and will also help other academicians who undertake the similar topics in their studies while highlighting other significant relationships that require further research.

1.8 Limitations of the study

The study was limited to Kenya Power Company and focusing on the compact fluorescent lamps project only. There are many other ways of saving electrical energy but the study did not consider other ways and therefore the study cannot be generalized since Kenya Power Company has other energy saving projects.

1.9 Delimitations of the study

The research focused on evaluation of factors influencing the Kenya Power Compact Fluorescent Lamps (CFL) project by looking at variables which included cost, time, training and information. The study used a case study of Kenya Power Company since it had the mandate to carry out the project in all parts of the country. Kenya Power Company is a state owned company that is government-regulated.

1.10 Basic assumptions of the study

The study was carried out on the basis of the following assumptions:

1. That the sample chosen for the study represented the population.
2. That the data collection instrument used in the study was valid and measured the desired constructs.

1.11 Definition of significant terms

Compact fluorescent lamp - A fluorescent lamp designed to replace an incandescent lamp.

Efficient energy - The goal of reducing the amount of energy required to provide light

Energy consumption - The consumption of electrical energy or power.

Lamp - A light source made in order to produce an optical radiation, usually visible.

1.12 Organization of the study

Chapter One of the study contains the introduction that gives a background of the study while putting the topic of study in perspective. It gives the statement of the problem and outlines the objectives, limitations, and the assumptions of the study. Chapter Two presents scholars' work on evaluation of the Compact Fluorescent Lamp (CFL). It critically looks at the issues of time, cost, training and knowledge of the Compact Fluorescent Lamp (CFL). It also outlines empirical review as well as the conceptual framework variables. Chapter Three consists of the research methodology which was used in the study. It covers the research design, target population, sample design, data collection, validity and reliability of data collection instruments, data analysis techniques, and ethical considerations. Chapter Four presents the results of analyses of the data collected together with significant findings. Chapter Five gives the summary, conclusions, discussions and recommendations of the study and suggests areas of further study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter covers a review of relevant literature concerning factors influencing the adoption of the Kenya Power Company Compact Fluorescent Lamp. The Cost effects on the project, Time effects on the project, Training effects on the project and information effects on project.

Fluorescent lamps produce light in a different way from traditional incandescent lamps. In an incandescent lamp, electric current runs through a wire filament and heats the filament until it starts to glow. In a fluorescent lamp, an electric current is driven through a tube containing an inert gas (generally argon) and a small amount of mercury vapour. This generates invisible ultraviolet light that excites a fluorescent coating (called phosphor) on the inside of the tube, which then emits visible light (Blades, 1992).

Fluorescent lamps do need a little more energy when they are first turned on, but once they are successfully started, they use about 75 percent less energy than incandescent bulbs. In traditional incandescent bulbs, which work by heating a filament until it becomes hot enough to emit light, only 10 percent of the energy output produces useful light. Fluorescent lamps ballast helps "kick start" the lamp and then regulates the current once the electricity starts flowing. This entire process typically takes from 30 seconds to 3 minutes to complete, which is why fluorescent lamps take longer than other lights to become fully lit. Lamps with decorative covers like globe or reflector shapes have a unique design challenge that results in a trade-off for a slower warm up time, which is why these lamps take longer than incandescent ones to reach full brightness. Older fluorescent lamps used large and heavy magnetic ballasts that caused a buzzing noise in some bulbs. Most CFLs today use electronic ballasts, which do not buzz or hum (Energy Star, 2013).

Compact Fluorescent Lamps (CFL) are a type of fluorescent lamps that are designed to replace incandescent lamps by fitting directly into the existing holders without modification. This is possible because CFLs are manufactured with electronic ballasts affixed to their stems and their fluorescent tubes modified to mimic the shape of incandescent lamps that they are designed to replace, and some, such as CFL flood light bulbs, are exactly the same shape and size as their

incandescent counterparts. CFLs have undergone significant improvement since their early years. Early CFLs had large starter/ballast assemblies, and the light tubes often resembled those found in standard fluorescent ceiling fixtures. Nowadays, CFLs are available in a large variety of shapes, sizes, and wattages that are appropriate for home use. Several kinds can be used to replace ordinary 25-watt to 100-watt incandescent bulbs in lamps and fixtures. Others can be used to replace globe bulbs, flood bulbs, and decorator bulbs (Laurier, 2009). These bulbs can be installed in many existing household light fittings without any modification (McBride, 2005).

The principle of operation is that a plasma discharge between tungsten cathodes produces light within a tube filled with low pressure mercury vapour and an inert gas or mixture of gases (like argon, or a mixture of argon and krypton or neon). A liquid mercury drop is also introduced. This mixture is good in converting electricity into radiant energy, mainly ultraviolet light. Phosphor coating on the inside face of the tube glass produces the fluorescent effect converting the ultraviolet light into visible light and furthermore, the glass is transparent to visible light but prevents the escape of ultraviolet light. The tube is usually made of a soda-lime silicate or low sodium content glasses. The cathode is composed of two or three coils of tungsten filament held by the electrode. This filament is coated with some electron-massive materials. Lead wires carry electrical current to the electrode through the glass-to-metal seals (McBride, 2005).

Fluorescent lamps (including CFLs) not only need a ballast to limit the starting current like other discharge lamps, but also need an electronic starter device to initiate the discharge, which can be made in different circuitry depending on the lamp. This starter device draws a current through filaments and heats them to emit electrons. After a few moments, the plasma discharge device starts up and a peak voltage generates the discharge. This explains why the starting process of fluorescent lamps is not immediate. Considering their functionality, traditional fluorescent lamps are not fully dimmable, like incandescent lamps are, and furthermore not all of them are compatible with existing dimming circuits. Despite this, modern CFLs can reach dimmability from 2% to 100%, which requires specific electronics that can increase the price of the lamp. Still most of the conventional CFLs in the market are not dimmable which is a problem if, for instance, a CFL adopter wants to replace an incandescent while still using the same dimmer circuit. In addition their power factor is dependent on the lamp from 0.5 to close to 1 in the best

cases all of which increase the energy consumption (reactive and active) compared with incandescent lamps that have a power factor of 1 since they are a purely resistive load. The working life of Compact Fluorescent lamps is longer than that for incandescent lamps and ranges between 10,000h and 25,000h (Blades, 1992).

Electricity energy input is converted into ultraviolet light with an efficiency of about 63%, while the rest is dissipated as heat in the plasma discharge and the electrodes. About 40% of the ultraviolet light is then absorbed by phosphor and emitted as visible light and the rest is lost. Globally, 28% of the electricity consumption is converted into visible light. Luminous efficacy can be grouped depending on the three categories of lamps. Thus, halophosphates and multiphosphor are less efficient in a range from 60 to 75lm/W while tri-phosphor has efficacies from 80 to 95lm/W. Efficacy can be reduced for these lamps in cold environments since the optimal temperatures are from 15ºC to 30ºC (Blades, 1992).

The colour rendering of Compact Fluorescent Lamps depends on the qualities of the fluorescence and phosphorescent substances used. Hence, there is no unique standard light output, but there are different standard colours. Green colour will be always generated because UV is easy converted into visible light of 550nm, but in order to achieve a good colour, the three primary colours red, blue and green are necessary. These colours can be produced by using halophosphates, three-band phosphor mixtures and multi-band phosphor lamps, where the first ones have the lowest colour rendering index (CRI) of over 50, and multi-band has a very high CRI of over 90 (McBride, 2005).

