2020

An Assessment of the challenges affecting electricity transmission network expansion in Kenya; a case study of KETRACO

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AN ASSESSMENT OF THE CHALLENGES AFFECTING ELECTRICITY TRANSMISSION NETWORK EXPANSION IN KENYA; A CASE STUDY OF KETRACO

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MPPM/102014/17

Submitted in partial fulfillment of the requirements for the Degree of Masters in Public Policy and Management at Strathmore University.

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Nairobi, Kenya

November 2020

DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

Sitienei Lydia Chelagat
November 2020

Approval

The dissertation of **Sitienei Lydia Chelagat** was reviewed and approved for examination by; -

Prof. Robert Mudida (Supervisor)

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ABSTRACT

Electricity remains a key economic driver in promoting economic activities such as manufacturing and trade. The Kenyan government in late 2008 introduced KETRACO, as a company with the sole mandate of planning, designing, building, operating and maintaining the national electricity transmission grid in the country. Since its inception, when compared to the planned 16,000km grid expansion, only 1,800km has been achieved by the Kenya Electricity Transmission Company Ltd (KETRACO). It is on this merit that the study sought to assess the challenges affecting electricity transmission network expansion in Kenya, the emerging trends and the possible solutions to the challenges thereof. The study adopted an exploratory research design with the targeted population being the stakeholders in the energy sector in Kenya who include KETRACO, the Ministry of Energy, the National Treasury, Kenya Power & Lighting Company (KPLC), and the Kenya Electricity Generating Company (KenGen). Purposive sampling was used where 103 respondents were chosen based on their knowledge and experience on electricity transmission and power management. A structured questionnaire was used to collect data which was analysed through mixed analysis methods. Documents review guide enabled collection of secondary data from sectoral plans and official documents within the Energy Sector. Quantitative data was analysed using descriptive and inferential statistics while qualitative data was analysed using content analysis. The study concludes that all the three challenges namely implementation capacity, right of way acquisition and vandalism negatively affect electricity transmission expansion efforts of KETRACO. The study underscores a need for an integrated plan of action within the sector and enhanced training of personnel with regard to specific skills relating to transmission. The study recommends allocation of adequate financial resources by the government especially for operation and maintenance while citing the importance of developing a community engagement plan for the areas along which the transmission line passes and the need to leverage on technology to reduce the land space needed for right of way acquisition. Use of the already existing government reserves alongside other public infrastructures such as roads networks, water and sewerage infrastructure, railways among others could be considered to reduce wayleave acquisition challenges. The researcher also recommends further research on use of technologies such as monopoles as opposed to lattice towers to reduce the negative effects of the right of way and underscores the need for research on the materials used in the construction of transmission towers to assist KETRACO in identifying safer materials and technology that could deter vandalism.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my Supervisor, Professor Robert Mudida, without whom this work would not have been possible. I am deeply indebted to him, my colleagues and other public officers in the Energy Sector for having provided me with extensive personal and professional guidance during the course of this study. I would especially like to thank my family for their patience during my time of studies. They gave up so much in order for me to complete my MPPM programme.

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LIST OF ABBREVIATIONS/ACRONYMS

AC	Alternating Current
ADB	Asian Development Bank
CPTL	Cambodia Power Transmission Lines
DC	Direct Current
EPAct	Energy Policy Act of 1992
EPRA	Energy & Petroleum Regulatory Authority
GDP	Gross Domestic Product
HV	High Voltage
IPP	Independent Power Producers
OECD	Organization for Economic Cooperation and Development
PAP	Project Affected Person
PPP	Public–Private Partnership
PSP	Private Sector Participation
GDC	Geothermal Development Company
GoK	Government of the Republic of Kenya
HVDC	High Voltage Direct Current
KenGen	Kenya Electricity Generating Company Ltd
KETRACO	Kenya Electricity Transmission Company Ltd
KNEB	Kenya Nuclear Electricity Board
KPLC	Kenya Power and Lighting Company Plc
kV	kilovolt
LCPDP	Least Cost Power Development Plan
LTWP	Lake Turkana Wind Power
MOE	Ministry of Energy
REREC	Rural Electrification & Renewable Energy Corporation
ROW	Right of Way Acquisition
T&D	Transmission and Distribution
UETCL	Uganda Electricity Transmission Company Limited
vRE	Variable Renewable Energy

DEFINITION OF KEY TERMS

Compensation	Payment for an asset that is affected or acquired for a project. This may be monetary or in kind.
Easement	Refers to the right amounting to an interest allowing for restriction of another's land. The owner of the land accepts the holder of the easement to enjoy the ROW by omitting to do some defined act or allowing some defined act to be effected on his land. An easement conveys limited rights to KETRACO for a specified use, while property owners retain the land for other uses.
Electricity Transmission	Refers to the transportation at high voltage (132-kilovolt or above) of large amounts of electricity produced at power plants over long distances for eventual use by consumers.
Emerging Trends	Refers to changes in integration of renewable energy, technological changes, increased demand and environmental policies in respect of transmission network
Idling Charges	Refers to the cost of idle equipment resulting from legitimate requests by contractors for additional compensation in time and/or costs due to the changes occasioned by KETRACO
Factors	Refers to the issues facing transmission expansion which includes implementation capacity, vandalism and right of way acquisition challenges.
Implementation Capacity	Refers to the necessary human resource capacity and security measures in KETRACO required to successfully implement transmission infrastructure projects
Independent Power Producers (IPPs)	Refers to the private investors in the power sector involved in generation under the Feed In Tariff Policy.
Public–Private Partnership	Refers to a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance
Least Cost Power Development Plan	This is the energy sector's plan that guides stakeholders with respect to how the sector plans to meet the energy needs of the nation for subsistence and development at least cost to the economy and the environment. The LCPDP as indicated in the Vision 2030 medium term plan aims at enhancing national power generation and supply.
Project Affected Person	Refers to any person who, by virtue of implementation of a project, loses the right to benefit, use, or own land, structures, trees, crops or any other immovable or moveable asset, either in full or in part, permanently or temporarily.
Right of Way Acquisition	Refers to the wayleaves corridor that must be acquired from the public and registered as easements in order to gain access for transmission line construction.
Solutions to Transmission	Refer to technological innovation to reduce system losses, techno-based transmission and increased financing to support electricity transmission projects

Transmission Network	Refers to the high voltage Transmission Power Network owned and operated by KETRACO and which shall also be referred to as the System.
Vandalism	Refers to destruction and theft of transmission equipment including cables and tower members.
Wayleave	This is a registrable right of way over the land of another for carrying public infrastructure projects such as sewers, pipelines, electricity poles, water pipes etc. over, into, under or through any land but which may interfere with the existing structures.
Wheeling	Refers to the term used to describe the free movement 'transportation 'of electricity along interconnected transmission lines.
Wheeling revenue	Refers to the amount of wheeling charges, which may be charged by KETRACO for wheeling of electricity.

1.0 CHAPTER ONE: INTRODUCTION TO THE STUDY

1.1 Introduction

This Chapter details the background information on electric power systems across the globe and in Kenya while demonstrating the challenges facing transmission sector in developed countries as compared to advanced economies. This chapter also describes the structure of the energy sector in Kenya while detailing the institutions and stakeholders therein. The statement of the research problem, the objectives, scope and significance of the study have also been discussed in this Chapter.

1.1.1. Background to the Study

Electric power systems are among the most capital-intensive parts of a modern economy since their successful development requires massive deployment of resources from both the public and private sectors. Development of transmission assets requires intensive capital investments over a prolonged duration to time. Realization of return on investment is therefore achieved in the longer term. This implies that projects' execution risk is increased hence decreased benefits in the shorter term. Generally, the following risks impact on timely delivery of transmission projects: (i) conflicts associated with regulatory requirements, community demands as well as private and public institutions with respect to land use, (ii) challenges associated with valuation of crops and trees for compensation, (iii) community restrictions on ancestral land use (iv) negative perception on the effects of electromagnetic fields on the health of humans, (v) hypothetical negotiations while undertaking valuations for easements, and 6) technical specifications changes in the procurement process (Molina & Rudnick, 2014).

Over the past few decades, many structural reform programs involving private sector participation cutting across the electricity sector have been embraced by many countries. For example, the Latin American countries and member states of the Organization for Economic Cooperation and Development (OECD) have restructured their business models to accommodate more private finance as opposed to public investments in financing the transmission of electricity. In the United Kingdom, for example, privatization of state-owned electricity utilities reflected the ideology of the Thatcher government and its interest in reducing the costs of domestic coal subsidies, among other things (Erdogdu, 2014). This has also rapidly spread to Asia. In June 2007, the Asian Development Bank (ADB) funded the construction of the 221-kilometer, 115 kilovolt (kV) transmission line by CPTL to a tune of $8 million from its ordinary capital resources (Asia Development Bank, 2013). In India for example, the Electricity Act, 2003 opened up private investment in electricity transmission, power trading and other features (Yoginder, 2013). INR18,300 crore of projects went under tariff-based competitive bidding in 2015–16 (Ernst & Young, 2016). In Japan, however, utilities are predominantly privately owned.

In 1998, Peru's GDP per capita was US$3,266, and in 2006 India's was US$1,056. In comparison, Kenya's current GDP per capita is US$1,113 and Nigeria's is US$2,535. (World Bank, 2017). Nine of the African countries out of thirty-eight have do not have transmission lines above 100 kilovolt (kV). The total length of transmission in these thirty-eight countries in Africa is 112,196 kilometers (km), which is less than Brazil's at 125,640 km, and, United States of America at 257,000 km. Despite its large land mass, Africa also has fewer kilometers of transmission lines per capita than other regions. The length of transmission lines in Africa is 247 km per million people: excluding South Africa, this indicator drops to 229 km per million people. In contrast, Colombia has 295km of transmission lines per million people, Peru has 339km, Brazil has 610km,

Chile has 694km, and the United States has 807km. Building more transmission lines and upgrading transmission capacity will be an essential part of the overall expansion of the electricity sector. As Africa needs transmission both within and between countries, investments are required at both the national and regional levels. Africa needs to invest in long-distance lines, using both alternating current (AC) and direct current (DC) technologies, and to expand in-country transmission networks at a range of voltages. Africa has large low-cost hydro generation resources, but the realized potential is far below the load they could serve. Transmission investment, including investment in transmission between countries, is needed to connect these resources to consumers. In-country investments requirements are also large covering various project types (World Bank, 2017).

Generally, as part of a wider market oriented reform program, governments have embraced private sector participation in transmission and distribution (T&D) in order to offset years of underinvestment and poor operating performance under public ownership; attract considerable private investment to fill the financing gap stemming from new T&D additions amid rapidly growing demand for electricity; and raise fiscal revenues by offloading state assets. In the cases of Brazil and Peru, prolonged electricity supply crises prompted the respective governments into structural reforms of the T&D sector (Energy Sector Management Assistance Program, 2014).

Transmission, which has traditionally been considered a natural monopoly, and which contributes a relatively small part of the overall cost of the sector value chain, needs to move in tandem with additions to generation capacity in order to achieve timely transmission and final delivery to consumers (World Bank, 2017). Braumol (1977) defines a natural monopoly as a single firm in an industry that is capable of producing output to supply the entire market at a lower per-unit cost than can two or more firms or an industry to which entrants are not 'naturally' attracted and are incapable of survival, even in the absence of predatory.

Electricity transmission remains as one of the best ways most governments across the globe use to speed development and promote industrialization across the board. In developed countries like China and Japan, electricity transmission has been upheld by their governments where numerous investments through government allocations are made to steer the process (Japan Electric Power Information Centre, JEPIC, 2019). In these countries, the challenges facing the transmission sector highly differ with those faced in developing countries. In Japan for-instance, JEPIC report notes that natural calamities such as earthquakes and international policies affect the expansion of the electricity transmission network. In the USA, Quadrennial Technology Review (2015) records that the major challenges facing electricity transmission in the country include climatic changes, environmental issues as well as global energy competitiveness. Wessner and Wolff (2012) propose that for the USA to expand its electricity transmission network further from the current 200,000 miles, there ought to be continued investment in innovativeness and effectively adopting techno-based transmission as well as integrating renewable energy.

In Africa, countries like Egypt and South Africa have recorded rapid growth in electricity transmission network expansion but also with their couple of challenges as well. In Egypt, as highlighted by Dóci, Vasileiadou and Petersen (2014), electricity transmission network expansion is faced by challenges such as inadequate financial schemes, integration of renewable energy and rapid population growth which increases the demand against the minimal supply the government can sustain. In South Africa, Joffe (2016) notes that electricity transmission has been unsuccessful due to challenges such as poor planning of the transmission process and increased focus on generation with little attention on transmission. Joffe argues that as much as generation is

important for power supply, the process is incomplete without effective transmission and maintenance of the power lines.

In Kenya, the electricity transmission network expansion has also been making some progress although the set targets have not been met. For Kenya to attain the vision 2030 goals, one of the benchmarks is to have over 16,000Km transmission lines completed across the country. While at it, only 1,800Km had been completed as of February 2019 since the new target was set in 2008. This is an indication that only 155Km are done every year while as per the target over 760Km should be done every year. The major challenges facing the energy sector in Kenya have revolved around affordability, availability and reliability of the energy generation, transmission and connectivity (World Bank, 2017).

1.1.2 The Kenyan Energy Sector

The Energy sector in Kenya comprises of the Ministry of Energy (MOE), Energy and Petroleum Regulatory Authority (EPRA), Kenya Electricity Generation Company (KenGen), Kenya Power and Lighting Company (KPLC), the Rural Electrification & Renewable Energy Corporation (REREC), Kenya Electricity Transmission Company (KETRACO), Geothermal Development Company (GDC), Independent Power Producers (IPPs), Kenya Nuclear Electricity Board (KNEB) and the Energy Tribunal. The country's electricity supply industry structure is the single buyer model where all generators sell power in bulk to KPLC for dispatch and onward transmission and distribution to consumers. Currently the transmission network is shared between KPLC and KETRACO. Power Transmission Network is currently operating at 132&220kV. The size of transmission network (400kV, 220kV and 132kV) is approximately 5,000km of which 1,799km (36%) is owned by KETRACO. This includes 831kms of 132kV lines, 373km of 220kV lines and 584km of 400kV line which are currently being operated at 220kV awaiting construction and completion of Mariakani and Isinya 400/220kV substations (KETRACO, 2015/16).

Kenya's electric power market, particularly the transmission segment, is monopolized through KPLC (for lines below 66KV) and KETRACO (for high voltage lines above 66KV). By the end of the4 year 2020, KETRACO envisages to complete up to 7,000 km of transmission lines comprising of 132 kV, 220 kV and 400 kV lines including 612 km of 500 kV High Voltage Direct Current (HVDC) lines. KETRACO has been selected on the basis of its existence as the only entity mandated to handle the country's high voltage transmission infrastructure. One of the recommendations of the Sessional Paper No 4 of 2004 was to unbundle transmission from distribution resulting in the establishment of KETRACO from KPLC. KETRACO was incorporated in December 2008 under the Company's Act Cap 486 as a state corporation wholly owned by the GoK. The Company was established to plan, design, construct, own, operate and maintain high voltage (132kV and above) electricity transmission grid and regional power interconnectors, in line with Kenya Vision 2030 (USAID, 2015). Development of the energy sector is critical if Kenya is to achieve the Kenya Vision 2030. (Ministry of Devolution and Planning, 2017). By the end of 2017 more than 6.1 million Kenyans had been connected to electricity compared to 2.3 million Kenyans connected in 2013. Access to adequate, affordable and reliable energy supply is necessary to reduce the cost of doing business, spur growth of enterprises and industries, and accelerate the realization of "The Big Four" Plan. To this effect, the Government of the Republic of Kenya (GoK) targets 100 percent access to affordable and reliable energy by the year 2022 (The National Treasury, 2017).

1.2 Statement of the Research Problem

The global power and utilities sector is undergoing significant transformation, which is challenging traditional business models, and paving way for new technologies. In all major developed economies, utility companies face a tough operating environment, and this is resulting in several new business models that are mainly based on technological advancements and customer services (Ernst & Young, 2016). Electricity transmission grid, historically a regulated and traditionally run entity, is also moving in the same direction, and adopting several new technologies, such as Smart, energy storage, and high voltage capacity corridors. Evolution is mostly seen in developed regions with a mature power and utility sector, such as Germany, the United Kingdom and the United States of America. However, developing economies like Nigeria, Kenya, Zambia, Egypt and Philippines are looking to leapfrog to new models, and currently building plans. The global smart grid market is considered as the grid of the future and is pegged at US$70 billion by 2023.

An estimated 1.2 billion people across the world—half of whom are in Sub-Saharan Africa—are currently without access to electricity (IEA 2016). These estimates are often used as motivation for large-scale programs to expand rural electrification and home solar adoption. Less attention is placed on the persistent blackouts that many electricity consumers experience in developing countries. This could be explained by a constrained electricity grid that is unable to meet the energy demand. This poses the question as what informs these constraints, a question that leads to exploration of challenges affecting the grid expansion measures.

In a bid to enhance electricity transmission and power connectivity across the country, the government of Kenya through the ministry of energy formed KETRACO in 2008 which was mandated to strengthen and expand the national grid. However, despite the expectations that KETRACO would spearhead the expansion of transmission infrastructure, very little has been achieved as compared to the set targets. Currently, the company has completed only 1,800KM of transmission lines against a targeted 16,000KM under the 2031 Transmission Master Plan and the Kenya Vision 2030 (KETRACO Technical Division, 2017). Notably, Kenya continues to highly rely on importation of power from neighboring countries such as Uganda and Ethiopia and the main cause has been due to inadequate transmission from the generation sites to the remote areas. The Western Kenyan region specifically experienced unreliable and low power supply due to lack of transmission network in that region. Notably, strategies such as those of strengthening and expanding the grid have not been realized since out of the targeted 16,000km, only 1,800km has been achieved over the last ten years. In addition, the world is moving towards new technologies in transmission such as smart grids, improved energy storage for variable renewable energy and digital substations. Little effort has been seen for the case of Kenya to adopt these new technologies. This raises a question as to whether KETRACO has the capacity to successfully implement the country's targeted transmission network of 16,000KM.

Empirical studies have majorly focused on electricity generation and distribution with no attention paid on transmission despite this being a critical process in the GoK' s agenda. For example, while proposing what needs to be done to meet energy needs in Kenya, Da Silva (2017) highlighted the lack of reliable renewable energy, high costs of energy infrastructure and lack of effective transmission from the points of production to the consumers especially in the rural areas as key challenges and proposed the need for the government to invest in renewable energy, invest more in transmission network expansion as well as promote adoption of new technology such as time-of-use metering and smart-grids. Yarrow (2017) highlighted the major challenges facing energy production to include the management support, community involvement and support as well as procurement procedures and policies. While these studies are beneficial to the researcher, there

exists scanty research focus on the challenges affecting electricity transmission network expansion in Kenya, hence a knowledge gap. It is against this background that this study sought to examine the effect of the challenges facing the electricity transmission network expansion in Kenya in order to propose possible solutions to the energy sector stakeholders for the realization of GoK' s promise to Kenyans on promotion of universal access of cheap, reliable and efficient energy to all Kenyans.

1.3 Research Objectives

1.3.1 Overall objective

The overall objective of this study was to examine the effect of the challenges affecting electricity transmission expansion projects in Kenya and the emerging issues thereof.

1.3.2 Specific Objectives

Specifically, the study sought:

i. To examine the effect of Implementation Capacity, Right of Way Acquisition, and Vandalism on expansion of the electricity transmission network in Kenya.
ii. To determine emerging issues on electricity transmission network expansion in Kenya.

1.4 Research questions

The study was guided by the following research questions:

i. What is the effect of Implementation Capacity, Right of Way Acquisition, and Vandalism on expansion of the electricity transmission network in Kenya?
ii. What are the emerging issues on electricity transmission network expansion in Kenya?

1.5 Scope of the study

The study focused on KETRACO, a state corporation in the energy sector in Kenya. The study probed on the challenges experienced in transmission network expansion in order to assess GoK' s realization of provision of affordable, reliable and accessible electric power to all Kenyans. To achieve this, the study collated all the information regarding transmission planning and investment requirements contained in several documents such as Least Cost Power Development Plan (LCPDP), Power Generation & Transmission Master Plan, KETRACO Strategic Plan, Vision 2030, Medium Term Plans I, II and III (MTP I, MTP II, MTP III) in order to identify any gaps in the national and energy sector plans and outline appropriate intervention strategies. It also expounds on the critical transmission implementation issues that were identified and proposes possible solutions to those challenges.

1.6 Significance of the study

It was particularly important to focus on electricity transmission network expansion implementation in the Kenyan context, so as to establish the factors that are key for the stakeholders in the energy sector to find answers to a number of practical questions and challenges facing transmission lines expansion projects. The findings of this study are useful for scholars and researchers in providing empirical literature on theories, regulations and practices with respect of challenges of transmission infrastructure development in developing economies. The study also prompts areas for further research and opportunities for replication of the study in other

jurisdictions within developing economies. It is also expected that the study findings will motivate similar studies in electricity generation and distribution within the electricity market value chain.

In addition, this study will be useful for policy and decision makers at the GoK, foreign investors in electricity transmission infrastructure as well as other non-state actors mainly the project financiers such as the World Bank, Japan International Cooperation Agency (JICA) and Africa Development Bank. This will facilitate decision making on funding, national policy on compulsory acquisition of land for Right of Way and implementation capacity enhancement mechanisms since it is critical to meet the impending challenge of the bigger national grid not only in Kenya but also within the East African region. The study findings give greater insights that are useful to the GoK in the realization of its promise under the Big Four Agenda under which it targets 100 percent access to affordable and reliable energy by the year 2022 and promote the long-term development of a regional electricity market to enhance regional interconnection imports and exports. This promise can be achieved through efficiency in planning, budgeting and implementation of Transmission Network expansion projects.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The chapter covers the theories and a review of previous studies on challenges affecting electricity transmission networks with regard to the challenges, emerging issues and possible solutions to these challenges. The chapter is divided into three major sections where the first section covers the theoretical review which comprises the theories in line with the study and the second section outlines the empirical review which comprises previous studies on the challenges affecting transmission network expansion. Section three covers the conceptual framework which outlines the link between the challenges, emerging issues and possible solutions in transmission network expansion.

