FACTORS INFLUENCING TIMELY COMPLETION OF GEOTHERMAL WELLS; A CASE OF MENENGAI GEOTHERMAL PROSPECTS SITE IN NAKURU COUNTY, KENYA

BY

NGIGI ANTHONY NG'ANG'A

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DECLARATION

This is to certify that, this research project report is my original work and has never been presented in any other institution of learning for any academic award.

NGIGI ANTHONY NG'ANG'A

DATE

REG.NO.L50/71682/2011

DECLARATION BY THE SUPERVISOR

This research project report has been submitted for examination with my approval as the appointed university supervisor.

PROF. CHRISTOPHER MWANGI GAKUU DATE

Department of Extra Mural Studies

University of Nairobi

DEDICATION

To my dad Benjamin Ngigi and grandfather Ng'ang'a Njini for instilling the importance of higher education and to my wife Catherine and daughter Khloe for their moral support for the last 2 years when this journey began and specially to my late mum Catherine Wambui Ngugi.

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GDC:	Geothermal Development Company
GIA:	Geothermal Implementation Authority
GWh:	Gigawatt hours
IEA:	International Energy Agency
KNCST	Kenya National Council of Science and Technology
KWh:	Kilowatt hours
Mtoe:	Megatons in oil energy
SPSS	Statistical Package for Social Scientists
UON	University of Nairobi

ABSTRACT

Geothermal energy is present everywhere on earth because temperature increases with depth and is one of the few renewable energy resources that can provide continuous power with minimal visual and other environmental impacts. Geothermal systems have a small footprint and comparatively less carbon dioxide emissions. Geothermal power is a potential major source of power in Kenya; The Kenyan government with aid of donors has taken deliberate steps towards harnessing this power in line with the development goals and vision 2030. While executing the plans time is of great importance and the drilling of geothermal wells in Menengai Geothermal Prospects has been falling behind schedule significantly, thus threatening the time value of the goals. This study researched on the factors influencing timely completion of geothermal wells in Menengai Geothermal Prospect Site in Nakuru. The objective of this research was to establish the extent to which human factors, procurement process and maintenance of the rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. Literature relating to the factors under study was sort and a further comparison of operations on a drilling rig and a mechanized manufacturing plant was made especially in areas of human operations and maintenance of equipment. A survey was conducted on the employees of GDC working at the geothermal site at Menengai Crater where purposive sampling design was used to select 112 respondents. Questionnaires were used to collect the data which was analysed using Statistical Packages for Social Scientists (SPSS) and presented in a tabular summaries form. Correlation was used in establishing relationship between selected variables and chi-square tests were employed in rejecting or failing to reject hypotheses stated. The study revealed that human factors and maintenance of rig and equipment did not have significant influence on timely completion of geothermal wells in Menengai Geothermal Prospects Site. In addition procurement process influenced very much timely completion of geothermal wells in Menengai Geothermal Prospects Site. Furthermore, formation characteristics may have significant influence on the timely completion of geothermal wells. The researcher recommends a further scientific study on the influence of formation characteristics on timely completion of geothermal wells in Menengai Geothermal Prospects Site as the respondents felt there was a significant influence. The results of this study will be important to the Kenyan Government and Geothermal Development Company (GDC) as they strive towards providing cost effective and affordable energy with the aim of fulfilling vision 2030 and also to the donors who have come on board to support the exploration and development of geothermal energy in Menengai Geothermal Prospects. Furthermore this study will provide literature for scholars for future studies.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study.

Geothermal development for electricity generation and direct use has experienced a high growth rate worldwide for the past few years and future prospects continue to look very positive. Geothermal is a significant global renewable energy resource, with many valuable characteristics, including its: extensive global distribution, environmentally friendly character, independence of season, immunity from weather effects, indigenous nature, contribution to development of diversified power, effectiveness for distributed application, sustainable development capabilities and small areal foot-print (IEA, 2012) . Geothermal resources have the potential to make a considerable contribution towards meeting the world‘s current and future energy needs well into the future, while contributing to the reduction of emissions and the mitigation of climate change. The global geothermal potential is enormous; however, attaining their maximum deployment requires continued research and development.

In 2010, worldwide geothermal data was comprehensively updated for reporting at the World Geothermal Congress 2010, held on 25-29 April 2010, in Bali, Indonesia (Bertani, 2010). Twenty-four countries were producing electricity from geothermal resources, with a total geothermal installed capacity exceeding 10,892 MW(megawatts), with electricity generation of 66,184.1 GWh, based on 2010 data (Bertani, 2010).