2.2 Cost effects on the project adoption

Compact fluorescent lamps are much more energy efficient than incandescent lamps and they burn much cooler. This results in tremendous energy savings and a quick payback. In addition, CFLs last up to 10 times longer than incandescent lamps. Therefore, maintenance costs are also reduced. Further, since CFLs are available in a 2700 degrees Kelvin colour temperature, their appearance is much the same as incandescent lamps. Most people won't be able to tell the difference without actually looking into the fixture. Studies generally paint a similar picture of the so called efficiency paradox: where profitable efficiency investment opportunities are often not taken and very high hurdle rates are usually imposed (e.g. payback of no more than 2 years

with IRR's of 50% or more (DeCanio & Laitner, 2003)). Most studies find that conventional economic reasoning can explain some of this behaviour through bounded rationality and hidden costs; however where studies often differ is in their treatment of barriers including particularly hidden costs barriers. For some researchers, these can largely account for the non-investment behaviour because the efficiency investment is only apparently profitable. In fact when all costs, including the hidden ones, are taken into account profitability evaporates and consequently no action is taken. Consequently, in this view, firms do behave in an economically rational manner. For other researchers, the issue of hidden costs and profitability are red herrings as these are considered concepts that do not adequately describe the reality of organisational decision-making. They point to situations where hidden costs are minimal or non-existent and yet very high hurdle rates remain and investments in efficiency are not undertaken (McBride, 2005).

Anderson & Newell (2004) analysed a large dataset of medium-sized manufacturers which received energy audits as part of a US government programme. They found that the average payback period for projects which were taken up was 1-2 years, with the average implicit discount rate being 50%-100%; a very high hurdle rate, although consistent with that the investment criteria that these firms stated that they intended to use. It also seems the decision to invest will vary between different types of efficiency investment: Anderson & Newell (2004) found that certain project types are more likely to be adopted than others, suggesting that there may be "many economic costs, benefits, risks, and other factors that simple financial measures do not capture". When the stated reasons for non-adoption are examined these authors conclude that non-adoption is largely the result of various "institutional factors" such as "bureaucratic restrictions". This finding is supported by DeCanio (1998) who examined the characteristics of lighting investments made by firms as part of "Green Lights", a US efficient lighting retrofit program (DeCanio 1998).

In theory, the risk barrier and associated hidden costs were not an issue as the lighting investments in the program were low risk, using well-known reliable technologies. The study found that required paybacks and IRRs differed between firms and were often very different to the risk-adjusted discount rate that would constitute the appropriate 'hurdle rate' for investments under conventional investment analysis. DeCanio concluded that there is "a large potential for

profitable energy-saving investments that is not being realised because of impediments that are internal to private and public-sector organizations". These "internal impediments" are investigated in a second paper by DeCanio (DeCanio & Watkins, 1998) which examined how firm characteristics influenced participation in the Green Lights scheme. They found a number of firm characteristics were influential. Larger companies were more likely to join the programme, as were better performing companies. In terms of sector, utilities were more likely to join Green Lights and finance, insurance, real estate, and service companies were less likely to join.

DeCanio and Laitner (2003) identify three principle reasons why the profit-maximising model of the firm seems untenable: The principal-agent problems where there are differences in objectives and skills between different individuals within the firm, the problem of management control meaning it is difficult to manage the modern, complex organisation in a profit-maximising way and the problem of bounded rationality since resource constraints will always prevent optimal information search and processing. The conclusion of the paper is that models assuming optimal economic behaviour by firms should be questioned and even abandoned in some cases. Instead, models embracing the "tangible realities of industrial behaviour" should be constructed. Once assumptions about optimal behaviours are no longer centre stage a range of non-price and information based policies is suggested. For example measures that increase the salience of energy efficiency, voluntary pollution-prevention programs, labelling, smart standards, government demonstrations, information-gathering initiatives, and the facilitation of inter-firm and interpersonal networking are examples of the extended set of possibilities (DeCanio and Laitner, 2003).

2.3 Influence of time management on the project adoption

Time management is the act of planning, controlling and finally executing specific activities, especially to increase efficiency or productivity. It applies to a wide usage area starting from personal time organization and up to business related time management. For the best results and the biggest efficiency dedicated time management software should be used. A time management system is a combination of processes, tools, techniques, and methods. There are many books and case studies focusing on these notions (Beardwell et al. 2004).

Time management is an essential subset of project management and it describes the processes required to ensure timely completion of the project. More exactly, according to Becker, (1993) it consists of five main phases: activity definition or to establish the activities necessary to produce the deliverables of the project; activity sequencing meaning to establish the dependencies between these activities; activity duration estimating or to estimate the effort of work necessary to complete the tasks; schedule development**,** to create the project schedule based on the above estimates and on the necessary resources; schedule control or to control the changes made to the project schedule (Becker, 1993)

The most important phase is project planning when the project plan is established. A well defined project plan can contribute significantly to the success of the project. Once established the project plan is used to create the project schedule. All it remains now is for the schedule to be respected as much as possible over time and deadlines to be met (Becker, 1993). Project time management is often confused with the term project management. This is a misconception since project management covers many areas like scope management, cost management, resource management, quality management, risk management and not just the management of time (Becker, 1993).

2.4 Influence of training on project adoption

Training is of growing importance to companies seeking to gain an advantage among competitors. There is significant debate among professionals and scholars as to the affect that training has on both employee and organizational goals. One school of thought argues that training leads to an increase in turnover while the other states that training is a tool to that can lead to higher levels of employee retention (Colarelli and Montei, 1996; Becker, 1993).

Training can have a considerable influence on company finances as there are several potential training costs that companies may incur. One type of training related cost is direct cost. This may include instructor salary, materials, and follow-up supervision. A second type of training related cost is indirect cost. These costs are related to worker output and productivity during and upon completion of the training. Along these lines, once a training program is completed, worker productivity is expected to increase. The benefits will be to the company, due to an increase in worker output and productivity, and to the worker, as the increase in output should translate into

higher wages and opportunities for career advancement. In general, a company will weigh the costs and returns to training to determine the amount of investment it will incur (Kaufman and Hotchkiss, 2006).

It is worth nothing that, as researchers continue with their quest into the training research area, they also continue their arguments into its importance. Some of these researchers argue that the recognition of the importance of training in recent years has been heavily influenced by the intensification of competition and the relative success of organizations where investment in employee development is considerably emphasized (Beardwell et al., 2004). Literature also adds that technological developments and organizational change have gradually led some employers to the realization that success relies on the skills and abilities of their employees, thus a need for considerable and continuous investment in training and development (Beardwell et al., 2004).

Most of the benefits derived from training are easily attained when training is planned. This means that the organization, trainers and trainees are prepared for the training well in advance. According to Kenney and Reid (1996) planned training is the deliberate intervention aimed at achieving the learning necessary for improved job performance (Kenney and Reid, 1996).

2.5 Information effects on project adoption

A number of the studies in our evidence base discuss the concept of bounded rationality as a major barrier to optimising investments in energy efficiency (DeCanio et al., 2003)). Finite time, limited information and the cognitive capability of decision makers leads to sub-optimal decision-making for satisfactory rather than optimal investment decisions. De Groot, Verhoef and Nijkamp (2001) found that lack of information is a "principal source of market failures that can account for sub-optimal investment behaviour" and find size and sectoral differences in information use: large firms which have high levels of investment and facing strong competition are more likely to have knowledge on new technologies, while smaller firms, those that face limited competition, and those that invest little are less likely to have the required knowledge. Other studies in the evidence base support the view that smaller firms have less time and money coupled with fewer technical skills to assess information. This has been found across all sectors. For example, Bohdanowicz (2005) found that knowledge of energy reduction schemes for the hotel sector were low, but especially so for smaller, unaffiliated (non-chain) establishments

where the company did not have the resources to actively seek out information (De Groot, Verhoef and Nijkamp, 2001).

