# FACTORS INFLUENCING THE PERFORMANCE OF GEOTHERMAL ENERGY PROJECTS: A CASE OF MENENGAI GEOTHERMAL PROJECT, KENYA

**BY**

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**A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTERS OF ARTS IN PROJECT PLANNING AND MANAGEMENT OF THE UNIVERSITY OF NAIROBI**

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## DECLARATION

This research project report is my original work and has not been presented for a degree in any other University or any other award**.**

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

**L50/84951/2016**

**Amos Lepatei**

This research project report `has been submitted for examination with my approval as the University Supervisor.

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

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## DEDICATION

This work is dedicated to my family and friends for encouraging me to complete this project.

**ACKNOWLEDGEMENT**

First and foremost I would like to give thanks to God for giving me the will; resources and support that I so desperately needed to complete this project successfully. I would also like to thank my family again for their support, vision and guidance through this journey. I would like to take this opportunity to express my profound gratitude and deep regard to my research project supervisor, Professor Harriet Kidombo for her exemplary guidance, valuable feedback and constant encouragement throughout the duration of the project proposal. Her valuable suggestions were of immense help throughout my project proposal work. Her perceptive criticism kept me working to make this research project a success. Working under her was an extremely knowledgeable experience for me. To the Geothermal Development Company management & staff, thank you for your support and understanding.

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## ACRONYMS & ABBREVIATIONS

| | |
|---|---|
| **BOT** | Build Operate and Transfer |
| **BLT** | Build-Lease-and-Transfer |
| **BOO** | Build-Own-and-Operate |
| **BOOT** | Build-Own-Operate-and-Transfer |
| **BT** | Built-and-Transfer |
| **DOPU** | Drop-Off and Pick-Up |
| **ERC** | Energy Regulatory Commission |
| **GDC** | Geothermal Development Company |
| **GWs** | Giga Watts |
| **IPPs** | Independent Power Producers |
| **INECEL** | Instituto Ecuatoriano de Electrification |
| **KenGen** | Kenya Generating Company |
| **KETRACO** | Kenya Electricity Transmission Company |
| **KPLC** | Kenyan Power and Lighting Company |
| **MWe** | Mega Watts |
| **NACOSTI** | National Council of Science, Technology and Innovation |
| **NEDP** | National Electricity Development Plan |
| **PPP** | Public Private Partnerships |
| **REA** | Rural Electrification Authority |
| **US** | United States |

## ABSTRACT

The electricity demand in Kenya has continued to rise over the years. For example, the country's electricity demand stood at 1, 191 MWs against a generation capacity of 1,429 MWs in 2011. The country's energy demand is expected to hit 15,000 MWs in 2030 as a result of expected industrial growth as well as more households' connection due diverse connection initiatives by KPLC. The geothermal development company (GDC) is expected to make a major contribution to the electricity supply in the country. The national electricity consumption by mode 47% geothermal, 39% hydro, 13% thermal and 1% wind. Therefore, geothermal electricity is the largest source of electricity in the country. The Kenya's geothermal energy potential with the rift valley has been estimated at 7,000 to 10,000 MWs. Out of this potential, the Geothermal Development Company (GDC) aims to extract 5,000 MWs by the year 2030. The Menengai geothermal project has a capacity to generate 1600 MW with phase I set to provide 400 MW. The performance of geothermal energy projects therefore remains a critical component of the energy mix in the country. This study aims at examining the factors influencing the performance of geothermal energy projects with a special reference to the Menengai Geothermal Project, Kenya. The specific objectives included the examination of the influence of the operational costs, public private partnership, and technology adoption on performance of geothermal projects. The study was based on the Resource Based View (RBV) and Dynamic Capabilities Theory. The descriptive research design was used for this study. The target population of this study was the GDC company employees at Menengai Geothermal Project. The study used a sample size of 80 respondents. This research used the structured questionnaires in order to address the specific research objectives. The content validity was tested during the pilot study through the use of experts in the area of performance of the geothermal plants who were employees of Olkaria Geothermal Plant. Cronbach alpha coefficient of a range of 0.7 and above was used to measure the reliability of the study. The data was then analyzed using the descriptive and inferential statistics. The descriptive statistics undertaken included means, standard deviations and frequency distributions. The inferential statistics undertaken included the correlations and multiple linear regression. Simple linear regression was undertaken and the p-value from the ANOVA used to test the different hypothesis used for this study. A 5% level of significance was used for rejecting the null hypothesis, that is, a p-value of 0.05 ($p<0.05$). In this context, the p-values for each of the null hypothesis ($H_{01}$, $H_{02}$, and $H_{03}$) were each 0.000 which made each null hypothesis, that is, operational costs, technology adoption, and Public Private Partnerships have no significant influence on performance of Menengai geothermal project, Kenya to be rejected. This implied that each variable had significant influence on performance of Menengai geothermal project, Kenya. The study recommended that funds used for corporate social responsibility, and the procurement costs be minimized and diverted to capital intensive areas to enhance the recovery of the financial investment from the revenues generated from the systems. Additionally, arising challenges in project execution should be mitigated and solutions to the challenges found fast so as to improve on the timelines of project delivery and reduce costs of project delivery. Finally, the study recommended that Public and Private Partnerships should be encouraged in order to improve on the quality and timelines of project delivery.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

The geothermal energy was used in the ancient times for the purposes of mostly bathing and heating purposes in ancient Rome (Zheng, Zhang, Zhu, & Liu, 2005). This usage was mostly from the hot springs that had formed on the surface of the earth. In modern times, technologies have been developed to enable the harnessing of geothermal energy from deep into the earth. In this context, Miyazaki, Hanano, Zeng, & Jiang, (2006) notes that the geothermal potential is harnessed through bringing the heat to the surface in a fluid (steam or water) where it can be utilized for diverse services including electricity generation (Kaptuya, 2014). The geothermal energy is made by through the high temperatures and pressure at the core of the earth that causes melting of the rocks in the earth crust resulting in portions of mantle converting upward since it is lighter than the surrounding rock (Kathutwa, 2013).

The geothermal energy is being increasing used by diverse countries across the world in order due to its cost effectiveness, reliability, sustainability, and its environmentally friendly aspects (Smith, 2012). The geothermal energy has been used for diverse functions across the world including heating aspects, electricity generation, and spas amongst other functions (Heijnen, Rijkers, & Ohmann, 2015). The geothermal energy generation around the world was estimated in 2013 to standard at 11,700 Mega Watts (MWe) (Bloomquist, 2012). Diverse countries across the world have formed specialized geothermal generation and regulation authorities to enable the countries expedite the generation of geothermal energy. In Ecudor, Beate & Salgado (2015) notes that the government through the Instituto Ecuatoriano de Electrification (INECEL) developed a geothermal plan for electricity generation in order to explore the geothermal generation potential in the country. In this context, several geothermal projects including Chachimbiro, Chacana, Chalpatan, Tufino-Chiles, Chalupas and Cuenca geothermal prospects.

In the United States of America, Thorsteinsson (2008) notes that the geothermal capabilities were first harnessed in 1890 by the Boise Water Works in Boise, Idaho. The geothermal energy was harnessed for the purposes of providing heating systems in US homes. Since the first harnessing of the geothermal energy in 1890 in the US, the geothermal energy was estimated to provide 0.5% of the total US energy mix by 2006. Thorsteinsson (2008) further notes that the US geothermal electricity production was 2,285 Mega Watts by 2005. By 2009, the geothermal electricity production had risen to 3152.72 MWs in the US (Jennejohn, 2010). According to Jennejohn (2010), diverse states within the US had installed geothermal energy generation capacity including Alaska, California, Hawaii, Idaho, Nevada, New Mexico, Utah, and Wyoming as October, 2009. The other states that were developing their geothermal energy capacity included Oregon, Colorado, Florida, Louisiana, and Mississippi states. Similarly, Kunkel, Gomshei, & Ellis (2012) noted that in Australia, there were diverse geothermal energy projects that were being undertaken including Pebble Creek, Canoe Reach, Knights Inlet, South Meager, Swan Hil, and Con Mine amongst other aspects.

In Indonesia, Smith (2012) in a study on the Potential for Investment in Indonesia's Geothermal Resource notes that the county has over 40% of the world's capacity for electricity production. The country's National Electricity Development Plan (NEDP) aims at realizing a total of 6 Giga Watts (GWs) by the year 2025 in order to meet an expanding electricity demand. In this context, up to 265 geothermal fields have been identified in Indonesia although majorities are not economically viable to develop. In Africa, counties have geothermal potential are located along the rift system. These countries include Eritrea, Djibouti, Ethiopia, Sudan, Kenya, Uganda, Tanzania, Mozambique, Malawi and Comoros. However, this potential is only tapped by Kenya and Ethiopia.

The generation and use of the geothermal energy in Kenya has undergone diverse developmental milestones. According to Maina (2013), the geothermal energy potential was first explored in Kenya through an exploration of Olkaria Geothermal resources in 1956. Further feasibility study was to be undertaken in the 1970s before deep drilling started leading to established of the Olkaria plants thereon. According to Maina (2013), the Olkaria I, Olkaria II and Olkaria III have 45 MWe, 105 MWe, and 48 MWe installed capacity respectively. In the context of the institutional development in geothermal energy generation, the major significant development was the constitution of the Geothermal Development Company (Kiptoo, 2012). The sessional paper number 4 of 2004 and energy act number 12 of 2006 created provisions for diverse institutions from the monolithic Kenya Power and Lighting Company. These institutions included Energy Regulatory Commission (ERC), Kenya Generating Company (KenGen), Kenyan Power and Lighting Company (KPLC), the Rural Electrification Authority (REA), Kenya Electricity Transmission Company (KETRACO), Geothermal Development Company (GDC) and Independent Power Producers (IPPs)(Siapei, 2011). The GDC Company was formed in 2008 (hence operationalizing the energy act of 2006) as a special purpose vehicle tasked with the acceleration of the geothermal energy development in Kenya. In this context, the company is charged with exploration, appraisal, production, drilling, steam field development and management.

The geothermal energy production in Kenya has been of a significant importance to the country due to the challenges associated with the hydro generation of electricity. The hydro electricity used to be the main source of electricity in Kenya. According to Kengen (2016), the hydroelectricity accounted for 80% of the electricity used in Kenya in the early 2000s. Therefore, challenges associated with the hydro generation of electricity significantly affected the energy supply within the country (Mwaura, 2016). The hydro generation of electricity was highly unreliable due to diverse climatic conditions such as rainfall, temperature and the wind speeds. These climatic conditions have the effect on the level of water in the power generating dams through affecting the rate of evaporation of such water. The water levels affected the hydro electricity supply in two main ways; low water levels (due to drought) reduced capacity to generate electricity while flooding introduced silt to the hydro dams leading to interference with electricity generation (Kaptuya, 2014). The fluctuating electricity generation from hydro sources often forced the government to purchase power at high costs, or source power from expensive sources such as thermal power plants. For example, the government was forced to buy power from Aggreko during the 2009 power blackouts in the country with the firm contracted to supply 140 MWs at an extremely high price. According to Kengen (2016), following the full operationalization of the 280MW Geothermal plant in Olkaria, the national electricity consumption by mode 47% geothermal, 39% hydro, 13% thermal and 1% wind.

Despite the advantages associated with the use of the geothermal energy across the world, diverse challenge still face geothermal energy production efforts. According to Beate & Salgado (2015) diverse factors influence the performance of geothermal energy projects across the world ranging from the operational aspects, technology aspects and financing aspects. From an operational perspective, Moon & Zarrouk (2015) in a study on Efficiency of Geothermal Power Plants notes that diverse operational aspects impact on the performance of geothermal plants. Amongst the factors that the study noted to impact on the geothermal power plant performance include the power plant system design, heat loss from equipment, turbine and generator efficiencies amongst other aspects (Moon & Zarrouk, 2015).

## 1.2 Statement of the Problem

The electricity demand in Kenya has continued to rise over the years. For example, the country's electricity demand stood at 1, 191 MWs against a generation capacity of 1,429 MWs in 2011. On the other hand, the electricity demands stood at 1, 191 MW in 2013 against a capacity of 1,600 MW. In 2015, the electricity demand stood at 2,500 MW against a capacity of 3,000 MW. The country's energy demand is expected to hit 15,000 MWs in 2030 as a result of expected industrial growth as well as more households' connection due diverse connection initiatives by KPLC. The geothermal development company (GDC) is expected to make a major contribution to the electricity supply in the country. According to Kengen (2016), the national electricity consumption by mode 47% geothermal, 39% hydro, 13% thermal and 1% wind. Therefore, geothermal electricity is the largest source of electricity in the country. The Kenya's geothermal energy potential with the rift valley has been estimated at 7,000 to 10,000 MWs (Mading, 2013). Out of this potential, the Geothermal Development Company (GDC) aims to extract 5,000 MWs by the year 2030. According to Mading (2013), the Menengai geothermal project has a capacity to generate 1600 MW with phase I set to provide 400 MW. The performance of geothermal energy projects therefore remains a critical component of the energy mix in the country. This study aims at examining the factors influencing the performance of geothermal energy projects with a special reference to the Menengai Geothermal Project, Kenya.

## 1.3 Purpose of the Study

The purpose of the study was the examination of the factors influencing the performance of Geothermal Energy projects with a reference to the Menengai Geothermal Project in Kenya

## 1.4 Objectives of the Study

The objectives of the study include the following;

1. To establish the influence of operational costs on performance of Menengai geothermal project, Kenya
2. To examine the influence of public private partnerships on performance of Menengai geothermal project, Kenya

3. To examine the influence of Technology Adoption on performance of Menengai geothermal project, Kenya

## 1.5 Research Questions

The study was guided by the following research questions;

1. How do operational costs influence performance of Menengai geothermal project in Kenya?
2. How does public private partnership influence performance of Menengai geothermal project in Kenya?
3. How does technology adoption influence performance of Menengai geothermal project in Kenya?