According to IEA Geothermal Implementation Authority (GIA) geothermal generation of 39,969.3 GWh/yr is equivalent to a savings of about 10.1Mtoe (Million tonnes of oil equivalent) (using GIA conversion (Mongillo, 2005)) and avoided CO_2 emissions of 32.78 Mt (mega tonne). The equivalent savings for the worldwide total generation of 66,184.1 GWh/yr is about 16.8 Mtoe and avoided CO2 emissions of some 54.1 Mt (Mongillo, 2005).

Every part of the world has potential for geothermal though factors like individual conditions of each geothermal system, cost of exploration and return on investment varies a lot from one place to the next due to geographic profile of the earth’s surface. Kenya’s geographical peculiarities have endowed her with vast geothermal resources. Kenya is only second to New Zealand, but falls far behind in the exploration of the same.

In Kenya geothermal exploration and development is undertaken by Geothermal Development Company (GDC). GDC is a parastatal under the ministry of energy formed to fast track the development of geothermal resources in Kenya. The vision of the company is to be the world leader in development of geothermal resources. The company's mission is to develop 5000MW by year 2030. To put itself in line with this mandate GDC is charged with provision of services to the satisfaction of its stakeholders, among them is drilling and supervision of geothermal wells. GDC was entrusted to develop Menengai Geothermal Prospects after successful exploration results showed a potential of more than 1000MW. The company procured drilling rigs to undertake the drilling process. Up to date the company has four operational drilling rigs on site.

Grace R. D et al. (2008) suggest that for any drilling venture in oil and gas to succeed proper planning has to be done and by so doing operations will be optimized and at the same time minimize expenditures. More drilling time escalates the drilling cost of a well. Drilling a geothermal well takes a similar procedure as drilling a well in oil and gas with the only difference being the resource being exploited.

The first well to be drilled in Menengai began in February 2011; up to date several wells have been drilled and completed successfully and they have shown remarkable potential to produce geothermal energy. During the drilling phase of the project various factors have led to delayed completion of these wells. Some of the factors are controllable whilst others are not. This research aims to shed light on the factors that ought to have been taken into consideration before drilling a geothermal well namely; maintenance of the rig and equipment, human factors and the procurement process. These factors fall under controllable category and their contribution towards timely completion of geothermal wells in Menengai Geothermal Prospects Site will be investigated.

1.2 Problem statement.

Kenya's development agenda involves reaching industrialization status by the year 2020. Adequate, reliable, affordable and environmentally friendly power source is a critical input in meeting this goal. Geothermal power can provide the requisite input. However, geothermal drilling in Menengai Geothermal Prospect Site requires an in depth scrutiny as to why the geothermal wells are not completed as scheduled. Out of eleven (11) sampled wells only one (1) well has been completed within the set or planned time. There have been delays that have prolonged drilling time. More drilling time escalates the drilling cost of a well. Thus there is a pressing need to investigate the factors that cause the delay in the drilling of wells and make necessary recommendations. The table in Appendix 1 shows wells drilled in Menengai Geothermal Prospect Site with the expected completion time and the actual time taken to drill the wells.

1.3 Purpose of the study.

The purpose of this study was to research on factors influencing timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.

1.4 Research objectives of the study.

This research aimed to achieve the following objectives:

1. To ascertain the extent to which human factors influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.
2. To establish how procurement process influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.
3. To ascertain how maintenance of the rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.

1.5 Research questions.

The following research questions were crafted from the above objectives that guided the study:

1. To what extent do human factors influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya?
2. How does the procurement process influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya?
3. How does maintenance of the rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya?

1.5.1 Research Hypotheses

The following hypotheses were derived from the questions above:

1. H_O: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.
2. H_O: Maintenance of the rig and equipment does not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.

1.6 Significance of the study.

The importance of geothermal energy as a source of power in Kenya cannot be overemphasized; the Kenyan Government with aid of donors has taken deliberate steps towards harnessing this power in line with the development goals and vision 2030. Geothermal Development Company is a parastatal under the ministry of energy formed to fast track the development of geothermal resources in Kenya. Menengai Geothermal Prospect Site in Nakuru County, Kenya formed the base of this research since this was the first geothermal site where exploration and drilling had taken place since inception of GDC. The study was important as the results and recommendations would be of importance to Kenya Government, GDC and donors as they collaborate in exploration and drilling of other wells in Menengai Geothermal Prospect Site and other geothermal sites in Kenya.

