FACTORS INFLUENCING PERFORMANCE OF MEGA ENGINEERING PROJECTS: A CASE OF KENGEN' S OLKARIA GEOTHERMAL PROJECTS, KENYA

NYAKITI NESTER OUMA

A Research Report Submitted in Partial Fulfillment of the Requirement for the Award of the Degree of Master of Arts in Project Planning and Management, University of Nairobi

2015

DECLARATION

This research project is my own work and contains no materials previously published or written by another author and has not been accepted for the award of any other degree or equivalent qualification at the University of Nairobi or any other educational institution.

Signature: ………………………………….. **Date: …………..………………….**

Nyakiti Nester Ouma **L50/69107/2013**

The research project has been submitted for examination with my approval as the university supervisor

Signature: ………………………………….. **Date: …………..………………….**

Prof. Harriet Kidombo,

Professor, Department of Extra Mural Studies

DEDICATION

This research project is dedicated to my mum, Elizabeth Nyakiti.

ACKNOWLEDGEMENTS

I cannot express enough thanks to the following people who have positively contributed to this research project. Firstly, Prof. Harriet Kidombo has been the ideal research project supervisor. Her sage advice, insightful criticisms, patient encouragement, and steadfast support aided the writing of this proposal in innumerable ways. I offer my sincere appreciation.

Secondly, I wish to thank the school of continuing education especially my lecturers in project planning and management for imparting in me the right skill and knowledge in project planning and management. Their contributions in various units of project planning and management have greatly contributed in gaining a clearer understanding of various concepts and principles of project managements. I specifically wish to recognize Prof. Christopher Gakuu for expansive knowledge he offered in research methods which broadened my understanding of the various research methods and suitable areas of application. Dr. Stephen Luketero has been a key mentor to me as far as data analysis is concerned. Through his lessons, I was able to appreciate statistics as a powerful tool to analyse data and make meaningful inferences.

Utmost appreciation to my fellow classmates for their cooperation and team spirit which made us go through several assignments, group discussions and presentations. More specifically, our class representative, Mr. James Irungu for his dedication to providing useful link between the class and the lecturers. I wish also to acknowledge my research assistants and volunteers with whom we worked together in data collection and entry.

My dear wife Dorcas, I say thank you. Your loving kindness and encouragement was a pillar to this success.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
EUR	European Currency
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GRD	Geothermal Resource Development
GWDC	Greatwall Drilling Company of China
ICT	Information and Communication Technology
IEA	International Energy Agency
KENGEN	Kenya Electricity Generating Company
LAPSSET	Lamu Port South Sudan Ethiopia Transport
LNG	Liquid Natural Gas
LWD	Logging While Drilling
MW	Mega watt
MWD	Measurement While Drilling
PDC	Polycrystalline Diamond Bit
PMI	Project Management Institute
US	United states of America
US$	United States Dollar

ABSTRACT

Mega engineering projects are critical to success of any developed or developing economy. Unfortunately, and despite their criticality, megaprojects are associated with extremely poor design and delivery performance. Studies conducted with a view to explore performance based issues in this regard are largely concentrated internationally while Kenyan literature on the same remains scanty. Against this backdrop, the present study set out to investigate the factors influencing the performance of mega engineering projects with the reference to KenGen's Olkaria geothermal projects. The study adopted descriptive research design to collect research data. This study targeted various stakeholders in the infrastructure development sector and more specifically to the energy sector including; geoscientists, the drilling engineers, project managers, project funders, environmentalists, the energy ministry, the local governments and the citizens in the affected areas. Samples were identified based on existing differences by use of a stratified probability sampling procedures as well as purposive non-probability sampling procedure. Data was collected from subjects and phenomena by use of self-administered questionnaires. Data was analyzed using both descriptive and inferential techniques from which generalizations were drawn about the behavior of various variables. The findings of the study are presented in accordance with the variables and themes of the study. Findings reveal that most mega engineering projects by the organization perform best in resource utilization, followed by schedule performance, then societal and commercial viability. It was also noted that a considerable number of projects are not completed within budget. Finally, the study concludes that the most critical factors determining mega engineering project performance according to the respondents include technology, personnel training, physical infrastructure and procurement policy respectively. The study recommends the adoption of infrastructure assessment systems to measure the sustainability of available physical infrastructure in the event of mega project developments; technology integration through the adoption of Project Management Information Systems (PMIS); adoption of Web Service-based Procurement services; and adequate training and development is thus crucial on matters relating to pertinent mega project development concepts.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The world is full of projects. Projects range from simple, short duration projects only costing a few dollars to very complex, long-term multibillion dollar projects. The US Federal Highway Administration defines megaprojects as major infrastructure projects that cost more than US$1 billion, or projects of a significant cost that attract a high level of public attention or political interest because of the substantial direct and indirect impacts on the community, environment and budgets.

Locatelli, Litau, Brooks & Mancini (2014) consider mega projects as ‘major projects’ or ‘complex projects and services’ that are extremely large-scale investment typically costing more than EUR 0.5 billion. In Africa and most developing economies mega projects are considered to cost not less than $100 million (Delloite, 2014). Megaprojects include power plants (conventional, nuclear or renewable), oil and gas extraction and processing, highways, tunnels, bridges, railways, seaports and even cultural events such as the Olympics.

The world’s top mega projects include: the $22 billion Three Gorges Dam of China to be completed in 17 years, the $20 billion new Dubai Airport to be completed in 20 years, the $11 billion Jubail Industrial cityof Saudi Arabia, and the famous One World Trade Centre of New York as the tallest building in the western hemisphere costing about $3.8 billion and lasting 7 years to build (Newcomb, 2015).In Africa, mega projects include: the $1 billion Al Noor Tower in Morocco, the $6.5 billion Modderfontein development in South Africa, the $8 billion Suez canal expansion in Egypt, the $12 billion Bonga South West deep-water oil project in Nigeria and the $80 billion Inga hydroelectric dam of DRC Congo. In Kenya, examples of mega projects include; the $4 billion Lappset corridor, the $3.8 billion Standard gauge railway, the $ 140 million Olkaria geothermal project, and the $330 million Thika super highway and the $9.2 billion Konza technology city.

Unfortunately, and despite their criticality, megaprojects are associated with extremely poor design and delivery performance (Cantarelli, Flyvbjerg, & Buhl, 2012). Megaprojects are also renowned for failing to respond to the original societal or commercial need that instigated them and for providing functionality that does not meet their stakeholders' requirements and a high risk of poor financial performance (Locatelli& Mancini, 2010). Project failure is perceived as a widespread and substantive phenomenon. (Project Management Solutions, 2011) states that 37% of projects fail. Other researchers regard project failure rates as being even higher (Morris, 2008). Morris (2008) shows that between 60% and 82% of projects fail. Regarding megaprojects, (Cantarelli, Flyvbjerg, & Buhl, 2012) analyzed a database composed of 806 projects (energy project, transportation projects etc.) delivered worldwide and found an average cost overrun of 35.5% with very heterogeneous performance (standard deviation 56.3). Moreover, once completed, the projects usually provide less benefit than expected.

Mendel (2012) argues that though the failure rate of mega projects are high, successful mega projects also exist. One of the better documented examples is the Beneluxlijn extension of the Rotterdam metro network which was finished just a few months after the original schedule and under budget. Projects like this demonstrate that it is possible to deliver megaprojects on time, budget and scope. But still the preconditions, enabling factors and barriers to deliver megaprojects on time and on budget are unclear. This presents a case to investigate the factors that influence the performance of mega engineering projects.

1.2 Statement of the Problem

Mega projects are critical to success of any developed or developing economy. Unfortunately, and despite their criticality, megaprojects are associated with extremely poor design and delivery performance. They are also renowned for failing to respond to the original societal or commercial need that instigated them, they fail to provide functionality that meet their stakeholders' requirements and are usually characterized by a high risk of poor financial performance. Kenya also has few empirical studies that have directly analyzed the factors that influence the performance of mega engineering projects. Studies conducted by both international and local researchers have contributed to useful knowledge in mega engineering projects. However, statistics still indicate dismal and inconsistent performance of mega engineering project especially in Kenya. This necessitates a study on the factors that influence the performance of mega engineering projects in Kenya, the case of Olkaria geothermal field.

1.3 General Objective

This study sought to examine the main factors influencing the performance of mega engineering projects taking the case of KenGen's Olkaria geothermal projects, Kenya.

1.3.1 Specific Objectives

This study aimed to achieve the following four objectives:

1. To examine the influence of physical infrastructure on performance of mega engineering projects.
2. To establish the influence of technology on performance of mega engineering projects.
3. To determine the influence of procurement policy on performance of mega engineering projects.
4. To assess the influence personnel training on performance of mega engineering projects.

1.4 Research Questions

This study was guided by the following four research questions:

1. How does physical infrastructure influence the performance of mega engineering projects?
2. How does technology influence the performance of mega engineering projects?
3. How does procurement policy influence the performance of mega engineering projects?
4. How does personnel training influence the performance of mega engineering projects?

1.5 Significance of the Study

It is hoped that the findings and recommendations of this study will be benefit the government of Kenya. Kenya has an ambitious vision 2030 plan which involves a series of mega projects. To realize this dream, the performance of mega projects must be earnest through an understating of the various factors which may impede efficiency.

It is also hoped that the results of this study will provide useful information to project managers, policy makers, project financiers, engineers and scientists. These professionals are daily involved in making critical project decisions. The findings of this study will enhance their decision making ability based on scientifically proven facts.

The study further hopes to provide a baseline for developing best approaches to improving the performance mega engineering projects both at local and international scene, contribute to knowledge and be part of existing literature to be reviewed and as reference by scholars and stakeholders interested re-examining the performance of mega engineering projects in future.

1.6 Delimitation of the Study

The study focused on mega engineering projects in geothermal development industry. Geothermal development is implemented in Nakuru, Menengai an Olkaria Naivasha. However, the study was confined to Olkaria geothermal projects since geothermal development in Olkaria dates back to 1983 and has hence been implemented for long compared to the GDC's Menengai geothermal project which is only six (6) years old.

The target population of 196 respondents was employees from six departments of geothermal resource development. This group of employees are considered to be the most relevant and well informed on the subject of study. They include managers, engineer, scientists and officers.

The study focused on four independent variables as the main factors influencing the performance of mega engineering projects namely; physical infrastructure, technology, procurement policy and personnel training. Other factors including project financing and stakeholder engagement could also influence to performance of mega engineering projects but are beyond the scope of this study. The study employed also a close-ended Likert scale survey to collect data and use descriptive statistics to analyse data.

1.7 Limitations of the Study

The study was limited to KenGen employees working at the Olkaria geothermal project. This is due to the fact that these employees interact with geothermal execution challenges in their daily line of duty and are hence best suited to respond to queries about performance of mega geothermal projects. The researcher employed

Likert scale survey where respondents may feel they would be exposing sensitive information about their organization. The researcher eliminated this fear by assuring the respondents that any piece of information provided was handled with utmost confidentiality and only for the purpose of the study. Some of the target respondents may choose not to complete or return the questionnaires. The researcher conducted proper piloting of the research instruments, work closely with the research assistants and other volunteers.

1.8 Assumptions of the Study

The study assumed that the data collection instrument had both internal and external validity and measured the desired constructs; the respondents answered questions correctly and with honesty. The researcher also assumed the chosen respondents were the custodians of information in various departments of the organization they represent.

1.9 Definitions of Significant Terms

Mega projects

Mega projects refer to extremely large-scale investment projects which attract a high level of public attention or political interest because of the substantial direct and indirect impacts on the community, environment, and budgets. Mega projects include power plants, oil and gas extraction and processing, highways, tunnels, bridges, railways, seaports and even cultural events such as the Olympics

Performance of mega engineering projects

The performance of mega engineering project defines how best the project meets its objective within the budgeted constrains of time, cost and quality. Performance of mega projects is also defined by how well the projects meet societal and commercial needs.

Physical infrastructure

Physical infrastructure refers to the basic physical structures or equipment required for an economy or project to function and survive. For the purpose of this project, physical infrastructure shall mean all the required equipment, machinery or services which supports successful delivery of mega engineering projects.

Technology

Technology is defined as the application of scientific knowledge to solve problems in the most efficient manner. It involves creation and use of technical means to accomplish tasks, drawing upon such subjects as industrial arts, engineering, applied science and pure science. In this context technology refers to those new approaches that will be used to improve the performance of mega engineering projects.

Procurement policy

Procurement policy is simply a set of rules and regulations that govern the process of acquiring goods and services needed by an organization to function efficiently. In the context of this study, procurement policy shall refer to those internal and external procedures that an organization must follow in the process of acquiring goods and services for use in mega engineering projects.

Personnel training

Personnel training also known as "employee training", involves enriching the employee with requisite knowledge to operate and maintain an equipment, work within standards and offer quality. In geothermal projects development, a personnel training involves enriching the staff with necessary skills to operate and maintain geothermal related equipment.

1.10 Organization of the Study

This study is organized in five main chapters namely: introduction; Literature review; Research Methodology; Data Analysis, Presentation and Interpretation; and Findings, Conclusion and Recommendations. Each chapter has sections which provide details as required for a standard academic research.