## 1.6 Research Hypotheses

The study was guided by the following research hypotheses;

**$H_{A1}$:** Operational costs have a significant influence on performance of Menengai geothermal project, Kenya

**$H_{A2}$:** Public Private Partnerships have a significant influence on performance of Menengai geothermal project, Kenya

**$H_{A3}$:** Technology adoption has a significant influence on performance of Menengai geothermal project, Kenya

## 1.7 Significance of the Study

The study was of significance to diverse stakeholders including Ministry of Energy, Kenya Electricity Generating Company (KenGen), Independent Power Producers (IPPs), Power Investors, diverse countries, project management professionals, general public, and scholars. The Ministry of Energy through Energy Regulatory Commission performs diverse functions including oversight performance of the energy sector including the GDC. This study highlighted diverse aspects that impact on the performance of the geothermal energy projects in Kenya. This was critical in formulation of policies due to the huge public funds that are expended in the geothermal operations as well as government involvement of the negotiation for the Public Private Partnership for GDC Company. The KenGen and IPPs offer supplementary and sometimes competing products to the GDC services of geothermal energy production. This study was of importance to these organizations as getting this information enabled them strengthen their operational performance. Diverse countries in Africa especially those in the rift valley belt stand to gain through this study through getting an understanding on the factors that influence performance of geothermal projects hence improving on their nascent geothermal industries. Such countries include Ethiopia. The project management professionals, and researchers gained from the study through gaining an understanding on how diverse aspects such as PPP, operational costs and technology adoption impact on project performance within the context of a geothermal energy project.

## 1.8 Assumptions of the Study

The study made the assumption that the researcher was able to get access to the respondents who were GDC employees. Additionally, the study used the descriptive research design of which the major disadvantage includes possibilities of the atypical individuals in the sample. The atypical individuals are individuals who are the exceptions rather than the norm and as such leads to poor generalization of the results. The study did not have atypical individuals.

## 1.9 Delimitation of the Study

The geographical scope of the study was the Menengai Geothermal Project due to scarcity of time and funds to undertake a wider geographical scope. The study had a limitation of Ksh 55,000 in respect to funding aspects as the study is self-funded in nature. The time limitation as allocated by the University of Nairobi as this research is meant for an awardment of Masters of Arts in Projects Management degree is one academic semester. Therefore, this study was undertaken within a period of six calendar months from January to June of 2017 with anticipation to graduate in August of 2017.

## 1.10 Limitations of the Study

The study faced different challenges during the execution of the field work for data collection process. The GDC is a critical and sensitive government installation due to its importance in the electricity generation purposes in the country. In this context the management may be reluctant to authorize data collection from the institution. These concerns were mitigated through the researcher having a formal written authority from the University of Nairobi as well as National Council of Science, Technology and Innovation (NACOSTI) authorizing data collection. These letters served to illustrate the data collection was of an academic purpose.

## 1.11 Significant Terms

**Energy;** Power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines (Kathutwa, 2013).

**Geothermal Energy;** Energy made through high temperatures and pressure at the core of the earth that causes melting of the rocks in the earth crust resulting in portions of mantle converting upward since it is lighter than the surrounding rock (Kathutwa, 2013).

**Operational Costs;** Financial expenses incurred during the process of running an organization (Magu, 2013).

**Performance;** The function of the efficiency and effectiveness of diverse functions (Magu, 2013).

**Public Private Partnership;** The contractual relationship between public and private entities involving time, investment, risk and rewards, responsibilities and the use of public and private resources for the provision of basic services (Ürel, 2015).

**Technology;** The collection of diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants (Mbuthi, 2014)

**Technology Adoption;** Acceptance of a new technology product or innovation

## 1.12 Organization of the Study

This study was organized in five chapters that is chapter one, two, three, four and five. Chapter one introduced the background of the study. In this context, the study examined the geothermal concepts and geothermal projects across the world. The chapter also examined the statement of the problem, objectives of the study, significance of the study, and delimitations of the study amongst other aspects. Chapter two examined the available literature review through an examination of influence of operational costs, public private partnership, and technology adoption on the performance of geothermal. The study also examined the theoretical review of the study. Chapter three examined the research methodology of the study including sampling, research design, population, data collection instruments, validity and reliability, and data analysis processes. Chapter four examined the data analysis process and presentation. Finally, chapter five examined the summary, conclusion and recommendations of the study.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter examines in detail the aspects of operational costs, private public partnerships and technology adoptions and their influence on the performance of geothermal projects in Kenya. The study also examined the conceptual framework and research gaps.

## 2.2 Operational Costs and Performance of Geothermal Projects

The operational costs play a significant role in the performance of geothermal projects. According to Thorsteinsson (2008) in a study on barriers and enablers of US Geothermal District Heating notes that operational costs has an impact on the overall feasibility of a geothermal project. In this context, the study noted that the financiers of geothermal projects must be in a position to recoup the operational costs from the revenues generated from the systems. In this context, the Kaptuya (2014) in a study on the Role of Strategic Orientation as a Source of Competitive Advantage at Geothermal Development Company in Kenya indicated importance of saving costs in geothermal energy projects. In this context, the study noted that diverse strategies are deployed at geothermal projects with a view of minimizing operational costs. In this context, in order to cut costs associated with the hiring or leasing of expensive machinery and technical expertise, the GDC has bought its own rigs/machinery (Kathutwa, 2013). The costs for exploration are often prohibitive in nature and therefore GDC first experiments with potential fields before full blown exploration work to minimize the operational costs. Kaptuya (2014) also notes that the GDC also outsources noncore services to external service provider.

Siapei (2011) in a study on Organizational Structure and Strategy Implementation at Geothermal Development Company in Kenya notes that impact of diverse costs that GDC incurs. The Geothermal projects often depend on imported machinery in order to execute diverse operational functionalities within the organization. There are diverse costs that associated with the importation of machinery including costs associated with international tendering inclusive of lawyer and bank fees, and the costs associated with the actual purchases of the items in foreign denominated currencies as well as the logistical costs of machinery movements (Leyiaro, 2015). The GDC operational processes also impacts significantly on the community that surrounds their operations through land use, diverse health hazards such as noise and release of harmful gas amongst other aspects (Jerobon, 2011). The GDC therefore as a strategy to achieve mutual coexistence platform undertakes community related projects such as hospitals, schools, and provision of water points amongst other functions which costs GDC funds.

A study on the Potential for Investment in Indonesia’s Geothermal Resource by Smith (2012), examined the impact of diverse costs associated with geothermal exploration aspects. In illustration of the diverse costs associated with geothermal projects in Indonesia, Smith (2012) noted that the costs varied on the geothermal plants output sizes as illustrated in Table 2.1.

**Table 2.1; Costs Involved in Geothermal Projects**

| US Dollars (Millions) | Power Plant Size MW | | |
|---|---|---|---|
| | 20 MW | 50MW | 100MW |
| Total Exploration Cost (including establishment costs, but not including land purchase, bidding, licencing) | 9.05-28 | 9.05-28 | 9.05-28 |
| Total Power Plant Costs (not including transmission) | 40.5-62.5 | 69.65-90.05 | 109.05-134.5 |
| Total Cost/MW | 2.05-3.12 | 1.38-1.8 | 1.09-1.35 |

**Source; Smith (2012)**

According to Smith (2012, p.301) the major costs associated with geothermal projects include; Establishment Costs (land, survey and exploration, well testing, feasibility studies, civil and infrastructure, operations);Drilling Costs (dependant on the number and depth of the wells and the geology, these can account for between 40% and 95% of total costs); Stimulation Costs (dependant on the type of field, resource temperature and terrain: fluid pipes, plant, civil works), and Power Plant (dependant on size and type of plant). Others include Transmission costs (dependent on distance from suitable grid connection); Operations and Maintenance (although dependent on capital costs other factors such as sulphur content, climate and terrain can impact on these).

The drilling costs consume a lot of operational costs in a geothermal project. In this context, Maina (2013) in a study on Multi-Criteria Suitability Analysis For Optimal Siting Of A Geothermal Well notes that geothermal drilling costs are expensive. This is because significant costs are expended in the geochemical, geological and geophysical surveys that are required for the drilling to take place. Finally, Mbuthi (2014) in a study on the feasibility and enhanced role of geothermal in Kenya's Energy Supply examined the diverse costs aspects within the context of geothermal projects. Mbuthi (2014) note that costs in a geothermal energy project are often characterized as indirect capital costs, indirect costs and operation and maintenance costs. The direct costs relate to exploration, steam field development and power plant construction. The operational costs include drilling costs that consume a huge part of the operational costs as well as staff related costs. Mbuthi (2014) notes that the turnkey investment on installing geothermal electric power generation at US $ 800 – 3000 per kilowatt as illustrated in Table 2.2.

**Table 2.2; Costs of electricity from geothermal steam (US $/kW installed capacity)**

| Plant Size | High Quality Resource | Low Quality Resource |
|---|---|---|
| <5 MW | $ 1600 - 2300 | $ 1800 – 3000 |
| 5-30 MW | $ 1300 - 2100 | $ 1600 – 2500 |
| >30 MW | $ 1150 - 1750 | $ 1350 – 2200 |

**Source; Mbuthi (2014)**

## 2.3 Public Private Partnerships and Performance of Geothermal Project

There are diverse conceptualizations of the Public Private Partnerships. According to Ürel (2015) the Public Private Partnership (PPP) refers to the contractual relationship between public and private entities involving time, investment, risk and rewards, responsibilities and the use of public and private resources for the provision of basic services (Matar & Al-Sa, 2013). On the other hand, World Bank (2012) notes that the PPP involves a contract between a public sector institution and a private party, in which the private party assumes substantial financial, technical and operational risk in the design, financing, building and operation of a project. The Public Private Partnership was first utilized in France in the $17^{th}$ century for the purposes of public infrastructure construction.

There are diverse advantages that are associated with the Public Private Partnerships. According to Hall (2014), the advantages of the PPP include faster delivery of infrastructure development compared to government infrastructural development of services, high quality of services delivered through PPP, and lower cost implications for services delivered through PPP systems. The PPP often deliver superior results through mitigating diverse challenges associated with the operational aspects in government services that undermine value for money aspects (Matar & Al-Sa, 2013). The PPP arrangement is able to achieve the lowest whole-of-life service costs since the due to the private entity operational involvement in a project, the project must be financially viable in the long run. The private entity therefore mostly finances, operate and maintain the asset leading to the minimization of the cost of service delivery over the entire life of the project (Bouma & Berkhout, 2015). The private firm evaluates the financial risks that may be inherent in the project design, construction and maintenance in order to be able to recover their financial investment.

The PPPs projects are also often delivered on time and within the projected costs compared to the government funds because of the commercial interest of the private entity (World Bank, 2012). The PPP projects also are able to access a diversity of financing options from both the government and the private sector due to the availability of technical expertise to execute the diverse operational aspects of geothermal project. The party providing the financial capacity is able to trade off with the technical expertise of the other party in the partnership. Amongst the critical technical expertise the private sector often bring to the partnership include the customer service aspects, risk management expertise and financial management skills (Michael, 2016). The PPP projects enable the government address the funding challenges that may be present in funding of public infrastructure through enabling funds to be diverted to other areas especially for the capital intensive projects. The PPP also distributes any project risks that may be prevalent in infrastructure development. Therefore PPP becomes a mechanism for the distribution of the project risks to diverse parties as well as enhancing efficiency (Elijah, 2010). Thus PPP are critical in emphasizes Value for Money focusing on reduced costs, better risk allocation, faster implementation, improved services and possible generation of additional revenue

Diverse factors influence the success of PPP in any country including the ability to have policy, institutional and legal frameworks that guide the partnership areas as well as the availability of technical expertise to improve on performance of PPP (Gebreselassie, 2016). The policy, institutional and legal frameworks are critical in PPPs for the purposes of setting the scope of partnership, operational aspects of partnership, mandates of each party in the partnership, chain of command and dispute resolution mechanisms in the project implementation. The legal framework is particularly useful in enhancing transparency and accountability aspects in the partnership execution. Other factors that have been seen to influence the success of the PPP projects include level of public authority involvement in funding aspects, terms of the contractual agreement between parties, risk sharing appetite, and the technical expertise of diverse parties involved in the partnership(Michael, 2016).

There are diverse types of PPP partnerships within the context of the infrastructure development including Built-and-Transfer (BT), Build-Lease-and-Transfer (BLT), Build Operate and Transfer (BOT), Build-Own-Operate-and-Transfer (BOOT), and Build-

Own-and-Operate (BOO)(Gebreselassie, 2016). The BT involves the contractual arrangement whereby the concessionaire undertakes the financing and construction of a given infrastructure or development facility and after its completion turns it over to the Government Agency or Local Government unit concerned, which shall pay the proponent on an agreed Schedule its total investments expended on the project, plus a reasonable rate of return thereon (Rapajic, Puric, & Puric, 2013). The BLT involves the private sector financing and developing a facility then leasing it upon completion to a government institution before finally the ownership reverts to the government. The Build Operate and Transfer (BOT) involve a private institution financing and developing a facility, operating it on a given period to recoup its investment and thereafter transferring the facility to the government. Examples of institutional help to the GDC are numerous. Geothermal Development Company.,(2015) in its 2015 annual report noted that GDC had received diverse financial help from African Development Bank to develop phase I of Menengai Geothermal. The GDC further received 36 million United States Dollars from European Investment Bank.

### 2.4 Technology Adoption and Performance of Geothermal Project

Technology is a collection of diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants as defined by Taylor (2007) in a study on the State of Geothermal Technology Part. The performance of diverse technologies within the geothermal projects imparts on the performance of the projects. In the context of the exploration technologies, Mbuthi (2014) notes that there are three different technologies that can be utilized including Flash plants, Binary cycle plan, and Hybrid flash and binary cycle plant. The flash plants are the most commonly used technology in geothermal energy exploration and has been used in Olkaria I and II Geothermal Power Plants. On the other hand, the Olkaria III uses the binary cycle technology. The flash power plants are used for moderate to high temperature geothermal projects. According to Mendoza (2014), the technologies to be utilized on the geothermal energy projects is influenced by diverse considerations including flexibility of technology use; costs of the technology; Scale of energy supply required; Maturity and reliability of the technology; Sophistication of the technology (level of skill required to produce, operate and maintain the technology); cost structure and versatility of technology use.