There is extensive literature on the exploration and development of geothermal, oil and gas, despite the existing literature on the exploration of geothermal and oil and the efficient running of drilling rigs; there is a knowledge gap on the factors that influence the timely completion of geothermal wells by GDC in Kenya.

1.7 Delimitation of the study.

This study aimed at obtaining information on how human factors, procurement process and maintenance of the rig and equipment influenced timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya and thereby draw informed conclusions. The researcher opted to get this information from the Drilling Operations Department Staffs even though there were other departments in GDC that interacted with the Drilling Operations Department. The researcher felt that there was a direct interaction with the factors under the study and the drilling staffs; hence questionnaires were administered to the staffs involved in drilling from the Drilling Operations Department.

1.8 Limitations of the study.

This study was heavily dependent on a survey administered to existing employees and thus they might have been compromised as not many people would report anything negative in departments they were currently serving. Another limitation of this study was that the workers on site were usually busy and some of them were not free during the duration of study so as to respond and this affected the response rate.

Following the critique of Fielding and Fielding (1986) of social research and Silverman (1989) in a study of two social science journals, found a tendency for authors to select data which supported their preconceptions of the phenomenon and to select existing and dramatic data for discussion and argument. This came into play especially when the management employees responded to questions on fall backs in regard to timely completion of geothermal wells in Menengai Geothermal Prospect Site.

1.9 Basic assumptions of the study.

This study was undertaken with few assumptions: the main assumption of this study was that the respondents were truthful in their responses and the researcher strived to achieve this. Another assumption is that the intervening variable had little or no net effect on the subject as it was difficult to measure.

1.10 Definitions of significant terms.

Rig: A machine that creates holes in the ground and can be a massive structure used to drill water wells, oil wells, natural gas extraction wells or they can be pretty small to be moved by manually by one person. In this study rigs refer to the massive mechanical machines used to drill holes in the ground for the purpose of extraction.

Formation: Formation refers to a rock unit that is distinctive enough in appearance that a geological mapper can tell it apart from the surrounding rock layers. It must also be thick enough to plot on a map.

Geothermal field/site: This is the specific area where geothermal power is explored through the process of drilling of wells. In this particular study, Menengai Crater is the geothermal exploration site of interest.

Drill bits: These are cutting tools used to create cylindrical holes, almost always of circular cross-section. Bits are held into a tool called a drill, which rotates them and provides torque and axial force to create a hole. There are specialized bits for drilling different formations.

Completion: Finishing of drilling a geothermal well.

Timely completion: Finishing drilling a geothermal well within the planned or projected time.

Spud in: Point where actual drilling commences.

1.11 Organization of the study

This study is organized into five chapters: The first chapter introduces the problem that the study sort to explore and justified why there was need to explore the subject in pursuit of the solution; the second chapter looks at past literature on the subject of geothermal exploration and development and the factors that affect timely completion of geothermal wells also with close comparison to mechanized manufacturing operations that are more similar to drilling operations; the third chapter introduces the target group, sampling size, explains in detail the research design adopted, the method of data collection, data analysis and presentation that was used in the study; the fourth chapter deals with data analysis, presentation and interpretation; the fifth chapter deals with summary of findings, discussion, conclusions, recommendations and recommendation for further studies.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter of the study looks at available literature on the factors that affect timely completion of geothermal wells namely; the procurement processes, human factors with regard to the management of a workforce that worked on a shift basis and maintenance of rig and equipment. Mechanized manufacturing plants have been used as a comparison since their mode of operation and working environment is similar to the running of drilling rigs. This has been done with the aim of providing an understanding of the effects these factors have on timely completion of geothermal wells in Menengai Geothermal Prospect Site in Nakuru County, Kenya Site.

2.2 Geothermal Energy

Global total demand for energy has grown nearly every year between 1971 and 2008, though there was a slight (1%) decrease in the 2009 worldwide total primary energy supply to 12,150 Mtoe (Megatons in oil energy) compared to 2008 (12,267 Mtoe) and a 0.6% decrease in electricity generation to 20,055 TWh (IEA, 2010; 2011), probable consequences of the global financial crisis. However, this slight lull was overwhelmed by the extraordinary 5% increase in primary energy demand in 2010, with associated CO_2 emissions of 30.4 (Gt), an increase of 5.3% over 2009 (Birol, 2011). This exceptional annual growth is now raising some concern about the possibility of achieving the global climate change objective of limiting the temperature increases this century to 2 °C above the pre-industrial levels (IEA, 2011). In addition, an unacceptable 20% of the world's population will remain without access to electricity.