The introduction covered in chapter one gives the background of the study, clearly states the research problem, the purpose and objectives of the study. The chapter also outlines the research questions, the significance of the study including the delimitation and limitations of the study. Further, the assumptions and definitions of significant terms are outlined. Chapter two covers the literature review. The chapter takes a critical look into the previous research conducted by other researchers and scholars on the same topic or simply literature relevant to the topic of study including gaps identified in the review. It also includes the theoretical and conceptual framework.

Chapter three entails the research methodology. The chapter presents the research design, elaborates on the target population, sampling procedure and the research instruments. Data collection methods and analysis techniques, ethical considerations, and operationalization of variables are also captured in this chapter.

Chapter four provides data analysis, presentation and interpretation. This chapter concentrates on analysis of the collected data using suitable statistical techniques, presents the results in easily understood formats, and interprets the results to suit vast consumers. It also discusses the results as per the objectives of the study. Chapter five is the final chapter identified as summary of findings, conclusions and recommendations. The chapter briefly describes the summary of findings and conclusions as gathered in chapter four. It also puts forth recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents an analysis of the existing literature on the topic of study. It considers a critical look into the previous work done by researchers and other scholars on the four variables of study with a view to establish any similarities and gaps that need to be addressed in order to achieve the project objectives. The literature shall be reviewed based on themes drawn from the four variables of study: physical infrastructure, technology, procurement policy and personnel training. The chapter further provides a theoretical and conceptual framework.

2.2 The Concept of Mega Projects

"Mega" comes from the Greek word "megas" and means great, large, vast, big, high, tall, mighty, and important. As a scientific and technical unit of measurement "mega" specifically means a million. If we were to use this unit of measurement in economic terms, then strictly speaking megaprojects would be million-dollar (or euro, pound, etc.) projects, and for more than a hundred years the largest projects in the world were indeed measured mostly in the millions (Flyvbjerg, 2014). However, after the Second World War, Cold War, and Space Race. Project costs now escalated to the billions, led by the Manhattan Project (1939-46), a research and development program that produced the first atomic bomb, and later the Apollo program (1961-72), which landed the first humans on the moon (Morris, 1994; Flyvbjerg, 2014). According to Merriam-Webster, the first known use of the term "megaproject" was in 1976, but before that, from 1968, "mega" was used in "megacity" and later, from 1982, as a standalone adjective to indicate "very large."

Today, megaprojects refers to large-scale, complex ventures that typically cost a billion dollars or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people. Hirschman (1995) calls such projects "privileged particles of the development process" and points out that often they are "trait making," that is, they are designed to ambitiously change the structure of society, as opposed to smaller and more conventional projects that are "trait taking," i.e., they fit into pre-existing structures and do not attempt to modify these. Megaprojects, therefore, are not just magnified versions of smaller projects but are a completely different breed of project in terms of their level of aspiration, lead times, complexity, and stakeholder involvement.

Megaprojects are increasingly used as the preferred delivery model for goods and services across a range of businesses and sectors, like infrastructure, water and energy, information technology, industrial processing plants, mining, supply chains, enterprise systems, strategic corporate initiatives and change programs, mergers and acquisitions, government administrative systems, banking, defense, intelligence, air and space exploration, big science, urban regeneration, and major events. Examples of mega engineering projects are high-speed rail lines, airports, seaports, motorways, ICT systems, national broadband, dams, wind farms, offshore oil and gas extraction, aluminum smelters, the development of new aircrafts, the largest container and cruise ships, high-energy particle accelerators, and the logistics systems used to run large supply-chain-based companies like Amazon and Maersk (Flyvbjerg, 2014).

The definition of mega projects differ depending on the investments costs and the country or economy under which the project is implemented. While mega projects in developed countries give a threshold of $ 1billion dollar or project cost, most developing countries in Africa including Kenya consider projects mega projects as costing not less than $50 million (Deloitte, 2014).Arguably from statistics in Kenya mega projects could well be considered above $100 million. Based on this criteria mega engineering projects in Kenya include: the Thika superhighway, the Lapsset corridor, the Greenfield terminal, the Olkaria geothermal project, the Menengai geothermal project, the Konza technology city and the standard gauge railway among others

2.2.1 Mega projects in oil and gas development

The oil and gas industry is witnessing an unprecedented wave of capital spending, driven by the need to build capacity to meet growing energy demand from emerging markets and to replace depleting supply sources. This capital expenditure has, to date, been underpinned by consistently higher oil prices, globally and gas prices outside North America. This trend is expected to continue. In its World Energy Investment Outlook 2014, the International Energy Agency (IEA) estimates a cumulative investment of US$22.4 trillion in the global oil and gas sector between 2014 and 2035, equivalent to an average annual spend of more than US$1 trillion. As the era of “easy oil” approaches its end, industry players are looking to diversify their portfolios by tapping into emerging opportunities in unconventional oil and gas and frontier areas, such as: Shale gas, Coal seam gas, Light tight oil, LNG liquefaction, Oil sands, Ultra-deep-water and the Arctic. To commercialize these opportunities as well as unexploited conventional reserves, companies are increasingly engaging in multibillion-dollar technically and operationally demanding projects called megaprojects (“spotlight on oil & gas,”2014).

Oil and gas companies often must invest huge sums of money over a long payback period. If executed well, these projects create a competitive edge and enhance enterprise value; however, where execution is poor, the result may be a project that is economically uncompetitive. To limit risk exposure, many of the larger oil and gas companies often participate in megaprojects through complex operator or non-operator joint venture agreements. This added complexity, combined with the high-risk, high-value nature of the projects, presents a challenge for companies in managing their total portfolio risk. Governments and local communities have an equally keen interest in these projects as they have the potential to drive a region’s environmental and economic development. The decision to unlock natural resource wealth needs to be balanced against longer-term interests and environmental issues. High-profile environmental incidents mean that local groups are acutely aware of the importance of safe, environmentally sensitive developments. The increased technical and commercial complexity, along with the commercial, environmental and political cost and risk, means that oil and gas megaprojects are under intense and growing stakeholder scrutiny. Consequently, high levels of transparency, value-adding assurance and proven delivery capabilities are needed to secure economically attractive funding, resource access rights and corporate approvals.

2.2.2 Mega projects in geothermal development

Geothermal development borrows every leaf from oil and gas drilling. In fact, the machinery for executing geothermal drilling are by and large the same. The global geothermal power market continues to grow substantially, with exciting new opportunities arising around the globe. As of August 2013, the global geothermal industry reached 11,765 MW of installed geothermal capacity. Currently there are 11,766 MW of planned capacity additions of geothermal power in the early stages of development or under construction in 70 countries and territories around the world. Additionally, developers are actively engaged with 27 gigawatts of geothermal resource globally (Geothermal Power, 2013).

Philippines is home to three of the 10 mega geothermal power plant installations in the world, followed by the US and Indonesia with two each, and Italy, Mexico and Iceland with one each. The Geysers Geothermal Complex located about 121km north of San Francisco, California, is comprised of 18 power plants making it the biggest geothermal installation in the world. The complex has an installed capacity of 1,517MW and active production capacity of 900MW. Larderello Geothermal Complex, comprising of 34 plants with a total net capacity of 769MW, is the second biggest geothermal power plant in the world. The power produced from the geothermal field, located in Tuscany, Central Italy, accounts for ten percent of all geothermal energy produced worldwide and caters for 26.5% of regional power needs. Also, at 720MW, Cerro Prieto Geothermal Power Station in south Mexicali, Baja California in north Mexico, is the second and third geothermal plant in the world while Makban Geothermal Power Complex, also known as Makiling-Banahaw Power Plants, is located in the municipalities of Bay and Calauan in the Laguna province and Santo Tomas, in the Batangas province. It is the fourth biggest geothermal power facility in the world, with an output capacity of 458MW (“top 10 biggest geothermal power,” 2103).

Efficiency has been defined in different way by a number of authors and scholars. The definitions of efficiency are unique to the context in which it is applied. Social scientists, economists, engineers, medics and other professionals define efficiency in reference to their line of discipline. While economists define efficiency as a comparative measure (ratio) of the budgeted (estimated or expected against the actual results, engineers consider efficiency as the ratio of useful work done to the energy expended. Quality managers on the contrary argue it to mean doing thing right i.e. whatever is performed, it is performed in the most suitable way, given the available resources (Makdissi, 2006). This presents a case of ambiguity in definitions of efficiency.

According to Project Management Institute (PMI), efficiency is best defined in reference to the goals and objectives of the project. Projects have set time limits, budget, and scope. Efficiency therefore is the extent to which the project meets these three primary indicators of project success. Efficiency of a project therefore is the extent to which, or “how well” the projects utilizes the assigned resources in terms of time, expenditure and scope. Performance of mega engineering projects means how well the project objectives are met within the budgeted cost, time and scope.

2.3 Physical infrastructure and performance of mega engineering projects

Physical infrastructure cans be defined as a set of basic facilities, services, and installations needed for the functioning of a community or society such as transportation and communications systems, water and power lines, and public institutions including schools and post offices (Hirshman, 1958). Esterly and Rebelo (1993) posits physical infrastructure to be a comprehensive term and it encompasses the facilities like electricity, piped gas, telecommunications, piped water, sanitation and sewerage system, solid waste collection and disposal, roads, railways, airports, seaports, dams, irrigation and drainage system and now the mobile phones and broadband internet facilities. He reiterates that most of the infrastructure facilities are consumed directly by the people. People consume piped water, piped gas and electricity etc. They use modern transportation and communication facilities to access; the information for better decisions, the job markets for employment, the goods markets for marketing their agricultural products, the hospitals for health care and the schools for educating their children. This widens the employment opportunities for the people and also increases the productivity of the people through increased human capital. This results in high economic growth and thus higher level of per capita income (Canning, 1988).

Byoungki (2006) suggests a nation's physical infrastructure to consist of a broad array of systems and facilities that house and transport people and goods and provide services. Among other things, this infrastructure includes transportation networks, including roads, airports, rail, and mass transit; housing; federal buildings and facilities; and postal and telecommunications services. These systems and facilities do not exist in isolation: decisions about where to build or expand roads affect decisions about housing and vice versa, and, in turn, these decisions affect the need for and location of public facilities and communications and energy services.

Economists have viewed physical infrastructure as a key ingredient for productivity and growth. Conceptually, infrastructure may affect aggregate output in two main ways: first, directly because infrastructure services enter production as an additional input, and second, because they raise total factor productivity by reducing transaction and other costs thus allowing a more efficient use of conventional productive inputs. World Bank (1994) emphasized that there is a close relationship between infrastructure and economic growth.

Physical infrastructure increases productivity, reduces cost of production, facilitates the easy and wider diffusion of information and technology, enlarges markets and promotes more innovations. Physical infrastructure affects the location decisions of the investors and firms. This helps more industrialization and provision of more employment opportunities and thus high GDP (Charni & Pervaiz, 2012).

Extensive and efficient infrastructure is critical for ensuring the effective functioning of the economy, as it is an important factor determining the location of economic activity and the kinds of activities or sectors that can develop in a particular economy. Well-developed infrastructure reduces the effect of distance between regions, integrating the national market and connecting it at low cost to markets in other countries and regions. In addition, the quality and extensiveness of infrastructure networks significantly impact economic growth and affect income inequalities and poverty in a variety of ways. A well-developed transport and communications infrastructure network is a prerequisite for the access of less-developed communities to core economic activities and services.

Projects are supported by all manner of physical infrastructural facilities. Small to large-scale projects require roads, water, security, electricity, communication systems to keep running efficiently. The physical infrastructure required to execute a project determines what kind of project can be done, how well it can be done and how effective it will be once completed. Most developed countries invest in huge infrastructural project to help develop or sustain other projects (Goel, 2002). The economic status of a nation dictates the kind of physical infrastructure they are able to put in place. This explains why developing countries are yet struggling to have mega project implemented.

Mega projects cannot be implemented in a country where even the small road network is a problem. For example, the Thika superhighway of Kenya could only be implemented after a long duration an existing dual carriage from Nairobi to Thika. The plan to have this highway dates back to 1970s but due to lack of other basic and urgent physical infrastructure, the country had to consider this for a later schedule. The development of the oil field in Turkana is equally several decades in knowledge. However, Kenya lacks necessary equipment and machinery including technology to appraise and exploit the oil basin. The exploration of this resource is now left to foreign companies who have the resource required to exploit the valued oil. Tullow oil currently having the biggest license for the north eastern Kenya oil basin has put in place several high technology rig and complex data acquisition and monitoring systems. This multimillion mega project could only be possible with the right physical infrastructure in place.

The development of the Olkaria geothermal field has too been greatly affected by the availability of physical infrastructure. The development of geothermal involves use of drilling rigs and installation of the power plants. The drilling rigs vary in terms of cost and ability to drill through complex and challenging geological formations. One modern drilling rig costs an estimate of US$ 24 million. However, other rig manufactures have special but efficient rigs of over US$ 40 million (Cherutich, 2009). In order to effectively drill geothermal wells, such costly rigs are required. In a growing nation where a number of competing need exist, not so many of such equipment can be procured. Complex and latest technology field equipment including the measurement while drilling, logging while drilling, inner string cementing units have still not been procured. This directly affect the efficiency of delivering major geothermal projects.