There are three broad technologies that impact on the performance of geothermal projects as noted by Livesay (2014) in a study on the Future of Geothermal Energy. These technologies include drilling technologies, power conversion technologies, and reservoir technologies. The drilling technologies impact on diverse operational aspects of geothermal energy extraction hence overall geothermal energy production. The drilling technologies utilized will enable the better rock penetrative levels, and better accessibility to deeper and hotter regions hence higher efficiency levels. For example, the drilling-with-casting is a new technology with the potential to reduce the operational costs as it allows longer casting intervals, leading to fewer strings and, therefore, reduced costs. Livesay (2014) further note that the power conversion technologies impact on the heat-to-power conversion efficiency hence the overall performance of the geothermal performance. The use of the appropriate reservoir technology enables the heat-removal efficiencies in fractured rock systems, will lead to immediate cost reductions by increasing output per well and extending reservoir lifetimes. Thorhallson (2006) in a study on the new developments in geothermal drilling seeks to examine the impact of technology on the operational performance of geothermal projects. In the context of drilling speed, Thorhallson (2006) notes that new drilling technologies introduced in 2006 enabled the ability to drill to over 200 meters in a day compared to the earlier technologies with capacity of 40-100 meters per day.

## 2.5 Performance of Geothermal Projects

Performance refers to the function of the efficiency and effectiveness of diverse functions as defined by Magu (2013). The organizational performance refers to the actual output or results of an organization as measured against its intended outputs (or goals and objectives)(Amin, 2012). The GDC Company was formed in 2008 (hence operationalizing the energy act of 2006) as a special purpose vehicle tasked with the acceleration of the geothermal energy development in Kenya. In this context, the company is charged with exploration, appraisal, production, drilling, steam field development and management. According to the GDC strategic plan for the 2012 to 2017, the Menengai phase I ought to have been completed by 2015 and produce 400 MW (Maina, 2013). The GDC strategic plan for 2012 to 2017 notes that in 2012, the total installed geothermal generating capacity in Kenya was 202 MWe with 150 Mwe by Kengen and 52 MWe by Independent Power Producers (IPPs) (Irene, 2015). The GDC strategic plan of 2012 to 2017 identified the functions of GDC as follows; To conduct surface exploration, exploration and appraisal drilling and development of low temperature and direct use of geothermal energy; Manage public resources such as rigs and other infrastructure required for faster geothermal development; Develop the human capacity in Geothermal Technology in Kenya; Support and promote development of direct uses of geothermal resources and Consulting on geothermal energy, other geo science and resource projects, environment studies and project management. Others include to Market geothermal as a benign environment friendly and least cost power source for Kenya; Support the Government efforts to attract fundings and investment in geothermal energy for rapid development, and Sell steam to power generators.

In relations to its organizational mandate, the GDC in 2015 annual report indicated the diverse achievements had been realized in the organization. The GDC had by 2015 developed 59 wells within Olkaria with a steam potential of 412MWs which was being sold to KenGen for power supply. In this context, GDC had entered into a 25 year steam supply arrangement. In the context of the Menengai geothermal project, GDC had developed steam equivalent to 135MW out of which 105MW was being offered to independent power producers. The company had also acquired 7 drilling rigs that had the capacity to drill up to 35 geothermal wells per year and produce about 175 MW of steam annually.

## 2.6 Theoretical Framework

The theoretical framework was based on the Resource Based View and Dynamic Capabilities Theory.

### 2.6.1 Resource Based View

The Resource Based Based was developed by Birger Wernerfelt in 1984 based on Edith Penrose works. The theory was contained in the book “A Resource Based View of the Firm” by Birger Wernerfelt (Gwendo, 2014). The theory argues that institutions deliver superior resources through the use of resources that is at its disposal. These resources include assets, skills, and diverse capabilities that is within the means of the company to access. The firms must therefore utilize their resources prudently in order to achieve desired organizational performance. The RBV notes that the organizational resources can be divided into the tangible and intangible resources. The tangible resources include resources within the organization that can be observed and touched such as land, plant, buildings, equipment, machines, materials, money, and other capital goods and stocks, debtors and bank deposits (Wafula, 2016). The intangible resources are those resources within the organization that are not physical in nature but are present in the employees of the organization. Examples of intangible resources include human competencies, brand names, customer service, and brand loyalty amongst other factors.

This theory is applicable to this study in the context that the study seeks to examine the factors affecting the performance of Menengai Geothermal Plant. In this context, amongst the resources that the study examined was their influence on the performance of geothermal project is Public Private Partnership (PPP), and technology adopted at GDC. the PPP is an intangible resources that impacts on the technical expertise, assumption of risks, provision of finances, quality of project delivery, costs of project delivery and timelines of project delivery amongst the geothermal project implementation. Similarly, the technology adoption within the GDC is an intangible resource that imparts significantly on the performance of geothermal projects.

### 2.6.2 Dynamic Capabilities Theory

The Dynamic Capabilities Theory is based on the concept of dynamic capabilities. The dynamic capability is defined as the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments. The dynamic capability is the ability for the organization to adapt to the changing environment through adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competencies (Ndung'u, 2014). The dynamic capability is about the reorganization of the available resources and reconfiguring their usage with a view of ensuring that the organization continuously achieves its organizational mandates. Four main aspects are involved in dynamic capabilities theory include reconfiguration, leveraging, learning and integration. The reconfiguration refers to the using the available resources in a different way in order to achieve superior results. The leveraging refers to the use of a resource that is in a given area to a different area in the organization (Ndung'u, 2014). The learning aspect involves the ability of the organization to know on the diverse ways in which resources can be applied while integration involves the institutionalization of the learnt activities. The Dynamic Capabilities Theory is useful in this study since the study examines the aspects of operational costs on performance of the geothermal projects. Within the context of operational costs several aspects that have been examined include  the influence of Training & Development, Wages & Bills, Corporate Social Responsibility, Equipment Purchase, procurement Costs , and Drilling Costs in respect to performance of geothermal project.

## 2.7 Conceptual Framework

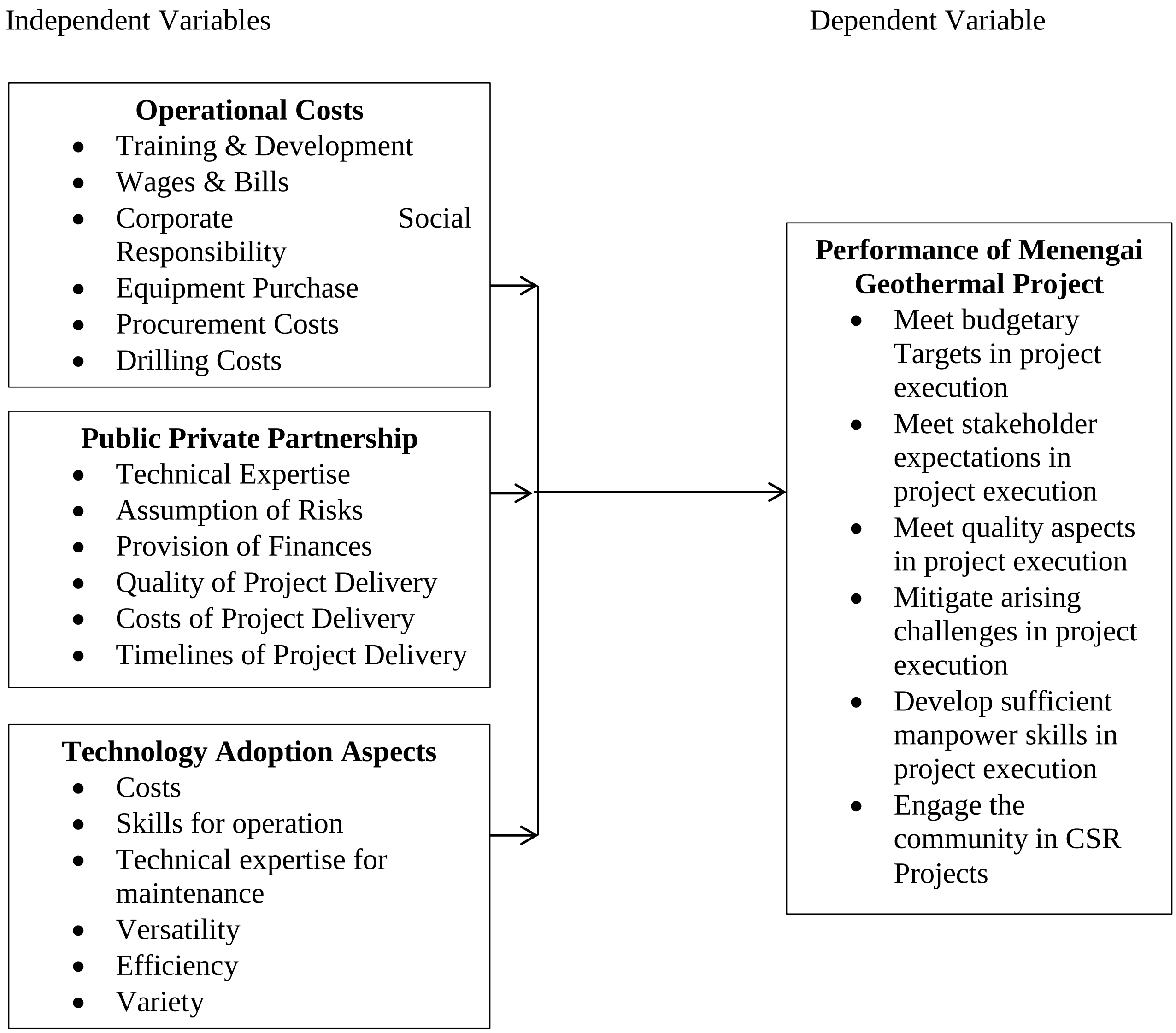


**Figure 1; Conceptual Framework**

## 2.8 Research Gap

Diverse studies have examined GDC as company in respect to diverse aspects. These studies include Irene (2015) who undertook a study on Transport and Dispersion of Hydrogen Sulphide Gas in the Greater Olkaria Geothermal Area. Jerobon (2011) examined the Subsurface Structures and Characterization of the Silali Geothermal System, Kenya Rift. Finally, Mading (2013 examined factors influencing Community

Participation in Geothermal Energy Project Implementation. These studies don't examine the determinants of the performance within geothermal project which is what this study seeks to examine.

## 2.9 Summary of Literature Review

The operational costs play a significant role in the performance of geothermal projects. According to Thorsteinsson (2008), operational costs have an impact on the overall feasibility of a geothermal project. In this context, the financiers of geothermal projects must be in a position to recoup the operational costs from the revenues generated from the systems. Kaptuya (2014) indicated importance of saving costs in geothermal energy projects. In order to cut costs associated with the hiring or leasing of expensive machinery and technical expertise, the GDC has bought its own rigs/machinery (Kathutwa, 2013). Kaptuya (2014) also notes that the GDC also outsources noncore services to external service provider. Siapei (2011) notes that the Geothermal projects often depend on imported machinery in order to execute diverse operational functionalities within the organization. The GDC operational processes also impacts significantly on the community that surrounds their operations through land use, diverse health hazards such as noise and release of harmful gas amongst other aspects (Jerobon, 2011).

According to Hall (2014), the Public Private Partnership PPP ensures faster delivery of infrastructure development compared to government infrastructural development of services, high quality of services delivered through PPP, and lower cost implications for services delivered through PPP systems. The PPP projects enable the government address the funding challenges that may be present in funding of public infrastructure through enabling funds to be diverted to other areas especially for the capital intensive projects. The PPP also distributes any project risks that may be prevalent in infrastructure development. Gebreselassie (2016), notes that the policy, institutional and legal frameworks are critical in PPPs for the purposes of setting the scope of partnership, operational aspects of partnership, mandates of each party in the partnership, chain of command and dispute resolution mechanisms in the project implementation. There are diverse types of PPP partnerships within the context of the infrastructure development including Built-and-Transfer (BT), Build-Lease-and-Transfer (BLT), Build Operate and Transfer (BOT), Build-Own-Operate-and-Transfer (BOOT), and Build-Own-and-Operate (BOO) (Gebreselassie, 2016).

The performance of diverse technologies within the geothermal projects imparts on the performance of the projects. According to Mendoza (2014), the technologies to be utilized on the geothermal energy projects is influenced by diverse considerations including flexibility of technology use; costs of the technology; Scale of energy supply required; Maturity and reliability of the technology; Sophistication of the technology (level of skill required to produce, operate and maintain the technology); cost structure and versatility of technology use. Livesay (2014) in a study on the Future of Geothermal Energy notes that there are three broad technologies that impact on the performance of geothermal projects. These technologies include drilling technologies, power conversion technologies, and reservoir technologies.

The GDC Company was formed in 2008 (hence operationalizing the energy act of 2006) as a special purpose vehicle tasked with the acceleration of the geothermal energy development in Kenya. In this context, the company is charged with exploration, appraisal, production, drilling, steam field development and management. In relations to its organizational mandate, the GDC in 2015 annual report indicated the diverse achievements had been realized in the organization. The GDC had by 2015 developed 59 wells within Olkaria with a steam potential of 412MWs which was being sold to KenGen for power supply. In this context, GDC had entered into a 25 year steam supply arrangement. In the context of the Menengai geothermal project, GDC had developed steam equivalent to 135MW out of which 105MW was being offered to independent power producers. The company had also acquired 7 drilling rigs that had the capacity to drill up to 35 geothermal wells per year and produce about 175 MW of steam annually.