2.2 Theoretical Review

The theoretical underpinning of the study is herein presented. The major theories anchoring this study include; Public Choice Theory, Theory of Regulation, Property Rights Theory, Bureaucracy Theory and the Technology Adoption Models.

2.2.1 Public Choice Theory

Public choice theory is now a well-developed and influential body of scholarship and is dated back from the work of Duncan Black who is referred to as the father of public choice but has extensively been publicized by Buchanan and Gordon (1962). The Public Choice Theory aims at explaining the degree of the impact associated with the political decision that conflicts with the general public preferences in decision making. The Public Choice Theory attempts to apply the general economic theory tools in the political process of decision making (Rowley & Friedrich, 2004). Through analysis of individual goals and incentives as well as the problem posed to the public, the Public Choice Theory gives a clear insight into the working and outcome associated with the political process in making the decision.

Individuals in the political arena try to avoid conflicts with the group representatives who are influential within the community to retain their validity among the people. Individuals in political authority exercises their powers in making decisions such as controlling and delaying transparency development to ensure they are not forgotten by the public (Mueller, 2003). Muller's' traditional approach concludes that the political individual is concerned with the interest of the public while the economic individual within a politician is mainly concerned with personal interest while in the real sense, the public is completely against the divided dual structure (Self, 1993). Naturally, accentuate that in relation to basic behaviour, the main concern of the individual in authority is served with selfishness, the rationale as well as the maximization of personal interest (Mueller, 1997). As Mueller's description suggests, public choice involves questions that span different social science disciplines, and practitioners of public choice are as likely to be found in political science and economics departments as in law schools.

In reference implementation capacity challenges, the theory of public choice has a lot of significance to this study in that the rate of political influence possessed by leaders has contributed highly to limiting the expansion of the transmission network. In some cases, leaders have been established diverting their attention from the public inquiry on electricity energy for fear of losing their political relevance on exhausting their next campaign manifestos. While some needy areas have been established to miss the accesses to electricity which is a core manifesto of the

government due to increased self-interest by their leaders, the leaders sometimes have been established to divert the transmission line network to areas that are less productive in order to satisfy their self needs.

However, some Public Choice Theory scholars differ in certain core views of the theory such as the absolute self-interest action. There is some nuance that individuals act only partly in their own self- interest, since other drivers such as pride, performance, loyalty or altruism, do also affect their behaviour (Downs, 1967). Moreover, interventionist's scholars close to social democracy criticize the theory for several reasons. First, they state it has little empirical evidence of the fact that agents are more self-interested and rational than they are in practice at the same time that judge it as ideologically empty (Lewis-Beck, 1979). On the contrary, Ginsburg (2002) posits that although public choice has been criticized for lack of empirical support, there is a huge body of empirical work on the propositions put forth by public choice theorists. Due to lack of sufficient literature to support the theory critics however, the theory was adopted in the study.

2.2.2 The theory of Bureaucracy

Bureaucracy refers to an organization structure characterized by several rules, standardized processes, division of labor, competency hierarchies and professional and interaction between employees. The theory of Bureaucracy dates back to the end of the 19th century as formulated by Max Weber who believed Bureaucracy as the most efficient way of setting an organization and its administration. Weber believed that the act of emulating Bureaucracy in an organization ensures equal treatment of a person as well as equal division of labor among all the employees. According to Lane (1987), the budgetary provision of goods and services reflects the bureaus making the structure as well as implementation decisions on the goods and services to be supplied, amount estimation and to which consumers are the goods and services targeted at.

According to Peter (1989), the growth of government, as well as the public sector, serves as a fundamental feature of contemporary government mainly in industrial society. However, it is difficult to estimate the growth of the government. Gajduschek (2003) argues that bureaucracy is far from being efficient and the success of the organization greatly depends on the interaction between the organization environment and the internal organizational movement. Mueller (2003) demonstrates Bureaucracy as a concept that can be expressed mathematically. In his sense, Mueller (2003) contends that the bureau budget is a function of the final expectation from the service of the bureau. The function could act as a benefit to the public which increases with the increase in administrative rate.

However, despite Weber's opinion on Bureaucracy theory, various critics from different models have emerged. Balle (1999) considered bureaucracy as an organization disease suffered by several organizations that can be characterized by someone as having an enormous amount of paperwork. "The vulnerability of bureaucracy concept in its practical form does not reduce its merits". It is our vision of this concept that is wrong (Nikoo, 2012). The theory of Bureaucracy reflects widely on this study's objective thus leading to its adoption. The structure of organization management as reflected in the theory of Bureaucracy serves a greater role in ensuring the organization delivers its services. Based on the topic of this study, several challenges related to organization management have been established to form the barrier in the expansion of electricity transmission networks. However, due to its great recommendation by several scholars as well as its close relationship with this study, the Bureaucracy theory was adopted in this study.

2.2.3 Property Rights Theory

The theory of property rights dates back in 1937 by Coase whereby he regards a market as an economic form of a system that costlessly coordinates economic activities efficiently. However, these rights are taken to be assigned by law. A second approach of the property rights theory was put forward by Locke (1967). To him, property right is the conferring of labor on an object by a person that makes it that person's property. An important insight of property rights theory is that different specifications of property rights arise in response to the economic problem of allocating scarce resources, and the prevailing specification of property rights affects economic behavior and economic outcomes (Pejovich, 1982).

According to Furubotn and Pejovich (1972), all the economic activities such as trade and production involve the exchange of property right bundles. The act of an individual to have freedom of control to a certain property symbolizes his right to own it. However, when more than two contracting parties can affect the income flow from a set of property rights, delineating each party's respective property rights becomes difficult. The critical economic issue of distribution of income that is generated by the collective efforts of different contracting parties (i.e. team production) needs consideration (Libecap, 1989).

The theory of property rights forms a significant part of the study. While analyzing Nozick's theory on property rights, Mack (2018) argued that respect for individual rights is the key standard for assessing state action and, hence, that the only legitimate state is a minimal state that restricts its activities to the protection of the rights of life, liberty, property, and contract. Several challenges established in the ways assigned for the passing of the electric line makes it impossible for KETRACO to implement its mandate due to conflicts experienced between landowners and KETRACO in respect of compensation demands and access challenges.

Property rights theories suggest allocating property rights of assets to owners that have efficiency maximization as their objective, whereas bureaucracy theories recognize that civil servants and politicians who may be responsible for running publicly owned utilities are not primarily interested in the profitability of the enterprise or in minimizing its costs. In contrast, theories of regulation suggest that the regulations that need to accompany privatization of utilities with asymmetric information about their private costs create incentives for overinvestment and not for cost minimization (Pollitt 1997). However, the theory has been criticized by various authors. According to Kreps (1990), it is important for an individual in possession of a property to analyze and differentiate between property rights, other legal and public interests as well as mere uses. Hence the theory of property rights was adopted in the study.

2.2.4 Theory of Regulation

The approach of regulation theory originated from the French academic debate that discussed the economic and social change in the 1970s. The theory aimed at enabling the economic and extra-economic mechanism that ensures a stabilized and capitalist society is achieved despite the existence of fundamental contradictions that may result in disintegration and crisis. Generally, regulation suggests interventions in conducting any activity whereby it ranges on the application of the legal control process by the government or other authorities (Ogus, 1994). Moran (1986) argues that regulation is an activity whereby the individual or institution discretion operates under set rules.

The regulation institution would ensure the maximization of the public interest since they acquire more specialized experts, monitor industrial development in detail as well as making more informed decisions in a rapid manner. As a rule, operating under laws, the regulation of the institutional structure is designed with the aim of achieving both economic and objectives related to social policy (Melody, 2016). Parker (2002) refers to regulation as an occurrence that involves a dynamic process in an entrepreneurial manner whereby regulators, bureaucrats, and firms try to maximize their own interest. Spiller (2013) states that the structure of the institution regulation affects investment directly in the industry of the public utility thus increasing the country's economic performance. The regulation institution interaction determines the regulation quality which in turn influences the investment decision making of the investors.

This theory proves to be significant for adaptation in this study given the challenges in implementation of transmission infrastructure as discussed in this study. While project implementation is guided by rules, regulations, processes and procedures, certain barriers arising from individuals in and outside government impact on expansion of the transmission network. The reluctance by the individual responsible to pass guidelines or provide budgetary allocations that are needed to facilitate electricity transmission network has proved to be a major challenge faced by the KETRACO in executing its mandate.

Nevertheless, several critics follow the theory of regulation that marks the theory as a model failure whereby the theory is regarded as limited in explaining the market economic failure. According to Zerbe (2001), for a regulation theory to be regarded adequate, the theory must explain critically the reason as to why and how regulation is comparatively the best transaction cost minimizing institution in the efficient allocation of resources for particular goods, services or societal values. This theory has been adopted in this study due to its relevance and various reviews from multiple scholars.

2.2.5 Technology Adoption Models

Constant technological change simultaneously creates threats to established business models, while also offering opportunities for novel service offerings (Lai, 2016). Leading firms often seek to shape the evolution of technological applications to their own advantage. With the advanced and dynamic growth of technologies, how fast the consumers are accepting these technologies depends on a number of factors such as availability of technology, convenience, consumers' need, security etc.

Technology Adoption Model (TAM) was developed by Davis in the late 1980s and has been widely used in studies in respect of technology adoption. It is based on the principles of Fishbein and Ajzen's Theory of Reasoned Action. The strength of the model lies in its simplicity as it has only two constructs, namely, "perceived usefulness" and "perceived ease of use" for predicting extent of adoption of new technologies at individual level as shown below of use as "the degree to which an innovation is perceived as relatively difficult to understand and use". TAM was originally tested in the context of adoption of email service and file editor at IBM Canada with 14 items on each of 2 constructs. The results of the survey on a sample of 112 users validated the model with the finding that perceived usefulness is a stronger factor than perceived ease of use that drives technology adoption. In the next ten years, TAM became well-established as a robust, powerful, and parsimonious model for predicting user acceptance. King and He (2006) presented a meta-analysis of TAM and found that it is a valid and robust model with applications in a wide range of areas. Both theories focus on two questions to explain technology acceptance and resulting technology use.

The Unified Theory of Acceptance and Use of Technology (UTAUT) was published by Venkatesh and Davis (2003) and is based on the analysis of comparison of eight technology acceptance models, among them TAM, TAM2, the Theory of Reasoned Action and the Diffusion of Innovation Theory. The aim was to synthesize the multitude of available models on technology acceptance into one unified model. Dwivedi et al. (2010) carried out a comparison of TAM and UTAUT (Venkatesh et al., 2003) and found that focus is now shifting away from TAM to UTAUT while citing in the research articles. In another study, Benbasat and Barki (2007) have criticized TAM especially on the grounds of its limitations in the fast-changing IT environment. In the context of this study, this theory has been adopted for the purpose of understanding the emerging issues and adoption and use of technology in the electricity transmission subsector.

2.3 Empirical literature

This section covers the review of studies that have been carried out previously on the challenges facing electricity transmission network expansion and emerging issues thereof. The studies are reviewed systematically based on the study variables. These studies have been highlighted from a global, regional and national perspective in respect to each variable.

2.3.1 Challenges Facing Transmission Network Expansion

Transmission network expansion has been upheld as one of the major ways to ensure sustainable access to reliable, adequate, safe and clean energy for economic growth and development. Transmission network expansion has however faced tremendous challenges most of which have continued to affect the effectiveness of the entire process. Empirical studies have highlighted a number of challenges among them lack implementation capacity, increased vandalism and challenges with right of way acquisition across the globe. This study cites studies in the USA, Asia (India, Malaysia, Indonesia), South America (Chile) and Sub Saharan Africa (Kenya Uganda, Tanzania, Mozambique and Nigeria)

Acquisition of Right of Way

Right-of-way (ROW) acquisition is the act of taking the land from its original owner by another party, with legal rights to take the real property, by providing monetary compensation for the value of the property (Francis, 2009). Power transmission wayleaves refer to corridors beneath a power line. Wayleave is important in protecting mains service lines from being interfered with by activities like farming, waste dumping or mining, which damage equipment and interfere with the provision of services. Wayleaves also protects people from accidental electrocution from loosely hanging power lines or fallen pylons.

Berry (2013) did a study on the aspects of getting Right-of-Way Right with focus on landowner compensation for electric power transmission Rights-of-Way. The study sought to analyze the effects Right-of-Way rights on electric power transmission. The study established that the Rights-of-Way acquisition affected the effective transmission of electricity in that the projects of constructing power lines and other related infrastructure stalled due to processes of compensation. According to Berry (2013), different property owners have different needs and preferences. There are those that will prefer one-time compensation, up-front payments while others will prefer instalments. While citing Chalmers and Voorvaart (2009), Berry (2013) explained that rights of way acquisition negatively affects effective transmission hence the need for developers to focus on meeting the interests of landowners as a way of enhancing projects' ability to meet the set goals in terms of timeline and budgets.

Jackson and Pitts (2015) did a literature review on the effects of electric transmission lines on property values. The study sought to exemplify how electric transmission affects the property values in line with right of way acquisition. The study was a literature review focusing on studies across the globe. The scholars established that electric transmission enhanced the property values through promotion of accessibility to energy thus driving economic activities. Jackson and Pitts (2015) indicated that as the rights of way acquisition focused on enhancing the needs of the property owners, the property values got inflated thus affecting the expansion of transmission. This compares with the argument by Wolverton and Bottemiller (2003) that the immediate effect of electricity transmission is enhanced property prices but with time the transmission is reduced due to increased property values which makes it expensive for further expansion. Similarly, Chalmers and Voorvaart (2009) also addressed the issue of impacts on residential property values and prices using a multiple regression framework. Based on a study of residential properties in Connecticut and Massachusetts sold from 1999 to 2007 and located in proximity to 345 kV transmission lines, the authors analyzed the effects of proximity (distance to the lines) and encumbrance (area on a property encumbered by the easement) and found proximity to have an insignificant effect on sales price. They concluded that ‘‘the only variable that appears to have any kind of systematic effect is the encumbrance variable,’’ although its statistical significance varied, and the effect was ‘‘generally small.’’ The authors also addressed potential effects due to the visibility of the transmission line structures and found a lack of any significant impacts on sales prices.

Gransberg and Hyungseok (2016) carried out a study on the right of way acquisition costs and delays and its influence on project success. The researchers sought to address the effect of costs and delays brought about by the right of way acquisition on effective implementation and completion of road construction projects. The study utilized interviews and secondary data to derive findings and recommendations. Gransberg and Hyungseok (2016) established that the right of way acquisition stalled the implementation of projects due to high costs and delays in getting to an agreement with the landowners. The scholars exemplified that too much time was used in obtaining the property while the property owners on the other hand inflated the costs due to the unplanned sales and anticipation of better opportunities from the property. Gransberg and Hyungseok (2016) recommended the use of agencies where the agents buy the land directly from the property owners and transfer the same to the government.

In Indonesia, (Negara, S., 2016) underscores the importance of the government to provide a business climate conducive to attracting private investors to the sector. He argues that complex land acquisition processes have deterred any potential investors from entering the infrastructure sector. He refers to several studies that show that the most binding constraint to investment in infrastructure is difficulty in land acquisition and cites the case of the Batang power plant project along the north coast of Central Java which had been delayed for more than four years due to difficulties in acquiring the remaining 20 per cent of the project land.

Tanui (2015) studied the influence of rural electrification projects on household connectivity in Nandi county in Kenya. The study found that 36% of the respondents noted that a baraza had been organized to sensitize. 16% of the household showed that wayleaves acquisition had challenges and were unwilling to cut down trees with this regard. An examination into the relationship between wayleaves acquisition and household connectivity showed that 17 (16%) of households with electricity faced wayleaves challenges when seeking electricity. Among the reasons for wayleaves objection was unwillingness to have trees cut down, in some instances, it took some time to negotiate for wayleaves grant. None of those yet to get connected were in a position to anticipate whether or not they would encounter wayleaves challenges.

Vandalism

Chalmers and Voorvaart (2009) analysed the destruction effects on the effectiveness of high-voltage transmission lines in Connecticut and Massachusetts on 345 kV transmission lines. The study assessed the impact of vandalism using a cross-sectional research design and had a sample size of 96 respondents surveyed using interview schedules. Their study found out that vandalism was a major pullback to effectiveness of electricity transmission in that it affected the programmes and projects meant to enhance transmission. According to Chalmers and Voorvaart (2009), lack of proper security and focus on maintenance measures has led to continued destruction of electricity lines and generators which derail the expansion.

Ikejemba and Schuur (2018) did a study on the challenges affecting sustainability of renewable energy development projects in Sub-Saharan Africa. The study assessed the effect of societal security, technical security and human security, the government inequality, sabotage to investigations and actions taken to the offenders on the sustainability of the projects. The study established that most of the vandalism of the energy projects were as a result of inequality in distribution of wealth among Sub-Saharan Africa countries hence leading to increase in unrest where people protest by destructing the government projects. While citing Gqirana (2015), Ikejemba and Schuur (2018) indicated that the low sustainability and little expansion of energy projects in most of the Sub-Saharan countries was as a result of vandalism which is caused by crime to survive where people steal to survive. Douhou, Magnus and van Soest (2011) contend that criminal activities derail economic development through continued vandalism of government projects thus affecting the sustainability of the latter. Further, Utonih and Dlamini (2001) found out that the issue of theft and vandalism has also resulted in the slow phasing out of PV projects in some countries in Southern Africa

In Zimbabwe, there were 256 cases of copper conductors valued at USD 1 364 324-24 and 67 cases of transformer oil theft and 75 cases of transformer vandalism, with a combined total value of USD 796 626. (Sithole, 2016). In South Africa, the main metals targeted by vandals are copper and aluminium. (Leigh, 2011). Leigh notes that the South African Parliament took the issue of metal theft head on in August 2010, this was after the Democratic Alliance's shadow deputy minister of public enterprises, Pieter van Dalen, highlighted the repercussions of vandalism on the likes of Transnet and Eskom whose combined losses due to copper theft amounted to a loss increase of 38.1% in 2008/09 and replacement costs increasing by 57.4%.

Vandalism and theft of electrical equipment in Uganda has also been cited for causing delays in commissioning of new power transmission lines. In 2017, the Uganda Electricity Transmission Company Limited (UETCL) reported that angle nuts, stay earth wires and galvanized angle bars for the power pylons were being cut and stolen by unknown thugs across the country causing power blackouts in various regions of the country. UETCL experienced vandalism when Tororo-Opuyo-Lira 132kV power transmission line was vandalized thereby compromising the strength of the towers and putting the transmission line at risk of collapsing. Theft of transmission steel towers and electrical equipment (wires and transformer oil) has cost the transmission company billions of shillings in maintenance costs, revenue to the country and affected efficient and reliable power. (Mugume, 2017).

In Kenya, vandalism of transformers is a major hindrance to provision of electricity in Kenya. This causes great losses to the service provider (KPLC) and the consumers. For instance, in 2012, KPLC spent 4 million US dollars replacing transformers, while on average, Kenyans stay without power for 25 days a year (Kirunguru, and Ayambire). Cheseto (2013) studied the challenges in planning

for electricity infrastructure in informal settlements: case of Kosovo village, Mathare valley – Nairobi. The study established that the risks associated with vandalism of the power lines and illegal connections have also discouraged further investment in the area. The study also established that the low demand evidenced by low power consumption among the slum people discourages KPLC to invest in expansion of power supply to such areas as the returns hardly meet the costs of installation and maintenance.

Yarrow (2017) analysed the challenges in the implementation of electricity power generation expansion projects in Kenya. The study aimed at assessing the impact of community support, government commitment and availability of resources on implementation of electricity power generation expansion projects in Kenya. The scholar utilized a descriptive research design and sampled 128 employees from Kenya Electricity Generating Company. The study established that government commitment, community support and financial resource availability had a significant impact on implementation of electricity power generation expansion projects. According to Yarrow (2017), expansion of the electricity generation is affected by the community involvement and support in that community members are the main watchdogs of the projects and if not well involved they can be the main vandalizers of the projects.

Ogallo (2011) studied the factors influencing electricity distribution in Nyamarambe Division; Kisii County, Kenya. The study found out that vandalism comprised security of the electricity distribution network. The study concluded that Vandalism contributed negatively to the growth of electricity distribution network. Bill (2014) asserts that vandalism of electricity transmission equipment in Kenya has become a menace and a costly affair to the society in terms of safety and low economic activities. Particularly, transformer vandalism has been on the rise and happens almost everywhere within the country (Dzansi, Rambe & Mathe, 2014). As the nation continues to grapple with persistent power outages and unreliable electricity supply, this critical electricity sector is currently beset by the twin problems of theft and vandalism of its transformers and power-line cables (Korir & Ayienga, 2014). Vandalism of electric equipment is catalyzed by the existence of a "market" for the stolen items. Sometimes these stolen transformers and other equipment surprisingly turn up for supply by contractors in the same electricity sector (Amadi, 2015). The damage to these electricity supply equipment attracts costs to both the supplier of power and the consumer. Power consumers then pay for maintenance or replacement of electrical equipment through operation and maintenance costs which is factored in the tariffs.

According to the study by Orvika and Haako, (2009), Electricity companies also face very challenging physical conditions and tenure issues in slums that are unlike those encountered in formal, legal settlements. Given that many slums consist of squatters who do not have land tenure, the electricity company faces difficult legal issues in providing service, including the lack of a means to obtain right-of-way for distribution system equipment. There is need to legislate laws that will protect the spatial part of electricity provision especially in informal settlements. The vast majority is covered by wayleaves. Cheseto (2013) studied the challenges in planning for electricity infrastructure in informal settlements: case of Kosovo village, Mathare valley –Nairobi. The study established that the lack of means to obtain right of way is a deterrent to electricity supply in the slum.