Physical infrastructure is therefore key to successful implementation of mega engineering projects. However, this has not been investigated to a fair detail and necessitates further study.

2.4 Technology and performance of mega engineering projects

Technology can be defined as the purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities (Rasouli 2011). In the industrial view point, technology can well be defined as advanced scientific knowledge used for practical purposes, especially in the industry. Technology is generally divided into five categories: Tangible technology which deals with blueprints, models, operating manuals, prototypes; Intangible technology associated with consultancy, problem, and training methods; high technology focusing on entirely or almost entirely automated and intelligent technology that manipulates ever finer matter and ever powerful forces; Intermediate technology or simply semi-automated partially intelligent technology that manipulates refined matter and medium level forces and low technology which is a labor technology that manipulates only coarse or gross matter and weaker forces (Hoon ,2008).

While technology is often described as the most important influence upon society, it remains a subject which deserves further study. Technology has and is still revolutionizing the world. This situation is generally accepted, with politicians, sociologists, industrialists and educationalists alike recognizing that technology lies at the very heart of society (Chandler, 1996). The critical role that technology plays in the development of society, stimulating not only the economy but society's socio-cultural values, rather than being merely a tool of society, however, is referred to as 'technological determinism' (Underwood, 2009).

Social progress has come to be equated with technical progress, particularly since the Industrial Revolution (Beniger, 1989). This progress has not always been acknowledged at the time it was occurring; indeed. As Beniger further notes, 'human society seems rather to evolve largely through changes so gradual as to be all but imperceptible, at least compared to the generational cycles of the individuals through whose lives they unfold'. Perhaps because of this 'historical myopia', the value of the change may not be evaluated until the changes has already passed.

Technological advancement seems important at the time to different ages in different societies, psychologically if not practically; in a variety of modern societies, for example, young people presently feel a heightened empathy with the digital age (Bennett and Maton, 2010). However, not all sectors of the community will be directly involved with, share an understanding, or even see the relevance, of the latest technological inventions. Nevertheless, as de Tocqueville (1990) noted in 1840, 'this social revolution, which I believe to be irresistible already accomplished or about to be so', and thus recognition of it is recognition of the past as much as the present. The current revolution in technology, known variously as the 'Information Age' or 'Age of Technology', similarly is unrelenting: the older person who is reluctant to use a computer has a life shaped by others' use of computers and may even accept a basic mobile telephone, once considered a glamorous accessory (Coeckelbergh, 2012). As globalization becomes an increasingly significant factor in countries' economic success, technological competence is becoming an essential tool for surviving and thriving not only in society, but in its constituent parts, such as employment, education, agriculture and industry.

Technology and projects are inseparable. Technology dictates how well, how fast, how easily and how safely we execute the simplest to the most complex and costly projects or simply mega projects. Technology is the key to industrialization. Most developed nations are beneficiaries of a technological integrated approach to development.

As technology evolves to meet the demands of our dreams, more and more wondrous risky achievements will transform our world; and us with it. Dubai's offshore artificial island is one such achievement. Panama canal currently being upgraded at a cost of $5.25 billion to handle the ever-increasing world biggest cargo ships is another. Other confiscated technology mega projects include: the $80 billion Suadi Arabia's industrial park, the $ billion international space station (ISS) which circulates around the earth in 92 minutes, the construction of one of the world's deepest submerged transport tunnels is pulling east and west even closer together. The Marmaray Project is a 76-kilometer subterranean railway development that will ferry travelers under a 1.4-kilometer section of the Bosphorus Strait and connect busy railway lines on either side of the historic waterway are just a few examples.

Until the 1980s, it was also difficult to know details about what was going on with the drill bit as the hole was being drilled. This challenge was overcome by measurement-while-drilling (MWD) technology. MWD allows operators to receive real-time information on the status of drilling, as well as the ability to steer the well in other directions. This serves a myriad of functions. It helps operators drill more efficiently while preventing downhole drilling tool failures. Today drilling technology has seen drilling of well in a deviated path known as directional and horizontal drilling. Directional and horizontal wells utilize less surface while providing greatest output.

The Olkaria geothermal field is a beneficiary of technological changes. Drilling started in 1980s with old model and tedious to use mechanical rigs. The T12 and the N370 rig were the pioneers of the then remote Olkaria field. Wells drilled using these earlier technology suffered a number of challenges; no productivity, the depth to drill was limited to about 2000m, longer drilling period and frequent accidents. Between 2007 to date, more complex and latest technology rigs have been introduced. More wells have been drilled over a comparatively shorted time. It may be assumed that the drilling efficiency has increased by somewhat 20%. Mega engineering projects hence rely on technology to survive. Given world economic pressure, all nation strive to have efficient systems in place in order to reduce production costs, time to produce and quality of results. It hence critical to examine how technology influenced the success of mega projects.

2.5 Procurement policy and performance of mega engineering projects

Procurement is the act of acquiring, buying goods, services or works from an external process of buying goods and services. Such process acquisition of good and services is governed by a set of laws and regulations captured under the procurement policy. The procurement policy therefore clearly defines authority, responsibility, and establishes guidelines for the organization and procurement professionals to follow when carrying out their responsibilities.

While Masterman (2002) argues procurement policy as an organizational structure adopted by the client for the implementation and at times eventual operation of a project, Skitmore & Earl (1998) considers procurement policy as an organizational system that assigns specific responsibilities and authorities to people and organizations, and defines the relationship of the various elements in the construction industry. Leadra, Austeng, Haugen and Klakegg (2006) highlight the fact that even though terminologies used in the description of procurement systems differ from one country to the other, the recommended practice for selection of the procurement systems is almost the same across country organizations.

Procurement systems also involve drafting and signing of contracts. Contracts read out virtually every aspect of business correlation including payment terms, pricing and service levels. Therefore a contract that has not highlighted the entire project scenario may lead to dispute in the contract system. For instance, if the initial contract does not completely specify every relevant aspect of the project work, this may lead to long chains of negotiations, arbitration and/or mitigation due work change orders and the quest for reviewed contractual agreement with new budgets and schedule. The result will no doubt be a project delay and cost overrun. Similarly, ambiguous contractual agreement with unclear clauses can be of potential dispute thus generating delay and cost overrun in project. In the same vein, delay and cost overrun could be inherent in terms of poor contractor selection and unethical behavior, contract bid amount, difference between the winning bid and second bid, difference between the winning bid and the engineer's estimates, etc (Singh 2009), and since mega projects are executed by contractors, it is important to note that procurement process and contract management is critical to the successful completion of these projects. Thus poor selection of contractors due to low bids, with no technical capability to handle the project will lead to cost overruns, schedule delays, poor quality, and a final result that is not acceptable (PMI, 2010). Also, a contract management system with clients that have a slow payment schedule could lead to delay and cost overrun.

Procurement policies may also be unique to organizations depending on the size of the organization, the availability of suppliers, the rules governing the operations of the organization, politics, cashflow, the nature of the operations and the credit worthiness of the organization.

Mega engineering projects adopt almost all the available procurement system due to the vast and complex nature of project operations. However, some organization are limited to particular procurement systems. Government institutions and state corporations comply with the public procurement policies usually regulated by their state institutions. Such procurement policy is usually characterized by lengthy and bureaucratic processes that delay procurement of goods and services.

According to the Kenya Public Procurement Act (2005), a number of procurement systems are available for use. Open tendering where tenders are advertised to the entire public in the local and international media and a transparent evaluation process is done with the lowest evaluated and complaint bidder considered for tender award. Selective or restricted tendering involves tenders sent to specific pre-qualified firms who will also submit their bids and evaluated the same as that of open tendering. Selective tendering usually results into better quality for goods and services supplied since the pre-qualified firms usually meet the required technical specifications for the tender. Single sourcing is yet another procurement practice which is rarely adopted for public institution except in cases where there is only one supplier to the item or service being sort. It is quicker in implementation and in most cases efficient.

Currently, KenGen is contracted by Akiira to drill two geothermal appraisal wells at the Longmont field. The procurement challenges are already enormous. Equipment failures is responsible for the recorded standby of over 72 hours in the recently completed well. As a result of these challenges, the drilling engineers have managed to push through a paper seeking to allow the drilling operations management appoint a procurement agent who will fast-track the process of acquiring goods and services. The experiences and concerns raised by various stakeholders in the Kenya's drilling sector, the influence of procurement policy on performance of mega engineering projects need be studied in detail.

2.6 Personnel training and performance of mega engineering projects

Personnel training, also known as employee training, means training employees on operating procedures and standards. It also increases employees' productivity and knowledge. Employee training increases efficiency, effectiveness and productivity along with morale and job satisfaction (Sims, 1990). Training can take place prior to the employee performing the activity. It can also take place during the job, known as on-the-job training. On job training is usually recognized as one of the best training methods, as it is organized, planned and conducted on-site.

Organizations are facing increased competition due to globalization, changes in technology, political and economic environments (Evans, Pucik & Barsoux 2002) and therefore prompting these organizations to train their employees as one of the ways to prepare them to adjust to the increases above and thus enhance their performance. Regardless of the size or type of a project or project organization, personnel training can have a measurable impact on performance. In the view of Smith (2001) training that meets the needs of both the employees and employer can increase the quality and flexibility of the organization's services by fostering accuracy and efficiency, good work safety practices, and better customer service. He reiterates that staffs who receive formal training can be more productive than untrained colleagues who are working in the same role. High labour productivity, thus, increases organizations output and can open a greater share of the market or expand it by improving products, services and reputations.

Alao (2010), argues that in the development of organizations, training and development play a crucial role, and improves performance, increases productivity, and eventually put organizations in the pole position to face competition and stay at the top. This implies that a significant difference exists between the organizations that train their employees and organizations that do not. Training generates benefits for the employee as well as for the organization by positively influencing employee performance through the development of employee knowledge, skills, ability, competencies and behavior (Sultana, Irum, Ahmed & Mehmood 2012). Smith (2001) intimates that training and development increase staff retention which is significantly cost saving. Organizations with effective employee training and development programmes do not experience high turnover rate because the trained employee feels he has a future with the company.

Smith (2001) posits that training programmes in some organizations have reduced employee turnover by 70%. Safo (2006) postulates that it is only those employees who have nowhere to go that will remain with an organization that does not train its people. It must be noted that today's employee is always looking for an environment that promotes personal growth and to such people, training is just as important as their salary. He further indicates that the benefits of employee training in one area can flow through to all levels of an organization. With time, training reduces costs by decreasing wasted time and materials, maintenance cost of machinery and equipment, workplace accidents which leads to lower insurance premiums, recruitment costs through the internal promotion of skilled staff, and absenteeism. He argues further that organizations must continually change their work practices and infrastructure to stay competitive in a global market. Training and development programmes could help employees to manage the implementation of new technology, work practices and business strategies. Such training can also serve as a benchmark for future recruitment and quality assurance practices (Gross Esq 2006). In the opinion of Smith (2001), continuous employee training and development promotes development of new competencies and skills and help to meet the changing technologies of the world.

Hutchings, Zhua, Coopera, Zhangb & Shao (2009) contend that training and development practices had a positive impact on preparing them to be more effective in their work, increasing their technical abilities, interpersonal abilities, teamwork, job confidence and work motivation (Devi & Shaik 2012). Training and development programmes do not only teach employees how to do their jobs better, but it also helps them to work more independently and develop a can do attitude. Smith (2001) is also of the view that employee training and development, apart from impacting on an organization’s profit margins, can improve staff morale and satisfaction, soft skills such as inter-staff communication and leadership, time management, and customer satisfaction.

Kamran & Nasir (2012) argues that employees are assets and a crucial resource, it is important to optimize the contribution of employees to the company aims and goals as a means of sustaining effective performance. This therefore calls for managers to ensure an adequate supply of staff that is technically and socially competent and capable of career development into specialist departments or management positions.

Mega projects are run through project organizations. Personnel training cuts across projects and organizations and the benefits drawn from personnel training are enjoyed across board. However, mega projects have one unique characteristic that differentiates it from normal organizational training needs. The project are complex and cut across cultures hence the need for cross-cultural training. Performance of megaprojects is dependent on how well employees to the project easily integrate with each other, synergizing for the achievement of the project objectives. Personnel from different parts of the globe have differing perspectives of life, traditions, like and dislikes, religious beliefs among other unique behavioral characteristics and therefore require cross-cultural training.

Studies on cross-cultural training in the Australian public sector found the training to be effective in improving workplace performance and in contributing to multicultural policy objectives (Standing Committee on Immigration and Multicultural Affairs, 2006). Almost 60% of graduates who responded rated their overall satisfaction with their cross-cultural training as above average or excellent. Around 70% stated that the training had greatly or very greatly improved their: understanding of cultural diversity issues; cultural self-awareness; knowledge of cross-cultural communication skills;

understanding of other cultures; and confidence in dealing with people from different cultures.

The Olkaria geothermal project has also grown of age. From the more traditional and inefficient drilling practices using the first generation mechanical rigs to the present day semi-automated electrical rigs. In 1976, the first Kenya rig was procured under the Kenya power company and the ministry of energy. Five years later, the second and slightly improved version of mechanical rig was procured. The drilling crew were then trained by the Canadian drilling engineers on the operation and maintenance of the two rigs especially the N370 rig. Most of the drilling personnel were trained on the operation of this rig are now approaching retirement. The efficiency of executing drilling projects has greatly fallen based on age, level of education and computerized systems.