# CHAPTER THREE
# RESEARCH METHODOLOGY

## 3.1 Introduction

The research methodology has been defined as the analysis of how the research will proceed. On the other hand, Kothari (2004) indicates that the research methodology is a way of systematically solving the research problem. Kothari (2004) further notes that the scope of research methodology includes research techniques, the logic behind the research techniques used in the context of the study, and an explanation of the use of particular research technique so that the research results can be independently evaluated by others. Therefore, this chapter therefore explained in detail the diverse choices to be undertaken in relations to research design, sampling procedures, research instruments, validity and reliability aspects, data collection procedures, and data analysis techniques. The chapter also examined the logic on why specific choices in respect to diverse research methodology components

## 3.2 Research Design

The research design refers to the logical sequence that connects the empirical data to a study's initial research questions and ultimately to its conclusions. The descriptive research design was used for this study. The descriptive research design is a design that collects data in order to questions about the current status of the subject or topic of study. The descriptive research design has also been described as a research design that involves the gathering data that describe events and then organizes, tabulates, depicts, and describes the data. Finally, according to Mugenda and Mugenda (2003), the descriptive research design is interested in the description of the study phenomenon as it exists on the ground. There are diverse types of descriptive studies including case studies, observational studies and survey studies. This study used the case study type of descriptive research design. The use of the case study research design enabled an in depth examination of the aspects affecting the performance of geothermal energy from a Menengai Geothermal Project perspective. The gaining of an in-depth understanding of Menengai geothermal project assisted with having exploratory information for the other geothermal projects in Kenya and across the world in relations to factors impacting on their performance

### 3.3 Target Population

The target population refers to a set of well-defined collection of individuals or objects that have a set of similar characteristic(s) that is of interest to the researcher (Sekaran & Bougie, 2011). In this context, the target population of this study was the GDC company employees at Menengai Geothermal Project. The similar characteristic that they share is that they are GDC employees that collectively work in order for GDC to achieve its organizational performance. The aspect of organizational performance of Menengai Geothermal Project is the subject of interest in this study. There are 398 employees currently working at Menengai geothermal project (GDC, 2017).

### 3.4 Sampling Size and Design

Sampling refers to the act of choosing a subset of the target population to be representative of the whole population for the purposes of data collection. The sampling was done in this study because it was costly and logistically impractical to access the 398 employees that work at the Menengai Geothermal Project.

### 3.4.1 Sample Size

The sample size refers to the finite number of people that were selected from the target population in order to constitute a sample for the purposes of data collection. The sample size to be collected should fulfill the requirements of efficiency, representativeness, reliability and flexibility. This study used the formula illustrated by Naissuma (2009) that is;

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$ Where

n = sample size

N =size of target population

C = coefficient of variation (0.5)

*e* = error margin (0.05)

Substituting these values in the equation, estimated sample size (n) was:

$$n = \frac{398\ (0.5^2)}{0.5^2 + (398-1)0.05^2} = \frac{99.5}{1.2425}$$

n =80 respondents

### 3.4.2 Sampling Technique

The sampling design refers to the definite plan that was used for the purposes of obtaining a sample from a given population. It refers to the technique or procedure that the researcher adopted in the selection of items for the sample (Cooper & Schindler, 2008).. The simple random sampling refers to a subset of a statistical population in which each member of the subset has an equal probability of being chosen. The simple random sampling also eliminates any aspect bias in the sampling.

## 3.5 Research Instruments

The data collection method for this research was undertaken through the use of the questionnaires. A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. This research used the structured questionnaires in order to address the specific research objectives. There are reasons on why the structured questionnaires were used for this study. The reasons include the ease of data collection, cost efficiency, and respondents' getting a chance to address the questions exhaustively in their own time. The questionnaire was divided into five subsections. The first subsection was composed of the respondents' bio data. The other four subsections were composed of the variables of the study.

## 3.6 Pilot Study

The pilot study of this research was undertaken. The pilot study or feasibility study refers to a mini version of the full scale study undertaken with a view of evaluating aspects of feasibility, validity and reliability, time aspects, cost aspects, and any adverse effects that might impact on the undertaking of the final study (Upagade & Shende, 2012).. The pilot study of this research was undertaken in Olkaria Geothermal Plant in Naivasha. This was undertaken using 8 respondents which constituted 10% of the sample size. The 10% of the sample size was recommended by Mugenda (2003).

### 3.6.1 Validity of Research Instruments

The validity of the research instrument refers to the degree to which an instrument measures what it is supposed to measure (Kombo & Tromp, 2009). The validity of the research instrument of this study was examined using the content validity. The content validity refers to the extent to which a measure represents all facets of a given construct.

The content validity was tested during the pilot study through the use of experts in the area of performance of the geothermal plants who were employees of Olkaria Geothermal Plant.

### 3.6.2 Reliability of Research Instruments

The reliability of the research instrument refers to the consistency of the results after repeated trials. The study's reliability was measured using the cronbach alpha coefficient. The cronbach alpha coefficient is used to measure the internal consistency of the questionnaire. The cronbach alpha values range from 0 to 1 with a minimum threshold of 0.7 being used in this study as a measure of the item being reliable.

## 3.7 Data Collection Procedures

The data collection procedures refer to the processes that were used for the purposes of collection the data from the field. The researcher first obtained all the necessary authorization letters that is (i) letter from University of Nairobi identifying the purpose of data; (ii) letter from National Commission of Science, Technology and Innovation (NACOSTI) authorizing data collection in a government installation; and (iii) letter from the management of Menengai geothermal project authorizing data collection from the institution. The study used the Drop-Off and Pick-Up (DOPU) method self-administration method of data collection where the questionnaire was dropped to the potential respondents and picked up at a later date. The DOPU method has been proven to increase the response rate which advised its usage in this study. The DOPU method improves on the response rate as the respondents have sufficient time to address the questionnaires. This is because the respondents often want to balance between costs (e.g.

time, opportunity cost compared to other activities, difficulty, etc.) and benefits (e.g. satisfaction).

### 3.8 Data Analysis Techniques

Data analysis is a practice in which raw data is ordered and organized so that useful information can be extracted from it (Orodho, 2003). The collected raw data was taken through diverse processes including editing for the purposes of eliminating any questionnaire that were not completely filled or had identifiers such as names. The data was then coded into the SPSS version 20 software. The coding refers to act of assigning numerical values to the responses for the purposes of simplifying the analysis process. The data was then be analyzed using the descriptive and inferential statistics. The descriptive statistics to be undertaken included aspects such as means, standard deviations and frequency distributions. On the other hand, the inferential statistics to be undertaken included the correlations and multiple linear regression. The regression model used in the study is shown below:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where; Y= Performance of Geothermal Project

$\beta_0$ =constant

$\beta_{1....}\beta 3$ = Coeffeicients of estimates

$X_1$ = Operational Costs

$X_2$ = Public Private Partnerships

$X_3$ = Technological Adoption

And ε is the error term

The hypothesis testing was undertaken through the one way ANOVA in which the individual indicators of the specific variables were regressed against the composite variable of the dependent variable. The p-value  was used for the hypothesis testing of the study in which the null hypothesis was rejected if p-value was less than 0.05 as the hypothesis was tested using 5% level of significance.

## 3.9 Ethical Considerations

The researcher adhered to the ethical consideration of a research as the respondents were advised on the purpose of the study to the respondents and assures them of confidentiality of their responses and identities. The respondents were informed of their rights to voluntarily participate in the study. Consent was sought from the respondents before questionnaires are administered.

### 3.10 Operationalization of Variables

The operationalization of variables was examined using table 3.1**.**

**Table 3.1; Operationalization of Variables**

| **Objective** | **Variable** | **Indicator** | **Measurement** | **Measurement Scale** | **Data Collection Tool** | **Type of Analysis** | **Tool of Analysis** |
|---|---|---|---|---|---|---|---|
| To establish the influence of operational costs on performance of Menengai geothermal project, Kenya | Operational Costs | -Training & Development<br>-Wages & Bills<br>-Corporate Social Responsibility<br>-Equipment Purchase<br>-Procurement Costs<br>-Drilling Costs | -Likert Scale | -Ordinal | Questionnaire | -Descriptive Statistics (mean, frequency distributions, standard deviations)<br>-Inferential Statistics (Regression analysis) | SPSS |
| To examine the influence of public private partnerships on performance of Menengai geothermal project, Kenya | Public Private Partnerships | -Technical Expertise<br>-Assumption of Risks<br>-Provision of Finances<br>-Quality of Project Delivery<br>-Costs of Project Delivery<br>-Timelines of Project Delivery | Likert Scale | -Ordinal | Questionnaire | -Descriptive Statistics (mean, frequency distributions, standard deviations)<br>-Inferential Statistics (Regression analysis) | SPSS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| To examine the influence of Technology Adoption on performance of Menengai geothermal project, Kenya | Technology Adoption | -Costs of the Technology Adopted<br>-Skills required to operate the technology<br>-Technical expertise required to maintain the adopted technology<br>-Versatility of the adopted technology<br>-Efficiency of adopted technology<br>-Variety of technology adopted | Likert Scale | -Ordinal | Questionnaire | -Descriptive Statistics (mean, frequency distributions, standard deviations)<br>-Inferential Statistics (Regression analysis) | SPSS |
| | Performance of Menengai Geothermal Project | -Meet budgetary Targets in project execution<br>-Meet stakeholder expectations in project execution<br>-Meet quality | Likert Scale | -Ordinal | Questionnaire | -Descriptive Statistics (mean, frequency distributions, standard deviations)<br>-Inferential Statistics (Regression | SPSS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | aspects in project execution<br>-Mitigate arising challenges in project execution<br>-Develop sufficient manpower skills in project execution<br>-Engage the community in CSR Projects | | | | analysis) | |

# CHAPTER FOUR

# DATA ANALYSIS, PRESENTATION AND INTERPRETATION

## 4.1 Introduction

This chapter examined the results from the data analysis and the findings from the results. The study was interested in the factors that influence the performance of Menengai Geothermal Project, Kenya. The specific objectives of the study were to examine the influence of operational costs, public private partnerships, and technology adoption on performance of Menengai geothermal project, Kenya.

## 4.1 Response Rate of Respondents

The study covered employees who were currently working at Menengai geothermal project (GDC, 2017) at the time of study. A total of 80 respondents were sampled in the research study. The response rate was as illustrated in Table 4.1.

**Table 4.2; Response Rate of Respondents**

| | Number of Questionnaires | Percentage |
|---|---|---|
| Issued | 80 | 100.0% |
| Collected | 79 | 98.8% |
| No Response | 1 | 1.2% |
| Rejected | 11 | 13.8% |
| Analysed | 68 | 85.0% |
| **Response Rate** | | **85.0%** |

Out of the 80 respondents sampled, 79 respondents responded in the study, representing a 98.8 percent overall response rate. One respondent therefore either refused or was not available to take part in the research study, besides the researcher having informed the respondent about confidentiality and that the study was for an academic purpose. Additionally, the researcher had left the questionnaires to be filled at the comfort of the respondents in regards to privacy and time availability.

The researcher therefore had 79 questionnaires which were taken through the process of data cleaning and editing. 11 questionnaires were rejected during this process as they had been incompletely filled and would therefore give partial data for analysis. Therefore, 68 questionnaires were the ones found to be completely filled and were the basis for the data analysis and results. This therefore gave a response rate of 85.0% which was deemed sufficient for this study.

## 4.2 Respondents' Characteristics

The demographics of gender, department the respondents work in, age, highest education level, and years with the organization served to examine the background characteristics of the respondents in this study.

### 4.2.1 Gender Distribution of Respondents

The gender of the respondents was examined, and results presented in Table 4.2.

**Table 4.3; Distribution by Gender of Respondents**

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 43 | 63.2% |
| Female | 25 | 36.8% |
| **Total** | **68** | **100.0%** |

Among the 68 respondents, most respondents were male (63.2%) and the female respondents were 36.8%.

### 4.2.2 Distribution by Department of Respondents

The study examined the various departments of Menengai geothermal project, Kenya where the respondents worked. The departments included supply chain department, department of environment, department of geology, and department of infrastructure. Also included in the departments were drilling department, and operations/maintenance department. The results are as illustrated in Table 4.3.

**Table 4.4; Distribution by Department of Respondents**

| | Frequency | Percentage |
|---|---|---|
| Supply Chain | 9 | 13.2% |
| Environment | 10 | 14.7% |
| Geology | 12 | 17.6% |
| Infrastructure | 21 | 30.9% |
| Drilling Operations/Maintenance | 16 | 23.5% |
| **Total** | **68** | **100.0%** |

Most of the respondents (30.9%) in this study were from the infrastructure department, followed by those from the operations/maintenance department. The supply chain department had 13.2% of the respondents, department of environment had 14.7% of the respondents, department of geology had 17.6% of the respondents, and the drilling department had 23.5% of the respondents.

### 4.2.3 Distribution by Age of Respondents

The ages of the respondents were examined by grouping the ages into five categories, that is below 25 years, 26-35 years, 36-45 years, 46-55 years, and over 55 years. Results are presented in Table 4.4.

**Table 4.5; Distribution by Age of Respondents**

| | Frequency | Percentage |
|---|---|---|
| Below 25 Years | 22 | 32.4% |
| 26-35 Years | 14 | 20.6% |
| 36-45 Years | 12 | 17.6% |
| 46-55 Years | 12 | 17.6% |
| Over 55 Years | 8 | 11.8% |
| **Total** | **68** | **100.0%** |

Most of the respondents were aged below 25 years (32.4%). The respondents aged from 26-35 years were 20.6%, from 36-45 years were 17.6% same as those who were from 46-55 years (17.6%), while those aged above 55 years were 11.8%.

### 4.2.4 Distribution by Level of education of Respondents

The highest level of education of the respondents was examined as post graduate, graduate, or diploma. The results are as shown in Table 4.5.

**Table 4.6; Distribution by Level of education of Respondents**

| | **Frequency** | **Percentage** |
|---|---|---|
| Post Graduate | 39 | 57.4% |
| Graduate | 20 | 29.4% |
| Diploma | 9 | 13.2% |
| **Total** | **68** | **100.0%** |

Among the 68 respondents, slightly above half of the respondents had post graduate level of education. Those whose highest education level was graduate level were 29.4% and those whose highest level of education was diploma level were 13.2%.

### 4.2.5 Distribution by Years of Service of Respondents at GDC

The study was interested in finding out how long the respondents had worked at Menengai geothermal project, Kenya and results presented in Table 4.6.