Implementation Capacity

Jawad, Razali and Abang (2014) analysed the challenges facing the expansion of government projects in Asian countries in particular, Malaysia. The study sought to assess the role played by available resources, implementation setting and available competencies on project expansion. A

descriptive research design was adopted with a target population of 318 respondents drawn from officials in government construction projects. The study established that expansion of government projects highly elides on the capacity to implement which is best defined by resources, competencies and implementation settings. While citing Steven and Wallach (2008), Jawad *et al.* (2014) indicated that among the major aspects derailing success of projects is lack of internal capacity to run the projects into completion.

Eberhard and Shkaratan (2012) conducted a study on powering Africa with a view of examining the financing and reform challenges. The study found that funding gap was a major institutional challenge that affects electricity supply expansion in Africa. According to the study, Africa has a funding gap of $29.2 billion as a result of the difference between the investments required to meet demand of $40.8 billion and current annual investments of $11.6 billion. The gap is so significant that it requires that the ideological debate of public versus private be set aside and all mechanisms and resources to reduce the gap be mobilized. The study recommended the need for public versus private investment in the energy sector. Further, the study established that there is serious under – pricing of electricity in the continent thus difficult to raise the revenues needed to meet investment requirements. This revenue shortfall is rarely covered through timely and explicit fiscal transfers. Instead, maintenance and investment activities are cut back to make ends meet, which starves the utility of funds to expand service coverage and cuts the quality of service to existing customers.

Ahlborg and Hammar (2011) studied drivers and barriers to rural electrification in Tanzania and Mozambique. The study focused at grid extension, off-grid and renewable energy sources. Qualitative methodology data were collected through interviews with stakeholders. The interviews addressed six themes: (1) current state of the electricity infrastructure in rural areas; (2) institutional and socioeconomic drivers and barriers to renewable energy; (3) productive uses of electricity; (4) potential for off-grid and renewable energy systems; (5) local participation in electrification processes; and (6) impact from electricity on people's lives. The themes were based on a review of mostly African-related peer-reviewed literature. The study found that the main barriers to grid extension were implementation capacity based. The barriers included low institutional quality, inadequate planning capacity, financing gap due to lack of co-investments and incompatible donor policies, and lack of access to skilled personnel. In addition to implementation capacity based challenges, the study found that the high compensation cost for the required project land was a hindrance to grid extension both in Tanzania and in Mozambique.

Alamutu, Azee and Opeku (2011) studied the influence of project implementation capacity on success of electricity transmission projects in Nigeria. The study aimed at assessing the effect of implementation plans, employee skills and financial capacity as the major implementation capacity on success of the projects. The scholars adopted a descriptive research design and sampled 216 respondents who were surveyed using questionnaires. Their study established that implementation plans, financial capacity and employee skills were the key aspects of project implementation capacity that significantly influenced the success of electricity transmission projects. According to Alamutu et al. (2011), implementation capacity plays a key role in enhancing the transmission of electricity in that it steers the ability of various projects to meet the set goals.

Kogi (2013) studied the factors influencing the implementation of projects in Kenya. The study assessed the impact of project funding, project design, criteria of selecting contractors and control mechanisms on effective implementation of programmes in Kenya. A quantitative research approach was used and the sample size comprised of 37 respondents. The researcher established that the institutions' capacity to implement was defined by the available funds, the ability to design

and maintain the project design and internal ability for the organization to select contractors effectively. According to Kogi (2013), the implementation capacity determines the extent to which the project is implemented to meet the set goals with emphasizes on financial resources as the main aspect of implementation capacity. Kogi (2013) supports the findings using those by Memon, Rahman and Azis (2011) who contemplated that among the major causative factors leading to cost overruns of construction projects was lack of adequate implementation capacity by the constructing agency thus derailing the project success.

2.3.2 Emerging Trends in Transmission Network Expansion

In the energy sector, there are tremendous changes that affect the processes in the entire sector including generation, transmission and connection. The trends arise from technological changes, increased competition in the energy sectors, changes in policies and unpredictable climatic changes. These emerging trends may affect electricity transmission either positively or negatively thus proper planning on their emergence is paramount. This study cites studies on emerging trends in USA, India, Indonesia, Norway and Kenya.

Pindoriya and Gurrapu (2011) carried out a study on the emerging trends in the electricity market in India. The study aimed at establishing the continued changes that affected the generation and transmission of electricity in India. The scholars established that among the major emerging trends in the energy sectors included technological changes, regulations and policies as well as climatic changes and economic changes leading to tariff reviews. According to Pindoriya and Gurrapu, the reliability of electricity transmission and connectivity can be achieved through tuning the available systems to the new trends such as smart grids, adoption of micro-turbines and implementation of wind farm projects.

A study by Koomey, Belady and Patterson (2016) highlights that integration of digital technologies in the electricity transmission systems allow devices across the grid to communicate and provide data useful for customers and for grid management and operation. The scholars also note that smart meters, new smart/IoT sensors, network remote control and automation systems, and digital platforms that focus on optimization and aggregation, allow for real-time operation of the network and its connected resources and collect network data to improve situational awareness and utility services. Hertwich and Roux (2011) established that increased consumption and over-reliance on electricity-powered household items in Norway are some of the emerging trends that affect the electricity transmission by overpowering the transmitted capacity thus calling for a relook into the entire process.

Tveten, Kirkerud and Torjus (2016) conducted a survey on the integration of variable renewables with reference to the interconnection of thermal and hydropower regions. Their study sought to assess the effectiveness and challenges tied to the variable renewable energy and the benefits of interconnecting the Thermal energy and Hydropower. A cross-sectional research design was used and a sample of 119 respondents was adopted. The study established that renewable energy derailed the effectiveness of other sources of energy by reaping down resources that would be used to enhance the production and supply of controllable energy. According to Tveten *et al.* (2016), renewable energy has minimal capacity to produce reliable energy in that it is unpredictable, and the focus given to the sub-sector is more traditional based thus the output is limited. The scholars recommended that the interconnecting variable renewable energy with the controllable energy sources such as thermal and hydropower would serve to enhance the reliability and effectiveness of electricity transmission. This compares with the argument by Müller (2013) that for flexibility, adequacy and reliability to be obtained through variable renewable energy, there ought to be an

interconnectivity programme to ensure all the other sources are incorporated for better transmission.

Integration of the renewable energy into the power systems has also been termed as a major emerging trend in the energy sector. Boampong and Phillips (2016) studied the renewable energy incentives in Kenya with reference to the feed-in-tariffs and rural expansion. The study aimed at assessing the policies, government tariffs and the regulatory environment put across to enhance the growth and transmission of renewable energy in Kenya. The study targeted the feed-in-tariff and the Rural Electrification Authority. The findings revealed that the policies put across by the Kenyan government were not properly tied towards enhancing the reliability of the variable renewable energy but was based on enhancing the tapping of more energy from other sources. Boampong and Phillips (2016) noted that the Lake Turkana wind power plant project had not met its goals despite significant diversion of revenues from other sources of energy to the project. Boampong and Phillips (2016) cites Bounagui (2015) who explains that as much as Kenya aims to cut-down carbon by 30% come 2030, the efforts made with as far as variable renewable energy is concerned ought to affect the reliable transmission where the investments made in wind and solar power in Kenya are not significant to the output and the overall benefit.

Gayathri (2017) carried out a study on the recent trends in power systems. The study aimed at assessing the major changes that have impacted electricity transmission and how the changes have affected the effectiveness of the transmission processes. The study adopted an exploratory research design and reviewed empirical evidence. The findings revealed that technological changes and increased demand were among the major trends in the energy sector. According to Gayathri (2017), transmission network expansion relies on the available infrastructure and with increased demand, there grows the need for enhanced transmission equipment. The study also noted that transmission asset management systems are a trend in the electricity transmission sub-sector that needs to be upheld in order to enhance transmission effectiveness.

2.4 Research gaps

Empirical literature over the last decade provides extensive literature on transmission planning and pricing, financing and cost allocation, system modernization and smart grid and transmission system reliability etc. (These studies have however been biased towards electricity generation and distribution and not electricity transmission. In addition, there is limited published information on transmission in Kenya.

Table 2.1 below illustrates the various studies while demonstrating the research findings and gaps that this study sought to fill. While empirical literature has highlighted a number of challenges and emerging issues, literature review reveals that there is limited published information in the electricity transmission sub sector in Kenya.

Table 2.1: Research Studies, Findings and Research Gaps

EMPIRICAL LITERATURE & FINDINGS	RESEARCH GAPS
A study by (Negara, S., 2016) established that the most binding constraint to investment in infrastructure is difficulty in land acquisition	The study focuses on private finance for transmission infrastructure in Indonesia
Jackson and Pitts (2015) established that electric transmission enhanced the property values through promotion of accessibility to energy thus driving economic activities	The study focuses on effect of transmission in property values in USA
Pindoriya and Gurrapu (2011) established that merging trends in the energy sectors included technological changes, regulations and policies as well as climatic changes and economic changes leading to tariff reviews	The study focuses on emerging trends in the electricity market in India
Chalmers and Voorvaart (2009) established that vandalism is a major pullback to effectiveness of electricity transmission in that it affected the programmes and projects meant to enhance transmission.	The study focuses on destruction effects of high-voltage transmission lines in Connecticut and Massachusetts on 345 kV in USA
Cheseto (2013) established that risks associated with vandalism of the power lines and illegal connections have discouraged further investment in the area.	The study focuses on planning od Distribution aspect (KPLC) of the electricity sub sector.
Ogallo (2011) established that vandalism compromised security of the electricity distribution network	The study focuses on Distribution aspect (KPLC) of the electricity sub sector.
Ikejemba and Schuur (2018) established that vandalism of the energy projects results from inequality in distribution of wealth among Sub-Saharan Africa countries hence leading to increase in unrest where people protest by destroying the government projects.	The study focuses on Generation aspects of the electricity sub sector in Sub Saharan Africa.
Yarrow (2017) established that government commitment, community support and financial resource availability had a significant impact on implementation of electricity power generation expansion projects.	The study is biased towards power generation expansion projects in Kenya
Jawad, Razali and Abang (2014) established that expansion of government projects highly elides on the capacity to implement which is best defined by resources, competencies and implementation settings.	The study focuses on expansion of government projects in Malaysia hence limited published information in transmission in Kenya
Ahlborg and Hammar (2011) established that the main barriers to grid extension were implementation capacity based.	The study focuses drivers and barriers to rural electrification in Tanzania and Mozambique
Alamutu, Azee and Opeku (2011) established that implementation plans, financial capacity and employee skills are the key aspects of project implementation capacity that significantly influence the success of electricity transmission projects	The study focuses project implementation capacity on success of electricity transmission projects in Nigeria
Pindoriya and Gurrapu (2011) established that major emerging trends in the energy sectors include technological changes, regulations and policies as well as climatic changes and economic changes leading to tariff reviews	The scope of the study on emerging trends is carried out in India.

There is a need to add knowledge through research on the challenges affecting implementation of transmission network expansion in Africa, and Kenya in particular. It is this gap that the study sought to provide further insights into.

2.5 Conceptual framework

The conceptual framework of the study is presented in figure 2.1 as follow:

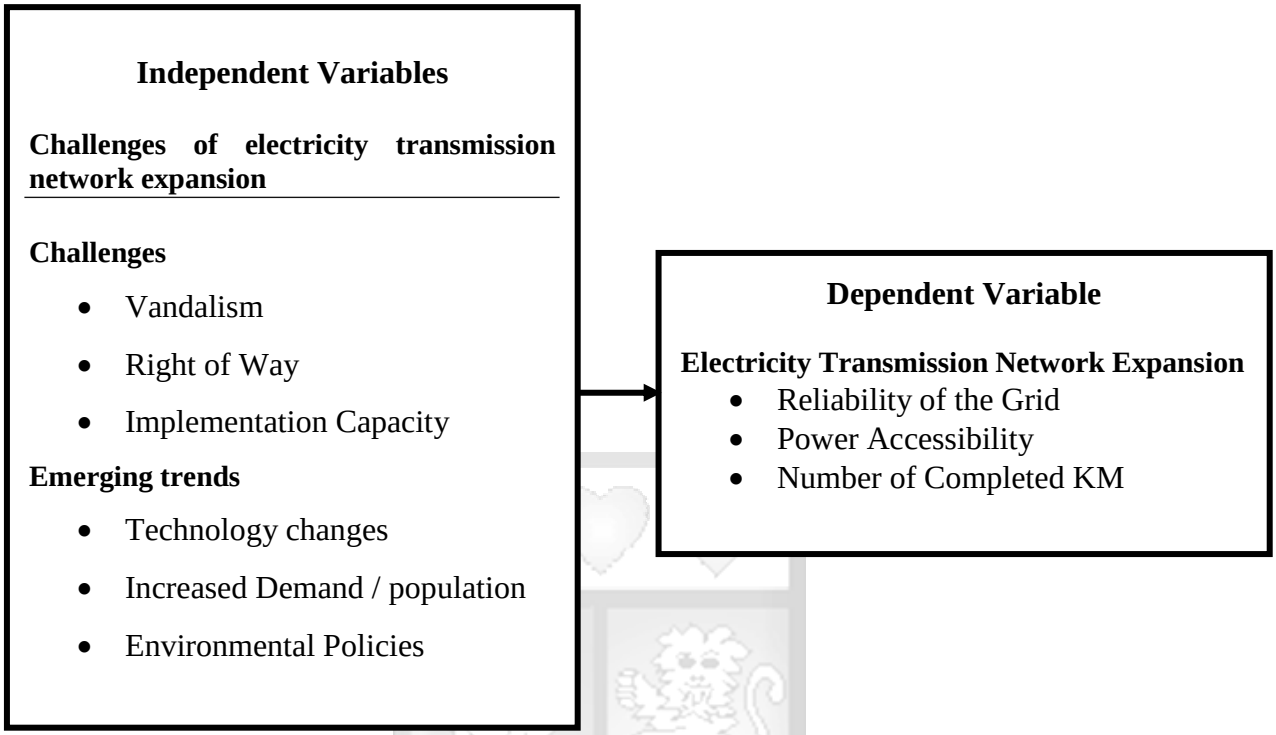

Figure 2.1: Conceptual Framework

The Challenges facing transmission refer to implementation capacity, vandalism and right of way acquisition. Implementation Capacity refers to the necessary human resource capacity and security measures in KETRACO required to successfully implement transmission infrastructure projects. This includes engineers who are tasked with engineering design works, procurement and construction, operation and maintenance, socio economists, land surveyors, environmental economists, wayleave offices and legal officers. It also refers to the capability of KETRACO to implement projects in accordance with the Transmission Master Plan, KETRACO Strategic Plan, LCPDP, Vision 2030 and MTP1, II and III. Implementation Capacity also refers to the capability of KETRACO to raise revenues for operation and maintenance of transmission equipment once installed and commissioned as well as training programs for the maintenance team aimed at building capacity for effectively undertaking preventive, predictive, corrective and fault/breakdown maintenance of the company's transmission assets to guarantee availability, operability and reliability indices. This was operationalized first by the number of projects implemented against the targets projected in the plans aforementioned. Implementation Capacity was also measured by the revenues raised by KETRACO from wheeling charges and budget allocations from GoK for operations and maintenance. The information was obtained from self-administered questionnaires and documents review.

Vandalism refers to destruction and theft of transmission equipment including cables and tower members. It was measured by the cost of repairs of the vandalized equipment, number of transmission losses and downtime occasioned by vandalism. Vandalism was also measured by installed reactive compensation equipment and transmission and substation system reinforcement mechanisms to determine security of transmission assets. The information was obtained from self-

administered questionnaires and documents review.

Right of Way refers to the wayleave corridor that must be acquired from the public and registered as easements in order to gain access for transmission line construction. This information was largely obtained from documents review and self-administered questionnaires. It was measured by the total budgetary allocation for compensation per project, the number of easements registered, the number of cases in court arising as a result of compensation disputes. Projects stalled due to failure to secure the wayleaves corridor was also established in order to determine the total idling charges accrued as a result of stoppages and lack of access to the project sites. An assessment of the principles & processes of compensation was undertaken to determine the manner in which route identification, valuations, community and stakeholder engagement initiatives are conducted.

Emerging Trends refer to changes in integration of renewable energy, technological changes, increased demand and environmental policies. This was measured by advancing system design, planning, and operation of the electric grid into new technologies for sustainability, security, resilience, reliability, availability and increased asset use. System designs were analyzed for compliance with environmental policy requirements.

Electricity transmission network expansion was measured by;- First, the number of KM electricity transmission projects implemented against the KETRACO Master Plan, KETRACO Strategic Plan, LCPDP, Vision 2030, Big Four Agenda and MTP 1, II and III intended to facilitate power access; Second, to measure system reliability/availability, a review of the % system availability was undertaken by examining the total number of outages and the causes and restorative mechanisms in place for emergency responses; and Third, the %level of accessibility of power was measured against the targeted 100% by GoK. This information was largely obtained from documents review.

3.0 CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter describes in detail the research design and methodology that was adopted in the study. In this chapter, the choice of methodology applied in conducting the research is justified, the target population highlighted, and the sampling design and technique described. The methods and instruments of data collection, data analysis, validity and reliability are also demonstrated in this chapter.

3.1 Research design

A research design refers to the plan for collection, measurement, analyzing, as well as utilizing data so that the researcher can obtain valid and desired information with sufficient precision (Gary, 2009; Cooper & Schindler, 2006; Jill & Roger, 2009). This study employed exploratory research design to investigate the challenges of electricity transmission network expansion, the emerging issues and possible solutions to these challenges. This approach was deemed appropriate for this study since it involves fact finding from documents and enquiries from energy sector stakeholders about the challenges affecting electricity transmission network expansion in Kenya. Exploratory research design incorporates both qualitative and quantitative data hence providing a wider scope for data collection in a study.

3.2 Population and Sampling

The target population comprises the main stakeholders in the energy sector who deal with electricity transmission processes including KETRACO, National Treasury, Ministry of Energy, KPLC, and KenGen. KETRACO is the State Agency mandated with electricity transmission while the National Treasury has a department to finance energy projects. The Ministry of Energy oversees all the energy projects, KPLC distributes power for domestic and industrial consumption while KenGen generates the electricity. This therefore implies that all the stakeholders mentioned herein play a key role in enhancing transmission network expansion hence the focus in the study.

The study employed a purposive sampling method to obtain the sample size. This non-probability sampling method involves choosing of the respondents in a study based on the preempted ability of the respondents. First, the study selected the respondents who are directly involved in matters of electricity transmission at KETRACO, KenGen, National Treasury, Ministry of Energy, and KPLC. This was estimated at 140 respondents distributed as follows: KETRACO (39), KenGen (14), National Treasury (16), Ministry of Energy (37) and KPLC (34).
From the sample obtained using the purposive sampling, since the chosen sample is less than 10,000 Fisher (1998) formula was applied to draw the final sample. The formula is given as follows:

$n = N*X / (X + N - 1)$,
Where,
$X = Z_{\alpha/2}^2 * p*(1-p) / MOE^2$

Assuming a normal distribution, $Z_{\alpha/2}$ is the critical value of the Normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96). p is the probability of the element of the sample being chosen with 1-p being the probability of being not chosen. The study used a rule of thumb of 0.5 or 50 percent. Therefore, if $p = 0.5$, $1-p = 0.5$. MOE is the margin of

error. The study adopted a margin of error of 5 percent implying a 95 percent confidence interval. N is the population (total of the sample chosen from purposive sampling = 140. This is the number of staff who are directly involved in making Transmission decisions from the target institutions) and n is the final sample size.

Application of the Fisher (1998) formula yields the following:

$X = Z_{\alpha/2}^2 * p*(1-p) / MOE^2 = (1.96^2*0.5*0.5)/ 0.50^2 = 384.16$

$n = N*X / (X + N - 1) = (140*384.16)/ \{384.16 + (140 -1)\} = 102.8 = 103$

Therefore, the final sample size was 103 respondents. The total sample was apportioned among the corporations and across the various levels of management according to their respective weights. Simple random sampling was applied in selecting the individuals to be interviewed. As such the study applied a combination of purposive sampling and simple random cluster sampling. The selected sample size was apportioned as follows in table 3.1:

Table 3.1: Distribution of Sample Size

Category	Sample Size	Percentage
KETRACO	29	28%
KPLC	25	24%
National Treasury	12	12%
KenGen	10	10%
Ministry of Energy	27	26%
Total	**103**	**100%**

Source: Author's Computation

3.3 Data Collection Methods

The study was based on both primary and secondary data which was collected directly from the respondents through use of a structured questionnaire and documents review. Document analysis can be used in many different fields of research, as either a primary method of data collection or as a compliment to other methods. Documents can provide supplementary research data, making document analysis a useful and beneficial method for most research. Documents can provide background information and broad coverage of data and are therefore helpful in contextualizing one's research within its subject or field (Bowen, 2009). Data was collected by first conducting a document review through content analysis of the following transmission expansion plans KETRACO Transmission Master Plan, KETRACO Strategic Plan, LCPDP, Vision 2030, KETRACO Strategic Plan, Big Four Agenda and MTP 1, II and III. The purpose of the review was to establish the necessary linkages between the various plans to enable the researcher to assess the status of implementation of the projects against those plans. Documents review enabled the researcher to establish existing information on Vandalism (operation and maintenance and repairs for vandalism, and transmission losses); ROW (no of court cases by land owners, no of easements or wayleaves registered, total project idling charges); Implementation Capacity (total no of projects planned and commenced, total no. of projects commissioned and energized, total no of projects

stalled). The researcher developed a document review guide form that ensured that valuable information is identified, analyzed, coded, and documented. This process was outlined in the document review template with the intention of collecting independently verifiable data and information. To ensure reliability, the researcher was personally involved in the document review.

According to Trochim, Donnelly and Arora (2016), a questionnaire helps collect first-hand data with very little or no influence from the researcher thus making the findings more reliable and concrete. The questionnaire contained both open-ended and closed-ended questions which were arranged in sections as per the study variables. The questionnaires were administered through an online survey. Constant communication was made to ensure effectiveness and enhance the response rate. Appropriate guidelines were adopted to ensure a controlled data collection process whilst taking into account ethical concerns. Use of questionnaires was chosen for this study as it had the advantage of enabling the researcher to obtain large amounts of information from a large number of participants in a short period of time and in a relatively cost effective way. It is however acknowledged that this instrument could be limited by changes of emotions, behavior, feelings hence bears some level of subjectivity by both the respondents as well as the level of researcher imposition in designing the questionnaire. In order to address these weaknesses, the researcher designed the questionnaire with a great deal of imagination, expertise, subject knowledge, and experience. It was prepared in light of the responses to be sought and was specific to the research variables. In addition, there was room for more information to be provided by the participants through the open ended questions for each study variable.