In 2012, KenGen procured two (2) new electric rigs. The technology of the new rigs required training of the staff on the use and maintenance. However, no major training has been implemented. Drilling is faced with serious downhole challenges, downtime, lost morale and increasing project cost. Drilling programs are not effective since the crew lack knowledge on how to adopt the new technologies to suit the field challenges. In 2007, KenGen engaged drilling contractors, Greatwall Drilling Company (GWDC) to help fast track drilling in the Olkaria geothermal field. Experiences with the contracted drilling indicate better performance. It is also evident that the improved drilling efficiency of GWDC is as a result of frequent training that it gives to its staff. However, KenGen as a state corporation subscribes to the public procurement and disposal act 2005, which limits on how fast the company can procure training services for the personnel.

The performance of mega engineering projects is dependent among other factors on training. Studies around the influence of training on performance of mega engineering project and more specifically geothermal development are limited. The Olkaria geothermal field has no known existing study on this subject.

2.7 Theoretical framework

This study seeks to analyze the factors that influence the performance of mega engineering projects; the case of KenGen's Olkaria geothermal field, Kenya. The study is informed by two research theories: the principal-agent theory and the diffusion of innovations theory.

2.7.1 Principal-Agent Theory

The study will apply and extend the principal-agent theory in exploring the performance of mega engineering projects. As in many situations, in mega projects, there is a variation in the degree of divergence between the interests of the donor (the principal) and the recipient government (the agent). The central dilemma in the theory is how to get the 'agent' to act in the best interests of the principal or, said otherwise, how to get the agent to have an optimal contractual relationship with the principal through enhanced project performance. To attain an optimal output, the problems of information asymmetry and goal incongruence that might arise from this contractual relationship should have to be minimized (Jugdev & Müller, 2005). The problem of information asymmetry might appear from the contractual relationship between the principal and the agent because the agent has not been given enough information on the principal's expectations; and the agent receives different signals from multiple principals, which then leads to ambiguity (Verhoest, 2005).

Various underlying factors can be attributed to the principal-agent problem. Apart from information asymmetry and goal incongruence, the present study conceptualizes physical infrastructure, technology, procurement policy rand personnel training as also key factors that may determine the principal-agent contractual relationship with respect to meeting project performance goals. Adverse selection and moral hazard are critical problems the principal might then be confronted with (Wright, 1987). Adverse selection refers to the 'misrepresentation' of ability by the agent. When the principal has to select an agent for delegating activities to him, it might be hard for the principal to know whether an agent really has the skills or abilities to accomplish these activities. As a result, the principal might select under qualified agents.

Moral hazard is another problem to the principal. Moral hazard stands for a lack of effort on part of the agent: the agent deliberately engages in selfish activities to the detriment of the principal. The agent does not put forth the agreed-upon effort, he is shirking. These problems in the principal-agent relationship might be avoided by three kinds of mechanisms: monitoring or closely controlling of agents by principals, bonding or having ex ante guarantees of compliance by the agent, and incentives and risk sharing (the risk-averse agent 'buys' insurance from the less risk-averse principal to avoid efficiency loss and discouragement) (Kwak, 2002).

2.7.2 The Social Dialectal Theory

Van de Ven and Poole (1995) posits that the social dialectical theory begins with the assumption that the organizational entity exists in a pluralistic world of colliding events, forces, or contradictory values that compete with each other for domination and control. These oppositions may be internal to an organizational entity which may have several conflicting goals or interest groups competing for priority. But oppositions may also be external to the organizational entity. These opposing forces are termed thesis and antithesis, thesis being the status quo or the ruling way of "doing things". Procurement policies are drafted amidst numerous thesis and the antithesis. In fact, procurement can be viewed as involving at least two parts with different goals, a buyer and one or more vendors competing for the contract. However, in addition to the agency relationship between buyer and competing vendors, there may be a number of internal stakeholders possibly with conflicting goals, adding complexity to the procurement process. These may have conflicting interests even though there may not be an agency relationship between them; one common observation is that different user groups in different parts of a business may have conflicting requirements. This theory shall be used to inform how procurement policy and can be addressed and positively influence the performance of mega engineering projects.

2.7.3 Diffusion of Innovation Theory

Rogers (1962) in diffusion of innovation theory tries to explain how, overtime, an idea or product gains momentum and diffuses (or spreads) through a specific population, organization or social system. The end result of this diffusion is that people, as part of a social system, adopt a new idea, behavior, or product. The rate of adoption or diffusion is determined by complexity, relative advantage, compatibility, risk and uncertainty level, reversibility, modifiability and the time require to adopt the new technology. However, people adopt new ideas differently and may be categorized as; innovators, early adopters, early majority, late majority and the laggards. Figure 1 below show a classic bell-shaped adopters curve.

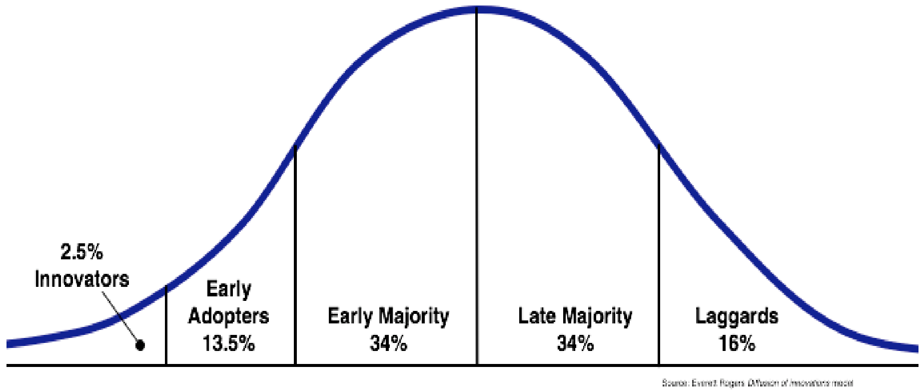

Figure 1: Adopters curve for diffusion of innovations theory

This theory will be used to analyze how personnel training can help diffuse new technologies and culture into executing mega engineering projects including geothermal development.

2.8 Conceptual framework

Conceptual framework is a hypothesized model identifying the concepts under study and their relationships in a diagrammatic form (Mugenda and Mugenda, 2003). The conceptual framework, Figure 2 below presents a diagrammatic relationship between the four independent variables under study, the intervening, the moderating and the dependent variable.

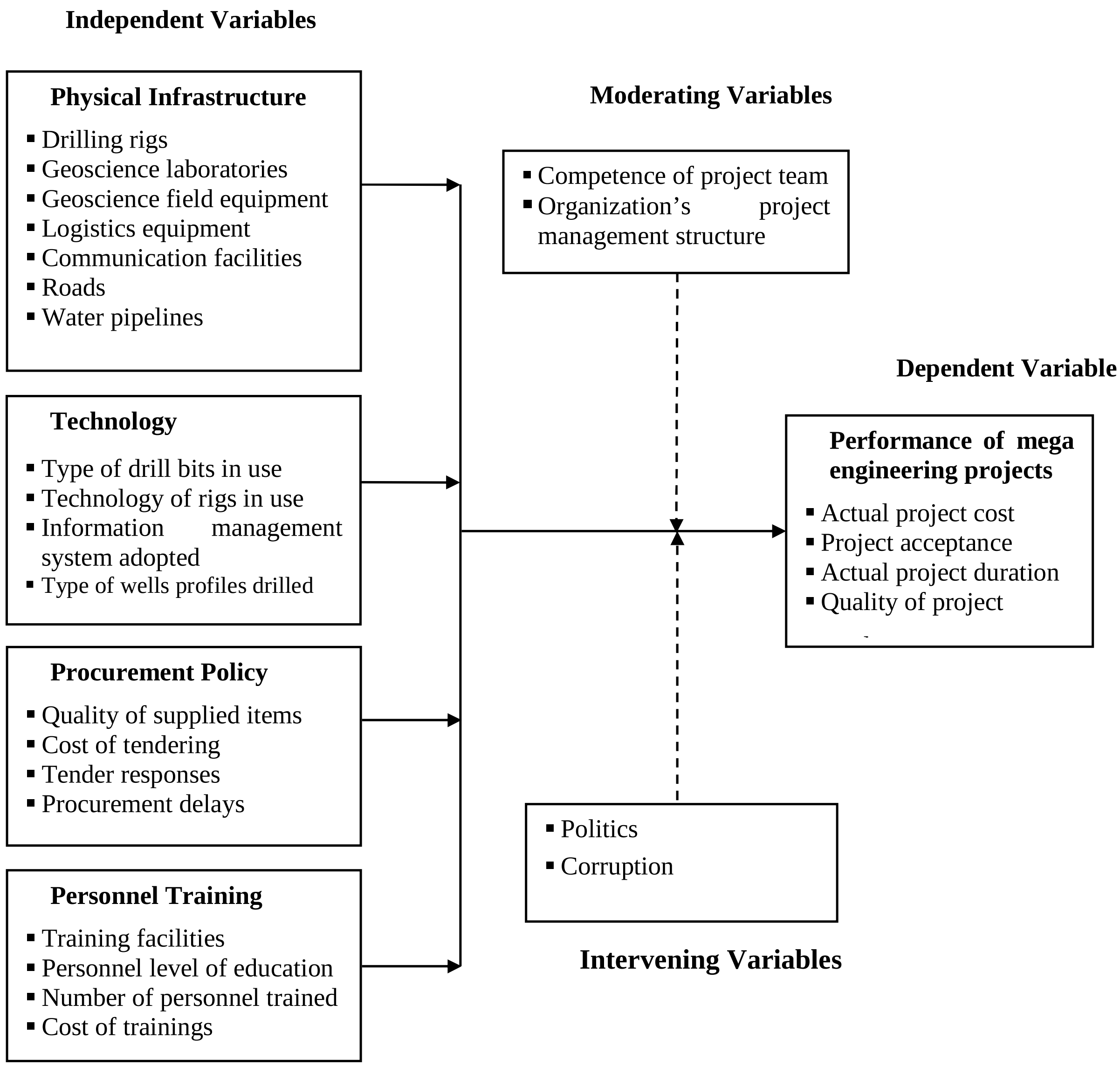

Figure 2: Conceptual Framework

2.9 Research Gaps

The review of literature has identified many scholarly resources that address the various factors influencing performance of mega engineering projects, namely physical infrastructure, technology, procurement policy and personnel training all in relation to project performance. These resources have shown that each component is important to the performance of mega projects. The literature however lacks in-depth linkage between these elements and mega project performance within the engineering context. The literature is also largely international with local studies remaining scanty. A literature gap is further conspicuous on geothermal projects. Against this backdrop, the present study sets out to address these gaps by exploring the factors influencing performance of mega engineering projects with reference to KenGen' s Olkaria geothermal projects, Kenya.

2.10 Summary of literature review

This chapter has provided a detailed review of existing literature on the subject of the study. The relevant local and international literature reviewed reveal serious knowledge gaps in understanding the factors that influencing performance of mega engineering projects both at local and international level. The study is also informed by two theories; principal-agent theory and the diffusion of innovations theory. From the conceptual framework, the study will investigate influence of the four independent variables; physical infrastructure, technology, procurement policy and personnel training against the performance of mega engineering projects as the dependent variable. Organization's project management structure and competence of the project team will be studied as moderating variables. Politics and corruption have been considered as intervening variable while natural disasters as extraneous variables.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a road map to the research project. It details how the objectives of the study were met by presenting the research design to be adopted, target population, sample size and sampling techniques, research instruments, data collection and analysis, ethical consideration and operationalization of the variables.

3.2 Research design

This study adopted the descriptive research design. Descriptive research portrays an accurate profile of persons, events, or situations (Kothari, 2000). Therefore, the descriptive survey was deemed the best strategy to fulfil the objectives of this study. According to Kombo and Tromp (2006) the basic purpose for descriptive research usually is to describe characteristics of the population of interest, make specific predictions and test associational relationships. Kothari (2000) further posits that quantitative research design is an excellent way of finalizing results and proving or disproving a hypothesis. The descriptive survey design is also appropriate for the study since it entailed a detailed examination of individual unit, single subject, a clique or group with similar characteristics.

3.3 Target population

The target population was drawn from professionals in geothermal projects development and working at KenGen's Olkaria geothermal project in Naivasha, Kenya. The study targeted KenGen employees working at the Olkaria geothermal project. The population of KenGen employees at the Olkaria geothermal project totals to 1, 158. The study focused on employees involved in geothermal resource development and working at top and middle levels of management positions. The staffs were drawn from six (6) sections namely: Engineering & Logistics, Geoscience, HR & Training, Projects Execution, Procurement and Geothermal Infrastructure. The total number of employees within this target group is 196. Therefore, the target population for this study is 196.

3.4 Sampling Size & Sampling Techniques

The sample size was drawn from 196 respondents forming the target population. The 196 respondents shall be purposively selected from KenGen's Olkaria staffs working at relevant departments and are key to execution of geothermal projects. Samples were randomly drawn from every strata hence simple random sampling while the sample size per strata was proportionate to the population in the strata.

The behavior of the target respondents for this study was unknown and the respondents are also drawn from a vast range of disciplines. To ensure scientific estimation of the sample size, Slovin's formula was used. The estimation adopted 90% confidence level.