**Table 4.7; Distribution by Years of Service of Respondents at GDC**

| | **Frequency** | **Percentage** |
|---|---|---|
| Below a Year | 6 | 8.8% |
| 1-3 Years | 14 | 20.6% |
| 3-5 Years | 18 | 26.5% |
| Over 5 years | 30 | 44.1% |
| **Total** | **68** | **100.0%** |

Most of the respondents (44.1%) had worked at Menengai geothermal project, Kenya for over five years. Few respondents (8.8%) had worked at Menengai geothermal project, Kenya for less than a year. The respondents who had worked at Menengai geothermal project, Kenya for 1-3 years were 20.6% while those who had worked for 3-5 years were 26.5%.

## 4.3 Operational Costs Elements

According to Thorsteinsson (2008) in a study on barriers and enablers of US Geothermal District Heating notes that operational costs has an impact on the overall feasibility of a geothermal project. In this context, the study noted that the financiers of geothermal projects must be in a position to recoup the operational costs from the revenues generated from the systems.

This study examined the operational costs elements that have impacted on the performance of Menengai Geothermal Project, Kenya. This was done by examining the degree to which respondents felt the aspects of training & development, wages & bills, corporate social responsibility, equipment purchase, procurement costs, and drilling costs had impacted on the performance of Menengai Geothermal Project, Kenya. The results of this examination are presented in Table 4.7.

**Table 4.8; Frequency Distributions of operational Costs Elements**

| | VGE Freq. (%) | GE Freq. (%) | AE Freq. (%) | SE Freq. (%) | NE Freq. (%) |
|---|---|---|---|---|---|
| Training & Development | 14 (20.6%) | 32 (47.1%) | 9 (13.2%) | 9 (13.2%) | 4 (5.9%) |
| Wages & Bills | 17 (25.0%) | 28 (41.2%) | 14 (20.6%) | 9 (13.2%) | 0 (0.0%) |
| Corporate Social Responsibility | 13 (19.1%) | 20 (29.4%) | 22 (32.4%) | 9 (13.2%) | 4 (5.9%) |
| Equipment Purchase | 26 (38.2%) | 24 (35.3%) | 14 (20.6%) | 4 (5.9%) | 0 (0.0%) |
| Procurement Costs | 16 (23.5%) | 33 (48.5%) | 12 (17.6%) | 7 (10.3%) | 0 (0.0%) |
| Drilling Costs | 30 44.1% | 19 (27.9%) | 15 (22.1%) | 4 (5.9%) | 0 (0.0%) |

Out of the 68 respondents, 47.1% felt that to a great extent, training & development had influence on the performance of Menengai Geothermal Project, Kenya, and 20.9% felt that it had influence to a very great extent. Wages and bills, equipment purchase and procurement costs all had great influence on the performance of Menengai Geothermal Project, Kenya a cumulative majority of the respondents chose the positive side of the likert scale (great extent and very great extent). That is, a cumulative 66.2% for wages and bills, 73.5% for equipment purchase, and 72.0% for procurement costs. Additionally, only the degree of influence of wages and bills, equipment purchase and procurement costs, varied among the respondents as none of the metrics had a "No Extent" response.

The influence of corporate social responsibility on the performance of Menengai Geothermal Project, Kenya is mostly more than average as 19.1% , 29.4%, 32.4% of the respondents felt that it had influence to a very great extent, great extent and average extent respectively. The extent of influence of drilling costs on the performance of Menengai Geothermal Project, Kenya was very great as affirmed by 44.1% of the respondents, and great as affirmed by 27.9%. The respondents who felt that drilling costs has a small influence and average influence on the performance of Menengai Geothermal Project, Kenya were 5.9% and 22.1% respectively.

On average, mean scores from 1 to 1.49 implied no influence, 1.500 to 2.499 implied a small influence, 2.500 to 3.499 implied average influence, 3.500 to 4.499 implied great influence and 4.500 to 5.000 implied very great influence. The low standard deviations from 0.000 to 0.499 meant there was minimal variance in responses implying high consensus, standard deviations from 0.500 to 0.999 meant there was moderate variation in responses implying moderate consensus, and standard deviations from 1 and above meant there was high variation in responses implying no consensus on a given metric.

The average extent of influence of operational costs elements was examined by using the mean scores of the different metrics on operational costs. The standard deviations were used to examine the variance in responses on the different metrics. These were mean scores and standard deviations of the aspects of training & development, wages & bills, corporate social responsibility, equipment purchase, procurement costs, and drilling costs. The results are as shown in Table 4.8.

**Table 4.9; Means and Standard deviations of Operational Costs Elements**

| | **Mean** | **Std. Dev.** |
|---|---|---|
| Training & Development | 4.102 | 0.949 |
| Wages & Bills | 3.779 | 0.975 |
| Corporate Social Responsibility | 3.632 | 1.132 |
| Equipment Purchase | 3.853 | 0.902 |
| Procurement Costs | 3.427 | 1.124 |
| Drilling Costs | 4.059 | 0.912 |

On average, operational costs elements had great influence on the performance of Menengai Geothermal Project, Kenya as all the metrics had mean scores from 3.500 to 4.499. Training & development had the highest mean therefore the respondents on average believe that it is more influential on the performance of Menengai Geothermal Project, Kenya than the other metrics. This drilling costs (mean=4.059) also influence the performance of Menengai Geothermal Project to a great extent. Smith (2012) in a study on the Potential for Investment in Indonesia's Geothermal Resource collaborated this by noting that the drilling costs dependent on the number and depth of the wells and the geology can account for between 40% and 95% of total costs. This makes the drilling costs to be part of the major costs associated with geothermal projects.

This is also because the drilling costs consume a lot of operational costs in a geothermal project. Mbuthi (2014) in a study on the feasibility and enhanced role of geothermal in Kenya's Energy Supply examined the diverse costs aspects within the context of geothermal projects. He noted that the operational costs include drilling costs that consume a huge part of the operational costs as well as staff related costs. The influence of drilling costs in the context of geothermal projects was also noted by Maina (2013) in a study on Multi-Criteria Suitability Analysis For Optimal Siting Of A Geothermal Well who noted that geothermal drilling costs are expensive. This is because significant costs are expended in the geochemical, geological and geophysical surveys that are required for the drilling to take place.

The wages & bills also influence the performance of Menengai Geothermal Project to a great extent (mean=3.779). Equipment purchase influenced the performance of Menengai Geothermal Project to a great extent (mean score=3.853). Siapei (2011) in a study on Organizational Structure and Strategy Implementation at Geothermal Development Company in Kenya noted that geothermal projects often depend on imported machinery in order to execute diverse operational functionalities within the organization. There are diverse costs that associated with the importation of machinery including costs associated with international tendering inclusive of lawyer and bank fees, and the costs associated with the actual purchases of the items in foreign denominated currencies as well as the logistical costs of machinery movements (Leyiaro, 2015). A study by Kathutwa (2013) noted that in order to cut costs associated with the hiring or leasing of expensive machinery and technical expertise, the GDC has bought its own rigs/machinery.

The performance of Menengai Geothermal Project was influenced to a great extent (mean=3.632) by its corporate social responsibility. This was consistent with Jerobon, (2011) who noted that GDC operational processes also impacts significantly on the community that surrounds their operations through land use, diverse health hazards such as noise and release of harmful gas amongst other aspects. The GDC therefore as a strategy to achieve mutual coexistence platform undertakes community related projects such as hospitals, schools, and provision of water points amongst other functions which costs GDC funds.

The mean score for procurement costs was 3.427 which implied that on average, the respondents felt that procurement costs had an average influence on the performance of Menengai Geothermal Project, Kenya (2.500 to 3.499). The standard deviations for training & development (0.949), wages & bills (0.975), equipment purchase (0.902), and drilling costs (0.912) were from 0.500 to 0.999 which meant there was moderate variance in responses implying moderate consensus on the influence of each of the metrics on the performance of Menengai Geothermal Project, Kenya. The high variance in responses for corporate social responsibility (standard deviation=1.132) and procurement costs (standard deviation=0.912) implied that there was no consensus (standard deviations above 1) on the influence of each of the metrics on the performance of Menengai Geothermal Project, Kenya.

## 4.4 Public Private Partnership Aspects

The Public Private Partnership aspects of this study were examined by getting the perception of the respondents on the extent to which technical expertise, assumption of risks, and provision of finances influence the performance of Menengai Geothermal Project, Kenya. Additionally, in the regards to project delivery, the influence of the quality, costs, and timelines of project delivery were examined. The frequency distributions from this examination are as shown in Table 4.9.

**Table 4.10; Frequency Distributions of Public Private Partnership Aspects**

| | **VGE Freq. (%)** | **GE Freq. (%)** | **AE Freq. (%)** | **SE Freq. (%)** | **NE Freq. (%)** |
|---|---|---|---|---|---|
| Technical Expertise | 28 (41.2%) | 19 (27.9%) | 13 (19.1%) | 8 (11.8%) | 0 (0.0%) |
| Assumption of Risks | 36 (52.9%) | 23 (33.8%) | 8 (11.8%) | 1 (1.5%) | 0 (0.0%) |
| Provision of Finances | 27 (39.7%) | 20 (29.4%) | 16 (23.5%) | 5 (7.4%) | 0 (0.0%) |
| Quality of Project Delivery | 11 (16.2%) | 26 (38.2%) | 16 (23.5%) | 9 (13.2%) | 6 (8.8%) |
| Costs of Project Delivery | 33 (48.5%) | 17 (25.0%) | 12 (17.6%) | 6 (8.8%) | 0 (0.0%) |
| Timelines of Project Delivery | 15 (22.1%) | 32 (47.1%) | 11 (16.2%) | 7 (10.3%) | 3 (4.4%) |

Most of the respondents felt all the Public Private Partnership metrics had an average and more than average influence on the performance of Menengai Geothermal Project, Kenya. This was because there were only few small extent and no extent responses, with the no extent responses being on costs of project delivery alone. Assumption of risks had a very great influence on the performance of Menengai Geothermal Project, Kenya with slightly more than half of the respondents choosing very great extent (52.9%). An additional 33.8% of the respondents felt that the assumption of risks had a great influence on the performance of Menengai Geothermal Project, Kenya (33.8%).

The quality of project delivery has a moderate influence (38.2%=great extent, 23.5%= average extent) on the performance of Menengai Geothermal Project, Kenya. Most of the respondents perceived the performance of Menengai Geothermal Project, Kenya to have been very greatly influenced by technical expertise (41.2%), provision of finances (39.7%), and costs of project delivery (48.5%). The timelines of project delivery have great influence on the performance of Menengai Geothermal Project, Kenya as most of the respondents chose the great extent response on this metric. Further, 22.1% of the respondents felt that the extent of influence of timeline s in project delivery on the performance of Menengai Geothermal Project, Kenya was very great. Those who felt that timelines of project delivery have average and small influence on the performance of Menengai Geothermal Project, Kenya were 16.2% and 10.3**%** respectively.

The average perception of the respondents on the extent to which Public Private Partnership aspects influence the performance of Menengai Geothermal Project, Kenya was examined using the mean scores for technical expertise, assumption of risks, and provision of finances. Additionally, in the regards to project delivery, the average influence of the quality, costs, and timelines of project delivery was examined. The examination of variation in responses was done using the standard deviations of the

Public Private Partnership to show the level of consensus. The standard deviation and mean score results are shown in Table 4.10.

**Table 4.11; Means and Standard Deviations of Public Private Partnerships**

| | Mean | Std. Dev. |
|---|---|---|
| Technical Expertise | 3.985 | 1.044 |
| Assumption of Risks | 4.382 | 0.754 |
| Provision of Finances | 4.015 | 0.970 |
| Quality of Project Delivery | 3.397 | 1.174 |
| Costs of Project Delivery | 4.132 | 1.006 |
| Timelines of Project Delivery | 3.721 | 1.063 |

On average, the respondents felt that the quality of project delivery had an average influence (mean from 2.500 to 3.499) on the performance of Menengai Geothermal Project, Kenya, and had a high variance in responses (mean=3.397, standard deviation=1.174). This high variance in responses implied that there was no consensus (standard deviation above 1) on the extent of influence of the quality of project delivery on the performance of Menengai Geothermal Project, Kenya.

On average, the assumptions of risks and provision of finances had to a great extent influenced the performance of Menengai Geothermal Project, Kenya. This is because they had mean scores from 3.500 to 4.499, that is, 4.382 and 4.015 respectively. The responses had moderate variation which implied there was moderate consensus (standard deviation from 0.500 to 0.999) that the assumptions of risks and provision of finances had an influence on the performance of Menengai Geothermal Project, Kenya. The standard deviation for assumptions of risks was 0.754 while that of provision of finances was 0.970.

In the context of provision of finances, the PPP projects are able to access a diversity of financing options from both the government and the private sector due to the availability of technical expertise to execute the diverse operational aspects of geothermal project. The PPP projects enable the government address the funding challenges that may be present in funding of public infrastructure through enabling funds to be diverted to other areas especially for the capital intensive projects. Examples of institutional help to the GDC are numerous. Geothermal Development Company.,(2015) in its 2015 annual report noted that GDC had received diverse financial help from African Development Bank to develop phase I of Menengai Geothermal. The GDC further received 36 million United States Dollars from European Investment Bank. In the context of assumptions of risks, the PPP distributes any project risks that may be prevalent in infrastructure development. Therefore PPP becomes a mechanism for the distribution of the project risks to diverse parties as well as enhancing efficiency (Elijah, 2010).

Technical expertise, costs of project delivery, and timelines of project delivery each had to a great extent influenced the performance of Menengai Geothermal Project, Kenya. This was because the mean scores for each of the metrics were between 3.500 and 4.499. The mean score for technical expertise was 3.985 which meant thatto a great extent, the technical skills had influenced the performance of Menengai Geothermal Project, Kenya. Gebreselassie (2016), also attested to this by noting that among the factors that influence the success of PPP in any country was the availability of technical expertise to improve on performance of PPP. The party providing the financial capacity is able to trade off with the technical expertise of the other party in the partnership. Amongst the critical technical expertise the private sector often bring to the partnership include the customer service aspects, risk management expertise and financial management skills (Michael, 2016).