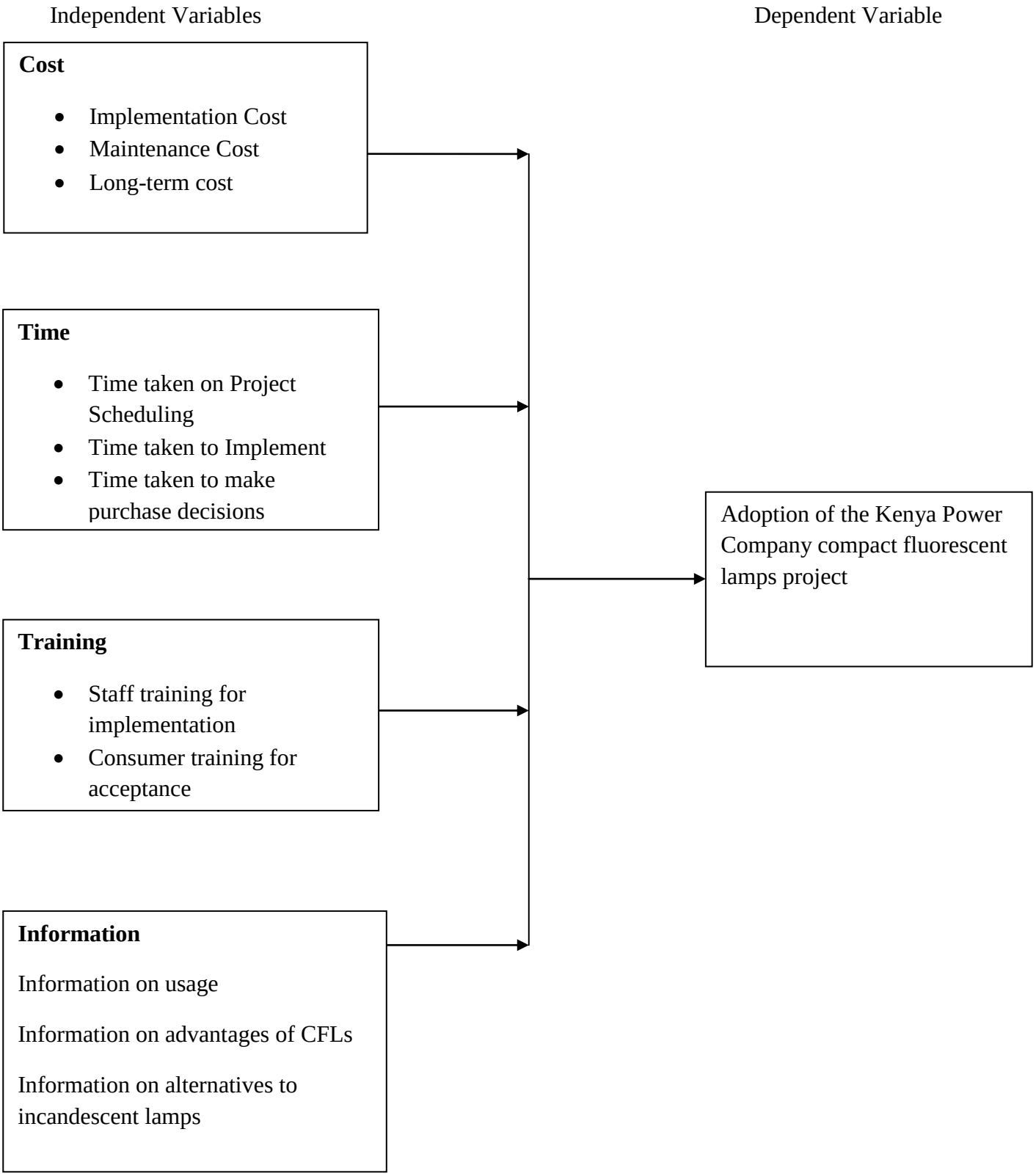
Lack of technical skill and time to judge the merits of energy efficiency opportunities has also been found in smaller manufacturing companies (Trianni and Cagno, 2012). Certainly, the smaller the organisation the less likely it is to have a dedicated energy or environmental manager (Martin et al., 2012). Consequently smaller organisations will tend to rely more on rules of thumb and folk wisdom although some studies have found that even large organisations use unreliable methods of discriminating investment choices such as using simple payback calculations (Anderson and Newell, 2004).

Trianni and Cagno (2012) also find sub-sectoral differences in judging barriers to energy efficiency demonstrating that regardless of energy intensity (all the sub-sectors studied were manufacturers), sub-sectors can behave quite differently as a result of their unique history. They found that the textile industry behaved quite differently to the wood, metals, plastics and metals industries in Italy, perceiving lower barriers to energy efficiency than the others. The authors attribute this to the individual circumstances of the textile industry in Italy at the time of the study which had recently endured a torrid period with a dramatically reduced number of companies operating, so that the remaining ones, were, by definition, better managed and more energy efficient than their counterparts. In sum, this evidence suggests that energy efficiency will be particularly attended to where there are resources for doing so and where it is considered to have strategic value. These assessments will be influenced by sectoral and sub-sector characteristics and the size of the organisation (Trianni and Cagno, 2012).

2.6 Conceptual framework

The independent variables in this research were the project cost, time, training and information while the dependent variable was project adoption. The table below shows the conceptual framework adopted for carrying out the research.

Figure 2.1: Conceptual Framework



2.7 Summary of literature and research gaps identified

From the foregoing, CFL lamps have been a major focus of research specifically the energy saving advantages of CFLs versus the traditional incandescent lamps. There has been an improvement in the electrical and compatibility design of CFLs especially in usability and endurance over the years, a trend that has resulted in cost savings and reduced expenditure on maintenance. It has also been shown that CFL lamps provide savings in the long-term over incandescent lamps especially regarding maintenance, electricity bills and replacement. However, the purchase cost (hence entry point) remains high. For this reason, the consumers in the lower income bracket for whom electricity costs represent a larger proportion of their costs, have tended to be reluctant to adopt CFLs without government subsidies. The payback period for recouping initial investment in CFLs has also not been viewed appropriately by industry resulting in the efficiency paradox.

Time management has also been identified as a factor influencing adoption of projects. This is especially true of purchase decisions by consumers where time pressure and the necessity of 'buying now, think later', with regard to new installations has resulted in missed opportunities. Proper planning and time management has also emerged as a significant factor in determining the success of the adoption of projects.

Training has been seen to have considerable beneficial impact on project adoption where both the implementing team and the intended beneficiaries are inducted into the benefits of the technology. Information on the other hand has been seen to be a two-edged sword; in the right hands and with the right attitude, information boosts adoption of new ideas, while the wrong approach or preconception leads to rejection of ideas even when the benefits are obvious. Therefore, consumers tend to depend on 'rule-of-thumb' wisdom while being reluctant to adopt newer technology.

From this, the implications of the factors of cost, time, training and information on the Kenya Power company compact fluorescent lamp project were visible. However, there had not been any cogent, structured and systematic examination yet into the factors influencing the adoption of the compact fluorescent lamp project. That is the knowledge gap that this study sought to fill.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The chapter outlines the overall methodology used in the study. This includes the research design, population of the study, the sampling procedure, the data collection method, research procedures and data analysis and presentation.

3.2 Research design

The research design employed was a descriptive survey method aimed at evaluating factors influencing the adoption of the Kenya Power Compact Fluorescent Lamp project. According to Zinkmund (2000), descriptive research studies are designed to obtain information concerning the current situation and other phenomena and wherever possible to draw valid conclusion from the facts discussed. Zinkmund also finds that that "descriptive research studies are based on some previous understating of the nature of the research problem". The survey research endeavours to explore the existing status of two or more variables at a given point in time. The method was preferred because it allows for prudent comparison of the research findings. Descriptive survey attempts to describe or define a subject often by creating a profile of a group of problems, people or events through the collection of data and tabulation of the frequencies on research variables or their interaction as indicated.