3.4 Data Analysis

Mixed methods of analysis were used in the study whereby both quantitative and qualitative techniques were adopted in the analysis. Secondary data collected was scrutinized and cleaned for any errors and coded. The data coding technique was applied to ensure that collected data had some meaningful patterns that were useful for statistical inference. The quantified primary data was subjected to a thorough analysis using STATA, to give it a descriptive statistical approach such as mean, standard deviation, frequencies and percentages for easy interpretation of the data collected for the study. Using the coded data, the researcher generated tables, graphs and pie-charts which were used in presenting the results of the study. Content analysis was used to analyse the qualitative data where the data was checked through and compared based on the relevance and presented in the form of explanations. Descriptive statistics were used to analyse the quantitative data which was presented in the form of means and standard deviation. Regression analysis was carried out to test for the relationship between the independent variables and the dependent variable. The following regression model was adopted:

$$Y_{it} = \alpha_0 + \beta_1 X_i + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + +\beta_5 X_{5i} + \beta_6 X_{6i} + \varepsilon_i \quad (3.1)$$

Where;
Y = the dependent variable (Electricity Transmission Network Expansion)
β_0 = Constant Term; β_1, β_2, and β_3 = Are constants regression coefficients representing the condition of the independent variables to the dependent variables (Beta coefficients)
X_1= Vandalism challenge
X_2= Right of way challenge
X_3= Implementation capacity
X_4 =Technological changes
X_5 = Increased demand / population growth
X_6 = Environmental policies

ε = (Extraneous) Error term explaining the variability of firm growth as a result of other factors not accounted for.

Whereas the study focused on the challenges of electricity transmission in Kenya, it was cognizant of the fact that the energy sector at large has been experiencing unprecedented emerging issues. These emerging issues in energy have an effect on the electricity transmission infrastructure expansion hence it was deemed necessary to incorporate technological changes, increased population / demand and environmental policy as emerging issues on electricity transmission infrastructure expansion to control for the effect of such variables on the dependent variable.

The empirical model is specifically defined as follows:

$$Transmission = \alpha_0 + \beta_1 Vandalism + \beta_2 Right\ of\ way + \beta_3 Capacity + \beta_4 Technology + \beta_5 Population + \beta_6 Environ\ Policies + \varepsilon_i \quad \ldots\ldots(3.2)$$

Regression analysis was applied for empirical model estimation. Specifically, the Ordinary Least Squares Method (OLS) was applied for empirical model regression. The choice of the model was informed by the assumptions of the OLS model. First is the assumption of linearity. This assumption asserts that the dependent variable is a linear function of parameters of the independent variables. The second assumption is that the error term of the model is normally distributed with the expected mean of 0 The assumption here is that the expected value of the mean of the error terms of OLS regression should be zero given the values of independent variables. In other words, the distribution of error terms has zero mean and does not depend on the independent variables. Thus, there must be no relationship between the independent variables and the error term of the model.

Further, the OLS model assumes that the variance error term is the same across all values of the independent variables (homoscedasticity). This assumption asserts that the error terms in the regression should all have the same variance. In case of violation of this assumption, then the linear regression model has heteroscedastic errors and likely to give incorrect estimates.

In addition, the model assumes that there is no multicollinearity (or perfect collinearity) in cases of multiple regression model. This assumption implies that there should be no linear relationship between the independent variables in the model. The important implication of this assumption of OLS regression is that there should be sufficient variation in the independent variables. This is because more variability in the independent variables is better as it makes the OLS estimates statistically significant in reference to their effect on the dependent variable.

Lastly is the assumption of no autocorrelation. This OLS assumption of no autocorrelation implies that the error terms of different observations should not be correlated with each other. This assumption means that the error terms should be Independent and Identically Distributed (iid).

It is also notable that while the choice of the OLS model for empirical estimation was informed by the model assumptions, its choice was informed by the fact that it is the basic econometric model upon which all other econometric models are built from.

Upon the regression model analysis, various diagnostic tests were conducted to determine whether the OLS model estimates were Best Linear Unbiased Estimator (BLUE). First, the test for Collinearity was carried out using the Spearman's Rank Correlation coefficients test. To test for autocorrelation, the Durbin Watson Statistic test was applied. Further, to test for variance of the error term (heteroschadasicty) the Breusch–Pagan test was used while Variance Inflation Factor was applied to test for multicollinearity in the model. In addition, the non – normality test was

conducted using the Jarque Bera test. Further, since the OLS model assumes correct model specification, the study conducted a model specification test using Ramsey Regression Equation Specification Error Test to determine whether the empirical model was well specified.

In addition to regression analysis, cross tabulations and the relevant chi2 statistics of the respective cross tabulations was applied to inform the relationships of dependent and independent variables. The cross tabulations show how correlations change from one variable grouping to another. Further, the cross tabulations inferred into the patterns, trends, and probabilities within raw data collected.

3.5 Data Presentation and Dissemination

Once data had been collected and analyzed, it was classified and organized in textual, tabular, and graphical forms and in a manner that was easily readable and interpretable. Information was presented in tables, charts, diagrams or graphs as may have been appropriate for ease of interpretation and explanation of study findings. The study findings will be made available to the participants and key stakeholders as well as academic researchers and policymakers in the Energy Sector.

3.6 Research quality

3.6.1 Reliability of the Research Instruments

Reliability refers to the accuracy and precision of a measurement procedure. It measures the degree to which a research instrument gives consistent results. The author states that reliability is concerned with estimates of the degree to which a measurement is free of random or unstable error (Cooper, 2003). A researcher can ensure the reliability of her research by thoroughly describing the research process which has been done in this document. That will increase the transparency of the research. In this chapter, the different steps of this research have been explained and analyzed with the help of methodology textbooks, in order to guarantee the reliability of this study. Errors likely to affect reliability of this study include inaccuracy of the instrument in use, inaccuracy in scoring by the researcher and finally, unexplained errors whose source cannot be determined. A standardized questionnaire was used, and this was administered using an online survey platform for ease of access, response and speedy transmission of the answers. Analysis was done using STATA to ensure accuracy and reduce the margin of error. This research focused on both construct and content validity. Kothari (2010) defines content validity of the instrument as the extent to which a measuring instrument provides adequate coverage of the topic under study. Further, he is of the argument that a measure is said to possess construct validity to the degree that it conforms to predicted correlations with other theoretical propositions (Kothari, 2010). In ensuring content validity, this study specified the array of indicators relevant to the study topic while construct validity was determined through ascertaining that the scores from the instrument are giving the correct inferences relevant to the study topic.

To ensure high validity and reliability of the data collection tool, Cronbach's alpha was computed using the responses from 10 percent of the total respondents. The alpha measures the internal consistency of variables i.e. how closely related a set of items are as a group. It is therefore considered to be a measure of scale reliability. An overall Cronbach's alpha of above 0.7 implies that the tool is valid and reliable enough to collate and analyze research findings.

3.6.2 Validity of the Research Instruments

Validity is the extent to which differences found with a measuring tool reflect true differences among respondents being tested (Cooper, 2003). It refers to the credibility of its results (Bryman& Bell, 2005). The credibility is affected by the appropriateness of the informants and the connection between the result of the research and the researcher's conclusions. Validity can be measured by the extent the data obtained accurately reflects the theoretical or conceptual concepts; that is if the measurements obtained are consistent with the expectations. Neuendorf (2002) suggested that when human coders are used in content analysis, reliability translates to the amount of agreement or correspondence among two or more coders. The validity test was done using convergent validity which was assessed using the average variance.

A pilot study was carried out to pretest the internal consistency and validity of the research instruments. Kombo and Tromp (2009) and Kothari (2004) define a pilot test as a duplication and preparation of the main study. According to Polit and Beck (2010), pilot tests can be done by a number of respondents that the researcher considers appropriate ranging from 4% to 15% of the sample size (Daniel, 2012; and Lim, 2013). The study therefore used 5% of the sample size for the pilot test which gave 5 respondents who were picked randomly from other departments not included in the study.

The flow of the questions and the right interpretability of the questions in the questionnaire by the respondents was an indication of the validity of the instruments in this study. This was confirmed through the pilot study. The pre-testing was done to assess the clarity of the instrument items so that those items found to be inadequate in measuring the variables were either discarded or modified to improve the quality of the research instrument thus increasing its validity.

3.7 Ethical Considerations

Ethical approval was sought from the Strathmore University Ethics Review Board and permission to conduct the study was obtained beforehand from the Strathmore University School of Graduate Studies as well as KETRACO to gain access to respondents from their administrators and relevant authority. The research recognizes the need to maintain confidentiality at all times and this was signified by acceptance of confidentiality agreements and informed consent forms between the researcher and the respondents. The ethical issues in research require the researcher to treat as trade secrets, all confidential or specialized data or information so acquired during the course of the study, and should not use any such trade secrets for its benefit nor disclose them to any other person, firm, association or corporation during the period of the study except as authorized in writing by the respondents. According to the research ethical issues, there should be no use of any document or information obtained except for the purposes of conducting the research. This was strictly adhered to.

CHAPTER 4: PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

This chapter presents the analysis and presentation of the findings of this study examining the challenges and emerging issues faced by KETRACO in expansion of the electricity transmission network in Kenya. In this analysis, the chapter presents the findings mainly on the effects of implementation capacity, vandalism, and right of way on the expansion of the electricity transmission network in Kenya. With reference to the emerging issues, the analysis presents how population increase, environmental issues and technological changes have affected expansion of the electricity transmission network in Kenya.

4.2 Response Rate

The section presents the results on the response rate. The response rate shows the level of achievement the researcher obtained in collecting data for the study. The research targeted to collect data from a sample of 103 respondents. However, the study did not achieve a response rate of 100% as there were some non-response incidences. Out of the target sample of 103 respondents only 86 responses were received implying a response rate of approximately 83.50 percent as presented in figure 4.1 below.

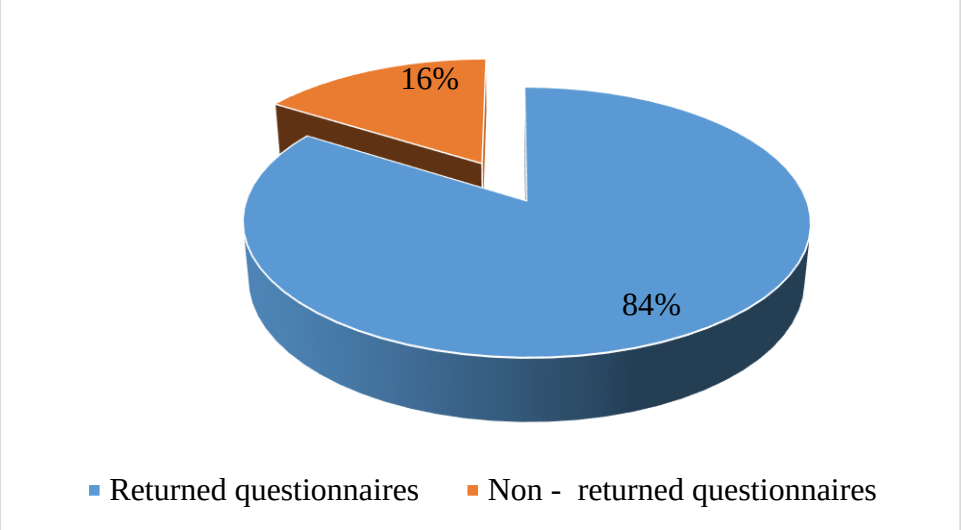

Figure 4.1 Response Rate

4.3 Demographic Characteristics

The study demographic characteristics of the respondents sought to determine the level of education of the respondents who participated in the study. The level of education of the respondents ranged from bachelor's to PhD degrees. As illustrated in Figure 4.2, those with bachelor's degrees were 30.23%; master's degrees 52.33% while those who had PhD qualification accounted for 17.44%. Thus, the majority of the respondents had a master's degree. The findings show that the respondents were well educated thus deemed to be fully aware of the research subject matter.

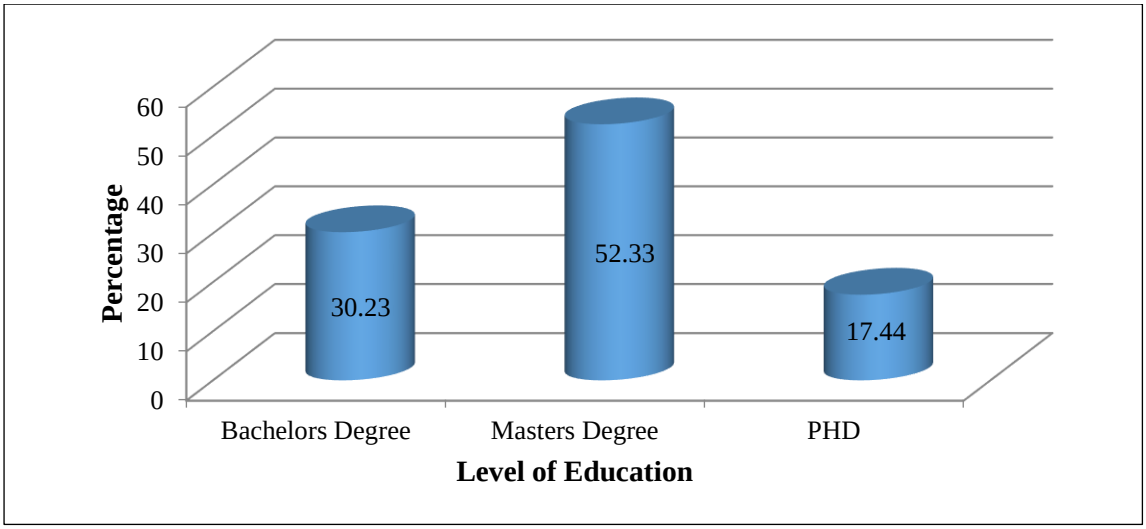

Figure 4.2 Level of Education of Respondents

On the length of work in their firms, the study found out that 43 respondents had worked within the energy sector for 10 years. Further, 11 respondents had worked in the energy sector for 4 years, 9 respondents for 22 years, 4 respondents for 29 years. The longest serving respondents had served for 31 years with a frequency for 4 respondents. Therefore, the majority of the respondents had 10 years of experience in the energy sector.

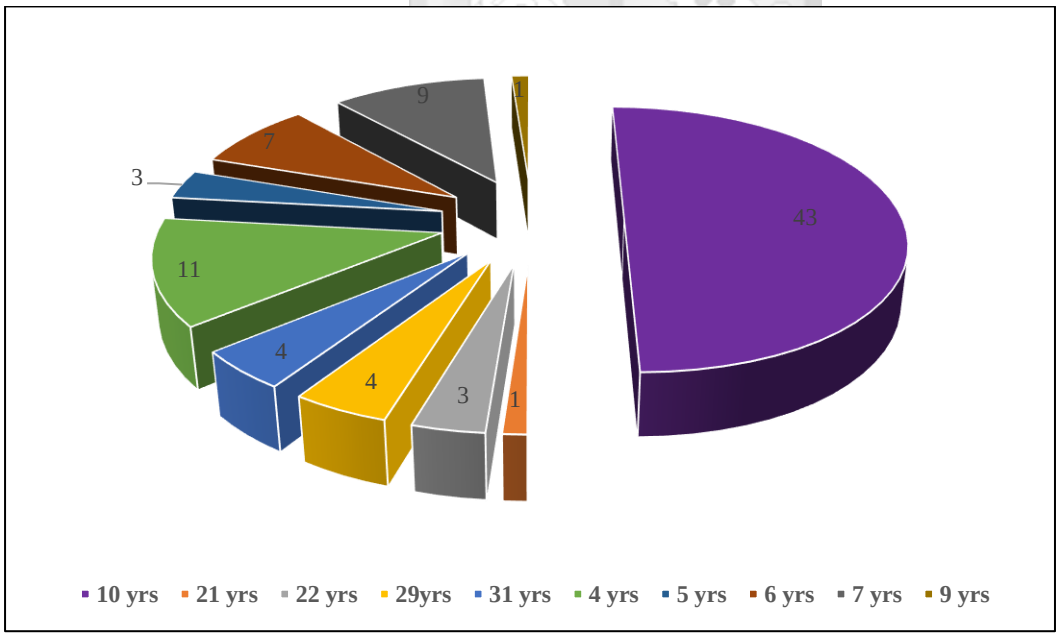

Figure: 4.3 Length of Work in Energy Sector

The study also sought to determine the respondents job level in terms of their respective managerial level. The findings indicate that about three – quarters of the respondents were in middle management level at 76.74%. Further, 19.77% were in top management with 3.49% being at union levels of management. This indicates that a majority of the respondents are in middle management therefore well versed with strategic level matters and involved in the day to day operations in their respective organization. The responses given by the respondents give a true reflection of the findings and could therefore be relied upon for analysis and policy pronouncements. From the definition of middle management in the context of this study, it implies senior officers and managers of divisions / departments. The findings of the study are shown in Figure 4.4

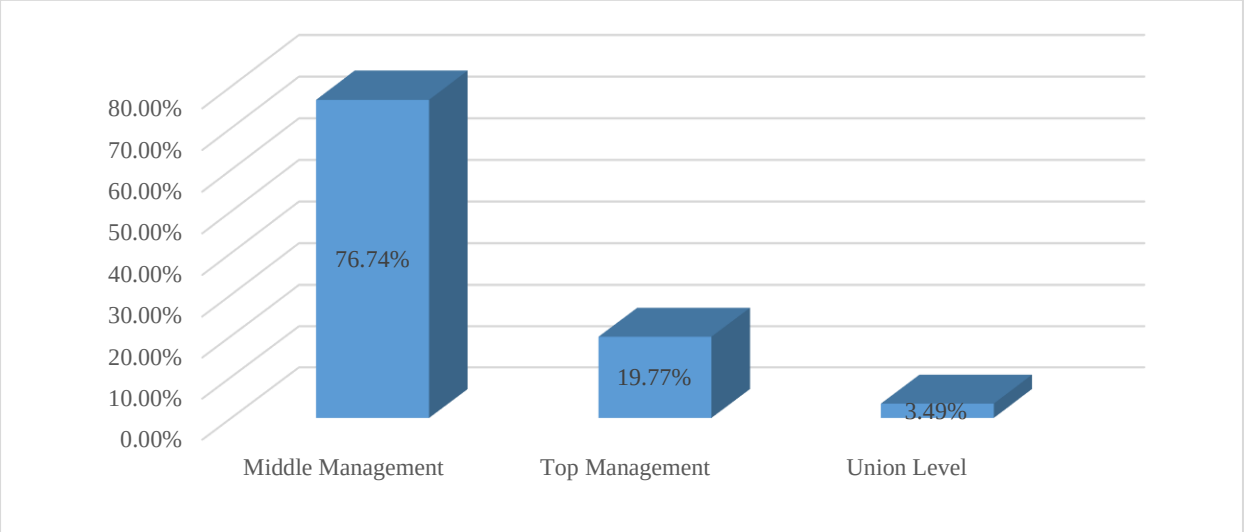

Figure 4.4 Respondents job level.

Further, the respondents' demographics captured the organization from which the respondents' worked with. The results indicate the 7 respondents work with KENGEN, 27 from KETRACO, 21 from KPLC, 22 from the Ministry of Energy and 9 from the National Treasury. The results are graphically presented in figure 4.5 as follows.

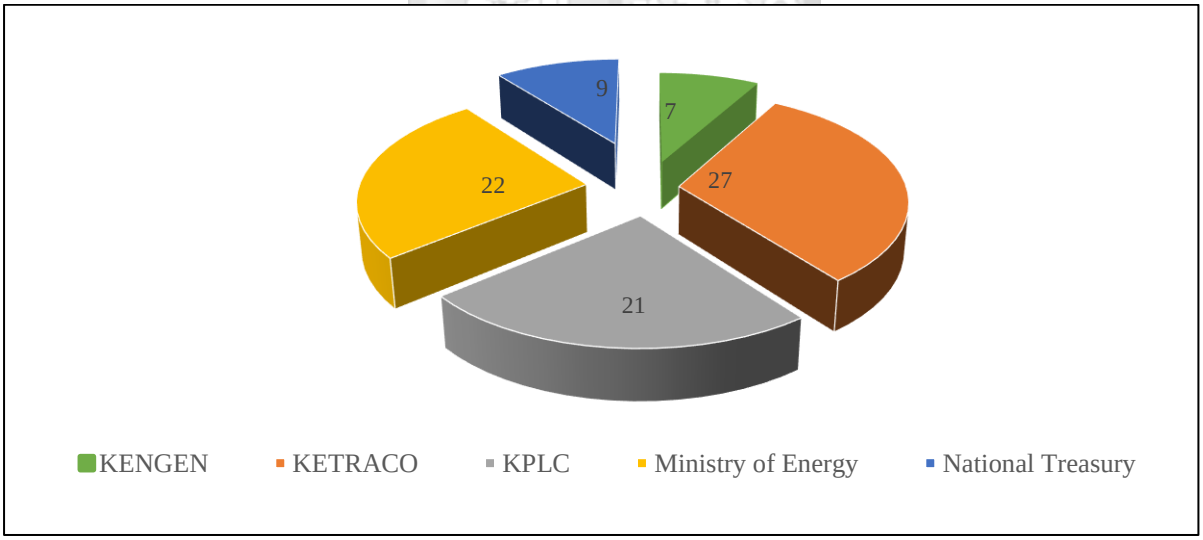

Figure 4.5 Name of the organization

4.4 Challenges faced by KETRACO in electricity transmission network expansion

The study evaluated the effect of different challenges facing the expansion of electricity transmission network in Kenya. The study focused on three core challenges namely: implementation capacity, right of way acquisition and vandalism of the transmission infrastructure. The influence of these challenges on the expansion of electricity transmission infrastructure are presented in this section as follows:

4.4.1 Implementation capacity and electricity transmission network expansion

The study evaluated the effect of different aspects of the implementation capacity on the expansion of the electricity transmission network in Kenya. The respondents' ratings on the influence of the different aspects of implementation capacity on the expansion of the electricity transmission network in Kenya are presented in table 4.1. From the findings, a majority of 83.72 percent of the respondents agreed that KETRACO has implemented transmission projects in accordance with the energy sector plans.