Slovin's formula is given by:

$$n = \frac{N}{1 + Ne^2}$$

Where: n – sample size,

N - Population size, 196.

e – the level of precision, in this case (±0.1)

Substituting for the values of N and e,

The sample size, $n = 65$

The 65 respondents were then distributed proportionally among the six (6) departments of KenGen's Olkaria geothermal staff. Table 3.1 illustrates the sampling distribution per given strata.

Table 3.1: Sampling distribution per strata

Department	Population	Frequency
Engineering & Logistics	51	17
Procurement	13	4
Geoscience	42	14
Project Execution	31	10
HR & Training	27	9
Geothermal Infrastructure	33	11
Totals	**196**	**65**

Stratified random sampling procedure was employed for this study. The target population is 196 staffs of KenGen working at the Olkaria geothermal project, purposely divided into six (6) subgroups (strata). Samples from every strata were drawn using simple random probability sampling. Stratified random sampling is suitable for this study since only respondents relevant to the topic of study are required. These respondents are also expected to exhibit some similar characteristics in terms of skills, education and level in management. The stratified respondents were considered to be interacting with geothermal projects in their daily line of duty and hence most suitable for the aim of this study.

3.5 Research Instruments

Warwick and Linninger (1975) posits that there are two basic goals in research design. To obtain information relevant to the purposes of the survey and to collect this information with maximal reliability and validity. A researcher must be sure that the data gathering instrument being used will measure what it is supposed to measure and will do this in a consistent manner.

The study used a closed-ended 5 point Likert scale questionnaire to be administered in two categories of KenGen staffs i.e. the Managers questionnaire, and the Engineers, scientists and officers questionnaire. This questionnaires targeted responses from the three levels of management namely: Top level including managers and assistant managers; Middle level including chief and seniors engineers/officers, Lower level including engineers, scientists and officers. The questionnaires have been designed to suit the employees of all these levels of management.

The questionnaires were structured with a set of inductive questions depending on the variable under study and the indicators of the variable. Mugenda &Mugenda (2003) indicates that structured questionnaires are easy to administer, analyze and allow for unambiguous responses.

3.5.1 Piloting of Research Instruments

A pilot study was undertaken to test the research instruments. The pilot study helped develop and test adequacy of research instruments, assessing the feasibility of study, designing a research protocol, assess whether the research protocol is realistic and workable and establish whether the sampling frame and technique are effective. It also identify logistical problems which might occur using proposed methods, estimate variability in outcomes to help determining sample size and also assess the proposed data analysis techniques to uncover potential problems.

10% of the total sample size is sufficient for testing of the research instruments (Mugenda & Mugenda, 2003). The researcher therefore used 20 questionnaires for the pilot test. The research assistants were also trained jointly to ensure they have capacity too effectively capture responses accurately during the actual research work.

3.5.2 Validity of Research Instruments

Validity can be defined as the accuracy and meaningfulness of inferences which are based of the research results. Validity can be internal or external. Hammel and Kaeck (1999), defines internal validity as how well the study was run (research design, operational definitions used, how variables were measured, what was/wasn't measured, etc.), and how confidently one can conclude that the change in the dependent variable was produced solely by the independent variable and not extraneous ones. On the other hand, Cook & Campblell (1979) defines external validity can be defined as to the extent to which the results of a study can be generalized or extended to others

In this research and to ensure internal validity of the study, the variables have been carefully analyzed to ensure that appropriate indicators are associated with each variable and the required data collected using the appropriate research instrument. For external validity appropriate and representative samples have been selected for study which provides an assurance tor results to be generalized to the population.

3.5.3 Reliability of Research Instruments

Reliability is the degree to which a measurement technique can be depended upon to secure consistent results upon repeated application. It can also be defined as the degree to which a research instrument yields consistent results or data the same way each time it is used under the same condition with the same subjects (Weiner, 2007). To ensure reliability of the study results, a test-retest method was used during piloting of instruments to obtain a reliability coefficient where consistency among different administrations was checked. The same test was given to a group of respondents on two separate occasions. If the relationship between the first and second administration is a high positive correlation, the instrument was considered reliable.

3.6 Data Collection methods

Bryan (2012) states that there are many data collection instruments whose choice of use depends on the type of data being collected or the data collection method chosen. In selecting or designing a data collection instrument, validity and reliability are very important to consider. The researcher adopted a closed-ended 5-point Likert scale questionnaire to collect primary data from two categories of respondents stratified as managers, and engineers, scientists and officers. The questionnaire was structured to cut across all the four variables of study.

Kothari (2004) confirms that the series of questions in the questionnaire forms are designed to extract/obtain information from the respondent and can either be administered by the interviewer or the interviewee can filled it by him/her. Questionnaires were provide an advantage over other data collection instruments since it can capture many respondents who are diversified and therefore conducting personal interviews for all would be difficult. Furthermore, questionnaires saved much time of the researcher as well as that of the respondents and the respondents had an ample time to think and fill the questionnaires at their free time, hence minimizing errors. However, the researcher made follow-ups to ensure the questionnaires are returned. Questionnaires collected specific information from the specific category of respondents.

The researcher coordinated the data collection process after having sought the permission of various stakeholders to conduct the research. The permission was sought from the relevant authorities who include the Kenya wildlife Service, the Kenya Electricity Generating Company, and the local administration.

The researcher engaged and trained at least two research assistants to assist in data collection and entry. The research assistants were trained on ethics and objectives of the study. The research assistants were further trained on the expectations from the questionnaires and possibly guide to document analysis.

3.7 Data Analysis Techniques

The raw data obtained from field questionnaires were checked for completeness, organized as per the objectives of the study and corresponding to the strata as well as the research question indicated in the questionnaire. The data collected was quantitative in nature and was entered into a spreadsheet using Microsoft excel for easy management.

Statistical Package for Social Sciences (SPSS) was then employed to analyses the quantitative data. Descriptive statistics such as frequencies and the measures of central tendencies were used to describe the characteristics and behavior the variables based on the data analyzed. Data was further analyzed in relation to the project objectives and indicators with comparisons made along the sub-counties and as well as the gender.

Inferential statistics was also applied. The Pearson’s Product Moment Correlation Coefficient was used to investigate any correlation between the variables of study and the extent to which the variable of correlated. It was also used to assess any the linear relationship between dependent variables and the independent variable and to assess overally, the influence of the dependent variables on the independent variable. The Chi Square tests were also generated to establish any existing relationships between the variables (for categorical variables).The data analyzed data was presented by way of frequency tables, charts and graphs for ease of comparison.

3.8 Ethical Consideration

The researcher sought all necessary approvals from various stakeholders before proceeding to conduct any data collection work. The necessary approval and authorities included; an introductory letter from the from the University of Nairobi, Extra Mural Department disclosing the main objective of the research to all authorities of interest as well as a permit from the National Council for Science, Technology and Innovation (NACOSTI).

The researcher sought consent from all respondents by way of introducing himself together with his research assistants, explain the main purpose of the study and produce relevant research permits including letter from the university and the National Council for Science, Technology and Innovation (NACOSTI) permit.

During the data collection process, no respondent was coerced to participate in the research. The data collected was analyzed and presented without any manipulation or biases whatsoever.

3.9 Operationalization of the Variables

The operationalization of the four independent variables; physical infrastructure, technology, procurement policy and personnel training together with the dependent variable: performance of mega engineering projects is shown in Table 3.2.

Table 3.2: Summary of operational definition of variables

Objective	Variable	Indicator	Measurement scale	Data collection Instrument	Data analysis method
	Performance of mega engineering projects	▪ Overall project cost ▪ Project completion time ▪ Quality of project results ▪ Community acceptance of project	Ordinal scale	▪ Structured Questionnaires	▪ Descriptive statistics ▪ Inferential statistics
To examine how physical infrastructure influences the performance of mega engineering projects	Physical infrastructure	▪ Available drilling equipment ▪ Available logging instrument ▪ Available Geoscience labs ▪ Available Logistics equipment ▪ Available roads & communication systems	Ordinal scale	▪ Structured Questionnaires ▪	▪ Descriptive statistics ▪ Inferential statistics
To assess influence of technology on performance of mega engineering projects	Technology	▪ Type of drill bits in use ▪ Type of drilling rig in use ▪ Type of well profile drilled ▪ Data management system used ▪ Technology of wellheads used	Ordinal scale	▪ Structured Questionnaires ▪	▪ Descriptive statistics ▪ Inferential statistics
To investigate how procurement policy influences the performance of mega engineering projects.	Procurement policy	▪ Procurement time ▪ Tender responses ▪ Cost of tendering ▪ Quality of supplied items ▪ Government policy on procurement	Ordinal scale	▪ Structured Questionnaires ▪	▪ Descriptive statistics ▪ Inferential statistics
To examine how personnel training influences the performance of mega engineering projects.	Personnel training	▪ Available training facilities ▪ Competency levels of personnel ▪ Number of trainings per year ▪ Number of accidents ▪ Recorded standby & nonproductive time	Ordinal scale	▪ Structured Questionnaires ▪	▪ Descriptive statistics ▪ Inferential statistics

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATIONS

4.1 Introduction

This chapter presents the results and discussions. The general objective of the study was to examine the main factors influencing the performance of mega engineering projects taking the case of KenGen's Olkaria geothermal projects, Kenya. More specifically, the study sought to examine the influence of physical infrastructure on performance of mega engineering projects; establish the influence of technology on performance of mega engineering projects; determine the influence of procurement policy on performance of mega engineering projects; and to assess the influence personnel training on performance of mega engineering projects. The reliability and viability of the data collected for the study were ascertained.

4.2 Response Rate

The study achieved a response rate of 83.1% with 54 respondents reached, out of the 65 targeted. According to Mugenda and Mugenda (2003), a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent. The study therefore attained an excellent response rate as presented in Table 4.1.

Table 4.1: Response rate

Questionnaires	Frequency	Percent (%)
Returned	54	83.1
Unreturned	11	16.9
Distributed	**65**	**100.0**

4.3 Reliability

A pilot study was carried out in order to determine reliability of the questionnaires. Reliability of the questionnaires was then evaluated through Cronbach's Alpha which measures the internal consistency. The Alpha measures internal consistency by establishing if certain item measures the same construct. Nunnally (1978) established the Alpha value threshold at 0.7 which the study benchmarked against. Cronbach

Alpha was established for every objective in order to determine if each scale (objective) would produce consistent results should the research be done later on.

Table 4.2: Reliability coefficients

Scale	Cronbach's Alpha	Number of Items
Project performance	0.801	8
Physical infrastructure	0.778	5
Technology	0.711	5
Procurement policy	0.819	5
Personnel training	0.833	5

Tables 4.2 shows that all the scales were significant, having an alpha above the prescribed threshold of 0.7. Personnel training had the highest reliability (α=0.833) followed by Procurement policy (α=0.819), then Project performance (α=0.801, while Physical infrastructure and Technology had the lowest at (α=0.778) and (α=0.711) respectively. The study thus found that the analysis was reliable and could be used for further investigation.

4.4 Demographic information

This section captures the responses by department, job designation, gender, level in management, length of service, as well as current education level analyzed in tables and figures below.

4.4.1 Department

The study sought to establish the different departments respondents worked in, so as to ascertain diversity in perspectives and for representability purposes and data reliability. Table 4.3 presents the findings.

Table 4.3: Response by department

Department	Frequency	Percent (%)
Engineering & Logistics	15	28.2
Procurement	2	4.5
Geoscience	12	21.3
Project Execution	7	13.1
HR & Training	5	9.3
Geothermal Infrastructure	13	23.6
Total	54	100.0

As Table 4.3 above illustrates, it was established that all targeted departments were reached and proportionately represented. The Engineering and Logistics department registered the majority (28.2%), followed by the Geothermal and Infrastructure department (23.6%) which was closely followed by Geoscience department at a response rate of 21.3%. Project execution, HR and training and Procurement departments were also presented as indicated by 13.1%, 9.3% and 4.5 of respondents respectively. From the foregoing, it can be deduced that all pertinent departments were reached and adequately represented, and findings can thus be deemed representative, hence reliable.

4.4.2 Designation

The study also sought to establish the different designations represented in the organization, with a view to establish informed findings based on the different mega project aspects addressed across the designations. Table 4.4 presents the findings.

Table 4.4: Response by Designation

Designation	Frequency	Percent (%)
Manager	8	14.4
Geoscientist	17	31.6
Engineer	23	42.7
Officer	6	11.3
Total	54	100.0

Results as shown in Table 4.4 reveal that a majority, 42.7% of the respondents reached were engineers, followed by Geoscientists (31.6%), then managers (14.4%) and others (11.3%). It can be deduced therefore, that the study reached respondents across various areas of specialization as regards mega projects in the study area, hence diverse perspectives in responses as informed by activities in the respective designations.

4.4.3 Gender

In order to show the gender distribution and parity in the study area, the study sought to determine the respondents' gender. Results are presented in Table 4.5.

Table 4.5: Response by gender

Gender	Frequency	Percent (%)
Male	33	61.1
Female	21	38.9
Total	54	100.0

As presented in Table 4.5, male respondents, 33 (66.1%), registered the majority as compared to their female counterparts, 21 (38.9%). It follows then, from the findings, that the male respondents make the dominant gender in the study, and therefore in the organization.