This research adopted a descriptive survey to observe the correlation of different effects on the evaluation of the Kenya Power Compact Fluorescent Lamp project. This approach yielded quantitative and qualitative information analyzed through both qualitative and quantitative methods.

3.3 Target population

According to Mugenda and Mugenda, (2003), a population can be defined as an entire set of relevant units of analysis or data. The target population of this study is 176 members of staff from Kenya Power Company Nairobi office. The study targeted staff at different levels as shown in the table below.

Table 3.1: Target Population

Category	Population size
Senior Assistant Director	1
Assistant Director	1
Administrator	1
Central Supervisor	3
Field supervisor	50
Technicians	120
Total	176

3.4 Sampling procedure and sample size

Sampling technique provides a range of methods which enables reduction of data to be collected, by focusing on data from a sub-group rather than all cases of elements. The sampling design used was non-probabilistic since it allowed for a selection of individuals who have been involved in implementation of the compact fluorescent lamps project and that were best suited to answer the research question. This technique is also suitable when working with smaller samples since it caters for cases that were particularly informative.

The research used stratified random sampling technique to select a sample size of 55 employees from the population 176 members of staff in the KPLC headquarters. Mugenda and Mugenda, (2003), state that a sample of 30% is considered representative for a population of less than 500. So if the population is less or equal to 30% it is appropriate to carry out census study. The sample size was justified at 30% since it minimized the duplicity and redundancy of the data obtained while the size was large enough to ensure collection of comprehensive data.

Table 3.2: Sample Population

Category	Population size	Sample size (30% of Population)
Senior Assistant Director	1	1
Assistant Director	1	1
Administrator	1	1
Central Supervisor	3	1
Field Supervisor	50	15
Technician	120	36
Total	176	55

3.5 Data collection procedures and instruments

The following are the data collection procedures and instruments used in the study.

3.5.1 Research instruments

The data for this research was collected using a survey questionnaire. The survey was created using suitable questions modified from related research and individual questions formed by the researcher. In the questionnaire, the Likert scale was used to determine if the respondent agreed or disagreed to a statement. The questionnaire had both closed and open-ended questions. The questionnaire was a self-administered questionnaire, to enable the study to gather a self-report on people's opinion, attitudes, beliefs and values on the compact fluorescent lamp project.

3.5.2 Data collection procedures

The study collected both primary and secondary data. Primary data was the information the researcher obtained from the field. Primary data was collected using semi-structured questionnaires. The questionnaire was used to allow the respondents to give their responses in a free environment. The questionnaires were self-administered to all the respondents.

Secondary data refers to the information obtained from articles, books, newspapers, internet and magazines. A clear benefit of using secondary data is that much of the background work that was needed was obtained through literature review. This wealth of background work means that secondary data generally have a pre-established degree of validity and reliability which need not be re-examined by the researcher who is re-using such data.

3.6 Validity of instruments

Joppe (2000) provides the following explanation of what validity is in quantitative research where validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. In other words, does the research instrument allow you to hit "the bull's eye" of your research object? Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others.

Wainer and Braun (1988) describe the validity in quantitative research as "construct validity". The construct is the initial concept, notion, question or hypothesis that determines which data is to be gathered and how it is to be gathered. They also assert that quantitative researchers actively cause or affect the interplay between construct and data in order to validate their investigation, usually by the application of a test or other process. In this sense, the involvement of the researchers in the research process greatly reduced the validity of a test. Data quality was incorporated in the entire study process especially at the data collection point to include completeness of questionnaires, legibility of records and validity of responses. At the data processing point, quality control included data cleaning, validation and confidentiality. There are three types of validity which were addressed and stated; *Face validity* with pre-testing of survey instruments is a good way used to increase the likelihood of face validity. *Content validity* the use of expert opinions, literature searches, and pre-test open-ended questions helped to establish content validity.

To establish the validity of the instruments used in this research, the instrument were presented to the research supervisor and defended in the faculty forums where the research proposal was presented. Thereafter the questionnaire was administered with the approval of the supervisor.

3.7 Reliability of instruments

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. According to Kothari (2009), reliability refers to consistency of measurement; the more reliable an instrument is, the more consistent the measure. Reliability is influenced by random error. As random errors increase, reliability decreases. Random error is the deviation from a true measurement due to factors that have not effectively been addressed by the researcher (Mugenda & Mugenda, 2003). The researcher attempted to minimize random error and hence increase the reliability of the data collected by pre-testing the instrument and later using the same instrument to collect data.

3.8 Data analysis

The process of data analysis involved several stages: the completed questionnaires were edited for completeness and consistency, checked for errors and omissions. Qualitatively the data was sorted into themes, categories and patterns. This was to enable the researcher to make general statements in terms of the observed attributes and conceptualization of the study. Quantitative analysis was employed both descriptive and inferential statistics. Data was analysed using descriptive analysis such as descriptive statistics mean scores and standard deviations frequencies distributions and percentages. The results are presented in table and charts.

3.9 Ethical considerations

The study was conducted in an ethical manner. The researcher explained to the respondents the purpose of the study and offered assurance that any information given was treated confidentially. Informed consent was sought from all the respondents that agreed to participate. Approval of the research was sought together with a letter of transmittal from the University of Nairobi. The researcher administered the questionnaire to the respondents in person.

3.10 Operationalization table of variables

This section analyses the operational definition of variables on the evaluation of the Kenya Power Compact Fluorescent Lamp project. The variables are given in Table 3.3.

Table 3.3: Operationalization table of variables

Objectives	Variable	Indicators	Measurement	Scale	Data collection methods	Analysis tool
Determination of how cost affects the Kenya Power Compact Fluorescent Lamp project.	Cost	Cost of CFLs in initial stage. Long-term costs	Frequency Percentage Mean Standard deviation	Ordinal Nominal	Questioners Observation	SPSS
Determination of how time affects the Kenya Power Compact Fluorescent Lamp project.	Time	Time management.	Frequency Percentage Mean Standard deviation	Ordinal Nominal	Questioners Observation	SPSS
Determination of how training affected the Kenya Power Compact Fluorescent Lamp project.	Training	Education program, participatory government programs.	Frequency Percentage Mean Standard deviation	Ordinal Nominal	Questioners Observation	SPSS
Study of how information affected the Kenya Power Compact Fluorescent Lamp project.	Informati on	Education gained	Frequency Percentage Mean Standard deviation	Ordinal Nominal	Questioners Observation	SPSS

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND INTEPRETATION

4.1 Introduction

This chapter presents the data that was collected and analyzed in order to give a clear picture of the findings. The aim of this study was to perform an evaluation of the factors influencing the adoption of the Kenya Power Compact Fluorescent Lamp project in Kenya, specifically Nairobi County. The material is summarized in table form to bring out the significant features. The data was collected in its raw form and required intensive analysis in order to classify it into meaningful categories. Proper analysis assisted in making comparisons of the different reactions from the responses which guided in the formulation of the conclusion and recommendations. The data was gathered with questionnaires as the research instrument. The questionnaire was designed in line with the objectives of the study.