The costs of project delivery had to a great extent influenced the performance of Menengai Geothermal Project, Kenya (mean=4.132). This was consistent with Matar & Al-Sa (2013), who noted that PPPs often deliver superior results through mitigating diverse challenges associated with the operational aspects in government services that undermine value for money aspects. The PPP arrangement is able to achieve the lowest whole-of-life service costs due to the private entity operational involvement in a project, which makes the project to be financially viable in the long run. The private entity therefore mostly finances, operates and maintains the asset leading to the minimization of the cost of service delivery over the entire life of the project (Bouma & Berkhout, 2015). The private firm evaluates the financial risks that may be inherent in the project design, construction and maintenance in order to be able to recover their financial investment. The PPPs projects are also often delivered within the projected costs compared to the government funds because of the commercial interest of the private entity (World Bank, 2012). Thus PPP are critical in emphasizing Value for Money focusing on reduced costs, better risk allocation, faster implementation, improved services and possible generation of additional revenue.

Timelines of project delivery had to a great extent influenced the performance of Menengai Geothermal Project, Kenya (mean=3.721) as shown in Table 4.10. According to Hall (2014), the advantages of the PPP include faster delivery of infrastructure development compared to government infrastructural development of services. There was high variation in responses for these metrics which gave high standard deviations. This implied that there was no consensus (standard deviations above 1) on whether the technical expertise (standard deviation=1.044), costs of project delivery (standard deviation=1.006), and timelines of project delivery (standard deviation=1.063), have an influence on the performance of Menengai Geothermal Project, Kenya.

## 4.5 Technology Adoption Aspects

The technological aspects that influence the performance of Menengai Geothermal Project, Kenya were examined by getting the perception of the respondents on the extent of influence of various metrics. These metrics included the costs, efficiency, variety and versatility of the adopted technology. Also, the skills required to operate the adopted technology, and the technical skills required to maintain the adopted technology were examined. The results are presented in Table 4.11.

**Table 4.12; Frequency Distributions of Technology Adoption Aspects**

| | **VGE Freq. (%)** | **GE Freq. (%)** | **AE Freq. (%)** | **SE Freq. (%)** | **NE Freq. (%)** |
|---|---|---|---|---|---|
| Costs of the Technology Adopted | 30 (44.1%) | 24 (35.3%) | 13 (19.1%) | 1 (1.5%) | 0 (0.0%) |
| Skills required to operate the technology | 41 (60.3%) | 19 (27.9%) | 8 (11.8%) | 0 (0.0%) | 0 (0.0%) |
| Technical expertise required to maintain the adopted technology | 37 (54.4%) | 18 (26.5%) | 10 (14.7%) | 3 (4.4%) | 0 (0.0%) |
| Versatility of the adopted technology | 29 (42.6%) | 20 (29.4%) | 15 (22.1%) | 4 (5.9%) | 0 (0.0%) |
| Efficiency of adopted technology | 14 (20.6%) | 32 (47.1%) | 11 (16.2%) | 11 (16.2%) | 0 (0.0%) |
| Variety of technology adopted | 21 (30.9%) | 27 (39.7%) | 20 (29.4%) | 0 (0.0%) | 0 (0.0%) |

There was no respondent who chose the no extent response (0.0%) for any of the metrics on technology adoption. This implied that the respondents felt that each of the metrics had to an extent, an influence on the performance of Menengai Geothermal Project, Kenya. The extent to which the skills required to operate the technology and the variety of technology adopted was beyond small as there was no small extent response on both metrics.

Above half of the respondents felt that the extent of influence of operational skills (60.3%) and technical expertise for maintenance (54.4%) of the adopted technology on the performance of Menengai Geothermal Project, Kenya was very great. Additionally, 27.9% of the respondents felt that the skills required to operate the adopted technology had a great influence on the performance of Menengai Geothermal Project, Kenya, and 11.8% felt the influence was average. Also, 26.5% of the respondents felt that the technical expertise required for maintenance of the adopted technology had a great influence on the performance of Menengai Geothermal Project, Kenya, and 14.7% felt the influence was average. Slightly below half of the respondents felt that costs (44.1%) and versatility (42.6%) of the adopted technology had very great influence on the performance of Menengai Geothermal Project, Kenya. An additional 35.3% felt that costs of the adopted technology had a great influence on the performance of Menengai Geothermal Project, Kenya, as was 26.5% who felt the same on technical skills required to maintain the adopted technology.

The respondents who felt that efficiency of the adopted technology had a very great influence were 20.6% while those who felt the influence was great were the majority (47.1%). The respondents who felt that the efficiency of the adopted technology had an average influence on the performance of Menengai Geothermal Project, Kenya were 22.1%. There was an equal number of average extent and small extent responses on the efficiency of adopted technology. The variety of technology adopted was viewed to have an influence which was very great for 30.9% of the respondents, great for 39.7% of the respondents and average for 29.4% of the respondents.

According to Mendoza (2014), the technologies to be utilized on the geothermal energy projects is influenced by diverse considerations including flexibility of technology use; costs of the technology; Scale of energy supply required; Maturity and reliability of the technology; Sophistication of the technology (level of skill required to produce, operate and maintain the technology); cost structure and versatility of technology use.

**Table 4.13; Means and Standard Deviations of Technology Adoption**

| | Mean | Std. Dev. |
|---|---|---|
| Costs of the Technology Adopted | 4.221 | 0.808 |
| Skills required to operate the technology | 4.485 | 0.702 |
| Technical expertise required to maintain the adopted technology | 4.309 | 0.885 |
| Versatility of the adopted technology | 4.088 | 0.942 |
| Efficiency of adopted technology | 3.721 | 0.975 |
| Variety of technology adopted | 4.015 | 0.782 |

The average influence of adoption of technology on the performance of Menengai Geothermal Project, Kenya was examined by getting the average perception of the respondents on the extent of influence of various metrics. This was done using the means of various aspects of technology adoption. These included mean scores for the costs, efficiency, variety and versatility of the adopted technology. Also, the mean scores for skills required to operate the adopted technology, and the technical skills required to maintain the adopted technology were examined, and results shown in Table 4.12.

All the metrics used to measure the influence of technology adoption on the performance of Menengai Geothermal Project, Kenya were between 3.500 and 4.999. This implied that each metric on technology adoption had to a great extent influenced the performance of Menengai Geothermal Project, Kenya. Additionally, there was moderate consensus (standard deviation from 0.500 to 0.999) on the influence of each metric on the performance of Menengai Geothermal Project as there was moderate variation in responses. Therefore, the skills required to operate the technology (mean=4.485, standard deviation=0.702), and the technical expertise required to maintain the technology (mean=4.309, standard deviation=0.885), had to a great extent influenced the performance of Menengai Geothermal Project.

There was moderate consensus that to a great extent, the costs of the technology adopted had influenced the performance of Menengai Geothermal Project, Kenya (mean=4.221, standard deviation=0.808). This was consistent with Livesay (2014) in a study on the Future of Geothermal Energy who noted that the drilling technologies impact on diverse operational aspects of geothermal energy extraction hence overall geothermal energy production. The drilling technologies utilized will enable the better rock penetrative levels, and better accessibility to deeper and hotter regions hence higher efficiency levels. For example, the drilling-with-casting is a new technology with the potential to reduce the operational costs as it allows longer casting intervals, leading to fewer strings and, therefore, reduced costs. Livesay (2014) further noted that the power conversion technologies impact on the heat-to-power conversion efficiency hence the overall performance of the geothermal performance. The use of the appropriate reservoir technology enables the heat-removal efficiencies in fractured rock systems, will lead to immediate cost reductions by increasing output per well and extending reservoir lifetimes.

The versatility of the adopted technology (mean=4.088, standard deviation=0.942), had to a great extent influenced the performance of Menengai Geothermal Project. According to Mendoza (2014), the technologies to be utilized on the geothermal energy projects is influenced by diverse considerations including flexibility of technology use. Additionally, efficiency of the adopted technology (mean=3.721, standard deviation=0.975) had to a great extent influenced the performance of Menengai Geothermal Project. Thorhallson (2006) notes that new drilling technologies introduced in 2006 enabled the ability to drill to over 200 meters in a day compared to the earlier technologies with capacity of 40-100 meters per day. The variety of technology adopted (mean=4.015, standard deviation=0.782), also had to a great extent influenced the performance of Menengai Geothermal Project. According to Livesay (2014), there are three broad technologies that impact on the performance of geothermal projects. These technologies include drilling technologies, power conversion technologies, and reservoir technologies.

When the means were ranked from the highest mean score to the lowest to get which of the metrics had greater influence than the rest, the skills required to operate the technology ranked first (mean score=4.485). Therefore, the skills required to operate the technology have greater influence on the performance of Menengai Geothermal Project as it was closer to 5.000 (implying influence to a very great extent) than the mean scores for the other metrics.

## 4.6 Menengai Geothermal Project Performance

The performance of Menengai Geothermal Project, Kenya was examined by the extent to which various achievements have been made. The results of this examination are shown in Table 4.13.

**Table 4.14; Menengai Geothermal Project Performance**

| | VGE Freq. (%) | GE Freq. (%) | AE Freq. (%) | SE Freq. (%) | NE Freq. (%) |
|---|---|---|---|---|---|
| Meet budgetary Targets in project execution | 16<br>23.5% | 33<br>48.5% | 12<br>17.6% | 7<br>10.3% | 0<br>0.0% |
| Meet stakeholder expectations in project execution | 13<br>19.1% | 26<br>38.2% | 14<br>20.6% | 15<br>22.1% | 0<br>0.0% |
| Meet quality aspects in project execution | 22<br>32.4% | 27<br>39.7% | 10<br>14.7% | 9<br>13.2% | 0<br>0.0% |
| Mitigate arising challenges in project execution | 16<br>23.5% | 23<br>33.8% | 16<br>23.5% | 13<br>19.1% | 0<br>0.0% |
| Develop sufficient manpower skills in project execution | 35<br>51.5% | 21<br>30.9% | 9<br>13.2% | 3<br>4.4% | 0<br>0.0% |
| Engage the community in CSR Projects | 17<br>25.0% | 41<br>60.3% | 7<br>10.3% | 3<br>4.4% | 0<br>0.0% |

The respondents were asked the extent to which they perceive the budgetary targets in execution of Menengai Geothermal Project, Kenya have been met. Most of the respondents (cumulative 89.6%) felt that the budgetary targets in execution of Menengai

Geothermal Project have on a minimum been met to an average extent. This was because 23.5% chose a very great extent, 48.5% chose great extent, and 17.6% chose average extent. The stakeholder expectations of the Menengai Geothermal Project were perceived to have been met to a great extent by most of the respondents (38.2%). On the other hand, 22.1% of the respondents felt that the stakeholder expectations of Menengai Geothermal Project were only met to a small extent. The quality aspects in execution of Menengai Geothermal Project were met a great extent on a minimum as was the opinion of 32.4% of the respondents who chose very great extent and 39.7% of the respondents who chose great extent responses.

Arising challenges in the execution of Menengai Geothermal Project were mitigated to a great extent (33.8), very great and average extent (each 23.5%), and as small extent (19.1%). The Menengai Geothermal Project has to a very great extent developed sufficient manpower skills in its execution as perceived by slightly more than half of the respondents (51.5%). An additional 30.9% of the respondents felt that the Menengai Geothermal Project has developed sufficient manpower skills in its execution to a great extent (Table 4.13). The Menengai Geothermal Project has engaged the community in CSR Projects to a great extent as perceived by a majority of respondents (60.3%). Additionally, a quarter of the respondents (25.0%) felt that the engagement of Menengai Geothermal Project with the community in CSR projects was to a very great extent.

The average performance of Menengai Geothermal Project, Kenya was examined by the extent to which various achievements have been made. The mean scores for various achievements met in Menengai Geothermal Project execution including budgetary targets, stakeholder expectations, and quality aspects were examined. Additionally, the mean scores for mitigation of arising challenges and development of sufficient manpower skills in the Menengai Geothermal Project execution were examined. The average engagement of Menengai Geothermal Project with the community in CSR projects was examined as well. The mean scores and standard deviations for each metric on performance of Menengai Geothermal Project, Kenya are as shown in Table 4.14.

**Table 4.15; Means and Standard Deviations of Menengai Geothermal Project Performance**

| | **Mean** | **Std. Dev.** |
|---|---|---|
| Meet budgetary Targets in project execution | 3.853 | 0.902 |
| Meet stakeholder expectations in project execution | 3.544 | 1.043 |
| Meet quality aspects in project execution | 3.912 | 1.003 |
| Mitigate arising challenges in project execution | 3.618 | 1.051 |
| Develop sufficient manpower skills in project execution | 4.294 | 0.865 |
| Engage the community in CSR Projects | 4.059 | 0.731 |

The mean scores for each metric on performance of Menengai Geothermal Project, Kenya were between 3.500 and 4.499 as shown in Table 4.14. This implied that on average the respondents felt that Menengai Geothermal Project's performance was great as a result of technology adoption, Public Private Partnerships, and elements of operational costs.

On ranking the mean scores from the highest to the lowest, development of sufficient manpower skills in Menengai Geothermal Project execution scored the highest mean. This implied that the respondents on average felt the extent of influence of technology adoption, Public Private Partnerships, and elements of operational costs in Menengai Geothermal Project execution was great which resulted in sufficient manpower skills development (mean=4.294). The community engagement in CSR projects on average, was influenced to a great extent by elements of operational costs, technology adoption, and Public Private Partnerships (mean=3.544). On average, the Menengai Geothermal Project execution to a great extent met budgetary targets (mean=3.853), stakeholder expectations (mean=3.544), and quality aspects (mean=3.912). Arising challenges in the Menengai Geothermal Project execution to a great extent were mitigated (mean=3.618) by elements of operational costs, technology adoption, and Public Private Partnerships.