4.4.4 Management level

Respondents were asked to indicate their management level in order to further ascertain diversity in perspectives. Table 4.6 presents the findings.

Table 4.6: Management level

Level in Management	Frequency	Percent (%)
Top Level	19	35.7
Middle level	22	40.8
Lower level	13	23.5
Total	54	100.0

Findings, as illustrated in Table 4.6 revealed that a majority, 40.8% of the respondents belonged to the middle management level, followed by 35.7% in the top management level while 23.5% belong to the lower cadre management. This indicates the diverse perspectives as informed by activities in the respective management levels.

4.4.5 Length of service

With some level of working experience necessary in establishing the study objectives, the study found it necessary to establish the length of service of the respondents, in years, serving in a geothermal (or energy) development organization. Table 4.7 presents the findings.

Table 4.7: Length of service

Length of service	Frequency	Percent (%)
Below 5 years	10	18.4
5-10 years	35	64.7
Over 10 years	9	16.9
Total	54	100.0

It was established that a majority of respondents, 64.7% have worked in a geothermal (or energy) development organization for between 5 and 10 years. This was distantly followed by those having worked for less than 5 years, as indicated by 18.4% of respondents while only 16.9% were found to have worked in a geothermal (or energy) development organization for over 10 years. With a majority of respondents (81.6%) having worked for over 5 years, responses can be deemed to be informed by adequate experience in pertinent mega project areas.

4.4.6 Highest education levels

Respondents were also asked to indicate their current levels of education. This would serve to give a general overview of education levels characteristic of a geothermal (or energy) development organization. Findings are as shown in Table 4.8.

Table 4.8: Respondents' highest levels of education

Level of education	Frequency	Percent (%)
Phd/Masters	13	24.3
Undergraduate degree	36	66.5
Diploma	5	9.2
Total	54	100.0

From the findings, a majority, 66.5% of respondents indicated having attained an undergraduate level, very followed by 24.3% having attained a postgraduate degree level. A further 9.2% indicated having attained a diploma level. Overall, the study area can be said to comprise staff from relatively high levels of education. It can be deduced therefore that based on their high education levels, respondents were in a position to comprehend the survey objectives and give reliable responses.

4.5 Physical infrastructure and performance of mega engineering projects

The study further sought to examine the influence of physical infrastructure on performance of mega engineering projects. Respondents were asked to respond to key statements posed in this regard on a five-point likert scale, where, 1= strongly disagree; 2= disagree; 3= indifferent; 4 = agree; 5= strongly agree. The scores of 'strongly disagree' and 'disagree', "S.D" have been taken to represent a variable which was not agreed upon (equivalent to mean score of 0 to 2.5 on the continuous Likert scale: $0\leq$ S.D ≤ 2.4. The score of 'indifferent', "IND", has been taken to represent a variable which was agreed upon, moderately (equivalent to a mean score of 2.5 to 3.4 on the continuous Likert scale: $2.5\leq$ IND ≤ 3.4. The score of 'agree' and 'strongly agree', "S.A" have been taken to represent a variable which was highly agreed upon (equivalent to a mean score of 3.5 to 5.4 and on a continuous Likert scale: $3.5\leq$ S.A ≤ 5.4.Table 4.9 presents the findings.

Table 4.9 Physical infrastructure and performance of mega engineering projects

Statement	**Mean**	**Standard Deviation**
Top management is committed to and fully supports acquisition of the physical infrastructure required for geothermal development	3.401	0.5431
Our organization has adequate physical infrastructure required for geothermal development	3.852	0.5423
The cost of acquiring the necessary physical infrastructure is affordable and encourages geothermal development	3.376	0.5612
Top management have set up proper security measures to ensure all infrastructure are safe from loss, damage or external aggression	3.713	0.4617
Availability of physical infrastructure has significant effect on performance of mega geothermal projects	4.063	0.6610
Composite Mean	**3.681**	

As findings in Table 4.9 indicate, a majority of respondents highly agrees that availability of physical infrastructure has significant effect on performance of mega geothermal projects (4.063); the organization has adequate physical infrastructure required for geothermal development (3.852); and that top management have set up proper security measures to ensure all infrastructure are safe from loss, damage or external aggression (3.713). A majority however only moderately agrees that top management is committed to and fully supports acquisition of the physical infrastructure required for geothermal development (3.401) and that the cost of acquiring the necessary physical infrastructure is affordable and encourages geothermal development (3.376).

With a composite mean of 3.681, it can be deduced that from the organization's perspective, the availability of physical infrastructure has significant effect on performance of mega geothermal projects. Going by the high levels of agreement, it can further be deduced that the organizations is well furnished with physical infrastructure required for geothermal development and has well established security measures to ensure all infrastructure are safe from loss, damage or external aggression. It is however evident from the findings that the cost of acquiring the necessary physical infrastructure is not very affordable and this may to a moderate extent influence geothermal development. To this end, top management commitment also needs to be enhanced to enable adequate acquisition of the physical infrastructure required for geothermal development.

4.6 Technology and performance of mega engineering projects

The study also established the influence of technology on performance of mega engineering projects. To this end, respondents were required to respond to key statements posed on a five-point likert scale, where, 1= strongly disagree; 2= disagree; 3= indifferent; 4 = agree; 5= strongly agree. Table 4.10 presents the findings.

Table 4.10: Technology and performance of mega engineering projects

Statement	Mean	Standard Deviation
Top management commitment to supporting innovative ideas across all levels and departments of the organization has greatest influence on performance of mega geothermal projects	3.983	0.9442
High technology equipment and machinery help save time and deliver projects in as per schedule	3.919	0.0429
Most of our employees appreciate, supports and flexible to changes in technology	3.729	0.8592
High technology equipment and machinery optimally utilizes available resources	3.803	0.3056
Latest technology equipment and machinery are environment friendly, and usually meet commercial and societal needs	3.701	1.3078
Composite Mean	**3.827**	

As shown in Table 4.10, a majority of respondents highly agree that top management commitment to supporting innovative ideas across all levels and departments of the organization has greatest influence on performance of mega geothermal projects (3.983); high technology equipment and machinery help save time and deliver projects in as per schedule (3.783); high technology equipment and machinery optimally utilizes available resources (3.803); most of the organization's employees appreciate, supports and flexible to changes in technology (3.729); and that latest technology equipment and machinery are environment friendly, and usually meet commercial and societal needs (3.701).

With a composite mean of 3.827, it can be deduced that based on the high technology is a significant element in mega project development success. Key technological attributes highly regarded as influencing the performance of mega projects in the organization includes among others, innovative ideas and top management support thereof, efficiency with respect to saving time and delivery per schedule, optimal resource utilization and its environmental, commercial and social viability.

4.7 Procurement policy and performance of mega engineering projects

The study further determined the influence of procurement policy on performance of mega engineering projects. Respondents were thus required to respond to pertinent statements posed on a five-point likert scale, where, 1= strongly disagree; 2= disagree; 3= indifferent; 4 = agree; 5= strongly agree. Table 4.11 presents the findings.

Table 4.11: Procurement policy and performance of mega engineering projects

Statement	Mean	Standard Deviation
Top management's commitment to the procurement policy generally improves performance of mega geothermal projects	3.739	0.5317
Procurement policy determines cost of procurement and may consequently lead to budget overruns	3.793	0.6315
The optimal utilization of available project resources is determined by our procurement policy	3.625	0.4092
The completion time, or project duration is determined by how efficient is the organization's procurement system	3.857	0.3718
A clearly set and transparent procurement policy wins public trust and usually lead to project success	3.942	0.6347
Composite Mean	**3.791**	

As presented in Table 4.11, a majority of respondents highly agrees that a clearly set and transparent procurement policy wins public trust and usually lead to project success (3.942); the completion time, or project duration is determined by how efficient is the organization's procurement system (3.857); procurement policy determines cost of procurement and may consequently lead to budget overruns (3.793); top management's commitment to the procurement policy generally improves performance of mega geothermal projects (3.739); and that optimal utilization of available project resources is determined by our procurement policy (3.625).

With a composite mean of 3.791, overall procurement policy is found to be a key determinant of mega project performance in the organization, going by the high levels of agreement established. More specifically, elements of procurement policy mostly affecting mega project performance according to a majority includes public trust courtesy of a clearly set and transparent procurement policy, procurement system's efficiency leading to timely project completion, cost determination and optimal utilization of available project resources.

4.8 Personnel training and performance of mega engineering projects

The study assessed the influence personnel training on performance of mega engineering projects. To this end, respondents were required to respond to key statements posed on a five-point likert scale, where, 1= strongly disagree; 2= disagree; 3= indifferent; 4 = agree; 5= strongly agree. Table 4.12 below presents the findings.

Table 4.12: Personnel training and performance of mega engineering projects

Statement	**Mean**	**Standard Deviation**
Top management's personnel commitment to personnel training is crucial to better performance of mega geothermal projects	4.052	0.5638
Personnel training is responsible for the rise or decline in work-based accidents and incidents	3.893	0.9025
Personnel training motivates employees and benefits performance of geothermal projects	3.859	0.7295
Well trained staffs are cost conscious, good decision makers, avoid material and time wastage and generally give good results.	3.719	0.6520
Cross cultural training promotes social integration and has positive impact on project performance	3.673	0.4028
Composite Mean	**3.839**	

As presented in Table 4.12, a majority of respondents highly agrees that top management’s personnel commitment to personnel training is crucial to better performance of mega geothermal projects (4.052); Personnel training is responsible for the rise or decline in work-based accidents and incidents (3.893) Personnel training motivates employees and benefits performance of geothermal projects (3.859); well trained staffs are cost conscious, good decision makers, avoid material and time wastage and generally give good results (3.719); and that cross cultural training promotes social integration and has positive impact on project performance (3.673).

With a composite mean of 3.839, personnel training can be deemed a critical factor in mega project performance. As is evident from the findings, top management’s personnel commitment to personnel training is a crucial success factor in mega project performance context. It is also evident from the findings that personnel training have the capacity to keep work-based accidents and incidents in check, plays a key role in employee motivation, enhances cost consciousness, efficiency and decision making abilities among employees.

4.9 Performance of mega engineering projects

In order to establish mega engineering project performance in the study area, respondents were asked to indicate their levels of agreement with respect to various aspects of project performance including time, resource utilization, societal and commercial viability and budgetary performance. This was also in relation to the various conceptualized factors of project performance in the study including physical infrastructure, procurement policy, technology and personnel training. Responses were also given on a five-point likert scale, where, 1= strongly disagree; 2= disagree; 3= indifferent; 4 = agree; 5= strongly agree. Table 4.13 presents the findings.

Table 4.13: Performance of Mega Engineering Projects

Statement	Mean	Standard deviation
Most of our geothermal projects are completed in time	3.843	.5360
Our project implementation strategy optimally utilizes available resources	3.915	.5137
Our geothermal projects are generally meet societal and commercial needs	3.813	.4976
Most of our geothermal projects are implemented within budgeted project cost	3.672	.5587
Composite Mean	**3.811**	
In general, availability of physical infrastructure greatly influences performance of mega geothermal projects	3.914	.5645
In general, procurement policy greatly influences performance of mega projects	3.872	.4762
In general, technology greatly influences performance of mega geothermal projects	3.991	.5765
In general, personnel training greatly influences performance of mega geothermal projects	3.928	.5284
Composite Mean	**3.926**	

As Table 4.13 presents, a majority of respondents highly agrees that in the organization, project implementation strategy optimally utilizes available resources (3.915); most of the geothermal projects are completed in time (3.843); geothermal projects are generally meet societal and commercial needs (3.813); and that most of our geothermal projects are implemented within budgeted project cost (3.672). With a composite mean of 3.811, it can be deduced that most mega engineering projects by the organization perform best in utilization, followed by schedule performance, then societal and commercial viability. A significant factor established also is that a considerable number of projects are not completed within budget. This is a crucial area that may need to be addressed, to further realize superior performance.

Among the success factors for mega engineering project performance, a majority of respondents highly agreed that in general, technology greatly influences performance of mega geothermal projects (3.991); personnel training greatly influences performance of mega geothermal projects (3.928); availability of physical infrastructure greatly influences performance of mega geothermal projects (3.914);

and that procurement policy greatly influences performance of mega projects (3.872). With a composite mean of 3.926, it can be noted that the most critical factors determining mega engineering project performance according to the respondents include technology, personnel training, physical infrastructure and procurement policy respectively.

4.10 Pearson Correlation Analysis

The study further conducted inferential statistics entailing both Pearson and regression analysis with a view to determine both the nature and respective strengths of associations between the conceptualized factors (independent) variables and performance of mega engineering projects (dependent variable) with reference to Kengen's Olkaria Geothermal Projects, Kenya. Table 4.14 presents the Pearson correlation matrix.