4.2 Questionnaire return rate

The study targeted a sample of 55 respondents from the target population in collecting data with regard to the evaluation of the factors influencing the adoption of the Kenya Power Compact Fluorescent Lamp project in Nairobi, Kenya. The questionnaire return rate results are as shown in Table 4.1

Table 4.1: Questionnaire Return Rate

Response Rate	Frequency	Percentage
Responded	48	87.2
Not responded	7	12.8
Total	55	100

From the study, 48 out of 55 target respondents filled in and returned the questionnaire making up 87.2%. This good response rate was made a reality by the researcher making personal visits to remind the respondents to fill-in and return the questionnaires as well as explaining the importance of their participation in this study. This response rate was good and representative while conforming to Mugenda and Mugenda (1999) stipulation that a response rate of 50% is adequate for analysis and reporting; a rate of 60% being good and a response

rate of 70% and over, is excellent. The questionnaires that were not returned were likely due to reasons like the respondents not being available to fill them in at that time. The response rate demonstrates a willingness of the respondents to participate in the study.

4.3 Characteristics of the study respondents

The study targeted employees of the Kenya Power Company. As such the results on demographic characteristics of these respondents were investigated in the first section of the questionnaire. Socio demographic characteristics of the respondents such as age, gender, educational level, role played, and the number of years of worked on project were important variables in this study. These variables indicate the proportions and representativeness of the respondents who were interested in this study.

4.3.1 Gender of the respondents

The research sought to find out the gender of the respondents. In this study the respondents sampled were expected to comprise both male and female stakeholders. As such, the study required the respondents to indicate their gender by ticking on the spaces provided in the questionnaire. Table 4.2 shows the distribution of the respondents by gender.

Table 4.2: Gender of the respondents

Gender	Frequency	Percentage
Male	35	72.9
Female	13	27.1
Total	48	100

It may be noted that 72.9% of the respondents comprised of male while 27.1% of them were female. The findings showed that Kenya Power had both male and female staff members. The findings imply that the views expressed in these findings can be considered as gender sensitive and can be taken as representative of the opinions of both genders as regards to the evaluation of adoption of the Kenya Power Compact Fluorescent Lamp project in Kenya.

4.3.2 Age of respondents

This study investigated the composition of the respondents in terms of age brackets to understand their familiarity with adoption of the Kenya Power Compact Fluorescent Lamp project in Kenya. The study thus posed a question requesting the respondents to indicate their

age brackets. Table 4.3 shows the results of the findings on the age brackets of the respondents.

Table 4.3: Age of respondents

Age Bracket	Frequency	Percentage
Below 25 years	4	8.3
25 – 35 years	16	33.3
36 years and above	28	58.4
Total	48	100

The findings are that 58.4% of the respondents were aged 36 years and above, 33.3% were aged between 25 – 35 years while 8.3% were aged below 25 years. These findings show that the respondents were well distributed in terms of age and that they are active in technological advancements and productivity and hence can contribute constructively adoption of the Kenya Power Compact Fluorescent Lamp project in Kenya.

4.3.3 Level of education of the respondents

The study sought to investigate the level of formal education achieved by the respondents. The difference in the level of education might contribute to differences in the responses given by the respondents. Responses to this question were as depicted in table below.

Table 4.4: Level of Education

Level of Education	Frequency	Percentage
Diploma	11	22.9
Graduate	28	58.3
Post Graduate	9	18.8
Total	48	100

These results show that 58.3% of the respondents had acquired an undergraduate degree level of education, 22.9% of the respondents indicated that they had acquired college diplomas, while 18.8% had acquired post graduate level of education as their highest level of education.

These results imply that majority of the respondents had at least an undergraduate degree and hence understood the information sought by this study. The findings further imply that all the respondents were academically qualified and were familiar with their duties and could dispense them effectively in terms of professional work ability and performance.

4.3.4 Length of service

The study therefore sought to establish the length of time that the respondents had been working in the company. The results on this question were as presented in the Table below.

Table 4.5: Length of service

Duration in Years	Frequency	Percentage
1 to 4	17	35.4
4 to 7	13	27
7 to 10	9	18.8
More than 10	9	18.8
Total	48	100

The results depicted in table above reveal that 35.4% of the respondents indicated that they had an experience of 1 - 4 years in the company, 27% of them had worked in the company for a period of 4 - 7 years, 18.8% of them had a working experience of 7-10 years, while 18.8% of the respondents indicated that they had an experience of more than 10 years in the company. This implies that the majority of respondents had adequate work experience in the company to respond effectively. Most of the respondents had worked in the company for an appreciable period of time hence suggesting that they understood the adoption of the Kenya Power Compact Fluorescent Lamp project.

4.3.5 Role played by respondents in the project

The study sought to establish the role played by respondents. The table below shows the results.

Table 4.6: Role played

Role played	Frequency	Percentage

Project sponsor	3	6.3
Management representative	6	12.5
Project Leader / manager	11	22.9
Technical expert	28	58.3
Total	48	100

According to these results, 58.3% of the respondents comprised of technical experts, 22.9% of them were Project Leaders, another 12.5% of the respondents were Management representatives and 6.3% were Project sponsors. The results imply that the various stakeholders had significant information sought by the study which is essential in coming up with recommendations on evaluation of the factors influencing the adoption of the Kenya Power Compact fluorescent lamp project in Kenya since the results depict the opinions of the involved stakeholders from the various designations involved.

4.4 How cost affected project adoption

The respondents were asked to rate cost factors affecting the project. The results are shown in the table below.

Table 4.7: Effect of cost on the project

	N	Mean	Standard deviation
Budget to be done before the project is initiated	48	4.4029	0.6653
Costs are evaluated for purposes of planning	48	4.6658	0.8688
High costs of projects affect planning and implementation	48	4.4517	0.7541
Price as an initial barrier with retail prices being high	48	4.2154	0.6857
Income plays an important role in decision about adoption of energy-conserving technologies	48	4.1544	0.7548
Costs have an indirect influence on the capital investment in energy efficiency projects	48	4.2651	0.3271
The payback period is dependent on the price, life time of the lamp and also on the ratio between the lamp price and electricity price	48	4.3257	0.4567
CFLs have higher purchase cost than incandescent lamps	48	4.1779	0.8655
CFLs are cost effective in the long run as they save much money in their life time while their payback time is short	48	4.1357	0.6648
The electricity bill for customers will be reduced by about 75 %.	48	2.3463	0.9876
By replacing incandescent lamps with CFLs, the utility could save money	48	4.0325	0.9654

These are descriptive results which indicate that majority of the respondents agreed with the factors in consideration in the following way. They strongly agreed that Costs are evaluated

for purposes of planning m=4.6658 and High costs of projects affect planning and implementation m=4.4517. They agreed that Budget has to be done before the project is initiated m=4.4029; The payback period is dependent on the price, life time of the lamp and also on the ratio between the lamp price and electricity price m=4.3257; Costs have an indirect influence on the capital investment in energy efficiency projects m=4.2651; income plays an important role in decision about adoption of energy-conserving technologies m=4.1544; CFLs are cost effective in the long run as they save much money in their life time and their payback time is short and CFLs have higher purchase cost than incandescent lamps m=4.1357. The respondents disagreed that the electricity bill for customers will be reduced by about 75 % m=2.3463.

The results show that while the majority of the respondents rate cost of the CFLs as a factor influencing the adoption of the CFLs, the consensus on the electricity cost reductions resulting from adoption of CFLs was mixed. The results also show that the budgeting and planning of the project will have a direct effect on the adoption. Costs also have an indirect effect on the adoption of the project especially with regard to the initial purchase cost and the long-term cost-effectiveness.

4.5 How time influenced the project adoption

The respondents were asked to rate time factors on their influence on the project adoption. The results are shown in the table below.