With respect to the availability of the adequate human resource that is endowed with the necessary skills in KETRACO required to successfully implement transmission infrastructure projects there were some disagreement at 26.74% of KETRACO having the necessary human resource to undertake transmission infrastructure projects albeit 47.67 agreeing on KETRACO having the right skills endowed human resource.

Diverse ratings were reported for the energy sector having put in place a Wheeling Tariff Policy for determining wheeling charges for high voltage electricity transmission with 24.42% of respondents strongly disagreeing, 19.77% disagreeing but slight majority of 29.07% of respondents agreeing. The findings agreed with the theoretical perspective that the structure of the institution regulation affects investment directly in the industry of the public utility hence increasing the country's economic performance. On KETRACO's capability to raise adequate wheeling revenues for operation and maintenance of transmission equipment, the majority were indifferent to this aspect at 26.74% with a closer proportion of 25.58% agreeing.

Regarding the Government of Kenya's commitment to allocating adequate funding towards the expansion of electricity transmission infrastructure development, operation and maintenance, the respondents majorly disagreed with the opinion with 24.42% strongly disagreeing and 32.56% disagreeing with this opinion.

From documents review, it was established that KETRACO is currently implementing about 2,500km of lines and substation capacity of 6,231MVA which are expected to be complete by the year 2022. The planned projects between the period 2021 – 2038 are about 5,939km of lines and substation capacity of 9,111MVA. The investment requirement is approximated at USD 4,646 million. The total ongoing and planned electricity transmission projects sum up to 8,469 km of lines and Substation capacity of 15,275MVA. The total investments requirement for all the projects are estimated to be USD 5,799 Million of which approximately USD 1,235 Million is secured/committed through development partners' assistance and EPC+Financing arising from Government to Government memoranda of understanding leaving an estimated financing gap of USD 4,564 Million, of which USD 281.50 Million is required before 2022..

Lastly, on the aspect of KETRACO having the resources to build capacity for effectively undertaking preventive, predictive, corrective and fault/breakdown maintenance of the transmission assets to guarantee availability, operability and reliability a majority of 59.3% of the total respondents were indifferent in their rating. However, in order to guarantee power system operational safety, minimum energy losses, system stability and reliability, KETRACO intends to undertake power system operations to enhance the Company's capacity to coordinate and facilitate power exchange and trade through the national grid and the regional power interconnectors. This function requires intensive capacity building and setting up the requisite infrastructure.

Table 4.2: Implementation capacity and electricity transmission network expansion

Implementation Capacity aspects	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
KETRACO has implemented transmission projects in accordance with the energy sector plans	6.98	8.14	0	83.72	1.16
There is adequate human resource capacity with the necessary skills in KETRACO required to successfully implement transmission infrastructure projects in Kenya	2.33	26.74	10.47	47.67	12.79
The energy sector has a Wheeling Tariff Policy for determining wheeling charges for high voltage electricity transmission	24.42	19.77	13.95	29.07	12.79
KETRACO has the capability to raise adequate wheeling revenues for operation and maintenance of transmission equipment	16.28	18.6	26.74	25.58	12.79
The GoK allocates adequate budgets to KETRACO for transmission infrastructure development, operation and maintenance	24.42	32.56	33.72	9.3	0
KETRACO has the resources to build capacity for effectively undertaking preventive, predictive, corrective and fault/breakdown maintenance of the transmission assets to guarantee availability, operability and reliability	9.3	8.14	59.3	19.77	3.49

4.4.2 Right of Way Acquisition and electricity transmission network expansion

Regarding the right of way, the respondents had mixed responses on the existence of a national Involuntary Resettlement Policy for Project Affected Persons (PAPs) with 39.53% agreeing the existence of such a policy while 20.93% strongly disagreeing. However, 26.74% were indifferent to the existence of such a policy. Further, respondents agreed that the resettlement Action Plan helps to define the resettlement and compensation necessary as a result of implementing a project with 45.35% agreeing and 44.19% strongly agreeing. In addition, respondents agreed that the transmission Line routes identified often led to physical displacement of people, loss of shelter, assets, income sources and livelihood, and restriction of access to economic resources with 39.53% agreeing and 46.51% strongly agreeing. A half of the respondents agreed that there is a mechanism for providing specific rates for compensation of loss of assets at fair market and equitable value and a methodology of how these values are derived with 31.4% strongly agreeing. Mixed responses were reported on the compensation rates on land and property of those affected by the transmission expansion projects being adequate with 12.79%, 37.21%, 16.28 and 25.58% disagreeing, being neutral, agreeing and strongly agreeing respectively. However, there was a strong agreement that Environmental and Social Impact Assessment (ESIA) studies are always done to assess the potential economic and social impacts of the project with a majority of 61.63%. Similarly, the respondents majorly agreed that grievance redress mechanisms are in place for PAPs to voice concerns about the resettlement and compensation process as may arise with 53.49% agreeing and 15.12% strongly agreeing. In the same note, a majority of 56.98% strongly agreed that unresolved grievances with PAPs often led to project stoppages thus undermining project expansion and completion efforts. It was established that 180 court cases had been filed by February 2019 involving both completed and ongoing projects and the disputes related to compensation of wayleave acquisition, land disputes and contractual disputes. Lastly, 43.02% and 26.74% of the respondents agreed and strongly agreed respectively that local Politicians often play a critical role in inciting PAPs and making unreasonable demands for compensation.

Table 4.3: Right of Way Acquisition and electricity transmission network expansion

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
There exists a national Involuntary Resettlement Policy for Project Affected Persons (PAPs)	20.93	10.47	26.74	39.53	2.33
Resettlement Action Plan helps to define the resettlement and compensation necessary as a result of implementing a Project	6.98	0	3.49	45.35	44.19
Transmission Line routes identified often lead to physical displacement of people, loss of shelter, assets, income sources and livelihood, and restriction of access to economic resources	6.98	3.49	3.49	39.53	46.51
There is a mechanism for providing specific rates for compensation of loss of assets at fair market and equitable value and a methodology of how these values are derived	6.98	4.65	6.98	50	31.4
Electric transmission lines increase property values within the wayleaves corridor	3.49	37.21	19.77	17.44	22.09
PAPs are dissatisfied with compensation for transmission expansion projects	0	18.6	50	26.74	4.65
The compensation rates on land and property of those affected by the transmission expansion projects are adequate	8.14	12.79	37.21	16.28	25.58
Environmental and Social Impact Assessment (ESIA) studies are done to assess the potential economic and social impacts of the project	6.98	0	0	31.4	61.63
Grievance redress mechanisms are in place for PAPs to voice concerns about the resettlement and compensation process as may arise	6.98	17.44	6.98	53.49	15.12
Unresolved grievances with PAPs often lead to project stoppages	9.3	0	0	33.72	56.98
Local Politicians often play a critical role in inciting PAPs and making unreasonable demands for compensation	9.3	10.47	10.47	43.02	26.74

4.4.3 Vandalism and electricity transmission network expansion

Concerning vandalism as a core challenge facing electricity transmission expansion, a majority of 53.49% of respondents agreed that destructions of transmission line assets have increasingly affected the expansion of the electricity transmission network. Similar responses were reported for the frequent and significant number of vandalism cases being reported on theft and/or vandalism of transmission assets at 60.47%. Regarding security and reinforcement measures taken to curb vandalism of electricity transmission infrastructure in Kenya, 47.67% agreed with 20.93% strongly agreeing on the existence of such measures. Further, the respondents strongly agreed that destruction of transmission assets significantly affects system downtime and reliability of power and destruction of transmission assets is a costly affair to the Government of Kenya and the public at 62.79% and 80.23% respectively.

Table 4.4: Vandalism and expansion of electricity transmission network in Kenya

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Destructions of transmission line assets have increasingly affected the expansion of electricity transmission network	6.98	8.14	24.42	53.49	6.98

There are frequent and significant number of cases reported on theft and/or vandalism of transmission assets	6.98	0	10.47	60.47	22.09
There are security and reinforcement measures taken to curb vandalism of electricity transmission infrastructure in Kenya	2.33	2.33	26.74	47.67	20.93
Destruction of transmission assets significantly affects system downtime and reliability of power	6.98	3.49	0	26.74	62.79
Destruction of transmission assets is a costly affair to the GoK and the public	6.98	0	0	12.79	80.23

4.5 Emerging issues on electricity transmission network expansion

The study evaluated the effect of emerging issues facing the expansion of electricity transmission expansion in Kenya. The study focused on three emerging issues namely: technology changes, population increase and environmental policies. The influence of these emerging issues on the expansion of electricity transmission infrastructure are presented in this section as follows:

4.5.1 Technological changes and electricity transmission network expansion

Regarding the technological changes and electricity transmission network expansion, a majority of 51.76% strongly disagreed with the issue of the energy sector having adopted modern technology in processes involving electricity transmission. Similarly, a majority of 64.71% strongly disagreed that automation of operation and maintenance processes had been enhanced in the electricity transmission sub-sector with 40% majorly strongly disagreeing with the fact that adequate measures had been taken to enhance transmission assets through Smart Grids and mini grids. Further, the majority of 44.71% strongly disagreed that monitoring systems had been put in place to reduce downtime of the electricity systems and blackouts with 50.59% strongly disagreeing with the existence of a well-established standardization/regulation to minimize transmission losses. However, majority of respondents were indifferent to whether the stakeholders in the energy sectors have put in place appropriate measures to integrate the available variable renewable energy into the national grid and whether there is increased financing in the energy sector to support electricity transmission projects at 41.18% and 49.41% respectively.
Further, it was established that in the recent past the government has put more emphasis towards increasing renewable power generation in order to reduce over-reliance on hydro generation. Currently, the renewables account for approximately 70% of the installed generation capacity i.e. Hydro 30%, Geothermal 24%, Wind 12% and Solar 2%. This has vastly improved power supply to the main load center, Nairobi with completion of Suswa-Isinya-Athi River-Embakasi lines providing alternative lines to the current existing Olkaria-Nairobi North and Nairobi North - Dandora 220kV double circuit lines.

However, this increase in renewable energy mainly wind and solar has brought operational challenges to the current transmission network due to the intermittent nature of these sources. This is expected to become more pronounced since from data collected during the study, renewable energy will supply about 64% of the system generation requirements by the year 2038 of which about 18% will be from solar and wind. Increased renewable generation is also intended to reduce thermal generation mainly in the coast region in an effort to reduce electricity cost. This implies that power has to come through long lines from Olkaria fields and Kiambere power plant. The coast region therefore is experiencing high voltages during periods of light loads and more interruptions to industries with sensitive loads. Furthermore, the wind and solar generation plants

do not increase the system's inertia which is critical to improving the network resilience to faults occurring in the system and therefore minimizing the chances of regional blackouts.

The commissioning of Ethiopia-Kenya 500kV HVDC with the existing low short circuit levels of national AC grid will present challenges in operation of the interconnector more so when a lot of power is supposed to be evacuated. In addition, due to the characteristic of the national grid overvoltage levels, lower frequencies and over frequencies are likely to be experienced. In addition, poor voltages are still experienced in West Kenya and at times lead to load shedding. The power transfer to West Kenya from Olkaria is limited as there is only one transformer at Olkaria 1AU rated at 105 MW and the Olkaria 1AU - Naivasha line though constructed at 220kV still uses a lower rated conductor rated at 132kV. Furthermore, the power still goes through the existing Juja Lanet-Lessos 132kV line which is currently overloaded and tends to experience power swings during fault conditions leading to islanding or blackouts in the West Kenya region.

The earlier expansion of transmission lines focused on financially viable lines which led to some lines being overloaded and lack of countrywide electricity coverage. In addition, new load growth centers in the Counties require reinforcement of the network to ensure reliable supply. The Government plans to have 100 % electricity access by 2020 and this requires expansion of the transmission network to ensure reliable and stable system. This will also reduce the transmission system losses to the required internationally accepted level of less than 3.5%.

Table 4.5: Technological changes and electricity transmission network expansion

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
The energy sector has adopted modern technological in processes involving electricity transmission	51.76	7.06	27.06	14.12	0
Automation of operation and maintenance processes has been enhanced in the electricity transmission sub-sector	64.71	4.71	22.35	8.24	0
There are adequate measures taken to enhance transmission assets through Smart Grids and mini grids	40	17.65	40	2.35	0
Monitoring systems have been put in place to reduce downtime of the electricity systems and blackouts	44.71	3.53	20	31.76	0
There is a well-established standardization/regulation to minimize transmission losses	50.59	5.88	43.53	0	0
The stakeholders in the energy sectors have put in place appropriate measures to integrate the available variable renewable energy into the national grid	30.59	16.47	41.18	10.59	1.18
There is increased financing in the energy sector to support electricity transmission projects	20	22.35	49.41	8.24	0

4.5.2 Population increase and electricity transmission network expansion

Electricity demand grew moderately over the period between 2014 and 2019 from 1,468MW in June 2014 to the current 1,882MW recorded in February 2019, being a cumulative increase of 414MW. Customer connectivity to electricity increased from 2,767,983 in June 2014 to 6,761,090 by the end of June 2018, an increase of 3,993,107. In addition, a total of 15,683 schools were connected to electricity during the same period bringing the total number of primary schools

connected to 23,886 out of the 35,442 primary schools in the country. Other public facilities such as trading centers, secondary schools, health centers and watering points totaling to 1,803 were also connected to electricity. Consequently, with these connections, the national electricity access rate increased from 32% in 2014 to an estimated 75 % in 2018, a 132% increase. New customers connected include 830,776 households living within informal and peri-urban areas that were connected under Global Partnership on Output Based Aid (GPOBA) and the Government funded Last Mile Connectivity Programme.

A review of the Energy Sector documented Demand Forecast projects that the demand will grow from 1,882MW in February 2019 to 6,308MW in 2038 in reference scenario; to 4,987MW in the low scenario and to 8,924MW in the high scenario as indicated in Table 4.6. The planned generation projects are targeted to enable the interconnected installed capacity to increase from 2,679MW to 9,589MW by the year 2038. Hence, in order to meet the projected power demand, evacuate the planned generation projects and meet all the National Transmission Grid Code requirements there is need to expand the electricity transmission network with approximately **8,469km** of high voltage transmission lines and **15,275MVA** transformation capacity by the year 2038.

Table 4.6: Electricity Demand Forecast

	Low			**Reference**			**High scenario**		
	MW	GWh	Growth Rate	MW	GWh	Growth Rate	MW	GWh	Growth Rate
Feb-19	1,882	10,965		1,882	10,965		1,882	10,965	
2019	1,937	11,582	5.63%	1,960	11,718	6.9%	2,023	12,084	10.2%
2020	2,009	12,000	3.61%	2,065	12,334	5.3%	2,185	13,023	7.8%
2021	2,083	12,424	3.53%	2,170	12,939	4.9%	2,361	14,045	7.8%
2022	2,165	12,900	3.83%	2,342	13,863	7.1%	2,558	15,188	8.1%
2023	2,252	13,404	3.91%	2,461	14,543	4.9%	2,744	16,267	7.1%
2024	2,370	14,092	5.13%	2,612	15,416	6.0%	2,970	17,585	8.1%
2025	2,496	14,820	5.17%	2,815	16,704	8.4%	3,224	19,065	8.4%
	Low			**Reference**			**High scenario**		
	MW	GWh	Growth Rate	MW	GWh	Growth Rate	MW	GWh	Growth Rate
2026	2,626	15,578	5.11%	3,028	17,913	7.2%	3,474	20,518	7.6%
2027	2,763	16,376	5.12%	3,219	19,047	6.3%	3,771	22,205	8.2%
2028	2,910	17,225	5.19%	3,445	20,454	7.4%	4,071	23,947	7.8%
2029	3,065	18,128	5.25%	3,695	21,895	7.0%	4,395	25,829	7.9%
2030	3,230	19,085	5.28%	3,930	23,284	6.3%	4,749	27,875	7.9%
2031	3,406	20,104	5.34%	4,174	24,723	6.2%	5,138	30,128	8.1%
2032	3,594	21,189	5.40%	4,433	26,249	6.2%	5,553	32,525	8.0%

2033	3,793	22,343	5.45%	4,710	27,865	6.2%	6,001	35,109	7.9%
2034	4,032	23,686	6.01%	5,004	29,581	6.2%	6,492	37,931	8.0%
2035	4,258	24,988	5.50%	5,317	31,396	6.1%	7,027	41,004	8.1%
2036	4,482	26,284	5.18%	5,632	33,208	5.8%	7,610	44,352	8.2%
2037	4,727	27,699	5.39%	5,974	35,163	5.9%	8,240	47,959	8.1%
2038	4,987	29,197	5.41%	6,308	37,007	5.2%	8,924	51,867	8.1%
Average Growth			**5.02%**	**6.3%**			**8.08%**		

Source: LCPDP Medium Term Plan (2018)

However, more than half of the respondents were indifferent to there being an increased demand for electricity in some areas due to increased populations thus requiring enhancement of the existing transmission lines at 52.94%. However, 50.59% disagreed with the aspect of there being available resources and capacity that are adequate to cater for the increased demand of electricity with a majority of 58.82% strongly disagreeing with the proposition that the emergence of industries in some locales has had an effect on the transmission network by increasing electricity demand. Mixed ratings were evident on the aspect of whether industry owners and members of the public are informed of the energy sector generation and transmission plans with 34.12% strongly disagreeing, 17.65% disagreeing, 37.65% being neutral, 10.59% agreeing and none strongly agreeing.

Table 4.7: Population growth and electricity transmission network expansion

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
There is increased demand for electricity in some areas due to increased populations thus requiring enhancement of the existing transmission lines	38.82	8.24	52.94	0	0
The available resources and capacity are adequate to cater for the increased demand of electricity	23.53	50.59	16.47	2.35	7.06
Emergence of industries in some locales affects the transmission by increasing electricity demand	58.82	2.35	12.94	25.88	0
Industry owners and members of the public are informed of the energy sector generation and transmission plans.	34.12	17.65	37.65	10.59	0

4.5.3 Environmental Policies and electricity transmission network expansion

A review on the findings of the environmental policies reveal that respondents strongly disagreed with the fact that there are adequate measures in place to ensure the transmission projects meet the existing environmental conditions to ensure environmental and social sustainability of the project at 45.88%. Notably, there was an overwhelming disagreement with the fact that KETRACO carries out environmental impact assessment and obtains the necessary approvals and EIA licenses from

the National Environmental Management Authority (NEMA) with 90.59% of respondents disagreeing with this proposition. Lastly, on the aspect of HV transmission lines being not constructed in places where they interfere with the natural resources, mixed ratings were recorded where 28.24% strongly disagreed, 9.41% disagreed, 31.76% were neutral, 18.82% agreed and 11.76 strongly agreed.

However, the findings agreed with empirical findings by Boampong and Phillips (2016)

Table 4.8: Environmental policies and electricity transmission network expansion

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
There are adequate measures in place to ensure the transmission projects meet the existing environmental conditions to ensure environmental and social sustainability of the project.	45.88	5.88	16.47	31.76	0
KETRACO carries out environmental impact assessment and obtains the necessary approvals and EIA licenses from the National Environmental Management Authority (NEMA)	9.41	90.59	0	0	0
HV transmission lines are not constructed in places where they interfere with the natural resources	28.24	9.41	31.76	18.82	11.76

4.6 Relationship between Variables

4.6.1 Correlation

The study sought to understand the relationship among the dependent variables (electricity transmission expansion) and the independent variables mainly the implementation capacity, right of way, vandalism, population increase, technology changes and environmental policies. Pearson's correlation was run to determine the relationship between independent factors internally as well as with the dependent factor. Prior to running Pearson's correlation, Principal Component Analysis was applied on the independent variables to convert the ratings on the different aspects on the independent variables into one composite rating. The results of the correlation analysis are presented in table 4.9. It is notable that correlation does not imply causality but rather gives insights into how the variables relate to each other. The correlation coefficient therefore indicates the degree of association / relationship between the variables. Therefore, a positive correlation between dependent variable and independent variable does not imply that independent variable positively causes dependent variable. To obtain the causality between the variables, a regression model is required.

From the correlation results, it is evident that a negative and significant correlation was established between electricity transmission network expansion and right of way acquisition as well as the correlation between electricity transmission network expansion and vandalism. A negative correlation, though insignificant, was reported between electricity transmission network expansion and implementation capacity. Further, positive and significant correlation was reported between population growth and vandalism. This could perhaps be attributed to possibilities of the available market for vandalized material. Further positive correlation was found between electricity transmission network expansion on one hand and population and environmental policies on the

other. In addition, population growth and right of way acquisition were positively and significantly correlated which would be explained by the fact that increased population comes with high population density, which causes challenge in wayleave acquisition. Technology changes and electricity transmission network expansion were found to be positively correlated though insignificantly.

The negative relationship between electricity transmission expansion and the challenges is generally expected both practically and from theoretical and empirical point of view. Inadequate institution capacity, challenges in right of way acquisition and vandalism are generally expected to derail the expansion efforts of the electricity transmission infrastructure (Jackson and Pitts, 2015; Yarrow, 2017; Chalmers and Voorvaart, 2009). On the other hand, emerging issues in terms of increased population and technological advances are expected to have positive effect on electricity transmission infrastructure expansion (Pindoriya and Gurrapu, 2011 and Gayathiri, 2017). However, their insignificant effect on electricity transmission infrastructure expansion could be an indication of inadequate exploration of the opportunities that come with increased demand and improvement in technology by the company. This failure to tap into potentials arising from increased population and technological advances could be informed by the fact that since they are emerging issues, the realization of their full potential could have a time lag hence their insignificant relationship with the electricity transmission infrastructure expansion.

Table 4.9: Correlation Coefficients among the variables.