Table 4.14: Pearson correlation matrix

	Project Performance	Physical infrastructure	Technology	Procurement policy	Personnel training
Project Performance	1				
Physical infrastructure	0.7603	1			
	(0.002)				
Technology	0.7910	0.642	1		
	(0.000)	(.022)			
Procurement policy	0.7084	0.679	0.687	1	
	(0.021)	(.046)	(.022)		
Personnel training	0.7901	0.417	0.545	0.506	1
	(0.013)	(0.038)	(0.055)	(0.333)	

*__Correlation is significant at the 0.05 level (2-tailed)__

From the findings, a positive correlation is seen between each factor and performance of mega engineering projects. The strongest correlation was established between Technology and Project Performance (r = 0.7910; P value = 0.000), and the weaker relationship found between Procurement policy and Project Performance (r = 0.7084; P value = 0.021). Personnel training (r = 0.7901; P value = 0.013) and Physical infrastructure (r = 0.7603; P value = 0.002) are also strongly and positively correlated with performance of mega engineering projects. All the independent variables were found to have a statistically significant association with the dependent variable at 0.05 level of confidence.

4.11 Regression Analysis

To establish the degree of influence of the factors on performance of mega engineering projects, a regression analysis was conducted, with the assumption that: variables are normally distributed to avoid distortion of associations and significance tests, which was achieved as outliers were not identified; a linear relationship between the independent and dependent variables for accuracy of estimation, which was achieved as the standardized coefficients were used in interpretation.

The regression model was as follows:

$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X4 + \epsilon$

Performance of mega engineering projects = α + β_1 (Physical infrastructure) + β_2 (Technology) + β_3 (Procurement policy) + β_4 (Personnel training) + ε.

Regression analysis produced the coefficient of determination and analysis of variance (ANOVA). Analysis of variance was done to show whether there is a significant mean difference between dependent and independent variables. The ANOVA was conducted at 95% confidence level.

4.11.1 Model goodness of fit

Regression analysis was used to establish the strengths of relationship between Project Performance (dependent variable) and the independent variables, that is, Physical infrastructure, Technology, Procurement policy and Personnel training (independent variables). The results showed a correlation value (R) of 0.753 which depicts that there is a good linear dependence between the independent and dependent variables. This is presented in Table 4.15.

Table 4.15: Model Goodness of Fit

R	R^2	Adjusted R^2	Std. Error of the Estimate
0.753	0.567	0.562	0.046

a. Predictors: (Constant), Physical infrastructure, Technology, Procurement policy, Personnel training

b. Dependent Variable: Performance of mega engineering projects

With an adjusted R-squared of 0.562, the model shows that Physical infrastructure, Technology, Procurement policy and Personnel training explain 56.2 percent of the variations in performance of mega engineering projects while 43.8 percent is explained by other factors not included in the model. According to Howell (2002), measures of goodness of fit typically summarize the discrepancy between observed values and the values expected under the model in question.

4.11.2 Analysis of Variance (ANOVA)

As presented in Table 4.16, ANOVA statistics was conducted to determine the differences in the means of the dependent and independent variables to show whether a relationship exists between the two.

Table 4.16: Analysis of variance (ANOVA)

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Regression	4.019	4	2.310	4.387	.002a
Residual	15.423	54	.445		
Total	19.442	58			

The P-value of 0.002 implies that performance of mega engineering projects has a significant joint relationship with Physical infrastructure, Technology, Procurement policy and Personnel training which is significant at 5 percent level of significance. This also depicted the significance of the regression analysis done at 95% confidence level. This is implies that the regression model is significant and can thus be used to assess the association between the dependent and independent variables. According to

Gelman (2006), ANOVA statistics analyzes the differences between group means and their associated procedures (such as "variation" among and between groups).

4.11.3 Regression Coefficients of Determination

To determine the relationship between the independent variables and the dependent variable and the respective strengths, the regression analysis produced coefficients of determination as presented in Table 4.17.

Table 4.17: Regression coefficient results

	Unstandardized Coefficients		**Standardized Coefficients**	**T**	**Sig.**
	B	Std. Error	Beta		
(Constant)	6.751	4.732		1.427	.043
Physical infrastructure	.821	0.589	.296	1.394	.017
Technology	.944	.697	.338	1.354	.033
Procurement policy	.761	.689	.287	1.104	.032
Personnel training	.889	.720	.362	1.234	.023

Findings in Table 4.17 reveal a positive relationship between Performance of mega engineering projects and all the independent variables.

Taking the regression model: $Y = \alpha + \beta_1X_1 + \beta_2X_2 + \beta_3 X_3 + \beta_4 X_4 + \epsilon$;

Where; Y= Performance of mega engineering projects; α = Constant; β_1 - β_4 = Beta coefficients; X_1 = Physical infrastructure; X_2 = Technology; X_3 = Procurement policy; X_4 = Personnel training and Є = Error term, the established regression equation was:

Performance of mega engineering projects = 6.751 + .821 (Physical infrastructure) + .944 Technology + .761 (Procurement policy) + .889 (Personnel training)

A unit change in Physical infrastructure would thus lead to a .821 change in Performance of mega engineering projects ceteris paribus; a unit change in Technology would lead to a .944 change in Project Performance ceteris paribus and a unit change in Procurement policy would lead to a .761 change in Project Performance ceteris paribus while a unit change in Personnel training would lead to a 0.889 change in Project Performance. This implies that among other factors, Physical infrastructure, Technology, Procurement policy and Personnel training are strong and significant determinants of Performance of mega engineering projects.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the research findings. The implications from the findings and areas for further research are also presented.

5.2 Summary of Findings

The study provided two types of data analysis; descriptive and inferential. The descriptive analysis helped the study to describe the relevant aspects of the phenomenon under study. The frequencies, percentages, mean and standard deviation were determined. For the inferential analysis, the study used Pearson correlation and multivariate regression analysis techniques to establish the relationship between the independent and dependent variables.

The study sought to examine the influence of physical infrastructure on performance of mega engineering projects. A majority of respondents highly agrees that availability of physical infrastructure has significant effect on performance of mega geothermal projects (4.063); the organization has adequate physical infrastructure required for geothermal development (3.852); and that top management have set up proper security measures to ensure all infrastructure are safe from loss, damage or external aggression (3.713). A majority however only moderately agrees that top management is committed to and fully supports acquisition of the physical infrastructure required for geothermal development (3.401) and that the cost of acquiring the necessary physical infrastructure is affordable and encourages geothermal development (3.376).

The study also established the influence of technology on performance of mega engineering projects. a majority of respondents highly agree that top management commitment to supporting innovative ideas across all levels and departments of the organization has greatest influence on performance of mega geothermal projects (3.983); high technology equipment and machinery help save time and deliver projects in as per schedule (3.783); high technology equipment and machinery optimally utilizes available resources (3.803); most of the organization's employees appreciate, supports and flexible to changes in technology (3.729); and that latest technology equipment and machinery are environment friendly, and usually meet commercial and societal needs (3.701).

The study further determined the influence of procurement policy on performance of mega engineering projects. a majority of respondents highly agrees that a clearly set and transparent procurement policy wins public trust and usually lead to project success (3.942); the completion time, or project duration is determined by how efficient is the organization’s procurement system (3.857); procurement policy determines cost of procurement and may consequently lead to budget overruns (3.793); top management’s commitment to the procurement policy generally improves performance of mega geothermal projects (3.739); and that optimal utilization of available project resources is determined by our procurement policy (3.625).

The study assessed the influence personnel training on performance of mega engineering projects. a majority of respondents highly agrees that top management’s personnel commitment to personnel training is crucial to better performance of mega geothermal projects (4.052); Personnel training is responsible for the rise or decline in work-based accidents and incidents (3.893) Personnel training motivates employees and benefits performance of geothermal projects (3.859); well trained staffs are cost conscious, good decision makers, avoid material and time wastage and generally give good results (3.719); and that cross cultural training promotes social integration and has positive impact on project performance (3.673).

In order to establish mega engineering project performance in the study area, respondents were asked to indicate their levels of agreement with respect to various aspects of project performance including time, resource utilization, societal and commercial viability and budgetary performance. a majority of respondents highly agrees that in the organization, project implementation strategy optimally utilizes available resources (3.915); most of the geothermal projects are completed in time (3.843); geothermal projects are generally meet societal and commercial needs (3.813); and that most of our geothermal projects are implemented within budgeted project cost (3.672).

Among the success factors for mega engineering project performance, a majority of respondents highly agreed that in general, technology greatly influences performance of mega geothermal projects (3.991); personnel training greatly influences performance of mega geothermal projects (3.928); availability of physical infrastructure greatly influences performance of mega geothermal projects (3.914); and that procurement policy greatly influences performance of mega projects (3.872).

5.3 Discussions

The findings on the influence of physical infrastructure on performance of mega projects are in tandem with Charni and Pervaiz (2012) who posit that Physical infrastructure increases productivity, reduces cost of production, facilitates the easy and wider diffusion of information and technology, enlarges markets and promotes more innovations. The findings is further in line with Goel’s (2002) assertion that most developed countries invest in huge infrastructural project to help develop or sustain other projects. Accordingly, World Bank (1994) emphasized that there is a close relationship between infrastructure and economic growth.

The findings on technology is in agreement with Underwood (2009) who argues that the critical role that technology plays in the development of society, stimulating not only the economy but society’s socio-cultural values, rather than being merely a tool of society, however, is referred to as ‘technological determinism’. The finding also supports Bennett and Maton (2010) who offer that technological advancement seems important at the time to different ages in different societies, psychologically if not practically; in a variety of modern societies, for example, young people presently feel a heightened empathy with the digital age.

Findings on procurement policy conforms to Singh’s (2009) argument that delay and cost overrun could be inherent in terms of poor contractor selection and unethical behavior, contract bid amount, difference between the winning bid and second bid, difference between the winning bid and the engineer’s estimate. Accordingly, PMI (2010) asserts that poor selection of contractors due to low bids, with no technical capability to handle the project will lead to cost overruns, schedule delays, poor quality, and a final result that is not acceptable.

On personnel training, the findings agree with Alao (2010) who offers that in the development of organizations, training and development play a crucial role, and improves performance, increases productivity, and eventually put organizations in the pole position to face competition and stay at the top. The finding also agrees with Smith (2001) intimates that training and development increase staff retention which is significantly cost saving and that organizations with effective employee training and development programmes do not experience high turnover rate because the trained employee feels he has a future with the company.

5.4 Conclusion

From the foregoing findings, it can be concluded that the availability of physical infrastructure has significant effect on performance of mega engineering projects. Going by the high levels of agreement, it can further be deduced that the organization is well furnished with physical infrastructure required for geothermal development and has well established security measures to ensure all infrastructure are safe from loss, damage or external aggression. It is however evident from the findings that the cost of acquiring the necessary physical infrastructure is not very affordable and this may to a moderate extent influence geothermal development. To this end, top management commitment also needs to be enhanced to enable adequate acquisition of the physical infrastructure required for geothermal development.

It can also be concluded that technology is a significant element in mega project development success. Key technological attributes highly regarded as influencing the performance of mega projects in the organization includes among others, innovative ideas and top management support thereof, efficiency with respect to saving time and delivery per schedule, optimal resource utilization and its environmental, commercial and social viability.

Overall procurement policy is found to be a key determinant of mega project performance in the organization, going by the high levels of agreement. More specifically, elements of procurement policy mostly affecting mega project performance according to a majority includes public trust courtesy of a clearly set and transparent procurement policy, procurement system’s efficiency leading to timely project completion, cost determination and optimal utilization of available project resources.

Further, the study concludes that personnel training are also a critical factor in mega project performance. As is evident from the findings, top management's commitment to personnel training is a crucial success factor in mega project performance context. It is also evident from the findings that personnel training have the capacity to keep work-based accidents and incidents in check, plays a key role in employee motivation, enhances cost consciousness, efficiency and decision making abilities among employees.

From the findings, it can also be deduced that most mega engineering projects by the organization perform best in resource utilization, followed by schedule performance, then societal and commercial viability. A significant factor established also is that a considerable number of projects are not completed within budget. This is a crucial area that may need to be addressed, to further realize superior performance. Finally, the study concludes that the most critical factors determining mega engineering project performance according to the respondents include technology, personnel training, physical infrastructure and procurement policy respectively.

5.5 Recommendations

The study has revealed the significance of physical infrastructure in relation to its contribution in mega engineering project performance. In order to avail adequate physical infrastructure to facilitate mega engineering project developments in the country, infrastructure assessment systems need to be developed with a view to measure the sustainability of available physical infrastructure in the event of mega project developments. These may be developed by governmental institutions, non-governmental institutions, and sometimes in collaboration with academia.

Technology was found to be the most crucial factor determining mega engineering project performance. In this regard, the study recommends that adoption of Project Management Information Systems (PMIS). These systems have continued to evolve from just being planning, scheduling and resource management information systems to complex, distributed, multi-functional systems that can easily generate information necessary to make decisions, improve the efficiency of implementation among other functions. What sets PMIS apart from other classes of IS is the highly volatile nature of their usage context i.e. project environments, and as such they need to be more customizable in their functionality than most other enterprise information systems. PMIS need to continuously match project requirements that originate from project-specific governance, complexity, strategic importance among other project requirements.

As regards procurement policies, there is need for mega projects, including Kengen's Olkaria Geothermal Projects to adopt the Web Service-based Procurement services, as both an efficient and a cost-effective way of sharing interspersed and/or disparate applications on the Internet and make them available for interoperation among public institutions. By adopting this, public administrations will be in a position to expose any involved public Procurement function, process and sub-process to any other entity, such as another business function, an organization, a particular community, or an end-user. Further, Web Service-based public e-Procurement processes has the ability to be assembled quickly and tailored to the needs of individual recipients with a degree of granularity not previously possible or economically viable.