Table 4.8: Effects of time on the project

	N	Mean	Standard deviation
Time is an important factor in project management.	48	4.6524	0.8651
Efficient use of time enables success of a project	48	4.5625	0.3265
Staff are trained in time management before the project starts	48	4.2741	0.5554
A schedule is done that show how every phase will be implemented and the time it will take.	48	4.3873	0.4124
Timing of purchase is influenced by expectations from innovative technology	48	4.3651	0.8647
More than 40% of appliance purchases are connected to replacement and moving to a new residence	48	3.2233	0.8101
The CFL life time is sensitive to frequent on/off switching.	48	4.3215	0.3261
CFLs contain a small amount of mercury for which they should be recycled after they are burnt out	48	4.1572	0.9517
The payback time for the CFL is about 1453 hours in Kenya and after that time the customers will pay only a very small energy bill.	48	2.2653	0.4325

The results in the table show that majority of the respondents strongly agreed that Time is an important factor of project management m= 4.6524 and Efficient use of time enables success of a project m=4.5625. The respondents agreed that A schedule is done that show how every

phase will be implemented and the time it will take m=4.3873; Timing of purchase is influenced by expectations from innovative technology m=4.3651; Their life time is sensitive to frequent on/off switching m= 4.3215; Staff are trained in time management before the project starts m= 4.2741; CFLs contain a small amount of mercury for which they should be recycled after they are burnt out m=4.1572. The respondents moderately agreed that more than 40% of appliance purchases are connected to replacement and moving to a new residence m=3.2233. The respondents however disagreed that the payback time for the CFL is about 1453 hours in Kenya and after that time the customers will pay only a very small energy bill m=2.2653.

The results show that the respondents consider time management as a factor influencing project success. They also agreed that efficiency in time management, scheduling and implementation work hand-in-hand to affect the project adoption. Another finding relates to the purchase of CFLs where the consumer is influenced by expectations from new technology and the replacement of older items while moving to a new residence. The respondents disagreed with the concept of payback time in Kenya for CFLs being 1453 hours. So a majority of respondents viewed time management as being crucial to project adoption.

4.6 How training influenced the project adoption

The respondents were asked to rate the training factors affecting project adoption. The results are shown in the table below.

Table 4.9: Effects of training on the project

	N	Mean	Standard deviation
Necessary training workshops were conducted for the team to foster team work	48	4.3741	0.5554
The project team members were experienced, knowledgeable and had necessary skills for delivery of the project	48	4.0879	0.4124
Project team showed commitment and achieved their targets and goal in time	48	3.5651	0.8647
Project team is all inclusive and representative of all key stakeholders	48	3.6524	0.8651
Consumers should be trained on about energy saving features	48	4.0625	0.3265
Lack of understanding of CFLs is a major contributor to the reluctance of the customer to use CFLs	48	3.9781	0.6002
Training can include giving consumers energy audits to provide customers with reasons to encourage and to save energy by use of CFLs	48	4.2879	0.3452

These results indicate that a majority of the respondents agreed that necessary training workshops were conducted for the team to foster team work m=4.3741; Training can include giving consumers energy audits to provide customers with reasons to encourage and to save energy by use of CFLs m=4.2879; Consumers should be trained on about energy saving

features m=4.0625; The project team members were experienced, knowledgeable and skilled for necessary for delivery of the project m= 4.0879;; Lack of understanding of CFLs is a major contributor to the reluctance of the customer to use CFLs m=3.978; Project team is all inclusive and representative of all key stakeholders m=3.6524 and Project team shows commitment and achieves their targets and goal in time m=3.5651.

The results show the respondents majorly agreeing that training of staff and consumers underlies the adoption of CFL lamps project. The training was of different aspects depending on the target group while conversely a lack of training on the use of the new technology adversely affected project adoption.

4.7 How information affected the project adoption

The respondents were asked to rate the information factors influencing project adoption. The results are shown in the table below.

Table 4.10: Effects of information on the project

	N	Mean	Standard deviation
Information is vital since it helps in decision making	48	4.3454	0.7851
Information is gathered from different sources for purposes of planning	48	4.0879	0.2265
Prior testing is done before implementation to enable acquire information	48	4.4041	0.5054
Information on usage, efficiency and effectiveness is gathered before planning is done.	48	4.4563	0.4184
Consumers often lack information and expertise in processing and applying the information	48	4.3242	0.7637
Lack of knowledge prevents customers from making decisions on energy investments	48	4.0987	0.7201
The presence of knowledge can also lead to non-adoption of energy-efficient technology	48	3.2432	0.3243
A lack of awareness is a minor barrier	48	4.2372	0.8617
Even in the regions with very active awareness campaigns, 10% of households didn't install CFLs due to not having heard of them	48	3.5653	0.425

The results show that the respondents agreed that Information on usage, efficiency and effectiveness is gathered before planning is done m=4.4563; Information on usage, efficiency

and effectiveness is gathered before planning is done m=4.4041; Information is vital since it helps in decision making m=4.3454; A lack of awareness is a minor barrier m=4.2372; Lack of knowledge prevents customers from making better decisions on energy investments m=4.0987; Information is gathered from different sources for purposes of planning m=4.0879; Even in the regions with very active awareness campaigns 10% of households didn't install CFLs due to not having heard of them m=3.5653. The respondents moderately agreed that the presence of knowledge can also lead to non-adoption of energy-efficient technology m=3.2432.

The results show the respondents agreeing that information on the CFLs was the key to successful adoption. Information considered was on the usage, efficiency and effectiveness. Information was reported to be vital to decision making and is gathered from different sources. On the other hand, information that was pre-existing was reported to sometimes prevent success in adoption, more so when decisions are made without proper information. Lack of information also militated against uptake while some information dissuaded consumers from accepting the new developments.

4.8 Testing of hypothesis

The hypotheses are summarized in the table below.

Since the direction of influence is not determined as the alternative hypotheses are non-directional, this calls for a single sample two-tailed test. Because the population mean is unknown, the *t*-test with n-1 degrees of freedom (df = n-1 = 47) is the most appropriate test. The study assumed a 0.05 level of significance. As the sample size was larger than 40 and based on the central limit theorem, the sampling distribution of the mean will be approximately normal (after Privitera). Computing the *t-value*

The standard error of the mean *SE* was computed as follows;

$$SE = \sigma * \sqrt{\left\{\left(\frac{1}{n}\right) * \left(1 - \frac{n}{N}\right) * \left[\frac{N}{(N-1)}\right]\right\}}$$

Where;

SE = Standard error of the mean

σ = Sample standard deviation

n = Sample size

N = Population size

Then, the t-statistic was computed as follows;

$$t = \left(\frac{\bar{x} - \mu}{SE}\right)$$

Where;

t = t-statistic

x = sample mean

μ = hypothetical population mean

These results are significant and lead to decisions about the hypothesis as shown in the table.

Table 4.11: Hypothesis Testing

Hypothesis	**Sample mean**	***SD***	***t-score***	***p-value***	***α***	**Result**
(H_0): No relationship between cost and the adoption (H_1): Cost has an effect on the adoption of compact fluorescent lamps	4.8796	0.3087	-2.0109	0.1573	0.05	**Accept H_1 & Reject H_0**
(H_0): Time management in project planning and execution has no effect on the adoption (H_1): Time management in project planning and execution has a direct effect on the adoption	4.5531	0.2891	-3.1010	0.00096	0.05	**Accept H_1 & Reject H_0**
(H_0): Staff and consumer training have no implication on the adoption (H_1): Training of staff and consumers has a direct bearing on the adoption	4.129	0.2583	-3.800	0.0286	0.05	**Accept H_1 & Reject H_0**
(H_0): There is no effect of information on the adoption (H_1): Information on CFLs has a direct effect on the adoption	4.0654	0.2185	-2.5081	0.0105	0.05	**Accept H_1 & Reject H_0**

For the first objective of the determination of the effect of cost, the null hypothesis is rejected and the alternative accepted. This means that cost has an effect on the project adoption.

Specifically, cost has both a direct effect through purchase price and project expenditure, and an indirect effect through long-term cost-effectiveness of CFLs.