With the energy challenges increasing, including the rise in the price of the wasteful fossil fuel prices; a shift to sustainable and clean sources of energy is needed. Geothermal energy comes in as a viable replacement as every part of the world has geothermal potential. The main sources for geothermal energy are the heat flow from the earth‘s core and mantle (40%), and that generated by the gradual decay of radioactive isotopes in the earth‘s continental crust (60%). Together, these result in an average terrestrial heat flow rate of 44 TWth (1,400EJ/yr), nearly 2.8 times the 2009 worldwide total primary energy supply, 509 EJth/yr, (IEA,2011) which is about 1% less than the 2008 value (514 EJth/yr). Though the world‘s geothermal heat resources are enormous and ubiquitous, it is difficult to accurately determine potentials on a global basis due to their generally found in the subsurface (GIA). Unlike the convectional energy sources such as fossil fuels which are known to emit large quantities of CO_2 gas into the atmosphere, geothermal energy is associated with very little emissions as shown in figure 1 below.

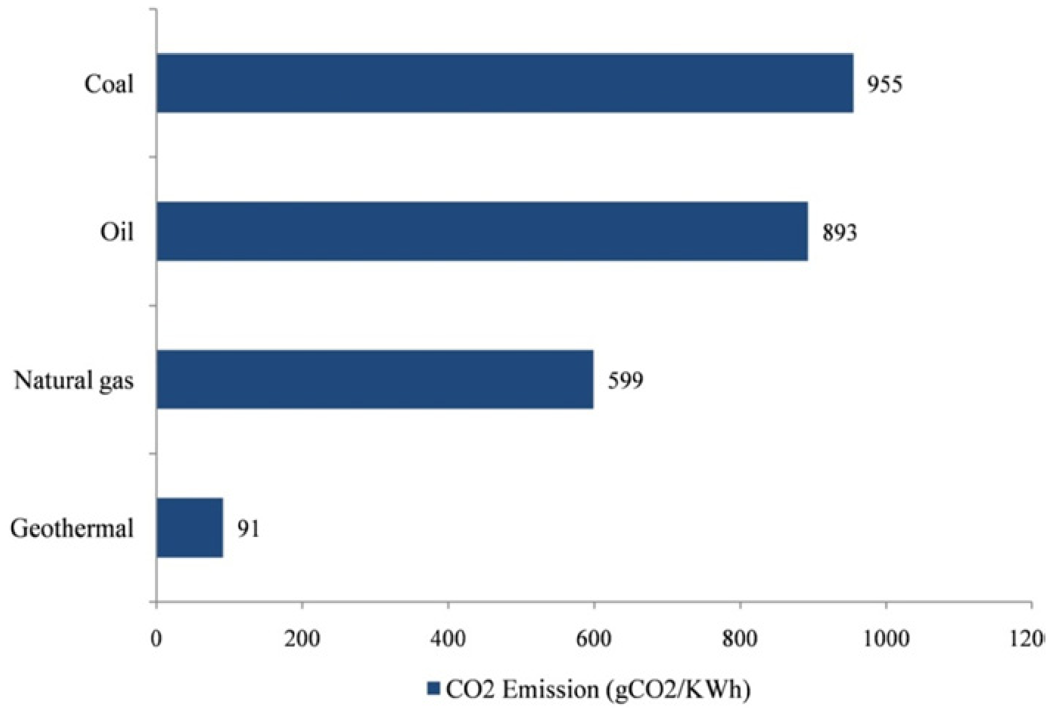

FIGURE 1: Carbon dioxide emission from electricity generation from different energy sources, Rybach (2010).

Geothermal energy is present everywhere on earth because temperature increases with depth. Existing technologies can extract heat from deep layers and utilize it to produce electricity. Geothermal energy is one of the few renewable energy resources that can provide continuous power with minimal visual and other environmental impacts. Geothermal systems have a small footprint with minimal carbon dioxide emissions (Eyal, S., Dov, L., Ran, G., & Ezra, Z. 2008). Geothermal energy could be a triple-win for developing countries: clean, reliable, locally-produced power and once it is up and running, it is cheap and virtually endless. In 2012 about 10% of all loans to renewable energy projects of the World Bank or $336 million went to geothermal. While in general this number could (and definitely should) be higher, it shows that geothermal is seen as a key renewable energy source for the bank in its activities accounting upto 10% of the total loans in 2012 (World Bank report, 2012).