Mega projects' personnel are a crucial determinant in the success thereof. Adequate training and development is thus crucial on matters relating to pertinent mega project development concepts based on the personnel's training needs identified by a training need analysis so that the time and money invested in training and management development is linked to the core business or goals of the organization as regards mega projects development. These training and development programs would best integrate crucial up to date developments in the context of mega projects upon which generic and redundant concepts and practices would be separated and the beneficial outcomes on mega engineering projects embraced.

5.6 Areas for Further Research

It is hoped that the findings of this study will contribute to the existing body of knowledge and form a basis for future researchers. Given that the study focused only on factors influencing performance of mega engineering projects with reference to Kengen's Olkaria geothermal projects in Kenya, the results may not apply to all other mega projects. It is therefore recommended that further research be done with a focus on other mega and smaller projects in other industrial sectors. Future studies could also focus on other hidden factors, one key determinant and assess the influence of the various elements of the determinant on project performance.

REFERENCES

Afshan, S., Sobia, I., Kamran, A. & Nasir, M. (2012). Impact of training on employee performance: a study of telecommunication sector in Pakistan. *Interdisciplinary Journal of Contemporary Research in Business* 4, 6.

Al-Khalil, M. & Al-Ghafly, M. (1999). Important causes of delay in public utility projects in Saudi Arabia, *Constr Manage Econ* 17 (5), 647–655.

Autio, E., Bianchi-Streit, M. &Hameri, A.-P. (2003). Technology transfer and technological learning through CERN's procurement activity.

Brady, T. &Maylor, H. (2010). The improvement paradox in project contexts: A clue to the way forward? *International Journal of Project Management*, 28(8), pp.787-795.

Casteneda, J. (2011). IPA Project Evaluation System. Retrieved August 2011, from Independent Project Analysis: http://www.ipaglobal.com/Methodology/Project---Evaluation---System

Creswell, J. W. (2008). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Thousand Oaks: Sage Publications, Inc.

Fellows, R. & Liu, A. (2008). *Research Methods for Construction*. John Wiley & Sons

Flyvberg, B., Bruzelius, N., *Rothengatter, W. Megaprojects and Risk: An Anatomy of Ambition*. Cambridge: Cambridge University Press

Flyvbjerg, B. (2007). *Megaproject Policy and Planning: Problems, Causes, Cures*. Aalborg University Press

Flyvbjerg, B., Bruzelius, N. &Rothengatter, W. (2003). *Megaprojects and Risk: An Anatomy of Ambition*, Cambridge University Press.

Fortune, J., & White, D. (2006). Framing of project critical success factors by a systems model. *International Journal of Project Management.*

Gordon, B. (1992). Are Canadian firms under investing in training? *Canadian Business Economics* 1,1, 25–33.

Iyer, K., Chaphalkar, N. & Joshi, G. (2008). Understanding time delay disputes in construction contracts. *International Journal of Project Management*, 26(2), pp.174-184.

Jergeas, G. (2008). Analysis of the Front-End Loading of Alberta Mega Oil Sands Projects. *Project Management Journal*, 39(4), pp.95-104.

Jugdev, K. and Müller, R. (2005). A retrospective look at our evolving understanding of project success. *Project Management Journal* 36 (4), 19–31

Kaming, P.F; Olomolaiye, P.O. Holt, G.D and Harris, F.C. (2009). Factors Influencing Construction Time and Cost Overruns on High-Rise Projects in Indonesia. *Construction Management and Economics*, 15, 83-94.

Kwak, Y.H. (2002). *Critical success factors in international development project management*. CIB 10th International Symposium Construction Innovation & Global Competitiveness. Cincinnati, Ohio. 9–13 septembre.

Lawrence, P. P. (2011). Planning In The Dark: Why major engineering projects fail to achieve key goals. *Journal of Technology Assessment and Strategic Management.*

Lawrence, P. P. (2011). Planning In The Dark: Why major engineering projects fail to achieve key goals. *Journal of Technology Assessment and Strategic Management.*

Leedy, P.D. &Ormrod, J. E. (2010) *Practical Research: Planning and Design*, Ninth Edition. NYC: Merril.

Lewis, M.A. and Roehrich, J.K. (2009). Contracts, relationships and integration: Towards a model of the procurement of complex performance. *International Journal of Procurement Management*, 2(2):125-142.

LiviuIlies, E. C. (2010). Best Practices in Project Management. *Review of International Comparative Management*, 11 (1)

Merrow, E. W. (2011). Industrial Megaprojects: Concepts, Strategies, and Practices for Success (Vol. 1). *Wiley*.

Morris, P. (1994). The *Management of Projects*, Thomas Telford.

Ogunlana, S.O, Promkuntong K, &Jearkjirm V. (1996). Construction delays in a fast-growing economy: comparing Thailand with other economies, *International Journal of project management* 14: 37-45

Pinto, J.K., Slevin, D.P. & English, B. (2009). Trust in projects: An empirical assessment of owner/contractor relationships. *International Journal of Project Management*, 27(6), pp.638-648.

Plotch, Philip Mark. What's Taking So Long? Identifying the Underlying Causes of Delays in Planning Transportation Megaprojects in the United States. *Journal of Planning Literature. Available online January* 8, 2015.

Plotch, Philip Mark. What's Taking So Long? Identifying the Underlying Causes of Delays in Planning Transportation Megaprojects in the United States. *Journal of Planning Literature*. Available online January 8, 2015.

PMI. (2011). Introduction to the Rudiments of Project Management. Retrieved September 2015, from Project Management Institute: www.pmi.org

Simon, M. K. (2011). *Dissertation and scholarly research*: Recipes for success (2011 Ed.). Seattle, WA, Dissertation Success, LLC.

Verhoest, K. (2005). *Control by Inputs, Results or Markets: the Control of Public Organisations and Their Performance in the NPM. Testing the Assumptions*. Paper presented at the IRSPM IV conference 26 p.

Villmo, H.B., 2010. Planning in Megaprojects: Planning and risk management.

Wright, P.A. (1987). Refinement of Porter's Generic Strategies. *Strategic Management Journal*, 8 (1), 93– 101.

APPENDICES

Appendix 1: Letter of transmittal of data collection instruments

Nyakiti Nester Ouma,
P.O Box 1203-00300,
Nairobi.

Cell: +254 722 152055
Email: nnyakiti@gmail.com

October 2015

To whom it may concern

RE: DATA COLLECTION FOR STUDY ON FACTORS INFLUENCING THE PERFORMANCE OF MEGA ENGINEERING PROJECTS: THE CASE OF KENGEN'S OLKARIA GEOTHERMAL PROJECT

I am Nyakiti Nester Ouma, National Identity No. 21729937 and a student at the University of Nairobi, School of Continuing and Distance Education, registration number L50/69107/2013. I am currently undertaking my research project as a requirement for award of the degree of Masters of Arts in Project Planning and Management. I am therefore carrying out a study on factors influencing the performance of mega engineering projects in Olkaria geothermal field.

The purpose of this letter is to kindly request for your permission and cooperation during my data collection process. I am involving two research assistants whom I would also like to request you to allow them collect the necessary data. It is my assurance that the data provided by any respondent will be treated with utmost confidentiality and only used for the purpose of this research. The details of respondents and other sources of information shall also be kept confidential.

For any more information or clarification, I may be contacted on my personal mobile or email contacts as above.

I look forward to your cooperation.

Thank you,

Nyakiti Nester Ouma

Appendix 2: Questionnaires

INTRODUCTION

Dear respondent,

My name is Nyakiti Nester Ouma, a student at the University of Nairobi, School of Continuing and Distance Education. I am currently undertaking my research project as a requirement for award of the degree of Masters of Arts in Project Planning and Management. The study is on the factors influencing performance of mega engineering projects; the case of KenGen's Olkaria geothermal field.

The findings of this study will contribute useful knowledge in Kenya's energy industry and provide a baseline for improving performance of mega engineering projects in geothermal development. Therefore, I would like to collect data that will assist in accomplishing the objectives of this study. Kindly answer the questions contained in this questionnaire by ticking as appropriate. Your contribution will be much appreciated and information provided will be treated with utmost confidentiality.

A. RESPONDENT'S DETAILS

(***Please as appropriate tick,✓, inside the box***)

1. Please indicate your department?

   Engineering & Logistics ☐ Geoscience ☐ Procurement ☐

   HR& Training ☐ Geothermal Infrastructure ☐ Project Execution ☐

2. What is your current job designation?

   Manager ☐ Geoscientist ☐ Engineer ☐ Officer ☐

3. Please specify your gender? Male ☐ Female ☐

4. What is your level in management?

   Top level ☐ Middle level ☐ Lower level ☐

1. For how long have your worked in a geothermal (or energy) development organization?

   Below 5 years ☐ 5 – 10 years ☐ Over 10 years ☐

2. What is your highest level of education?

   Phd/Masters ☐ Degree ☐ Diploma ☐

A. Physical infrastructure and performance of mega engineering projects

Please provide your opinion on each of the statements below by ticking (✓) the appropriate box.

Key: 1-Strongly Disagree; 2-Disagree; 3-Indiferrent; 4-Agree; 5-Strongly Agree.

(The statements below relate to how physical infrastructure influenced performance of mega engineering projects).

No	Physical infrastructure and performance of mega engineering projects	Rating				
		1	2	3	4	5
i	Top management is committed to and fully supports acquisition of the physical infrastructure required for geothermal development					
ii	Our organization has adequate physical infrastructure required for geothermal development					
iii	The cost of acquiring the necessary physical infrastructure affordable and encourages geothermal development					
iv	Top management have set up proper security measures to ensure all infrastructure are safe from loss, damage or external aggression					
v	Availability of physical infrastructure has significant effect on performance of mega geothermal projects					

B. Technology and performance of mega engineering projects

Please provide your opinion on each of the statements below by ticking (✓) the appropriate box.

Key: 1-Strongly Disagree; 2-Disagree; 3-Indiferrent; 4-Agree; 5-Strongly Agree.

(The statements below relate to how technology influenced performance of mega engineering projects).

No.	Technology and performance of mega engineering project	Rating				
		1	2	3	4	5
i	Top management commitment to supporting innovative ideas across all levels and departments of the organization has greatest influence on performance of mega geothermal projects					
ii	High technology equipment and machinery help save time and deliver projects in as per schedule					
iii	Most of our employees appreciate, supports and flexible to changes in technology					
iv	High technology equipment and machinery					

	optimally utilizes available resources					
v	Latest technology equipment and machinery are environment friendly, and usually meet commercial and societal needs					

C. Procurement policy and performance of mega engineering projects

Please provide your opinion on each of the statements below by ticking (✓) the appropriate box.

Key: 1-Strongly Disagree; 2-Disagree; 3-Indiferrent; 4-Agree; 5-Strongly Agree.

(The statements below relate to how procurement policy influenced performance of mega engineering projects).

No	**Procurement policy and performance of mega engineering projects**	**Rating**				
		1	2	3	4	5
i	Top management's commitment to the procurement policy generally improves performance of mega geothermal projects					
ii	Procurement policy determines cost of procurement and may consequently lead to budget overruns					
iii	The optimal utilization of available project resources is determined by our procurement policy					
iv	The completion time, or project duration is determined by how efficient is the organization's procurement system					
v	A clearly set and transparent procurement policy wins public trust and usually lead to project success					

D. Personnel training and performance of mega engineering projects

Please provide your opinion on each of the statements below by ticking (✓) the appropriate box.

Key: 1-Strongly Disagree; 2-Disagree; 3-Indiferrent; 4-Agree; 5-Strongly Agree.

(The statements below relate to how personnel training influenced performance of mega engineering projects).

No.	**Personnel training and performance of mega engineering project**	**Rating**				
		1	2	3	4	5
i	Top management's personnel commitment to personnel training is crucial to better performance of mega geothermal projects					
ii	Personnel training is responsible for the rise or decline in work-based accidents and incidents					

iii	Personnel training motivates employees and benefits performance of geothermal projects					
iv	Well trained staff are cost conscious, good decision makers, avoid material and time wastage and generally give good results.					
v	Cross cultural training promotes social integration and has positive impact on project performance					

E. Performance of mega engineering projects

Please provide your opinion on each of the statements below by ticking (✓) the appropriate box.

Key: 1-Strongly Disagree; 2-Disagree; 3-Indiferrent; 4-Agree; 5-Strongly Agree.

(The statements below relate to your general judgment on performance of mega engineering projects).

No.	**Performance of mega engineering project**	**Rating**				
		1	2	3	4	5
i	Most of our geothermal projects are completed in time					
ii	Our project implementation strategy optimally utilizes available resources					
iii	Our geothermal projects are generally meet societal and commercial needs					
iv	Most of our geothermal projects are implemented within budgeted project cost					
v	In general, availability of physical infrastructure greatly influences performance of mega geothermal projects					
vi	In general, procurement policy greatly influences performance of mega projects					
vii	In general, technology greatly influences performance of mega geothermal projects					
viii	In general, personnel training greatly influences performance of mega geothermal projects					

Thank you!