For the second objective to investigate how time affected the project adoption, the null objective is rejected and the alternative hypothesis is accepted, concluding that time has an influence on the project adoption through balancing the needs of optimization and time constraints on the consumer.

Training as a factor of project adoption was the subject of the third objective. Here, the null objective was rejected and the alternative accepted. From this, the training of implementing staff and the target consumers was seen to directly influence the adoption of the project especially through eliminating reluctance to adopt new technology.

The fourth objective investigated the influence of information on project adoption. The null hypothesis is rejected while the alternative is accepted showing that information has a direct bearing on the project adoption. This effect can be either positive or negative depending on whether proper information is available to the consumers.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the findings of the study and interpretation of the data analysis, discussions, conclusions and recommendations based on the findings. Further areas of study are also suggested.

5.2 Summary of findings

The study was aimed at investigating the factors influencing the adoption of the Kenya Power Company project on Compact Fluorescent Lamps in Nairobi County. This was to provide information on the relevant areas that impinged on the adoption of the project.

The first objective of the study was to investigate the effect of cost as a factor of project adoption. It was determined that whereas high initial costs discourage adoption of the CFLs, the long-term cost benefits on the cost of electricity and maintenance encourage adoption of the project. However, the consensus on electricity cost reductions from use of CFLs was mixed and this would require a separate long term study. By the utility absorbing the initial cost of the project, the uptake of CFLs was greatly enhanced. Thus, cost was found to have both a direct and indirect effect on project adoption.

The second objective of the study was to determine how time affected the project adoption. From the findings, 40% of new appliance purchases are linked to movement to a new residence. It was also found that the timing of purchase of CFLs was influenced by expectations of innovative technology. Since efficient use of time enables success of the project then time is an important factor in the project adoption.

The third objective of the study was to analyse how training influenced project adoption. The study found that a majority of implementing staff were involved in training workshops, and were experienced, knowledgeable and possessed necessary skills. Lack of training was seen as adversely affecting the project adoption. The project team were also found to be committed to the project and were thus able to achieve their goals in time. The study also found that training and involvement in energy audits has a positive correlation with the project adoption. It was thus concluded that training had a positive influence on project adoption.

The fourth objective was to determine how information affected the project adoption. Information was found to be vital in good decision making. Because prior testing was necessary before implementation of the project, consumers sometimes lacked information and expertise in processing and applying this information. This lack of information prevented them from proper decision making regarding energy investments. It was further found that since the information is gathered from different sources, it becomes a crucial factor influencing the project adoption.

5.3 Discussions

The study found that cost is a major factor influencing project adoption. Specifically, the high entry costs associated with CFLs would have discouraged adoption of the project, were it not for the utility's decision to absorb the initial costs for the consumers involved in the project. these findings are in agreement with DeCanio and Laitner who found that high entry costs for consumers tend to discourage adoption of energy efficient opportunities while Anderson and Newell have also postulated that these high hurdle rates for the investor discourages adoption especially when hidden costs and other risks that may not be obvious are considered. Because of the decision by Kenya Power to underwrite the costs associated with project implementation, and the determination of the utility company to trade off the benefits from CO_2 reductions as part of the Clean Development Mechanism, this was seen to directly affect the adoption of the project (DeCanio & Laitner, 2003 and Anderson & Newell, 2004).

Time management was found to be a factor influencing the adoption of the project. Specifically, the efficiency in time management was found to greatly enhance the success of the project due to timelines being met, while the possibility of failure is averted. Becker found that a well defined project plan that stipulates the correct project schedule and is followed will enhance project adoption. From the study findings, the efficient use of time both by the utility company and the consumer were identified as factors influencing the adoption of the project. Because the consumer was time-bound in decision making with regard to energy efficiency, then it can be seen that the use of critical time management policies will affect project adoption positively (Becker, 1993).

The study found that the project team was committed and achieved their goals and targets when they were trained. It was also shown that the consumers were more likely to embrace new technology when they had been trained and educated on the benefits expected and

involved in energy audits. Training of organisational staff was found by Colarelli and Montei to lead to higher degrees of employee retention and productivity. It was further reported separately by Becker and Beardwell et al. that organisational goals are more likely to be met when proper training of the employees was done especially when new technology is being introduced. Therefore, it can be seen that the study findings were in agreement with published works with regard to training and adoption of the project (Colarelli & Montei, 1996, Beardwell et al, 2004 and Becker, 1993)

The study found that information plays a crucial role in project adoption. Consumers were found to often lack information and expertise in new technology. Because of this lack, the consumers were prevented from making good decisions on energy investments. De Groot et al found that lack of information is a source of market failure in investments. Conversely, it was also found that the consumers who had incorrect information were also discouraged from proper decision making regarding energy efficiency. Trianni and Cagno also showed that lack of information in the implementing staff would lead to unreliable methods of decision making regarding energy-efficient models. Therefore, proper information was crucial to both the implementing team and the consumer in ensuring the success of the project. Thus it can be concluded that proper information given at the proper time is a key tenet affecting project adoption (De Groot et al, 2001 and Trianni & Cagno, 2012).

5.4 Conclusions

From the study findings it is evident that the factors considered in the study have a direct effect on the success of project adoption. Cost has been postulated by previous research to have a contradictory effect on project success through leading to the so-called "efficiency paradox". According to the study findings, cost remains both an inhibiting and promoting factor. If unchecked, the entry cost of CFL lamps remains untenable to the population. However, should the utility company seek to broaden the adoption, subsidizing their cost would lead about to increased uptake. Cost implications of maintenance and replacement also need to be borne in mind when looking at the adoption patterns. Since these latter costs are periodic and episodic, then their effect may not be clearly seen without long-term study of the target market.

Time management remains a critical facet of project implementation. In light of the CFL project, time management needs to be considered from the aspect of both the project

implementer and the intended beneficiary. Before the project commencement, the proper drawing up of a work plan while budgeting for time allocation is crucial. For the consumer, the timing of new purchases impinges on the acceptability, financial ability and undertaking to purchase. Managing the expectations of the consumer also affect the timing since new technology tends to face a difficult route to acceptance especially when replacing established technology.

Training influences project adoption in both direct and indirect ways. Firstly, the training of the implementation team will enhance their capacity in executing their mandate effectively and within scope. When interacting with the consumer who is the beneficiary of the project, the project team is then able to bring out the advantages of the new technology versus the older incandescent lamps. The team can also then educate the consumer on their responsibility and what to expect with regard to the CFLs. Secondly, training of the consumer allows the utility to interest, involve and bring on board the consumer. Because the technology is still relatively new, the training reinforces the desire of the consumer to enjoy technology (through lighting) while saving money (through reduced expenditure). Training also provides an entry point for the utility to deal with issues that may cause reluctance in the consumer by enabling a free exchange of ideas in both formal and informal environments.

Information leads to both positive and negative effects on project adoption. From previous studies, the use of rule-of-thumb concepts in decision making with regard to energy efficiency has been well documented. The study concurs with those findings with the added qualification that pre-existing information can sometimes be a minor barrier to the adoption. This is true especially when the benefits to the consumer can be demonstrated easily and spread by word of mouth. Since information is vital for good decision making, it is in the interest of the utility to ensure that proper information is disseminated to the target audience to improve adoption of the project.

5.5 Recommendations

Energy saving is going to be agenda of any individual or a government in near future at all forms. In order to save energy for the next generation, households or corporate bodies need to replace incandescent lamps with CFL bulbs. And also it is recommended for the market and utilities to insist that consumers use CFLs through benefit-based awareness programs and marketing efforts.