Kenya’s geothermal resources are mainly high enthalpy and are therefore better suited for electricity generation. Development projects recommended under Vision 2030 will increase demand on Kenya’s energy supply. Currently, Kenya’s energy costs are higher than those of her competitors. Kenya must, therefore, generate more energy at a lower cost and increase efficiency in energy consumption. The Government is committed to continued institutional reforms in the energy sector, including a strong regulatory framework, encouraging more private generators of power, and separating generation from distribution. New sources of energy will be found through exploitation of geothermal power, coal and renewable energy sources (The Kenya Vision 2030).

2.3 Influences of human factors and timely completion of geothermal wells

In an industrial setup similar to a drilling site, the human factors that affect productivity can be summarized under job satisfaction. The concept of job satisfaction is typically defined as an individual’s attitude about work roles and the relationship to worker motivation; there can be no job satisfaction where there is no motivation. Job satisfaction can be affected by job characteristics, job environment, and job organization.

Industrial work design can be defined as a specification of work content, method and relationships to satisfy the requirement of the worker and the system. Mechanized industrial work design must be developed as an integrated whole, taking into consideration the interdependencies among skills, organization and technology (Siti et al., 2011). Thus job satisfaction is the key to establishing a healthy organizational environment in an organization, and the most important evidence that indicates the worsening conditions of an organization is the low rate of job satisfaction. Nonetheless, factors related to job satisfaction are relevant in the prevention of employee frustration and low job satisfaction because employees will work harder and perform better if they are satisfied with their jobs. Many factors affect job satisfaction (Bowen et al, 1994), (DeSantis & Durst, 1996) and (Gaesser & Whitbourne, 1985). Despite the existence of numerous studies on the effect of job satisfaction in industries, findings were often specific to the particular investigation, and to date mainly consider individual components of the physical environment (Clegg et al, 1997).

Oldham, (1996) stated that little attention is being given to the actual process of designing a workplace. Clegg (1995) suggested that methods should be developed to facilitate this process; and to do so, a more thorough understanding is needed about how various factors affect industrial job satisfaction.

This is particularly similar to the environment in geothermal drilling sites due to the running of machines, equipment and the drilling rig. Workplace design researchers can make progress by applying that which is already known and by asking a more comprehensive set of research questions (Holman et al, 2002). An approach to the design of workplaces that is human centred is needed; Interventions should be made to improve the effectiveness of workplace design.

2.3.1 Job characteristics and timely completion of geothermal wells

Hackman & Oldham (1974) categorized job characteristics into five factors. They were skill variety, task identity, task significance, autonomy, and feedback from the job. The five factors were defined as follows: Skill variety this is defined as the degree to which a job requires a variety of different activities which involve the use of a number of different skills and talents; Task identity is the degree to which a job requires completion of a “whole” and identifiable piece of work; Task significance was defined as the degree to which a job has a substantial impact on the lives or work of other people, whether in the immediate organization or in the external environment; Autonomy is defined as the degree to which the job provides the employee substantial freedom, independence and discretion in scheduling the work and in determining procedures to complete it; Feedback from job was defined as the degree to which completing work activities required by the job results in the employee obtaining direct and clear information about the effectiveness of his or her performance.

2.3.2 Job environment and timely completion of geothermal wells

The job environment determines the extent to which the employees are comfortable and therefore affecting the rate of delivery on given tasks. Air temperature, noise, humidity, and light were four environmental factors that could influence job satisfaction. Environmental factors such as temperature and humidity can have important effects on psychological parameters such as level of arousal and motivation. Job environment is defined as “the condition of mind which expresses satisfaction with the thermal environment” Parsons (2000). The reference to “mind” indicates that satisfaction is a subjective measure. Warmth discomfort can be related to the stickiness caused by un-evaporated perspiration. Consequently, questions regarding thermal comfort addressed satisfaction and comfort.

Noise levels are known to affect worker satisfaction. The term comfort is not usually used when assessing the effect of noise on workers in a site. According to Parsons, (2000), annoyance levels are the most useful criterion. Thus questions on noise level addressed annoyance and comfort.

Again according to Parsons (2000), light can cause both discomfort and positive sensations. Questions regarding light addressed satisfaction and the degree of comfort in seeing the work task especially to those who worked the night shift.