There was moderate variation in responses that the Menengai Geothermal Project met budgetary targets (standard deviation=0.902), developed sufficient manpower skills (standard deviation=0.865), and engaged the community in CSR projects (standard deviation=0.731) in its execution. This implied that there was moderate consensus (standard deviations from (0.500 to 0.999) that each of the three metrics had to a great extent been influenced by elements of operational costs, technology adoption, and Public Private Partnerships. There was wide variation in responses that the execution of Menengai Geothermal Project met stakeholder expectations (standard deviation=1.043), mitigated arising challenges (standard deviation=1.003), and developed sufficient manpower skills (standard deviation=1.051). This implied that there was no consensus (standard deviations above 1) on the extent to which each of the three metrics had been influenced by elements of operational costs, technology adoption, and Public Private Partnerships.

## 4.7 Inferential Statistics

The correlation between the independent variables (operational costs, technology adoption, and Public Private Partnerships) was examined using the Pearson’s correlation test. Simple linear regression on each of the independent variables regressed against the dependent variable (performance of Menengai Geothermal Project) was done to get the ANOVA for hypothesis testing. The multiple linear regression was used to examine the combined effect of the independent variables on the dependent variable.

### 4.7.1 Correlation

The correlation between the independent variables (operational costs, technology adoption, and Public Private Partnerships) was examined using the Pearson's correlation test. The results are presented in Table 4.15.

**Table 4.16; Pearson's Correlation**

| | | Operational Costs | Public Private Partnership | Technology Adoption |
|---|---|---|---|---|
| Operational Costs | 1 | .691** | .653** | .647** |
| Public Private Partnership | | 1 | .809** | .819** |
| Technology Adoption | | | 1 | .723** |
| Performance | | | | 1 |

The Pearson's correlation for operational costs and public private partnerships was 0.653. This implies that there is a positive correlation between operational costs and public private partnerships. The Pearson's correlation for operational costs and technology adoption was 0.647. Therefore, there is a positive correlation between operational costs and technology adoption. The Pearson's correlation for public private partnerships and technology adoption was 0.819. A positive correlation therefore exists between public private partnerships and technology adoption.

### 4.7.2 Hypothesis Testing

Simple linear regression was undertaken where each of the independent variables (operational costs, technology adoption, and Public Private Partnerships) was regressed against the dependent variable (performance of Menengai Geothermal Project). The p-value from the ANOVA was used to test the different hypothesis used for this study. A 5% level of significance was used for rejecting the null hypothesis, that is, a p-value of 0.05 ($p<0.05$). The results of the ANOVA for each independent variable are shown in Table 4.16.

**Table 4.17; ANOVA for Operational Costs, Technology Adoption, and PPPs**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Operational Costs | 9.288 | 1 | 9.288 | 47.632 | .000[b] |
| Public Private Partnership | 14.851 | 1 | 14.851 | 134.130 | .000[b] |
| Technology Adoption | 11.585 | 1 | 11.585 | 72.315 | .000[b] |

In this context, the p-values for each of the null hypothesis ($H_{01}$, $H_{02}$, and $H_{03}$) were each 0.000. These p-values were less that 0.05 ($p<0.05$) which made each null hypothesis, that is, operational costs, technology adoption, and Public Private Partnerships have no significant influence on performance of Menengai geothermal project, Kenya (H01, H02, and H03) to be rejected. This implied that operational costs, technology adoption, and Public Private Partnerships each has significant influence on performance of Menengai geothermal project, Kenya. The null hypotheses that were rejected are as below;

**$H_{01}$:** Operational costs have no significant influence on performance of Menengai geothermal project, Kenya

**$H_{02}$:** Public Private Partnerships have no significant influence on performance of Menengai geothermal project, Kenya

**$H_{03}$:** Technology adoption has no significant influence on performance of Menengai geothermal project, Kenya

### 4.7.3 Multiple Linear Regression

The study examined the relationship between the dependent variable with the three independent variables by determining the multiple linear regression. The summary of this model is shown in Table 4.17.

**Table 4.17: Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .830[a] | .689 | .675 | .32788 |

a. Predictors: (Constant), Technology adoption, Operational costs, Public Private Partnership

The multiple correlation coefficient that is, R was of 0.830 indicating that the independent variables, that is, operational costs, Public and Private Partnerships and, technology adoption were positively correlated with the performance of Menengai Geothermal Project, Kenya. The variance in the performance of Menengai Geothermal Project, Kenya from operational costs, Public and Private Partnerships, and technology adoption was examined using the coefficient of determination (denoted as R2).

The multiple regression analysis in this study gave a coefficient of determination of 0.689. This implied that 68.9% of the variance in the performance of Menengai Geothermal Project, Kenya can be accounted for up to 68.9% by the independent variables (operational costs, Public and Private Partnerships, and technology adoption). This therefore implies that other factors which were not considered in this multiple regression model account for 31.1% of the variance in the performance of Menengai Geothermal Project, Kenya.

The analysis of variance (ANOVA) was undertaken with an aim of determining whether the multiple regression model with operational costs, Public and Private Partnerships, and technology adoption as the independent variables, and the performance of Menengai Geothermal Project, Kenya as the dependent variable was viable. This was done by testing the model on a 5% level of significance (0.05). The threshold for viability of the model was therefore a p-value less than 0.05 ($p<0.05$). The results from the ANOVA are presented in Table 4.18.

**Table 4.18: ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 15.278 | 3 | 5.093 | 47.368 | .000[b] |
| | Residual | 6.881 | 64 | .108 | | |
| | Total | 22.158 | 67 | | | |

a. Dependent Variable: Performance

b. Predictors: (Constant), Technology Adoption, Operational Costs, Public Private Partnership

The p-value from the ANOVA was 0.000 indicating there was no probability or likelihood of the multiple regression model giving a wrong prediction (0.0%). This p-value of 0.000 attained the threshold requirement for viability as it was less than 0.05, therefore the multiple regression with operational costs, Public and Private Partnerships, and technology adoption as the independent variables, and the performance of Menengai Geothermal Project, Kenya as the dependent variable was said to be reliable.

The coefficients of the individual independent variables (operational costs, Public and Private Partnerships, and technology adoption) were examined and results presented in Table 4.19.

**Table 4.19: Coefficients[a]**

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | | | |
| (Constant) | .347 | .314 | | 1.102 | .275 |
| Operational Costs | .139 | .104 | .132 | 1.331 | .188 |
| Public Private Partnership | .618 | .128 | .615 | 4.826 | .000 |
| Technology Adoption | .137 | .119 | .140 | 1.152 | .253 |

a. Dependent Variable: Performance

The resulting regression model was;

Performance of Menengai Geothermal Project = 0.347 + 0.139 (Operational Costs) + 0.618 (Public and Private Partnerships) + 0.137 (Technology Adoption)

This regression model indicates that a unit increase in operational costs while other factors are held constant would result in a 0.139 increase in performance of Menengai geothermal project, Kenya. Additionally, a unit increase in public and private partnerships would result in a 0.618 increase in performance of Menengai geothermal project, Kenya with the other metrics held constant. A unit increase in technology adoption would result in a 0.137 increase in performance of Menengai geothermal project, Kenya with the other metrics held constant. This implies that operational costs, Public and Private Partnerships, and technology adoption positively influence the performance of Menengai geothermal project, Kenya individually.

# CHAPTER FIVE

# SUMMARY OF FINDINGS, DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

## 5.1 Introduction

The study was interested in the factors that influence the performance of Menengai Geothermal Project, Kenya. The specific objectives of the study were to examine the influence of operational costs, public private partnerships, and technology adoption on performance of Menengai geothermal project, Kenya. The responses of 68 respondents who were employees who were currently working at Menengai geothermal project (GDC, 2017) at the time of study were used for purposes of data analysis. Most of the respondents were male (63.2%) and the female respondents were 36.8%. Most of the 68 respondents in this study were from the infrastructure department (30.9%), followed by those from the operations/maintenance department.

The supply chain department had 13.2% of the respondents, department of environment had 14.7% of the respondents, department of geology had 17.6% of the respondents, and the drilling department had 23.5% of the respondents. Most of the respondents were aged below 25 years (32.4%). The respondents aged between 26-35 years were 20.6%, between 36-45 years were 17.6% same as those who were between 46-55 years (17.6%), while those aged above 55 years were 11.8%.

Among the 68 respondents, slightly above half of the respondents had post graduate level of education. Those whose highest education level was graduate level were 29.4% and those whose highest level of education was diploma level were 13.2%. The study was interested in finding out how long the respondents had worked at Menengai geothermal project, Kenya. Most of the respondents (44.1%) had worked at Menengai geothermal project, Kenya for over five years. Few respondents (8.8%) had worked at Menengai geothermal project, Kenya for less than a year. The respondents who had worked at Menengai geothermal project, Kenya for 1-3 years were 20.6% while those who had worked for 3-5 years were 26.5%.

## 5.2 Summary of Findings

The summary of the study was examined using the specific research objectives;

### 5.2.1 Operational Costs Elements

The average extent of influence of operational costs elements was examined by using the mean scores of the different metrics on operational costs. These were mean scores of the aspects of training & development, wages & bills, corporate social responsibility, equipment purchase, procurement costs, and drilling costs. On average, operational costs elements had great influence on the performance of Menengai Geothermal Project, Kenya as all the metrics had mean scores from 3.500 to 4.499.

Training & development had the highest mean therefore the respondents on average believe that it is more influential on the performance of Menengai Geothermal Project, Kenya than the other metrics. This was followed by drilling costs, equipment purchase, wages & bills, and corporate social responsibility. The mean score for procurement costs was 3.427 which implied that on average, the respondents felt that procurement costs had an average influence on the performance of Menengai Geothermal Project, Kenya (2.500

to 3.499). The standard deviations for training & development, wages & bills, equipment purchase, and drilling costs were from 0.500 to 0.999 which meant there was moderate variance in responses implying moderate consensus on the influence of each of the metrics on the performance of Menengai Geothermal Project, Kenya. The high variance in responses for corporate social responsibility and procurement costs implied that there was no consensus (standard deviations above 1) on the influence of each of the metrics on the performance of Menengai Geothermal Project, Kenya.

### 5.2.2 Public Private Partnerships

The average perception of the respondents on the extent to which Public Private Partnership aspects influence the performance of Menengai Geothermal Project, Kenya was examined using the mean scores for technical expertise, assumption of risks, and provision of finances. Additionally, in the regards to project delivery, the average influence of the quality, costs, and timelines of project delivery was examined. The examination of variation in responses was done using the standard deviations of the Public Private Partnership to show the level of consensus.

On average, the respondents felt that the quality of project delivery had an average influence (mean from 2.500 to 3.499) on the performance of Menengai Geothermal Project, Kenya. There was a high variance in responses (mean=3.397, standard deviation=1.174) on the influence of quality of project delivery. This high variance in responses implied that there was no consensus (standard deviation above 1) on the extent of influence of the quality of project delivery on the performance of Menengai Geothermal Project, Kenya. On average, the assumptions of risks and provision of finances had to a great extent influenced the performance of Menengai Geothermal Project, Kenya (mean scores from 3.500 to 4.499). The responses had moderate variation which implied there was moderate consensus (standard deviation from 0.500 to 0.999) that the assumptions of risks and provision of finances had an influence on the performance of Menengai Geothermal Project, Kenya.

Technical expertise, costs of project delivery, and timelines of project delivery each had to a great extent influenced the performance of Menengai Geothermal Project, Kenya. This was because the mean scores for each of the metrics were between 3.500 and 4.499. There was high variation in responses for these metrics which gave high standard deviations. This implied that there was no consensus (standard deviations above 1) on whether the technical expertise, costs of project delivery, and timelines of project delivery have an influence on the performance of Menengai Geothermal Project, Kenya.

### 5.2.3 Technology Adoption Aspects

The average influence of adoption of technology on the performance of Menengai Geothermal Project, Kenya was examined by getting the average perception of the respondents on the extent of influence of various metrics. This was done using the means of various metrics on technology adoption. These included mean scores for the costs, efficiency, variety and versatility of the adopted technology. Also, the mean scores for skills required to operate the adopted technology, and the technical skills required to maintain the adopted technology were examined.

All the metrics used to measure the influence of technology adoption on the performance of Menengai Geothermal Project, Kenya were between 3.500 and 4.999. This implied that each metric on technology adoption had to a great extent influenced the performance of Menengai Geothermal Project, Kenya. Additionally, there was moderate consensus (standard deviation from 0.500 to 0.999) on the influence each metric on the performance of Menengai Geothermal Project as there was moderate variation in responses. Therefore, the costs of the technology adopted, skills required to operate the technology, and the technical expertise required to maintain the technology had to a great extent influenced the performance of Menengai Geothermal Project. Additionally, the versatility of the adopted technology, efficiency of the adopted technology, and variety of technology adopted, had to a great extent influenced the performance of Menengai Geothermal Project. The skills required to operate the technology have greater influence on the performance of Menengai Geothermal Project its mean score (4.485) was closer to 5.000 (implying influence to a very great extent) than the mean scores of the other metrics.

### 5.2.4 Menengai Geothermal Project Performance

The average performance of Menengai Geothermal Project, Kenya was examined by the extent to which various achievements have been made. The mean scores for various achievements met in Menengai Geothermal Project execution including budgetary targets, stakeholder expectations, and quality aspects were examined. Additionally, the mean scores for mitigation of arising challenges and development of sufficient manpower skills in the Menengai Geothermal Project execution were examined. The average engagement of Menengai Geothermal Project with the community in CSR projects was also examined.

The mean scores for each metric on performance of Menengai Geothermal Project, Kenya were between 3.500 and 4.499. This implied that on average the respondents felt that Menengai Geothermal Project's performance was great as a result of technology adoption, Public Private Partnerships, and elements of operational costs. On ranking the mean scores from the highest to the lowest, development of sufficient manpower skills in Menengai Geothermal Project execution scored the highest mean. This implied that the respondents on average felt the extent of influence of technology adoption, Public Private Partnerships, and elements of operational costs in Menengai Geothermal Project execution was great which resulted in sufficient manpower skills development (mean=4.294). The community engagement in CSR projects on average was influenced to a great extent by elements of operational costs, technology adoption, and Public Private Partnerships. On average, the Menengai Geothermal Project execution to a great extent met budgetary targets, stakeholder expectations, and quality aspects. Arising challenges in the Menengai Geothermal Project execution to a great extent were mitigated by elements of operational costs, technology adoption, and Public Private Partnerships.