The government through the Ministry of Energy may also be encouraged to consider more ambitious approaches. For example, the complete phase out of the inefficient incandescent lamps may constitute an adventurous but achievable policy objective. The government should therefore consider collaborating with other governments, international bodies, researchers and energy developers and investors to define an internationally binding agreement to completely phase out incandescent lamps. They may also wish to consider using the case of CFLs to push for more projects targeting energy efficiency as a direct boost to the economic performance of their jurisdictions by reducing costs.

Policy makers should therefore consider the reasons why the targeted population may not be engaged in their programmes. They should also plan and implement strategies to reduce resistance and inertia while providing positive incentives to engagement. This may be achieved through effectively lowering the entry point and cost especially for new technologies. Effective policy development considers all the perspectives and factors influencing market engagement and designs instruments to address the key barriers until a positive tipping point is passed. It is best if this can be done from the outset. However, it is usually not possible to foresee all factors in advance, so policy implementation should also build in a monitoring and evaluation feedback process to improve the outcome of the project.

5.6 Areas suggested for further study

Further studies should focus on awareness and utilization of compact fluorescent lamps among households.

Future study may also be directed at analysing the long-term effect of the adoption of CFLs on the stability of the electricity supply network and the effect of mass-uptake of CFLs on electricity consumption trends.

Another possibility is the possible adverse health effects caused by the CFLs when disposed of without proper disposal programs especially with regard to ground water quality with regard to the heavy metal content of the CFLs especially mercury, phosphorus and cobalt.

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APPENDICES

Appendix 1: Letter of transmittal

PHILIP KANDIE KIPTOON

University of Nairobi,

School of Distance and Continuing Education,

P.O Box 30197,

Mombasa.

Dear Sir/Madam,

I am a Masters student at the University of Nairobi, School of Continuing and Distance Education. In partial fulfilment of the requirement for a Master of Arts in Project Planning and Management, I am conducting a survey on the FACTORS INFLUENCING THE ADOPTION OF THE KENYA POWER COMPACT FLUORESCENT LAMPS PROJECT IN NAIROBI COUNTY.

I am glad to inform you that you have been selected to form part of the study. I would therefore kindly request you for your assistance in completing the attached questionnaire which forms a major input of the research process. The information and data will be used for academic purposes only and strict confidence shall be observed on the same.

You cooperation will go a long way in ensuring the success of this project.

I would like to thank you in advance for your valuable time and consideration.

Yours Sincerely,

PHILIP KANDIE KIPTOON

L50/60891/2010

University of Nairobi

Appendix 2: Questionnaire

Instructions

Please tick (☑) the box that best matches your answer or fill in the space where provided.

The information sought hereunder relates to the Kenya Power Company Compact Fluorescent Lamp project. Please fill it out completely and accurately and to the best of your knowledge.

PART A: General Information **Date ……**

1. What is your gender? (tick one)

   Male ( )

   Female ( )

2. What is your age range? (tick one)

Below 25 years ( )

25 – 35 years ( )

36 years and above ( )

3. What is your highest formal academic achievement?

Diploma [ ]

Undergraduate [ ]

Postgraduate [ ]

4. How long have you been working in your present capacity?

Up to 4 years ( )

4 to 7 years ( )

7 to 10 years ( )

Over 10 years ( )

5. Kindly indicate your official position/title in the organization (e.g. Project Engineer)

   _____

6. How long have you worked in the electrical energy industry? (include time spent in other employment but within the industry)

1 – 4 years ( )

4 – 7 years ( )

7 – 10 years ( )

Over 10 years ( )

PART B:

7. What is your role in the indicated Compact Fluorescent Lamp project?

Project sponsor [ ]

Management representative [ ]

Technical Expert [ ]

Project Leader/Manager [ ]

Other role (please specify) _____

Cost significance on the adoption of the Kenya Power CFL project

8. In your opinion, to what extent does cost affect project implementation?

Very high extent ( )

High extent ( )

Medium extent ( )

Low extent ( )

Very low extent ( )

9. What are the cost factors under consideration in the CFL project? (in order of importance, 1 being the least important and 5 the most important)

	1	2	3	4	5
Budget has to be done before the project is initiated					
Costs are evaluated for purposes of planning					
High costs of project affects planning and implementation					
Retail prices of CFL are high and a barrier to adoption					
Adoption of energy-efficient technologies is dependent on income level					
Capital investment in energy-efficient technologies is indirectly related to their cost					
Payback period of CFLs is dependent on the purchase price, lifetime of the lamp and the ratio of price of lamp to price of power					
CFLs are more expensive to buy than incandescent					
In the long-run, CFLs are more cost effective than incandescent lamps as they consume less					
Following adoption of CFLs, customers should expect a reduction of 75% in their power bill					
Kenya Power will save money from the CFL adoption					

10. (a) According to your own view, do financial resources affect the compact fluorescent project? Yes ( ) No ( )
    (b) Briefly explain your answer in question 10 (a) above.

    ……
    ……
    ……

Time implications on the adoption of the Kenya Power CFL project

11. In your opinion, to what extent does time affect project implementation?

Very high extent ( )

High extent ( )

Moderate extent ( )

Low extent ( )

Very low extent ( )

(Please fill out the table below in order of importance with 1 being the least important and 5 the most important)

	1	2	3	4	5
Time is an important factor of project management.					
Efficient use of time enables success of a project					
Staff are trained on time management before the project starts					
A schedule is done showing how every phase will be implemented and the time it will take to achieve.					
Expectations from innovative technology influences the timing of purchase of CFL lamps					
Moving to a new residence and replacements will influence 40% of appliance purchases					
CFL lifetime is sensitive to frequent on/off cycles					
CFLs contain a small amount of mercury hence should be recycled once burnt out					
Payback period of investment in CFL can be computed based on 5 hrs/day usage and 9 month usage to 1453 hrs after which the power bill will greatly reduce					

Training and its effects on the adoption of the Kenya Power CFL project

12. In your considered opinion, to what extent does training affect project implementation?

Very high extent ( )

High extent ( )

Moderate extent ( )

Low extent ( )

Very low extent ( )

(Please fill out the table below in order of importance with 1 being the least important and 5 the most important)

	1	2	3	4	5
Necessary trainings workshops were conducted for the team to foster team work					
The project team members were experienced, knowledgeable and skilled for necessary for delivery of the project					
The project team showed commitment in achieving their targets and goals in time					
The project team is all inclusive and representative of all key stakeholders					
Consumers should be trained on energy saving features of CFLs					
A lack of understanding of CFL greatly contributes to the reluctance of customers to use them					
Training may include energy audits to provide incentives for clients to save power through using CFLs					

Information and its effect on the execution of the Kenya Power CFL project

13. In your opinion, to what extent does knowledge affect project implementation

Very high extent ( )

High extent ( )

Moderate extent ( )

Low extent ( )

Very low extent ( )

(Please fill out the table below in order of importance with 1 being the least important and 5 the most important)

	1	2	3	4	5
Information is vital since it helps in decision making					
Information is gathered from different sources for purposes of planning					
Prior testing is done before implementation to enable Kenya Power acquire information					
Information on usage, efficiency and effectiveness is gathered before planning is done					
Customers often lack information and necessary expertise in processing and applying information on CFLs					
Lack of knowledge will prevent customers from decisions on energy investments					
Knowledge can sometimes prevent adoption of energy-efficient technologies					
Lack of awareness on CFLs would be a minor barrier to their uptake					
10% of households still did not install CFLs in spite of intensive awareness campaigns because they had not heard about them					

14. To the extent of your knowledge, how does Kenya Power obtain relevant information required for projects execution and adoption?

    .....
    .....

15. What other factors do you think will affect the Compact Fluorescent Project?

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Thank you for taking your time to fill out this questionnaire. Your responses will be of great assistance to the researcher and will remain confidential only being used for purposes of the research. The information will not be shared with any third party(s) in any identifiable manner.