		Expansion	Capacity	Right of way	Vandalism	Population	Technology	Environment
Expansion	Pearson Correlation	1	-.505	-.693**	-.606**	.310*	.169	.399*
	Sig. (2-tailed)		.304	.336	.598	.115	.399	.039
	N	86	86	86	86	86	86	86
Capacity	Pearson Correlation		1	-.052	-.274	-.134	-.350	.132
	Sig. (2-tailed)			.798	.166	.505	.073	.513
	N		86	86	86	86	86	86
Right of way	Pearson Correlation			1	.113	.154**	-.065	.191
	Sig. (2-tailed)				.575	.443	.746	.339
	N			86	86	86	86	86
Vandalism	Pearson Correlation				1	.527**	.116	.084
	Sig. (2-tailed)					.005	.563	.676
	N				86	86	86	86
Population	Pearson Correlation					1	.347	.164
	Sig. (2-tailed)						.076	.415
	N					86	86	86
Technology	Pearson Correlation						1	.204
	Sig. (2-tailed)							.307
	N						86	86
Environment	Pearson Correlation							1
	Sig. (2-tailed)							
	N							86

4.6.2 Inferential Statistics: Regression Analysis

Electricity transmission expansion which was the dependent variable was measured by the number of kilometers constructed. The independent variables were implementation capacity, right of way acquisition, vandalism, changes in technology, population increase and environmental policies. However, the independent variables were captured in terms of ranking by the respondents. Given that, the independent variables had a number of subcomponents, in order to generate dependent variables that have five ranks as per the responses (strongly disagree, disagree, neutral, agree and strongly agree), the principal component analysis technique was applied to generate composite scores for all the subcomponents of each independent variable.

Upon using principal component analysis technique for generation of scores and rating, the regression models were fitted using Ordinary Least Squares Model. The OLS model assumes that the dependent variable is a linear function of model parameters. Other assumptions of the OLS model adopted are: error term of the model is normally distributed with the expected mean of 0; the variance error term is the same across all values of the independent variables (homoscedasticity); that there is no multicollinearity (or perfect collinearity among independent variables); that the error terms of different observations should not be correlated with each other (no autocorrelation). It is also notable that while the choice of the OLS model for empirical estimation was informed by the model assumptions, its choice was informed by the fact that it is the basic econometric model upon which all other econometric models are built from. Upon the estimation of the OLS model, the appropriate diagnostic test was conducted. These included: autocorrelation test, multicollinearity test, heteroscedasticity test and linearity test.

The results of the estimated OLS model are presented in table 4.10. The regression results indicate that implementation capacity has a negative effect on the expansion of the electricity transmission infrastructure. Further, using the t- statistic two – tail hypothesis and the respective p – value, the results indicate that the positive effect of implementation capacity on expansion of the electricity transmission infrastructure is significant at 5% significance level as evidenced by the probability value which is equal to 0.025 which is less than 5%. implies the importance of enhancement of implementation capacity of the company and other stakeholders to effectively implement electricity transmission projects on time. Similar results are evidenced for squared implementation capacity. This finding negates the findings by Jawad, Razali and Abang (2014) which analysed the challenges facing the expansion of government projects in Malaysia and established that expansion of government projects highly elides on the capacity to implement which is best defined by resources, competencies and implementation settings. Further, the findings agree with Yarrow (2017) who in analysing the challenges in the implementation of electricity power generation expansion projects in Kenya found that government commitment, community support and financial resource availability had a significant impact on implementation of electricity power generation expansion projects.

The results of right of way on expansion of the electricity transmission infrastructure indicate that right of way acquisition challenges negatively affect expansion of the electricity transmission infrastructure. Using the t- statistic two – tail hypothesis and the respective p – value, the effect was found to be significant at 5% significance level as evidenced by the probability value which is equal to 0.003 which is less than 5%. This finding agrees with the findings by Jackson and Pitts (2015) who sought to exemplify how electric transmission affects the property values in line with right of way acquisition. Employing a desktop research review, the study established that electric transmission enhanced the property values through promotion of accessibility to energy thus driving economic activities. Based on this finding, Jackson and Pitts (2015) concluded that as the

rights of way acquisition focused on enhancing the needs of the property owners, the property values get inflated thus affecting the expansion of transmission.

Further, vandalism was found to have the highest negative effect on expansion of the electricity transmission infrastructure as evidenced by the magnitude of the coefficient. Using the t- statistic two – tail hypothesis and the respective p – value, the negative effect of vandalism was found to be significant at 5% significance level as evidenced by the probability value which is equal to 0.010 which is less than 5%. This finding agrees with the findings by Chalmers and Voorvaart (2009) who found out that vandalism was a major pullback to effectiveness of electricity transmission in that it affected the programmes and projects meant to enhance transmission. The study cited the lack of proper security and focus on maintenance measures has led to continued destruction of electricity lines and generators which derail the expansion. In addition, Ikejemba and Schuur (2018) in examining the challenges affecting sustainability of renewable energy development projects in Sub-Saharan Africa found that electricity network expansion is adversely affected by vandalism and infrastructure sabotage.

Regarding the effect of emerging issues on the expansion of the electricity transmission infrastructure, regression results indicate that technology changes and population increase have a positive effect on the expansion of the electricity transmission infrastructure. Using the t- statistic two – tail hypothesis and the respective p – value, the positive effect of technology changes on transmission network expansion were found to be significant at 5% significance level given that their respective probability values are lower than 5% significance level. However, the positive effect of population increase on transmission network expansion was found to be insignificant at 5% significance level given that the probability value is greater than 5% significance level. This finding agrees with the findings by Pindoriya and Gurrapu (2011) who carried out a study on the emerging trends in the electricity market in India. The study established that among the major emerging trends in the energy sectors included technological changes, regulations and policies as well as climatic changes and economic changes leading to tariff reviews. According to Pindoriya and Gurrapu (2011), the reliability of electricity transmission and connectivity can be achieved through tuning the available systems to the new trends such as smart grids, adoption of micro-turbines and implementation of wind farm projects. Further, the study findings on the effect of increased demand agree with Gayathri (2017) whose study revealed that technological changes and increased demand were among the major trends in the energy sector.

Environmental policies were found to negatively affect the expansion of the electricity transmission infrastructure. Using the t- statistic two – tail hypothesis and the respective p – value, the effect was found to be significant at 5% significance level given that their respective probability values are lower than 5% significance level. This finding agrees with the findings by Boampong and Phillips (2016) whose study revealed that the policies put across by the Kenyan government were not properly tied towards enhancing the reliability of the VRE but was based on enhancing the tapping of more energy from other sources. The findings however disagreed with the theoretical perspective that the regulation institution would ensure the maximization of the public interest since they acquire more specialized experts, monitor industrial development in detail as well as making more informed decision in a rapid manner.

Table 4.10: Regression analysis results.

	Sum of Squares	Degrees of freedom	Mean Square	Number of obs = 86		
Model	33.7194	9	2.5379	F (9, 76) = 8.49		
Residual	0.9510	76	0.0618	Prob > F = 0.0000		
Total	34.6704	85	2.5997			
					95% Conf. Interval	
	Coefficient	Robust Std. Err.	t - statistic	P>t	Lower bound	Upper Bound
Implementation capacity	0.5588	0.7004	0.80	0.025	-1.93166	-0.81402
Implementation capacity^2	1.3493	0.6514	2.07	0.045	0.03376	2.66478
Right of way	-0.5602	0.1758	-3.19	0.003	-0.9153	-0.20517
Vandalism	-0.1276	0.0782	-1.63	0.010	-0.28554	-0.03028
Technology changes	0.1278	0.1106	1.16	0.055	-0.09559	0.35122
Technology changes^2	0.1643	0.1936	0.85	0.001	-0.55533	0.22673
Population increase	0.2563	0.5607	0.46	0.648	-0.84266	1.35519
Population increase^2	0.0215	0.3867	0.06	0.056	-0.73644	0.77949
Environmental policies	-0.5487	0.5848	-0.94	0.048	-0.59757	1.69490
Constant	27.1092	6.3318	4.28	0.000	14.32179	39.8965
Durbin-Watson stat = 2.0127			Adj R-squared = 0.6539			

Coefficient of Determination of the regression Model

In addition to the regression results, additional information from the model reveals that 65.39% of total changes in the expansion of the electricity transmission infrastructure are explained by implementation capacity, right of way, vandalism, technological changes, population increase and environmental policies. This is evidenced by the adjusted R-squared of the model, which was found to be 0.6539. Therefore, only 34.61% of total changes in the expansion of the electricity transmission infrastructure are explained by other factors that are outside the model.

4.6.3 Diagnostic tests

The following diagnostic test were conducted to establish the reliability of the results of the OLS regression model

4.6.3.1 Test for heteroscedasticity

Heteroscedasticity is an econometric problem whereby the variance of the model error is non – constant. Within the study, the Breusch-Pagan-Godfrey test was used to examine heteroscedasticity. The results are presented in table 4.10. The results show that for the respective chi square statistics for the Breusch-Godfrey LM test was 2.74 with the respective p – value of 0.1249 Using a 2 – tail test and 5% significance level, the study concludes that since the p – value

of the Chi2 is greater than 5 percent, this indicates absence of heteroscedasticity in the model. Therefore, the null hypothesis is accepted that there is no heteroscedasticity in the model.

Table 4.10: Heteroscedasticity test results

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity	
Ho: Constant variance	
Chi2(1) = 2.74	Prob > chi2 = 0.1249

4.6.3.2 Test for multicollinearity

Multicollinearity is a regression problem that arises from interrelation between the independent variables in a model. To test for multicollinearity, the Variance Inflation Factors (VIF) was applied. From the results, the mean variance inflation factor is 2.822. Using a rule of thumb of 10, we conclude that there is no multicollinearity among the variables since the mean VIF for the model are less than 10

Table 4.11: Multicollinearity test results

Variable	**VIF**	**1/VIF**
Implementation capacity	3.56	0.304186
Implementation capacity^2	3.06	0.300681
Right of way	3.82	0.317292
Vandalism	3.12	0.337182
Technology changes	1.64	0.335264
Technology changes^2	1.92	0.339275
Population increase	2.72	0.342409
Population increase^2	2.81	0.342642
Environmental policies	2.75	0.480608
	2.822	**0.350338**

4.6.3.3 Test for Autocorrelation

Durbin Watson Statistic test was used to determine the presence or absence of autocorrelation in the estimated OLS model. The Durbin Watson statistic is equal to 2.0127 which is slightly above 2.0. From econometric theory, a Durbin Watson statistic equal to 0 implies absence of autocorrelation. Therefore, the closer the Durbin Watson statistic is to value 2 the more the likelihood of absence of autocorrelation. However, given that there are some areas of the Durbin Watson test that are indeterminate, the statistical Durbin Watson table was used to determine the dl and du for the model with 9 parameters and 86 observations. The value of dl was found to be 1.445 and du to be1.881 using the 9 parameters and 90 observations given that the table has no provision for 86 observations. The regions for rejection and acceptance of the null hypothesis were determined using the Durbin Watson statistics, dl and du as follows:

Table 4.12: Durbin Watson bound statistics

Positive correlation	indeterminate	No serial correlation	indeterminate	Negative correlation
0 dl =1.445	du =1.881	2	4-du=2.119	4-dl =2.555 4

Durbin Watson d statistics from the STATA is 2.0127, which lies between 2 and 4-du, implying there is no serial correlation between the residuals in the model. Therefore, we don't reject the null hypothesis implying no evidence of autocorrelation

4.6.3.4 Test for Joint Causality

Looking at the joint test of the model, the F- statistics of the model was equivalent to 8.49 with the respective probability value of 0.000. Since the probability value is less than 5%, this indicates that implementation capacity, right of way acquisition, vandalism, technological changes, population increase, and environmental policies jointly statistically determine the expansion of the electricity transmission infrastructure.

4.6.3.5 Non-normality

The Jarque Bera test for non – normality was applied. The test statistic is always nonnegative. If it is far from zero, it signals the data do not have a normal distribution. The test therefore is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution. The test was done on the OLS model residuals. The null hypothesis for the test states that the residuals have normal distribution while the alternative hypothesis states the residuals have not normal distribution. If p-value is less than 0.05, then we should reject H0 and accept H1, which means we cannot say the residuals have normal distribution. If p-value is higher than 0.05, then we should reject H1 and accept H0, which means we can say the residuals have normal distribution (Gujarati, 2011). From the test results, the p – value of the chi (2) equals to 0.2472 which is greater than 5% significance level. This leads to the rejection of alternative hypothesis and acceptance of null hypothesis implying that the residuals of the model are normally distributed.

Table 4.13: Jarque Bera test

Jarque-Bera normality test	
Ho: normality	
Chi2(1) = 2.796	Prob > chi2 = 0.2472

The findings of the Jarque Bera test for non – normality for residuals are further supported by the histogram of the residuals in figure 4.1 which confirm normal distribution of the model residuals.

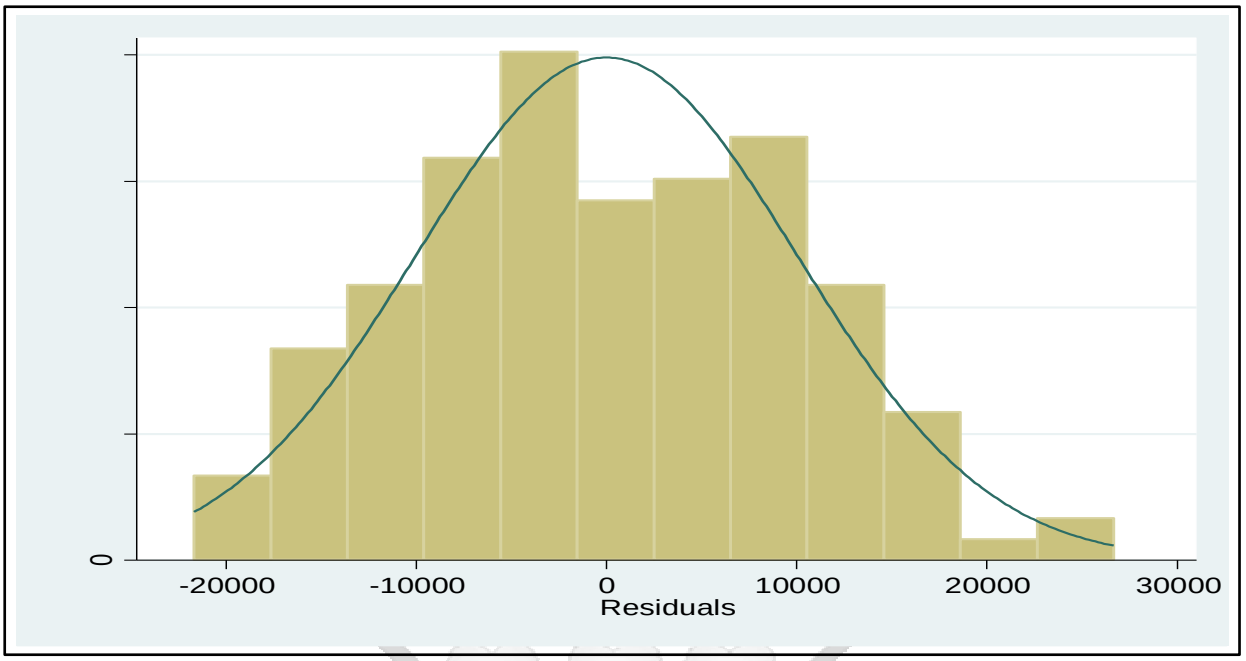

Figure 4.1: Histogram on distribution of model residuals

4.6.3.6 Ramsey Reset test

The Ramsey test was applied to conduct a model specification test. The test is applied to examine whether the model has omitted variables or not. The null hypothesis of the model tests that the model has no omitted variables implying that the alternative hypothesis states that the model does not have omitted variables. If p-value is higher than 0.05, then we should reject H1 and accept H0, which means we can say the model has no omitted variables (Gujarati, 2011). The test results, the p – value of the F - statistics equal 0.14518 which is greater than 5% significance level. This leads to the rejection of alternative hypothesis and acceptance of null hypothesis implying that the model has no omitted variables

Table 4.14: Ramsey RESET test

Ramsey RESET test	
Ho: model has no omitted variables	
F (3, 138) = 83.81	Prob > F = 0.14518

4.6.4 Chi-Squared Analysis

In addition to the regression analysis, the study applied the chi – square analysis to determine whether the ratings of the respondents with respect to the influence of the challenges and emerging issues on the expansion of electricity transmission infrastructure are statistically different or not. The Chi Square statistic is commonly used for testing relationships between categorical variables. The null hypothesis of the Chi-Square test is that no relationship exists on the categorical variables in the population; they are independent. Statistically, the Chi-square test analysis complements the

OLS regression model by testing how likely it is that an observed distribution is due to chance. It is also called a "goodness of fit" statistic, because it measures how well the observed distribution of data fits with the distribution that is expected if the variables are independent, thus complementing the outcome of the OLS regression model.

Based on the results of the chi – square analysis in table 4.15, the results evidenced that the respondents' individual ratings on how the different aspects of the challenges influence electricity transmission infrastructures are statistically different from each other. This is evidenced by the probability of the respective chi2 that are all less than 5%. Similar results are evidenced for the emerging issues presented in table 4.16.

The findings of the chi – square analysis agree with the findings of the OLS regression model. The OLS regression model found that challenges affecting electricity transmission infrastructures have a significant effect on the electricity transmission expansion. The chi – square analysis found that the ratings of the how different aspects of the challenges affecting electricity transmission network expansion are statistically different from each other. This therefore implies that each challenge has its unique effect on the electricity transmission network expansion, and they require unique solutions. This further implies that no single solution should be perceived as a peculiar solution to all challenges but rather the policy makers ought to design policies unique for each challenge. Similar findings were reported on the emerging issues.

Table 4.15: Chi - square analysis for challenges

	Implementation capacity ratings					
Right of way ratings	1	2	3	4	5	Total
1	5.56	11.11	33.33	50	0	100
2	11.11	11.11	55.56	22.22	0	100
3	17.39	34.78	0	4.35	43.48	100
4	44.12	17.65	0	35.29	2.94	100
5	0	0	50	50	0	100
Total	24.42	19.77	13.95	29.07	12.79	100
Pearson chi2(16) = 76.3881 Pr = 0.000						
	Vandalism ratings					
Right of way ratings	1	2	3	4	5	Total
1	0	0	16.67	83.33	0	100
2	0	33.33	0	11.11	55.56	100
3	26.09	8.7	13.04	52.17	0	100
4	0	5.88	44.12	47.06	2.94	100
5	0	0	0	100	0	100
Total	6.98	8.14	24.42	53.49	6.98	100
Pearson chi2(12) = 93.0628 Pr = 0.000						
	Implementation capacity ratings					
Vandalism ratings	1	2	3	4	5	Total
1	0	4.76	61.9	33.33	0	100
2	35.29	11.76	11.76	41.18	0	100
3	0	0	0	58.33	41.67	100
4	0	12	24	64	0	100
5	0	9.09	0	81.82	9.09	100
Total	6.98	8.14	24.42	53.49	6.98	100
	Pearson chi2(16) = 71.2456 Pr = 0.000					

Table 4.16: Chi - square analysis for Emerging issues

	Population increase ratings					
Technology ratings	1	2	3	4	5	Total
1	0	57.69	42.31	0	0	100
2	21.43	64.29	7.14	7.14	0	100
3	48.57	25.71	5.71	2.86	17.14	100
4	0	100	0	0	0	100
5	0	100	0	0	0	100
Total	23.53	50.59	16.47	2.35	7.06	100
Pearson chi2(16) = 53.9150 Pr = 0.000						
	Environmental policy ratings					
Technology ratings	1	2	3	4	5	Total
1	23.08	15.38	53.85	3.85	3.85	100
2	21.43	14.29	64.29	0	0	100
3	17.14	2.86	11.43	42.86	25.71	100
4	100	0	0	0	0	100
5	0	100	0	0	0	100
Total	28.24	9.41	31.76	18.82	11.76	100
Pearson chi2(12) = 49.5938 Pr = 0.000						
	Environmental policy ratings					
Population increase ratings	1	2	3	4	5	Total
1	15	0	10	30	45	100
2	34.88	16.28	23.26	23.26	2.33	100
3	0	0	100	0	0	100
4	0	50	50	0	0	100
5	100	0	0	0	0	100
Total	28.24	9.41	31.76	18.82	11.76	100
Pearson chi2(16) = 83.9347 Pr = 0.000						

4.6.5 Research Quality Tests

4.6.5.1 Reliability Tests

The findings indicate an overall Cronbach Alpha coefficient of 0.9651 for all the questions for the 10 questionnaires items as per the results presented in table 4.13.

Table 4.17: Reliability Findings

	Observations	Sign	Item-test correlation	Item-rest correlation	Alpha
Implementation capacity	10	+	0.8014	0.7713	0.9647
Right of way	10	+	0.7505	0.714	0.9657
Vandalism	10	+	0.933	0.922	0.9623
Technology changes	10	+	0.7723	0.7384	0.9653
Population increase	10	-	0.7239	0.6842	0.9662
Environmental policies	10	+	0.7259	0.6865	0.9661
Test scale					**0.9651**

4.6.5.1 Validity Tests

Table 4.14 indicates that the AVE of all constructs were above the 0.5 threshold demonstrating that the latent constructs account for at least fifty percent of the variance in the items. This shows that the measurement scales exhibited adequate measurement validity.

Table 4.18 Validity Test Findings

	Observations	Sign	item-test correlation	item-rest correlation	Average inter Item (Average Variance)
Implementation capacity	10	+	0.8014	0.7713	0.6459
Right of way	10	+	0.7505	0.714	0.6523
Vandalism	10	+	0.933	0.922	0.6296
Technology changes	10	+	0.7723	0.7384	0.6496
Population increase	10	-	0.7239	0.6842	0.6556
Environmental policies	10	+	0.7259	0.6865	0.6553
Test scale					**0.6481**

CHAPTER 5: DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions and recommendations made based on the findings of the study.