There was moderate variation in responses that the Menengai Geothermal Project met budgetary targets, developed sufficient manpower skills, and engaged the community in CSR projects in its execution. This implied that there was moderate consensus (standard deviations from (0.500 to 0.999) that each of the three metrics had to a great extent been influenced by elements of operational costs, technology adoption, and Public Private Partnerships. There was wide variation in responses that the execution of Menengai

Geothermal Project met stakeholder expectations, mitigated arising challenges, and developed sufficient manpower skills. This implied that there was no consensus (standard deviations above 1) on the extent to which each of the three metrics had been influenced by elements of operational costs, technology adoption, and Public Private Partnerships.

## 5.3 Discussion

Training and development was found to have a huge impact on the performance of the geothermal projects at Menengai. Training is critical in enhancing and passing critical skills and competences amongst the employees. Other critical aspects impacting on the performance of geothermal projects include drilling costs and equipment purchase. Drilling costs are critical to the performance of the geothermal energy projects due to the explorative nature of geothermal energy project works. The private public partnership is critical in the performance of geothermal energy projects at Menengai. Additionally, in the regards to project delivery, the average influence of the quality, costs, and timelines of project delivery was examined. The examination of variation in responses was done using the standard deviations of the Public Private Partnership to show the level of consensus. Technical expertise, costs of project delivery, and timelines of project delivery each had to a great extent influenced the performance of Menengai Geothermal Project, Kenya. There was high variation in responses for these metrics which gave high standard deviations. The versatility of the adopted technology, efficiency of the adopted technology, and variety of technology adopted, had to a great extent influenced the performance of Menengai Geothermal Project.

## 5.4 Conclusion

The study concluded that operational costs have a significant influence on performance of Menengai geothermal project, Kenya. The study also concluded that the performance of Menengai geothermal project, Kenya is significantly influenced by Public Private Partnerships. Additionally, the study concluded that technology adoption has a significant influence on performance of Menengai geothermal project, Kenya.

## 5.5 Recommendations

As a result of high variation in responses on various factors influencing the performance of Menengai Geothermal Project, Kenya, various recommendations were made. The recommendations if properly adhered will enhance the performance of Menengai Geothermal Project and GDC on a broader perspective.

The study recommends that funds used for corporate social responsibility, and the procurement costs should be minimized and the funds diverted to capital intensive areas. This will enhance the recovery of the financial investment from the revenues generated from the systems.

Additionally, arising challenges in project execution should be mitigated and solutions to the challenges found fast. This will improve on the timelines of project delivery and reduce costs of project delivery.

Finally, the study recommends that Public and Private Partnerships be encouraged more. This is because the project risks are distributed to diverse parties which enhance infrastructure development thus improving on the quality and timelines of project delivery.

## 5.6 Recommendations for Further Research

The study confined itself to the geothermal energy projects in Kenya. This research therefore should be replicated in all energy sector projects and also establish the effect of technology adoption on the performance of these organisations. Further research can be undertaken to test whether the quality aspects in project execution influences stakeholder commitment to finance the project.

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## APPENDIX A

## LETTER OF INTRODUCTION

Dear Participant,

My name is Amos Lepatei, currently undertaking a Masters of Arts in Project Planning and Management at the University Of Nairobi. You have been has been selected as part of the study entitled **"Factors Influencing the Performance of Geothermal Energy Projects: A Case of Menengai Geothermal Project, Kenya".** I am inviting you to participate in the research by completing the attached questionnaire.

The questionnaire will not take more than 20 minutes. The information that you will share with me will not be discussed or accessed by any other person apart from the researcher and the people directly involved in the project. Your participation is voluntary and you can withdraw at any time without penalty. Your answers will be kept confidential. There will be no financial compensation for participating in this study. The outcome of this research may be used for academic and general purposes such as research reports, conference papers, or books. By completing the questionnaire, you indicate that you voluntarily participate in this research.

Yours Faithfully,

Amos Lepatei

## APPENDIX B

## FACTORS INFLUENCING THE PERFORMANCE OF GEOTHERMAL ENERGY PROJECTS: A CASE OF MENENGAI GEOTHERMAL PROJECT, KENYA

## QUESTIONNAIRE

**Instructions:** Please complete the following questionnaire appropriately.

**Confidentiality:** The responses you provide will be strictly confidential. No reference will be made to any individual(s) in the report of the study.

Please tick or answer appropriately for each of the Question provided.

### SECTION I: RESPONDENTS' CHARACTERISTICS

| | | | |
|---|---|---|---|
| 1) | What is your Gender? | Male | [ ] |
| | | Female | [ ] |
| 2) | Which department do you work for? | Supply Chain | [ ] |
| | | Environment | [ ] |
| | | Geology | [ ] |
| | | Infrastructure | [ ] |
| | | Drilling Operations/Maintenance | [ ] |
| | | Central Workshop | [ ] |
| 3) | What is your age bracket? | Below 25 Years | [ ] |
| | | 26-35 Years | [ ] |
| | | 36-45 Years | [ ] |
| | | 46-55 Years | [ ] |
| | | Over 55 Years | [ ] |
| 4) | What is your highest education level? | Post Graduate | [ ] |
| | | Graduate Level | [ ] |
| | | Diploma Level | [ ] |
| 5) | How long have you worked at GDC? | Below a year | [ ] |

1-3 Years [ ]

3-5 Years [ ]

Over 5 Years [ ]

**SECTION II; OPERATIONAL COSTS**

Using the given scale below to which extent would you say the stated aspects have impacted on the performance of Menengai Geothermal Project?

1. No Extent 2. Small Extent 3. Average Extent. 4. Great Extent 5. Very Great Extent

| | Operational Costs Elements | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 6) | Training & Development | | | | | |
| 7) | Wages & Bills | | | | | |
| 8) | Corporate Social Responsibility | | | | | |
| 9) | Equipment Purchase | | | | | |
| 10) | Procurement Costs | | | | | |
| 11) | Drilling Costs | | | | | |

**SECTION III; PUBLIC PRIVATE PARTNERSHIP**

Using the given scale below to which extent would you say the stated PPP have impacted on the performance of Menengai Geothermal Project?

1. No Extent 2. Small Extent 3. Average Extent. 4. Great Extent 5. Very Great Extent

| | Public Private Partnership Aspects | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| 12) | Technical Expertise | | | | | |
| 13) | Assumption of Risks | | | | | |
| 14) | Provision of Finances | | | | | |
| 15) | Quality of Project Delivery | | | | | |
| 16) | Costs of Project Delivery | | | | | |
| 17) | Timelines of Project Delivery | | | | | |

**SECTION IV; TECHNOLOGY ADOPTION**

Using the given scale below to which extent would you say the stated technology adoption have impacted on the performance of Menengai Geothermal Project?

1. No Extent 2. Small Extent 3. Average Extent. 4. Great Extent 5. Very Great Extent

| | **Technology Adoption Aspects** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| 18) | Costs of the Technology Adopted | | | | | |
| 19) | Skills required to operate the technology | | | | | |
| 20) | Technical expertise required to maintain the adopted technology | | | | | |
| 21) | Versatility of the adopted technology | | | | | |
| 22) | Efficiency of adopted technology | | | | | |
| 23) | Variety of technology adopted | | | | | |

**SECTION V; PERFORMANCE OF MENENGAI GEOTHERMAL**

To what extent has Menengai Geothermal Project achieved the following performance metrics;

1. No Extent 2. Small Extent 3. Average Extent. 4. Great Extent 5. Very Great Extent

| | **Menengai Geothermal Performance** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| 24) | Meet budgetary Targets in project execution | | | | | |
| 25) | Meet stakeholder expectations in project execution | | | | | |
| 26) | Meet quality aspects in project execution | | | | | |
| 27) | Mitigate arising challenges in project execution | | | | | |
| 28) | Develop sufficient manpower skills in project execution | | | | | |
| 29) | Engage the community in CSR Projects | | | | | |

## APPENDIX C

## UNIVERSITY OF NAIROBI AUTHORIZATION LETTER

**UNIVERSITY OF NAIROBI**
**Open, Distance & e-Learning Campus**
**SCHOOL OF OPEN AND DISTANCE LEARNING**
**DEPARTMENT OF OPEN AND DISTANCE LEARNING**
NAKURU LEARNING CENTRE

Tel 051 – 2210863
***Our Ref:*** *UoN/ODeL/NKRLC/1/12*

P. O Box 1120, Nakuru
*26th* May 2017

### To whom it may concern:

**RE: AMOS LEPATEI L50/84951/2016**

The above named is a student of the University of Nairobi at Nakuru Extra-Mural Centre Pursuing Masters degree in Project Planning and Management.

Part of the course requirement is that students must undertake a research project during their course of study. He has now been released to undertake the same and has identified your institution for the purpose of data collection on "Factors Influencing the Performance of Geothermal of Energy Project," A case of Menengai Geothermal Project. Kenya.

For that reason, I am writing this, requesting you to assist him.

Yours Faithfully,

NAKURU EXTRA-MURAL CENTRE
RESIDENT LECTURER
P.O. Box 1120
NAKURU
UNIVERSITY OF NAIROBI

Mumo Mueke
Centre Coordinator
Nakuru Learning Centre

**APPENDIX D**

**NACOSTI AUTHORIZATION**

**NATIONAL COMMISSION FORSCIENCE, TECHNOLOGY ANDINNOVATION**

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9[th]Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/43010/17886**

Date: **12th July, 2017**

Amos Melonyie Lepatei
University of Nairobi
P.O. Box 30197-00100
**NAIROBI.**

**RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on ***"Factors influencing the performance of geothermal energy project. Case of Menengai Geothermal Project-Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for the period ending **12th July, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Nakuru County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

**GODFREY P. KALERWA MSc., MBA, MKIM**
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner
Nakuru County.

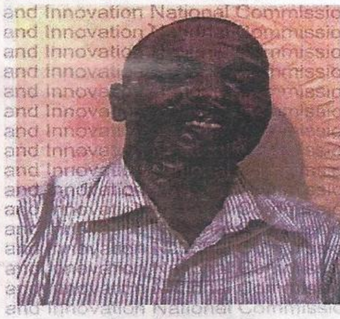
The County Director of Education
Nakuru County.

**THIS IS TO CERTIFY THAT:**
***MR. AMOS MELONYIE LEPATEI***
**of UNIVERSITY OF NAIROBI, 0-20100 NAKURU,has been permitted to conduct research in *Nakuru County***

**on the topic: *FACTORS INFLUENCING THE PERFORMANCE OF GEOTHERMAL ENERGY PROJECT.CASE OF MENENGAI GEOTHERMAL PROJECT-KENYA.***

**for the period ending:**
***12th July,2018***

**Permit No : NACOSTI/P/17/43010/17886**
**Date Of Issue : 12th July,2017**
**Fee Recieved :ksh 1000**



.............................
***Applicant's Signature***

.............................
***Director General***
***National Commission for Science Technology & Innovation***

## CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

**REPUBLIC OF KENYA**

**National Commission for Science, Technology and Innovation**

**RESEARCH CLEARANCE PERMIT**

**Serial No.A 14903**

**CONDITIONS: see back page**

**APPENDIX E**

**COUNTY GOVERNMENT AUTHORIZATION**

THE PRESIDENCY
MINISTRY OF INTERIOR AND
CO-ORDINATION OF NATIONAL GOVERNMENT

Telegrams:" DISTRICTER", Nakuru
Telephone: Nakuru 051-2212515
When replying please quote

COUNTY COMMISSIONER
NAKURU COUNTY
P.O. BOX 81
NAKURU

Ref. No. ***CC.SR.EDU 12/1/2 VOL.II/224***

**21st July, 2017**

**TO WHOM IT MAY CONCERN**

**RE: RESEARCH AUTHORIZATION – AMOS MELONYIE LEPATEI**

The above named student has been given permission to carry out research on ***"Factors influencing the performance of geothermal energy project. Case of Menengai Geothermal Project-Kenya"*** in Nakuru County for the period ending **12th July, 2018**.

Please accord him all the necessary support to facilitate the success of his research.

**JUDITH A. ONYANGO**
**FOR: COUNTY COMMISSIONER**
**NAKURU COUNTY**

# APPENDIX F

# MINISTRY OF EDUCATION AUTHORIZATION

**MINISTRY OF EDUCATION**
**State Department of Basic Education**

Telegrams: **"EDUCATION",**
Telephone: **051-2216917**
Fax: **051-2217308**
Email: **cdenakurucounty@yahoo.com**
When replying please quote
Ref. NO.
**CDE/NKU/GEN/4/1/21/VOL.V/102**

**COUNTY DIRECTOR OF EDUCATION**
**NAKURU COUNTY**
**P. O. BOX 259,**
**NAKURU.**

**21st July, 2017**

TO WHOM IT MAY CONCERN

**RE: RESEARCH AUTHORIZATION – AMOS MELONIE LEPATEI**
**PERMIT NO. NACOSTI/P/17/43010/17886**

Reference is made to letter NACOSTI/P/17/43010/17886 dated 12th July, 2017.

Authority is hereby granted to the above named to carry out research on **"Factors influencing the performance of geothermal energy project. Case of Menengai Geothermal Project-Kenya, Nakuru County,"** for a period ending 12th July, 2018.

Kindly accord him the necessary assistance.

**AKOKO OKAYO**
**FOR: COUNTY DIRECTOR OF EDUCATION**
**NAKURU COUNTY**

**Copy to:**

University of Nairobi
P. O. Box 30197-00100
**NAIROBI**

## APPENDIX G
## PLAGIARISM PAGE 1

Turnitin Originality Report

FACTORS INFLUENCING THE PERFORMANCE OF GEOTHERMAL ENERGY PROJECTS: A CASE OF MENENGAI GEOTHERMAL PROJECT, KENYA by Amos Lepatei

From FACTORS INFLUENCING THE PERFORMANCE OF GEOTHERMAL ENERGY PROJECTS: A CASE OF MENENGAI GEOTHERMAL PROJECT, KENYA (Innovative resources)

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## PLAGIARISM PAGE 2

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