2.3.3 Job organization and timely completion of geothermal wells

According to Das, (1999) the organization factors such as workers' participation in job related decision, self-regulation and worker autonomy can affect job satisfaction. There are five factors for job organization and they include: job rotation, work method, training, problem solving, and goal setting, (De Jong, 1989).

Job rotation allows workers to rotate among jobs to increase variety. The objective of job rotation is to broaden an employee's experience and to train backup staff to allow the company to cope with worker vacations and illnesses, and also with periods of increased production (The Ergonomics Group, 1986). This technique has been widely used to increase the competence of workers and to reduce monotony (Helander, 1995). Work method describes how tasks are being organized (Rouse et al., 1991) and according to Quirk (1999), the methods could include procedures, instructions and documentation that define how manufacturing steps or processes are accomplished. Training is defined as the systematic development of worker skills. Individuals need knowledge and skills to perform adequately on a given task (Stammers & Patrick, 1975). Problem solving describes how the workers handle work related problems by giving them the resources and authority to do so (Ugboro & Obeng, 2001). Goal setting is the process of developing, negotiating and formalizing the targets or objectives that an employee is responsible for accomplishing (Umstod et al., 1976).

Another important aspect of job satisfaction is the nature of work schedules and fatigue. Everyone can become fatigued. The best way to cope with fatigue is to prevent its onset. The continuous number of hours worked and the time of day worked (day vs. night shifts) need to be considered when developing work schedules. The potential for accumulated or sudden sleep loss should also be considered. To manage fatigue, the entire time a worker has to be awake should be considered, not just the time spent working. For example, the time spent commuting, especially for those who drive a long distance after leaving night shift. This time may add to an already long shift and increase the likelihood of fatigue impairment and thus inhibit productivity and increase risk of accidents.

2.4 Procurement processes and timely completion of geothermal wells

Procurement is the process of purchasing, hiring or obtaining by contractual means goods, construction works and services following defined procedures. While engaging in drilling activities procurement of equipment, tools, materials and services cannot be overlooked or underemphasized. GDC being 100% owned by the government of Kenya has to adhere to the procurement procedures and regulations. The company has to procure through public procurement as stipulated by the public procurement and disposal act of 2005 which has its bottlenecks especially in cases of emergency procurement as a result of breakdowns. The public procurement and disposal act is discussed below.

2.4.1 Public procurement and timely completion of geothermal wells

Public procurements have the same goals as private ones. However, public procurements are subject to a different and stricter jurisdiction than private procurements. The purpose is to protect companies from unfair competition and to avoid corruption and bribery. The result is often that the formal requirements become quite extensive and lengthy. In Kenya public procurement is subject to the Public procurement and disposal act, 2005.

2.4.2 The public procurement and disposal act, 2005

(LEGAL NOTICE No. 174, Kenya Gazette Supplement No. 92, 29th December, 2006, Legislative Supplement No. 53)

This Act applies to any body in which the Government has a controlling interest. In summary the act requires that: All international tendering will be allowed 30 days to prepare tender. If one was to use pre- qualifications one has to allow at least 14 days preparing the prequalification documents. This require advertisement in the local and where possible international journal etc.; National tendering requires bidders to be allowed at least 21 days to prepare their bid. In addition if the projected cost is estimated over Ksh 6 million (US 0.75 million) for goods and works and US$ 0.375 million for services will require to be advertised in the local newspapers; The tender documents are evaluated by a committee and approved by an official tender committee; The contract cannot be signed before 14 days after award to allow for complaints and appeal to the award.

2.4.3 Procurement of equipment and timely completion of geothermal wells

Equipment procurement process is as old as manufacturing plants. However organizations face challenges due to multiple factors. Organizations which work on improvising the process taking clues and corrective actions from the learning's benefit in future procurements. Some organizations are rigid in structures and are people centric. These have fixed ideas on process and often start backwards. Often they finalize the equipment and even the vendor and work by process of elimination. Such organizations feel the pressures and often suffer in overall performance. Procurement process itself has to be continuously assessed through self-evaluation and evolved to achieve the best. Operational excellence should integrate procurement process (Kanvinde, 2007)

2.4.4 E-procurement and timely completion of geothermal wells

E-procurement is the business-to-business purchase and sale of supplies and services over the internet. An important part of many B2B sites, e-procurement is also sometimes referred to by other terms, such as supplier exchange. Typically, e-procurement web sites allow qualified and registered users to look for buyers or sellers of goods and services. Depending on the approach, buyers or sellers may specify prices or invite bids. Transactions can be initiated and completed. On-going purchases may qualify customers for volume discounts or special offers.