5.2 Discussions of the findings

5.2.1 Implementation capacity and electricity transmission network expansion

The findings of the study were that implementation capacity has a positive effect on the expansion of the electricity transmission infrastructure. This implies an element of inadequate capacity of the company and other stakeholders to effectively implement electricity transmission projects on time. This could be arising from inadequate skilled personnel, inadequate funding both from the government allocation as well as from development partners among other capacity related challenges.

The findings of the study disagree with findings by Jawad, Razali and Abang (2014) which analysed the challenges facing the expansion of government projects in Malaysia. The study sought to assess the role played by available resources, implementation setting and available competencies on project expansion. A descriptive research design was adopted with a target population of 318 respondents drawn from officials in government construction projects. The study established that expansion of government projects highly elides on the capacity to implement which is best defined by resources, competencies and implementation settings. While citing Steven and Wallach (2008), Jawad *et al.* (2014) indicated that among the major aspects derailing success of projects is lack of internal capacity to run the projects into completion. Nevertheless, the findings agreed with the empirical study by Ahlborg and Hammar (2011) who studied drivers and barriers to rural electrification in Tanzania and Mozambique and found that that the main barriers to grid extension were implementation capacity based and included low institutional quality, inadequate planning capacity, financing gap due to lack of co-investments and incompatible donor policies, and lack of access to skilled personnel.

The findings also agree with the empirical study by Eberhard and Shkaratan (2012) who found that funding gap is a major institutional challenge that affects electricity supply expansion in Africa. According to the study, Africa has a funding gap of $29.2 billion as a result of the difference between the investments required to meet demand of $40.8 billion and current annual investments of $11.6 billion. The gap is so significant that it requires that the ideological debate of public versus private be set aside and all mechanisms and resources to reduce the gap be mobilized. This relates to the high rating that the wheeling charge revenue generated by KETRACO is insufficient to finance transmission infrastructure expansion. The study recommended the need for public versus private investment in the energy sector. Further, the study established that there is serious under – pricing of electricity in the continent thus difficult to raise the revenues needed to meet investment requirements. This revenue shortfall is rarely covered through timely and explicit fiscal transfers. Instead, maintenance and investment activities are cut back to make ends meet, which starves the utility of funds to expand service coverage and cuts the quality of service to existing customers.

Further, the findings disagree with Yarrow (2017) who analysed the challenges in the implementation of electricity power generation expansion projects in Kenya. The study aimed at assessing the impact of community support, government commitment and availability of resources on implementation of electricity power generation expansion projects in Kenya. The scholar utilized a descriptive research design and sampled 128 employees from Kenya power Generating Company. The study established that government commitment, community support and financial resource availability had a significant impact on implementation of electricity power generation expansion projects. This resonates with the theoretical perspective that while project implementation is guided by rules, regulations, processes and procedures, certain barriers arising from individuals in and outside government impact on expansion of the transmission network.

The findings also disagreed with the theoretical perspective that the structure of the institution regulation affects investment directly in the industry of the public utility hence increasing the country's economic performance. This resonates with the argument by Zerbe (2001) that for a regulation theory to be regarded adequate, the theory must explain critically the reason as to why and how regulation is comparatively the best transaction cost minimizing institution in the efficient allocation of resources for particular goods, services or societal values.

5.2.2 Right of way and electricity transmission network expansion

Regarding the right of way, the study found out that wayleave challenges negatively affect expansion of the electricity transmission infrastructure. The effect was found to be significant at 5% significance level as evidenced by the probability value, which is equal to 0.000 which is less than 5%. Wayleave acquisition has proof to be a major challenge causing stoppage of the project due to unreasonable compensation demand from the PAPs. This could explain why the effect is very significant at not only 5% but also at 1% significance level.

The negative and significant effect of right of way on the electricity transmission infrastructure expansion could imply a number of issues. First, is the failure of the company to consider some measures that would promote the project buy – in by the landowners. Further, the failure of the company to consider giving back to such communities and land owners by investing in Community Social Responsibility programmes embedded in the project such as building of schools to communities affected, provision of clean water by drilling boreholes among other programmes would inform the community / land owners being adamant to voluntarily give the right of way. In addition, the disagreements of the valuation by land and property owners could inform the negative effect on the electricity transmission infrastructure expansion through delay in project implementation as well as stoppage of the ongoing projects.

It can be noted also that negative and significant effect of right of way on the electricity transmission infrastructure expansion could also be arising from the company's reluctance to adopt modern technology and deployment of resources in demonstration research that would see invention in better ways of curbing the problem of right of way acquisition be reducing the acreage of land needed for transmission infrastructure. This failure to adopt modern technology and deployment of resources in demonstration research point out the fact that the company continues to conduct its business the same way it has done overtime since its incorporation despite the opportunities arising from the emerging issues such as technology innovations that could be tapped to minimize / alleviate the challenge of right of way.

The findings agree with the theoretical insight of property rights theory that different specifications of property rights arise in response to the economic problem of allocating scarce resources, and the prevailing specification of property rights affects economic behavior and economic outcomes.

The findings also agreed with the empirical literature by Cheseto (2013) who studied the challenges in planning for electricity infrastructure in informal settlements: case of Kosovo village, Mathare valley –Nairobi and established that the lack of means to obtain right of way is a deterrent to electricity supply in the slum. Further, Orvika and Haako, (2009) asserts that electricity companies face physical conditions and tenure issues in slums that are unlike those encountered in formal, legal settlements where electricity company faces difficult legal issues in providing service, including the lack of a means to obtain right-of-way for distribution system expansion.
The study findings resonate with the findings by Jackson and Pitts (2015) reviewed the effects of electric transmission lines on property values. The study sought to exemplify how electric transmission affects the property values in line with right of way acquisition. The study was a literature review focusing on studies across the globe. The scholars established that electric transmission enhanced the property values through promotion of accessibility to energy thus driving economic activities. Jackson and Pitts (2015) indicated that as the rights of way acquisition focused on enhancing the needs of the property owners, the property values get inflated thus affecting the expansion of transmission.

5.2.3 Vandalism and electricity transmission network expansion

The objective was to find out the influence of vandalism on the expansion of electricity transmission infrastructure. The study found that vandalism was found to have the highest negative effect on expansion of the electricity transmission infrastructure as evidenced by the magnitude of the coefficient. The negative effect of vandalism was found to be significant at 5% significance level as evidenced by the probability value which is equal to 0.000 which is less than 5%. Vandalism leads to reallocation of funds meant for expansion of the transmission network to go to repairs. Further vandalism has had a negative effect on the stability of the transmission grid thus hampering the grid expansion efforts.

The negative and significant effect of vandalism on electricity transmission infrastructure expansion could imply a number of aspects. First is the failure to deal with the drivers of the vandalism such as a ready black market for the vandalized equipment such as copper. Further, this could be attributed to high poverty levels in areas across which transmission lines and installations traverse. Vandalism could also be emanating from the dissatisfied land and property owners who may not have been compensated as per their expectations.

Further, it speaks to the weak link in enforcement of laws with regard to vandalism and economic sabotage arising from vandalism of critical infrastructure such as electricity transmission infrastructure. The inadequate collaboration between the company and other stakeholders in the energy sector in championing for the review of economic infrastructure vandalism laws and regulation to develop more stringent laws that would deter the menace could inform the negative effect of vandalism on transmission grid expansion.

In addition, The negative and significant effect of vandalism on the electricity transmission infrastructure expansion has a bearing on how the company has foregone the role of demonstration research that would go a long way in testing how internet of things can be applied to curbing the vandalism by offering timely alerts on any intrusion on the electricity transmission infrastructure by offenders. The findings on the effect of vandalism are in conformity with the findings by

Chalmers and Voorvaart (2009) analysed the destruction effects on the effectiveness of high-voltage transmission lines. The study aimed at assessing the impact of vandalism on the effectiveness of electricity transmission. The scholars used a cross-sectional research design and had a sample size of 96 respondents surveyed using interview schedules. Their study found out that vandalism was a major pullback to effectiveness of electricity transmission in that it affected the programmes and projects meant to enhance transmission. According to Chalmers and Voorvaart (2009), lack of proper security and focus on maintenance measures has led to continued destruction of electricity lines and generators which derail the expansion.

Further, the findings agree with the empirical literature by Ikejemba and Schuur (2018) who report that vandalism has led to unsustainability and little expansion of energy projects in Sub Saharan Africa. Further, Utonih and Dlamini (2001) report that theft and vandalism has also resulted in the slow phasing out of PV projects in some countries in the Southern Africa region. In addition, the findings associate with the findings by Douhou, Magnus and van Soest (2011) who contend that criminal activities derail economic development through continued vandalism of government projects thus affecting the sustainability of the latter.

5.2.4 Technology changes and electricity transmission network expansion

Regarding the effect of emerging issues on the expansion of the electricity transmission infrastructure, regression results indicate that technology changes have a positive effect on the expansion of the electricity transmission infrastructure. However, the effect was found to be insignificant at 5% significance level given that their respective probability values are greater than 5% significance level.

Technology advancement has been found to be one of the emerging issues in the energy sector that presents the sector with robust opportunities which if duly tapped could transform the sector. First is the ability of technological innovations in offering solutions to challenges facing electricity grid such as vandalism. Fitting of sensors on the grid installations and infrastructures would assist in detecting vandals. In addition, technology innovations are crucial in material engineering to develop materials that are deterrent to challenges of vandalism such as unlockable nuts for transmission tower members. With regard to right of way challenges, technology has proved useful in reducing the land acreage needed especially for substations such as development of satellite substations which has been applied in developed economies.

The findings concur with the theoretical perspective that the strength of the Technology Adoption Model (TAM) lies in its simplicity as it has only two constructs, namely, "perceived usefulness" and "perceived ease of use" for predicting extent of adoption of new technologies at individual level as shown below of use) and that perceived usefulness is a stronger factor than perceived ease of use that drives technology adoption.

The influence of technology changes on electricity transmission grid expansion resonates with the findings by Pindoriya and Gurrapu (2011) who carried out a study on the emerging trends in the electricity market in India. The study aimed at establishing the continued changes that affected the generation and transmission of electricity in India. The scholars established that among the major emerging trends in the energy sectors included technological changes, regulations and policies as well as climatic changes and economic changes leading to tariff reviews. According to Pindoriya and Gurrapu, the reliability of electricity transmission and connectivity can be achieved through tuning the available systems to the new trends such as smart grids, adoption of micro-turbines and implementation of wind farm projects. This resonates with the empirical findings by Gayathiri

(2017) which revealed that technological changes and increased demand were among the major trends in the energy sector.

5.2.5 Population increase and electricity transmission network expansion

Regarding the effect of emerging issues on the expansion of the electricity transmission infrastructure, regression results indicate that population increase has a positive effect on the expansion of the electricity transmission infrastructure. However, the effect was found to be insignificant at 5% significance level given that their respective probability values are greater than 5% significance level.

Changes in population comes with increased demand for goods and services. This implies expansion in the other sectors such as manufacturing thus implying increased demand for energy. Further, increase in population implies an increase in number of households which has a direct effect on demand for electricity for household consumption. However, its notable that despite the increase in population having a positive effect on the electricity grid expansion via increased demand, it could also have counter intuitive – counterproductive effect through increased population density that would in turn amplify the challenge of right of way acquisition arising from increased compensation due to high number of project affected persons. Therefore, the net benefit of increased population as an incentive towards expansion of the transmission grid lies on which effect outweighs the other.

These findings concur with the findings of Hertwich and Roux (2011) who established that increased consumption and over-reliance on electricity-powered household items are some of the emerging trends that affect the electricity transmission by overpowering the transmitted capacity thus calling for a relook into the entire process. Further, Gayathri (2017) carried out a study on the recent trends in power systems. The study aimed at assessing the major changes that have impacted the electricity transmission and how the changes have affected the effectiveness of the transmission processes. The study adopted an exploratory research design and reviewed empirical evidence. The findings revealed that technological changes and increased demand were among the major trends in the energy sector. According to Gayathri (2017), transmission network expansion relies on the available infrastructure and with increased demand, there grows the need for enhanced transmission equipment. Gayathri also noted that transmission asset management systems are a trend in the electricity transmission sub-sector that needs to be upheld in order to enhance the transmission effectiveness.

5.2.6 Environmental policies and e electricity transmission network expansion

Environmental policies were found to negatively affect the expansion of the electricity transmission infrastructure. The effect was however found to be insignificant. The global debate on energy has taken a bias on green energy. This is because green energy is considered as being clean, reliable and sustainable in the long run due to its renewable nature. As a result, the environmental policies are being formulated in such a way that they promote generation and consumption of green energy as opposed to non – renewable energies that have adverse environmental effects. This is evidenced by the feed-in-tariff programme that tends to support renewable energies at the expense of non – renewable sources.

Transmission grids will therefore be expanded to evacuate green power implying that only the regions producing green energy will experience expansion at the expense of regions generating

non – renewable energy. This has a bearing on the natural resources exploitation given that the renewable energy resources such as geothermal and hydro resources will be exploited more and the transmission grid in such areas will be more pronounced. Financial resources will therefore be biased towards where renewable sources are abundant.

The findings disagreed with the theoretical perspective that the regulation institution would ensure the maximization of the public interest since they acquire more specialized experts, monitor industrial development in detail as well as making more informed decisions in a rapid manner and that as a rule operating under laws, the regulation of the institutional structure is designed with the aim of achieving both economic and objectives related to social policy Melody (2016). However, the findings resonate with Boampong and Phillips (2016) findings on the renewable energy incentives in Kenya with reference to the feed-in-tariffs and Rural Expansion. The study aimed at assessing the policies, government tariffs and the regulatory environment put across to enhance the growth and transmission of renewable energy in Kenya. The study targeted the feed-in-tariff and the Rural Electrification Authority. The findings revealed that the policies put across by the Kenyan government were not properly tied towards enhancing the reliability of the VRE but was based on enhancing the tapping of more energy from other sources. Boampong and Phillips (2016) noted that the Turkana Wind power plant project had not met its goals despite significant diversion of revenues from other sources of energy to the project. Boampong and Phillips (2016) cites Bounagui (2015) who explains that as much as Kenya aims to cut-down carbon by 30% come 2030, the efforts made with as far as VRE is concerned ought to affect the reliable transmission where the investments made in Wind and Solar power in Kenya are not significant to the output and the overall benefit.

This finding also resonates with Muller's theoretical perspective that the political individual is concerned with the interest of the public while the economic individual within a politician is mainly concerned with personal interest while in the real sense, the public is completely against the divided dual structure.

5.3 Conclusions

The study concludes that all the three challenges namely implementation capacity, right of way and vandalism negatively affects the electricity transmission expansion efforts of KETRACO. These negative effects are further found to be statistically significant thus cannot be undermined. In addition, the study concluded that the emerging issues, though having potential to spur expansion of the transmission grid, their potentials have not been fully tapped hence they have no better influence on transmission grid expansion. Population increase, though could be seen as potential in creating demand thus spurring transmission grid expansion, has not yet had a significant effect. Similarly, is the role of technology whose effect was positive but insignificant. Special attention is needed with reference to the environmental policies affecting expansion of the transmission grid. This is because they were found to negatively affect expansion efforts though insignificant.

5.4 Recommendations

Based on the study findings a number of policy recommendations are elicited in this study.

5.4.1 Recommendations on implementation capacity

To enhance the implementation capacity of the company and the energy sector at large, there is a need for an integrated plan of action that links all the players in the energy value chain mainly the players and stakeholder in generation, transmission and distribution. This should be what informs the development of the transmission master plan that takes into consideration the expansion efforts of the transmission grid while taking into account generation capacity and potentials on one hand and distribution on the other. South Africa presents an excellent example of the application of this Policy whereby in accordance with its transmission licence, Eskom is required to publish an updated Transmission Development Plan (TDP) for a 10-year period and the periodic TDP focuses on the need to connect IPPs to the grid, plans to develop large-scale transmission corridors at key points in the grid over the long term, and plans for regional major transmission development schemes. Equally, in Peru, the country formalized the centralized transmission planning framework as an added measure to attract investors, the main objective being identifying the system expansion needs and thus resolving cost allocation disputes between the said investors and the public.

Increased training of the personnel with regard to specific skills relating to transmission is essential. This will help bridge the skills gap that currently presents the implementation capacity gap in the sector. In addition, deliberations of how to efficiently share some existing skilled personnel across the energy value – chain are worthwhile. Further, there is need to attach personnel especially the technical personnel to the contracted contractors to promote on – the job training of the company staff. This will ensure tapping on the technical skills from the contractor to the company staff thus bridging the technical skills gap among the technical staff. Further, is the need for the company to undertake a skill gap analysis to inform the training schedules. The skill gap analysis should focus not only eliciting the skills gap but also providing a priority matrix in terms of which skills are more critical to the company so that training on such skill can be prioritized. In addition to bridging the skills gap, there is a need for the Company to establish collaborations with institutions of learning, especially institutions in the mother country where the contractors come from. This can be negotiated in the contract process to ensure that some project funds are set aside for such collaborations that will focus on training company staff in such institutions outside the country.

To address the project financing challenge in order to implement the planned electricity transmission projects in a timely manner, there is need to timely secure and adequate the requisite financing. The planned projects have a financing gap of USD 4,564 Million hence the financing of these projects needs to be prioritized. This includes exploring a mechanism of financing through competitive EPC + Financing and PPPs or Private Sector Participation (PSP) besides the traditional development assistance. A consideration for innovative – cost – effective ways of financing projects would be ideal to bridge the financing gap. According to World Bank (2014) Brazil and South America can be cited for attracting private finance to the energy sector. This accounts for more than a third of the global energy sector project investment with private finance in developing countries. Due to its relatively long track record of engagement with the private sector in Transmission & Distribution, Latin America arguably has much insight to offer into experience and lessons learned with grid privatization. However, important recent developments in other regions-such as private concessions of the transmission grid in the Philippines and distribution companies in Turkey-are also of interest to countries considering similar initiatives.
The company in collaboration with the National Treasury should explore other appropriate financing mechanisms such as floating of green infrastructure bonds that would attract funds easily towards development of green infrastructure that are more reliable green energy which is more

sustainable. This policy has been implemented in Ethiopia's Mekele-Dallol and Semera-Afdera Power Supply for Industrial Development and Access Scale-up Project; Tunisia's Electricity Distribution Networks Rehabilitation and Restructuring Project; Morocco's Power Transmission and Distribution Development Project; and Uganda's Uganda Rural Electricity Access Project, all which had qualified for financing from the African Development Bank's eligible projects in the Green Bond Portfolio as of December 2019.(AfDB, 2019).
Further is the adoption of various PPP financing models such as, Build Operate and Transfer, Build-Own-Operate-Transfer, Build-Own-Operate, Design-Build-Finance-Operate models and Joint ventures. These innovative – cost – effective financing models have been applied in other countries such as in South Asia whereby close to 20,165 MW and 6,449 MW of bilateral hydropower projects and private sector hydropower projects respectively for cross-border power trade between Nepal and India have been initiated. In addition, double circuit cross-border transmission corridors between the two countries exist connecting the regions: Butwal–Gorakhpur, Dhalkebar–Muzaffarpur, Duhabi–Purnea, Duhabi–Siliguri, and Lamki–Bareilly have been developed through joint venture arrangements (Ray, 2015).

There is also a need to consider financing right of way associated costs from various other sources besides the exchequer funds. This could be done by reviewing the wheeling tariff model to ensure that the tariff is commensurate with the services offered by KETRACO in so far as the energy value chain service is concerned. South Africa presents an excellent example of the application of this Policy where the South African Grid Code transmission tariff code sets out the transmission services and pricing and the procedure to be followed in applications to change revenue requirements, tariff structures or both.

KETRACO needs to build capacity for effectively undertaking preventive, predictive, corrective and fault/breakdown maintenance of the transmission assets to guarantee availability, operability and reliability. This could be undertaken by continuous monitoring of the transmission expansion. In addition, investing in modern technology that is capable of predicting fault/breakdown in the infrastructures is critical especially on the already completed transmission infrastructures. However, for the planned projects, the company could consider entrenching such technologies in the project designs. In addition, establishing collaborations and ambient working relationships with the sister institutions involved in generation and distribution is important in forming synergy that strengthens the entire electricity value chain. This would enable the company to undertake joint preventing and predictive measures with regard to any fault in the system and be proactive in rectifying the fault on time.

5.4.2 Recommendations on right of way

Regarding the right of way, there is a need for the formation of a community engagement plan for the areas along which the transmission line passes. This will increase community ownership of the project thus increasing project acceptability by the community thus reducing the chances of project stoppage. Further, sensitization of the communities and Project Affected Persons (PAPs) is crucial in enhancing project ownership. The company should form a community engagement plan consisting of the project affected persons along the line and engagement them in the community policing of the transmission network passing near their areas of residence. To achieve this the company should consider giving back to such communities by investing in Community Social Responsibility programmes embedded in the project such as building of schools to communities affected, provision of clean water by drilling boreholes among other programmes. This will enhance community buy in the project and therefore increase community willingness to allow and

support the project implementation. Further, the community engagement plan would be crucial in identifying key influential community leaders who the company can negotiate with on behalf of the community and easily win community buy – in into the project.
To reduce the negative effect of the right of way that is posed by huge compensation depending on the area covered by the grid, there is need to consider leveraging on the technology to reduce the land space needed to be acquired. Research on technologies such as use of monopoles as opposed to lattice towers would be informative in this regard. Therefore, company research on the cost – benefit analysis of using monopoles transmission towers as opposed to lattice transmission towers would be informative in decision making into which tower to adopt in order to reduce space needed to be acquired for the project. The USA and European countries have adopted the use of monopoles for over 50 years while India introduced the same over a decade ago to deal with ROW challenges. In Africa, Ethiopia has recently adopted this technology in some of its projects that boasts low maintenance costs and modifiable, good protection against vandalism and theft, smaller footprints, lower probability of catastrophic failures, and excellent life expectancy.

In addition, there is need for consideration of utilizing the already existing government reserves alongside other physical infrastructures such as roads networks, water and sewerage infrastructure, railways among others. This has proved to be realistic in handling wayleave acquisition challenges in developing economies such as South Africa. The company and the government need to explore the existing reserves for other existing physical infrastructure to find out whether future planned transmission infrastructure can be fitted along the existing infrastructure. This would eliminate the need to acquire new way leave.