Geothermal exploration and drilling has been on the low side for quite some time in Kenya until recently when the pace for its development was emphasized, therefore it is very objective to postulate that most equipment for geothermal development is not locally manufactured thus making the process of procurement of equipment very important in the drilling of geothermal wells. Couple this with the bottlenecks provided by public procurement and you have a process that has a potential of going on for much longer than the industry average.

2.4.5 Tendering and timely completion of geothermal wells

Tendering plays a very important role in project procurement since it helps select the most appropriate contractors to execute projects or the best suppliers. The tendering system proves effective in shortening completion time, improving quality, and lowering costs of construction works (Wang et al., 1998). Poor tendering practices may cause challenges to achieving projects' objectives.

A study of oil and gas projects in Vietnam found that they often adopt one of the three main tendering methods: competitive tender, negotiated tender and combination of both. Open competitive tender is deemed to be the most effective one, when unlimited number of bidders can compete fairly in the tendering process. Thus, it is easy to choose the contractor who is best able to handle the project. However, this type of tendering is time consuming, complex and expensive. Therefore, its use is limited only to some very large and complex projects requiring international contractors. The selective competitive tender and negotiated tender are more often used because they are still effective while saving money and time as well as overcoming the lack of tendering expertise of the owner. These two kinds of tender are mainly based on the good relationship between clients and contractors (Van Thuyet N & Ogunlana S. O., 2007).

The study revealed that “poor evaluation criteria setting” and “unethical behaviour of bidders” were the two main reasons for tendering risk in the oil and gas industry in Vietnam. The criteria vary across projects. They are normally divided into four groups: finance, time, quality and the credibility of the bidders. In-depth interviews revealed that the contracts are awarded primarily on the basis of financial and credibility of the bidders. Often, the lowest bidder is chosen in order to save on project cost. In addition, since tendering is a very sensitive issue, accepting the lowest-price tender may help the public owners to defend themselves from criticisms and to show accountability (Wong et al., 2000). However, in some cases, bidders submit the low prices in order to win the bid and at the later stage they negotiate for higher pay. In some instances where the weights of the evaluation are not set out right, the incapability of the contractor may jeopardize the whole project.

Another problem in tendering that came out in Vietnam is unethical behaviour through collusion of prospective bidders. Collusive tendering is results when a number of firms that have been invited to tender agree between themselves either not to bid, or to bid in such a manner as not to be too competitive with the each other (Ray et al., 1999). Collusion affects the competitive tendering system by restricting free competition and restricting the choices available to the client. Collusion can appear in many kinds such as communication with other bidders, bribery, withdrawal, artificial inflation of tender prices, and covering price (Frazer & Skitmore, 2000).

2.5 Maintenance of rig and equipment and timely completion of geothermal wells

Maintenance is defined as an activity carried out on any equipment to ensure its reliability to perform its functions. Maintenance to most people is any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions, or to repair any equipment that has failed, or to keep the equipment running, or to restore to its favourable operating condition (Hisham B J, Perkasa S. B S, 2003). Hence another perspective of looking at maintenance function is not only to maintain but also to enhance the process or the plant operation system in this case the rig and supporting equipment as a result of turnaround planning. Thus rather than restoring or trying to restore the equipment to its original performance, planning a turnaround could better still be aimed at enhancing the process and performance of a plant or drilling rig, equipment or any system (Lindell & Perry, 2003).

Maintenance of equipment can be classified into the following four categories:

2.5.1 Breakdown Maintenance and timely completion of geothermal wells

This is one of the earliest maintenance programs implemented in industries. This approach to maintenance is totally reactive and only act when the equipment needs to be fixed. This strategy has no routine maintenance task and also described as ‘no schedule’ maintenance strategy. To rectify the problem, corrective maintenance is performed onto the equipment. Thus, this activity may consist of repairing, restoration or replacement of components. The strategy is to apply the corrective maintenance activity only, which is required to correct a failure that has occurred or is in the process of occurring (Hisham B J, Perkasa S. B S, 2003). Asset maintenance was not of high importance to most managers with only the need for simple lubrication, cleaning and servicing required. Run-to-failure was the maintenance strategy most prominently employed (Moubray J, 1997).