5.4.4 Recommendations on vandalism

On the vandalism aspect, a number of policy recommendations can be put forward. First is the need for material research. It is notable that some vandalism is mainly necessitated by the materials and technology used in the construction of transmission towers. Therefore, investment in material research would be worth in identifying safer materials and technology that could deter vandalism. A good example would be research on use of unlockable nuts used in the assembly of transmission towers' members.

Secondly, is the use of the internet of things to trigger alerts on vandalism by use of remote sensing along the transmission towers. Demonstration research by the company would go a long way in testing how the internet of things can be applied to curbing vandalism by offering timely alerts on any intrusion on the electricity transmission infrastructure by offenders. This would involve demonstration research on use of security alarm systems and neural sensors in detecting vandalism on transmission infrastructure.

On technology innovation angle, the company should consider incorporating Vigilant Energy Metering System (VEMS) in installations located in vandalism prone areas. VEMS is a tool that is utilized in detecting electricity theft. This system is an "advanced energy metering system that can fight against electricity machinery theft. It can collect, transfer and process data between other energy meters, local station and base station. It also identifies probable locations of theft and helps the utility companies to control theft." The significance of this method is that it can locate both domestic and commercial sources of electricity theft as it locates abnormal patterns of electricity consumption from both the meter and the station from which electricity is distributed. Vigilant Energy Metering System has worked well in South Africa in minimizing vandalism (Amarnath et al. 2013). In 2012, the Government of Vietnam (GoV) approved the smart grid development project which was aimed at the integration of new monitoring, protection and control systems to

improve grid reliability and make efficient use of infrastructure while facilitating future integration of scaled-up renewable energy options. (World Bank, 2016). The project entailed deployment of substation automation system (SAS) and wide area monitoring systems (WAMS) as well as an information system for operation and supervision. In Turkey privatized utilities introduced technological improvements such as GIS and SCADA systems, enhanced metering, and registration and maintenance techniques, in order to meet the loss reduction targets and requirements for service quality imposed by EMRA and the energy sector regulator. (World Bank, 2014).

Supporting the newly created special anti-vandalism police unit could supplement community policing. The government of Kenya has created a special police unit known as the Critical Infrastructure Protection Unit (CIPU) to provide security to critical infrastructures in the country. Electricity transmission infrastructure falls within the critical infrastructure classification. The company needs to create appropriate institutional frameworks to engage the CIPU and offer the unit necessary support in enforcing anti – vandalism laws. Further, is the need for integrating the CIPU officers deployed in KETRACO premises and substations / installation in the company Security Services to promote harmonious provision of security in company installations as well as affective apprehension of victims involved in infrastructure vandalism.

The Company, through its Legal Department, should actively participate in development of stringent laws and regulations to curb the menace. The Company in collaboration with other stakeholders in the energy sector should champion the review of economic infrastructure vandalism laws and regulation to develop more stringent laws that would deter the menace. Further is the need for the company through the legal division to sensitize the company security personnel and CIPU on such laws and regulations for their effective enforcement.

In addition, community sensitization on the need to protect the physical infrastructures would be of significance in promoting community policing and enhancing easier identification of vandalism perpetrators. The company should form a community engagement plan consisting of the project affected persons along the line and engage them in the community policing of the transmission network passing near their areas of residence. To achieve this the company should consider giving back to such communities by investing in Community Social Responsibility programmes embedded in the project such as building of schools to communities affected, provision of clean water by drilling boreholes among other programmes. This will enhance community buy in the project and therefore incentivize the community living around the transmission infrastructures to protect the infrastructure by reporting any observed or detected vandalism activity by the vandals.

5.5 Limitations of the Study

The researcher had intended to use interview schedules to collect data from two key informants in the energy sector. Key informants were experts who have an extensive knowledge and understanding on electricity transmission and the challenges faced in the sector as well as the possible solutions and had been identified as the Managing Director of KETRACO and the General Manager Technical Services. It was not possible to obtain the audiences of these two key informants both physically and virtually due to business disruption and the need to maintain social distance to mitigate the spread of COVID 19 virus. Nevertheless, this limitation was overcome by the level of responses obtained from the open-ended questions in the questionnaire/. Feedback obtained from the open-ended questions adequately responded to the issues that had been intended to be probed in interviews.

5.6 Areas for further research

The researcher recommends further research on use of technologies such as use of monopoles as opposed to lattice towers to reduce the negative effect of the right of way that is posed by huge compensation depending on the area covered by the grid. In addition, a need for research on the materials used in the construction of transmission towers has been recommended to assist KETRACO in identifying safer materials and technology that could deter vandalism. A good example has been cited as research on use of unlockable nuts used in the assembly of transmission towers' members.

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APPENDICES

Appendix 1: Introduction Letter

Ole Sangale Rd, Madaraka Estate,
P.O Box 59857 00200, Nairobi, Kenya.
Cell: +254 703 414/6/7, Twitter: @SBSKenya
Email: info@sbs.ac.ke or visit www.sbs.strathmore.edu

Strathmore UNIVERSITY
BUSINESS SCHOOL

Monday, 16 December 2019

To whom it may concern

Dear Sir/ Madam,

RE: FACILITATION OF RESEARCH – LYDIA CHELAGAT SITIENEI

This is to introduce Lydia Chelagat Sitienei who is a Master of Public Policy and Management student at Strathmore University Business School, admission number MPPM/102014/17. As part of our MPPM Program, Lydia is expected to do applied research and to undertake a project. This is in partial fulfilment of the requirements of the MBA course. To this effect, she would like to request for appropriate data from your organization.

Lydia is undertaking a research paper on '*An Assessment of Challenges Affecting Electricity Transmission Network Expansion in Kenya; Case of Ketraco*'. The information obtained from your organization shall be treated confidentially and shall be used for academic purposes only.

Our MPPM program seeks to establish links with industry, and one of these ways is by directing our research to areas that would be of direct use to industry. We would be glad to share the findings with you after the research, and we trust that you will find them of great interest and of practical value to your organization.

We appreciate your support and we shall be willing to provide any further information if required.

Yours sincerely,

Caroline Tiara,
Manager – MPPM Programs.

Appendix II: Ethical Review Approval

Strathmore UNIVERSITY

26th March 2020

Ms Sitienei, Lydia
kittiechela2010@gmail.com

Dear Ms Sitienei,

RE: An Assessment Of The Challenges Affecting Electricity Transmission Network Expansion In Kenya; Case Of KETRACO

This is to inform you that SU-IERC has reviewed and **approved** your above research proposal. Your application approval number is **SU-IERC0671/20.** The approval period is **26th March 2020 to 25th March 2021.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-IERC within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-IERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to SU-IERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

for: Dr Virginia Gichuru,
Secretary; SU-IERC

STRATHMORE UNIVERSITY INSTITUTIONAL ETHICS REVIEW COMMITTEE (SU-IERC)
26 MAR 2020
TEL: +254 (0)703 034 000
P. O. Box 59857 - 00200
NAIROBI - KENYA

Cc: Prof Fred Were,
Chairperson; SU-IERC

Appendix III: KETRACO Research Approval Letter

OFFICE OF THE MANAGING DIRECTOR

KETRACO
Kenya Electricity Transmission Company Limited
"Building a World Class National Grid"

Kawi Complex, Block B,
Popo Lane, off Red Cross, South C,
P. O. Box 34942 - 00100, NAIROBI
Phone: 020 4956000, 0719018000, 0732128000
Web: www.ketraco.co.ke | email: info@ketraco.co.ke

Our Ref: KET/LS/2/14G/G/1 26th March, 2020

Your Ref: TBA

Lydia Sitienei
P.O Box 104192 - 00101
NAIROBI

Dear Lydia,

RE: AUTHORITY TO CONDUCT RESEARCH - AN ASSESSMENT OF CHALLENGES AFFECTING ELECTRICITY TRANSMISSION NETWORK EXPANSION IN KENYA; CASE OF KETRACO.

Reference is made to the above matter and your request to conduct a research study of KETRACO under the subject *'An Assessment of Challenges Affecting Electricity Transmission Network Expansion in Kenya; Case of KETRACO'*.

I am pleased to inform you that your request has been approved. Accordingly, you are advised to liaise with the relevant teams in Research and Corporate Planning, Design & Construction, Project Development, System Operations & Maintenance, Human Resource, Finance and Legal Services for access to the necessary information that you may require for your research study.

We look forward to receiving the study findings duly approved by Strathmore University.

Yours Sincerely,

FCPA FERNANDES BARASA, OGW
MANAGING DIRECTOR

Appendix IV: NACOSTI Approval Letter

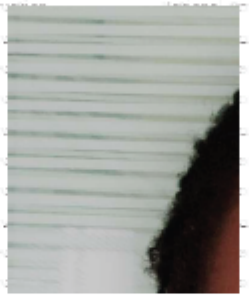
REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 538112

Date of Issue: 06/April/2020

RESEARCH LICENSE



This is to Certify that Ms.. Lydia Chelagat Sitienei of Strathmore University, has been licensed to conduct research in Nairobi on the topic: AN ASSESSMENT OF THE CHALLENGES AFFECTING ELECTRICITY TRANSMISSION NETWORK EXPANSION IN KENYA; CASE OF KETRACO for the period ending : 06/April/2021.

License No: NACOSTI/P/20/4700

538112

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is Guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014

CONDITIONS

1. The License is valid for the proposed research, location and specified period
2. The License any rights thereunder are non-transferable
3. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research
4. Excavation, filming and collection of specimens are subject to further necessary clearence from relevant Government Agencies
5. The License does not give authority to tranfer research materials
6. NACOSTI may monitor and evaluate the licensed research project
7. The Licensee shall submit one hard copy and upload a soft copy of their final report (thesis) within one of completion of the research
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice

National Commission for Science, Technology and Innovation
off Waiyaki Way, Upper Kabete,
P. O. Box 30623, 00100 Nairobi, KENYA
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Mobile: 0713 788 787 / 0735 404 245
E-mail: dg@nacosti.go.ke / registry@nacosti.go.ke
Website: www.nacosti.go.ke

Appendix V: Documents Review Guide

AN ASSESSMENT OF THE CHALLENGES AFFECTING TRANSMISSION NETWORK EXPANSION IN KENYA; CASE OF KETRACO.

Transmission Master Plan	Project Description	Capacity kV Length KM	Timelines	Human Resource Capacity (Total No of Project Managers, Engineers Consultants and non-technical staff)	Funding Total wheeling revenues/Exchequer Budget Allocation for Project Implementation and Right of Way acquisition	Expenditure (include operation and Maintenance and Repairs for vandalism, Total Idling Charges/Claims by Contractors and Transmission Losses	Status of Implementation (include No. of Easements Registered No. of Court Cases filed against KETRACO No of projects stalled, No of Court Cases, No of Easements or Wayleaves registered, Total No of Projects Planned and commenced, Total No. of Projects commissioned and energized, Total No of Projects stalled.	Gaps or overlaps
Strategic Plan	Project Description	Capacity kV Length KM	Timeline	Human Resource Capacity (Total No of Project Managers, Engineers Consultants and non-technical staff)	Funding Total wheeling revenues/Exchequer Budget Allocation for Project Implementation and Right of Way acquisition	Expenditure (include operation and Maintenance and Repairs for vandalism, Total Idling Charges/Claims by Contractors and Transmission Losses	Status of Implementation (include No. of Easements Registered No. of Court Cases filed against KETRACO No of projects stalled, No of Court Cases, No of Easements or	Gaps or overlaps

							Wayleaves registered, Total No of Projects Planned and commenced, Total No. of Projects commissioned and energized, Total No of Projects stalled.	
Kenya Vision 2030	Project description	Capacity kV Length KM	Timeline	Human Resource Capacity (Total No of Project Managers, Engineers Consultants and non-technical staff)	Funding Total wheeling revenues/Exchequer Budget Allocation for Project Implementation and Right of Way acquisition	Expenditure (include operation and Maintenance and Repairs for vandalism, Total Idling Charges/Claims by Contractors and Transmission Losses	Status of Implementation (include No. of Easements Registered No. of Court Cases filed against KETRACO No of projects stalled, No of Court Cases, No of Easements or Wayleaves registered, Total No of Projects Planned and commenced, Total No. of Projects commissioned and energized, Total No of Projects stalled.	Gaps or overlaps
LCPDP	Project description	Capacity kV Length KM	Timeline	Human Resource Capacity (Total No of Project Managers,	Funding Total wheeling revenues/Exchequer Budget Allocation for Project	Expenditure (include operation and Maintenance and Repairs	Status of Implementation (include No. of Easements Registered	Gaps or overlaps

				Engineers Consultants and non-technical staff)	Implementation and Right of Way acquisition	for vandalism, Total Idling Charges/Claims by Contractors and Transmission Losses	No. of Court Cases filed against KETRACO No of projects stalled, No of Court Cases, No of Easements or Wayleaves registered, Total No of Projects Planned and commenced, Total No. of Projects commissioned and energized, Total No of Projects stalled.	
MTP I, II & III **MTP II** **MTP III**	Project description	Capacity kV Length KM	Timeline	Human Resource Capacity (Total No of Project Managers, Engineers Consultants and non-technical staff)	Funding Total wheeling revenues/Exchequer Budget Allocation for Project Implementation and Right of Way acquisition	Expenditure (include operation and Maintenance and Repairs for vandalism, Total Idling Charges/Claims by Contractors and Transmission Losses	Status of Implementation (include No. of Easements Registered No. of Court Cases filed against KETRACO No of projects stalled, No of Court Cases, No of Easements or Wayleaves registered, Total No of Projects Planned and commenced, Total No. of Projects commissioned and energized, Total No of	Gaps or overlaps

							Projects stalled.	
BIG FOUR AGENDA	Project Description	Capacity kV Length KM	Timeline	Human Resource Capacity (Total No of Project Managers, Engineers Consultants and non-technical staff)	Funding Total wheeling revenues/Exchequer Budget Allocation for Project Implementation and Right of Way acquisition	Expenditure (include operation and Maintenance and Repairs for vandalism, Total Idling Charges/Claims by Contractors and Transmission Losses	Status of Implementation (include No. of Easements Registered No. of Court Cases filed against KETRACO No of projects stalled, No of Court Cases, No of Easements or Wayleaves registered, Total No of Projects Planned and commenced, Total No. of Projects commissioned and energized, Total No of Projects stalled.	Gaps or overlaps
Relevant Statutes i.e. Land Laws and Energy Laws	legislative framework							Gaps or overlaps
World Bank Reports								Gaps or overlaps

Appendix Vi - Questionnaire

AN ASSESSMENT OF THE CHALLENGES AFFECTING ELECTRICITY TRANSMISSION NETWORK EXPANSION IN KENYA; CASE OF KETRACO.

Please respond to the questions in Parts One, Two and Three (where applicable) to the best of your ability and as per instructions in each part.

PART ONE: GENERAL INFORMATION

1. Name of Organization_____
2. Directorate/Department/Division/Unit_____
   _____
3. Job Title: _____
4. Educational level: _____
5. Type of Professional Training: _____
6. Years of service in the electricity sector: _____
7. Indicate your job level (Top Management) (Middle Management) (Union level)

PART TWO: CHALLENGES FACING ELECTRICITY TRANSMISSION NETWORK EXPANSION

Indicate your level of agreement with following statements on the challenges faced in expansion of the Electricity Transmission Network. Use a Likert's scale of 1-5 where 1= Strongly disagree, 2=Disagree, 3= Neutral, 4= Agree and 5= Strongly agree

	1	2	3	4	5
Implementation Capacity					
The energy sector has an integrated planning mechanism for generation, transmission and distribution of electric power					
KETRACO has implemented transmission projects in accordance with the energy sector plans					
There is adequate human resource capacity with the necessary skills in KETRACO required to successfully implement transmission infrastructure projects in Kenya					
The energy sector has a Wheeling Tariff Policy for determining wheeling charges for high voltage electricity transmission					
KETRACO has the capability to raise adequate wheeling revenues for operation and maintenance of transmission equipment					
The GoK allocates adequate budgets to KETRACO for transmission infrastructure development, operation and maintenance					
KETRACO has the resources to build capacity for effectively undertaking preventive, predictive, corrective and fault/breakdown maintenance of the transmission assets to guarantee availability, operability and reliability					
Right of Way Acquisition					
There exists a national Involuntary Resettlement Policy for Project Affected Persons (PAPs)					
A Resettlement Action Plan helps to define the resettlement and compensation necessary as a result of implementing a project					

Transmission Line routes identified often lead to physical displacement of people, loss of shelter, assets, income sources and livelihood, and restriction of access to economic resources					
	1	**2**	**3**	**4**	**5**
There is a mechanism for providing specific rates for compensation of loss of assets at fair market and equitable value and a methodology of how these values are derived.					
Electric transmission lines increase property values within the wayleaves corridor					
PAPs are dissatisfied with compensation for transmission expansion projects					
The compensation rates on land and property of those affected by the transmission expansion projects are adequate					
Environmental and Social Impact Assessment (ESIA) studies are done to assess the potential economic and social impacts of the project					
PAPs, host communities and local nongovernmental organizations, as appropriate, are always consulted to determine the potential economic and social impacts of the project.					
Grievance redress mechanisms are in place for PAPs to voice concerns about the resettlement and compensation process as may arise.					
Unresolved grievances with PAPs often lead to project stoppages					
Unresolved grievances with PAPs often translate to lengthy court battles					
Local Politicians often play a critical role in inciting PAPs and making unreasonable demands for compensation					
Vandalism					
Destructions of transmission line assets have increasingly affected the expansion of electricity transmission network					
There are frequent and significant number of cases reported on theft and/or vandalism of transmission assets					
There are security and reinforcement measures taken to curb vandalism of electricity transmission infrastructure in Kenya					
Destruction of transmission assets significantly affects system downtime and reli					
Destruction of transmission assets is a costly affair to the GoK and the public					

What other challenges do you think are hindering the expansion of the electricity transmission network in Kenya?

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PART THREE: EMERGING TRENDS IN TRANSMISSION

Please indicate your level of agreement with the following statements regarding the emerging trends in the electricity transmission process. Use a Likert's scale of 1 to 5 where: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree 5 = Strongly Agree

	1	2	3	4	5
Technological Changes					
the energy sector has adopted modern technological in processes involving electricity transmission					
Automation of operation and maintenance processes has been enhanced in the electricity transmission sub-sector					
There are adequate measures taken to enhance transmission assets through Smart Grids and mini grids					
Monitoring systems have been put in place to reduce downtime of the electricity systems and blackouts					
There is a well establish standardization/regulation to minimize transmission losses					
The stakeholders in the energy sectors have put in place appropriate measures to integrate the available variable renewable energy into the national grid					
There is increased financing in the energy sector to support electricity transmission projects					
Population Growth					
There is increased demand for electricity in some areas due to increased populations thus requiring enhancement of the existing transmission lines					
The available resources and capacity are adequate to cater for the increased demand of electricity					
Emergence of industries in some locales affects the transmission by increasing electricity demand					
Industry owners and members of the public are informed of the energy sector generation and transmission plans.					
Environmental Policies					
There are adequate measures in place to ensure the transmission projects meet the existing environmental conditions to ensure environmental and social sustainability of the project.					
KETRACO carries out environmental impact assessment and obtains the necessary approvals and EIA licenses from the National Environmental Management Authority (NEMA)					
HV transmission lines are not constructed in places where they interfere with the natural resources					

In your opinion, what are some of the emerging trends that could be affecting the expansion of the electricity transmission network?

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PART FOUR: POSSIBLE SOLUTIONS TO TRANSMISSION NETWORK EXPANSION *(To be filled by the National Treasury & Ministry of Energy)*

Indicate your level of agreement with following statements on the possible solutions on the challenges facing expansion of electricity transmission network expansion. Use a Likert's scale of 1 to 5 where: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree 5 = Strongly Agree

Statement	**1**	**2**	**3**	**4**	**5**
Innovativeness					
Stakeholders in the energy sector continuously develop new ways of doing things to enhance transmission projects					
There are new energy products and supportive machineries put in place to steer the expansion of the transmission network					
New methods of electricity transmission such as use of underground cables have been adopted to save on costs and enhance efficiency					
There are efforts to build capacity at KETRACO in line with emerging new technologies					
Increased Financing					
The budgetary allocation for electricity transmission network has been increased in the recent past to enhance expansion projects					
Stakeholders in the energy sector mobilize funding for network expansion from donors and other agencies					
There is adequate and frequent monitoring to ensure that the finances allocated for transmission network expansion are appropriately and accountably used					
The Government prioritizes social safeguards and ROW acquisition funds over construction costs					
Techno-based Transmission					
Mini-grids and microgrids have been embraced to enhance transmission to small-scale and remote areas					
Analysis and survey of the electricity requirement in given areas is carried out before the actual transmission is done					

In your opinion, what do you think ought to be done to enhance electricity transmission network expansion?

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PART FIVE: Electricity Transmission Network Expansion

Please indicate your level of agreement with the following statements on electricity transmission network expansion. Use a Likert's scale of 1 to 5 where: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree 5 = Strongly Agree

Statement	1	2	3	4	5
There has been increased access to electricity for households and industries over the recent past					
The grids transmitted across the country are reliable					
Transmission Capacity adequately meets the demand capacity					
System restoration is conducted within the required standards					
The frequency of blackouts from system downtime have significantly reduced over the last five years					
The available transmission systems enable predictive maintenance and self-healing responses to system disturbances.					
Stakeholders in the energy sector are committed to have the set targets in transmission network met					

THANK YOU FOR YOUR TIME AND PARTICIPATION

Appendix VII: Project Time Plan

Activity	Period (Month)					
	May – December 2019	December 2019	January 2019	February-March 2020	March - April 2020	April 2020
Proposal Writing						
Approval of proposal						
Data collection, analysis and report writing						
Project report Draft submission						
Project report revision						
Submission of final project						

Appendix VIII: Project Budget Plan

Item	**Cost (Kshs)**
Stationery, Printing, photocopying, binding	8,000.00
Transport	4,000.00
Airtime	2,500.00
Research Assistant (Note taker)	5,000.00
Miscellaneous	5,500.00
Total	**25,000.00**