2.5.2 Preventive/Scheduled Maintenance and timely completion of geothermal wells

This is a time-based maintenance strategy where on a predetermined periodic basis; equipment is taken off-line and inspected. Based on visual inspection, repairs are made and the equipment is then put back on-line. The 1950’s period was post World War II and maintenance strategies being implemented at the time were not adequate particularly for equipment such as modernized commercial aircraft (Kennedy R, 2006).The development of Preventive Maintenance (PM) in 1951 introduced a periodic maintenance schedule based on time or asset utilization where the asset requirements would be recognized and a time-frame would be planned for maintenance implementation (Ben-Daya M, 2009).Thus under this equipment maintenance strategy, replacing, overhauling or remanufacturing an item is done at a fixed interval regardless of its condition at the time. Although this is a well-intended strategy, the process can be very expensive as it is based on no particular information and thus can result to misguided interventions which consume time (Peak Industrial solutions, 1999).

2.5.3 Predictive Maintenance and timely completion of geothermal wells

Predictive maintenance is a more condition-based approach to maintenance. The approach is based on past experience and measuring of the equipment condition in order to assess whether equipment will fail during some future period, and then taking action to avoid the consequences of that failure. This is where predictive technologies (i.e. vibration analysis, infrared thermographs, ultrasonic detection, etc.) are utilized to determine the condition of equipment, and to decide on any necessary repairs. Apart from the predictive technologies, statistical process control techniques, equipment performance monitoring or human senses are also adapted to monitor the equipment condition. This approach is more economically feasible strategy as labour, materials and production schedules are used much more efficiently (Hisham B J, Perkasa S. B S, 2003).

2.5.4 Proactive Maintenance and timely completion of geothermal wells

Unlike the three type of maintenance strategies which have been discussed earlier, proactive maintenance can be considered as another new approach to maintenance strategy. Dissimilar to preventive maintenance that based on time intervals or predictive maintenance that based on condition monitoring, proactive maintenance concentrate on the monitoring and correction of root causes to equipment failures. According to Hisham B J & Perkasa S. B S (2003), the proactive maintenance strategy is also designed to extend the useful age of the equipment to reach the wear-out stage by adapting a high mastery level of operating precision. This strategy is particularly important in drilling of wells as drill bits are supposed to be replaced before they wear out completely due to their reducing inefficiency. They are also supposed to be replaced to be changed when there is a change in formation as there are specialized drill bits for different formations. Poor maintenance of rigs and equipment could lead to breakdowns that could have been avoided in the first place and which end up consuming precious time thus delaying the completion of the drilling of a geothermal well. If they occur widely they could affect the drilling calendar and increase explorations costs and in turn increase the capital level needed to venture and successfully complete the drilling of a geothermal well (Moubray JM, 2000).

2.6 Conceptual framework

This part of the study explains the relationships between the variables under focus in the study. The independent variables are the procurement process, human factors and maintenance of the rig and equipment. The dependent variable is timely completion of geothermal wells. The moderating variable is government policy and the intervening variable is formation characteristics.

Timely completion of geothermal wells is affected by various independent variables. Human factors in the drilling of geothermal wells as in any industrial setup affects productivity of the workforce involved in the endeavour. Employees who are content with the remuneration, working conditions and organization tend to be more productive during the hours that they are employed in the job and this may translate to better results and faster completion of assigned tasks, completion of geothermal wells in this case; drilling of geothermal wells is executed by use of the rig and supporting machines and equipment; their proper, planned or scheduled maintenance may lead to minimal breakdowns hence efficient drilling operations leading to timely completion of geothermal wells; procurement of drilling equipment, materials, tools and spares has a potential of delaying the completion of wells if the procurement process proves to be lengthy.

Geological formation is an intervening variable that affects the timely completion of geothermal wells in the following way: Formations vary a lot in hardness and abrasiveness and have a considerable effect on drilling bit performance. If there were no differences in rock formations, one type of bit only would be needed which requires standard bit weight, rotary speed and pump pressure to drill at maximum rate. Unfortunately such a situation does not exist and several bits are required for the alternating layers of soft material, hard rocks and abrasive sections. Changing the bit every time the formation changes is however impractical. Therefore a bit that performs reasonably well has to be selected every time. Though hard to measure, geological formation affects the rate of completion of geothermal wells.

Government policy in this study is seen as a moderating variable in that for the reasons of attaining goals for Vision 2030 the Government of Kenya has taken measures to have sufficient energy sources for the purpose of industrialization. There is a lean by the Kenyan Government towards supporting harnessing of geothermal power that is known to be clean and renewable and at the same time having minimal footprints. In addition, the government has received immense support from the donors towards development of geothermal energy.

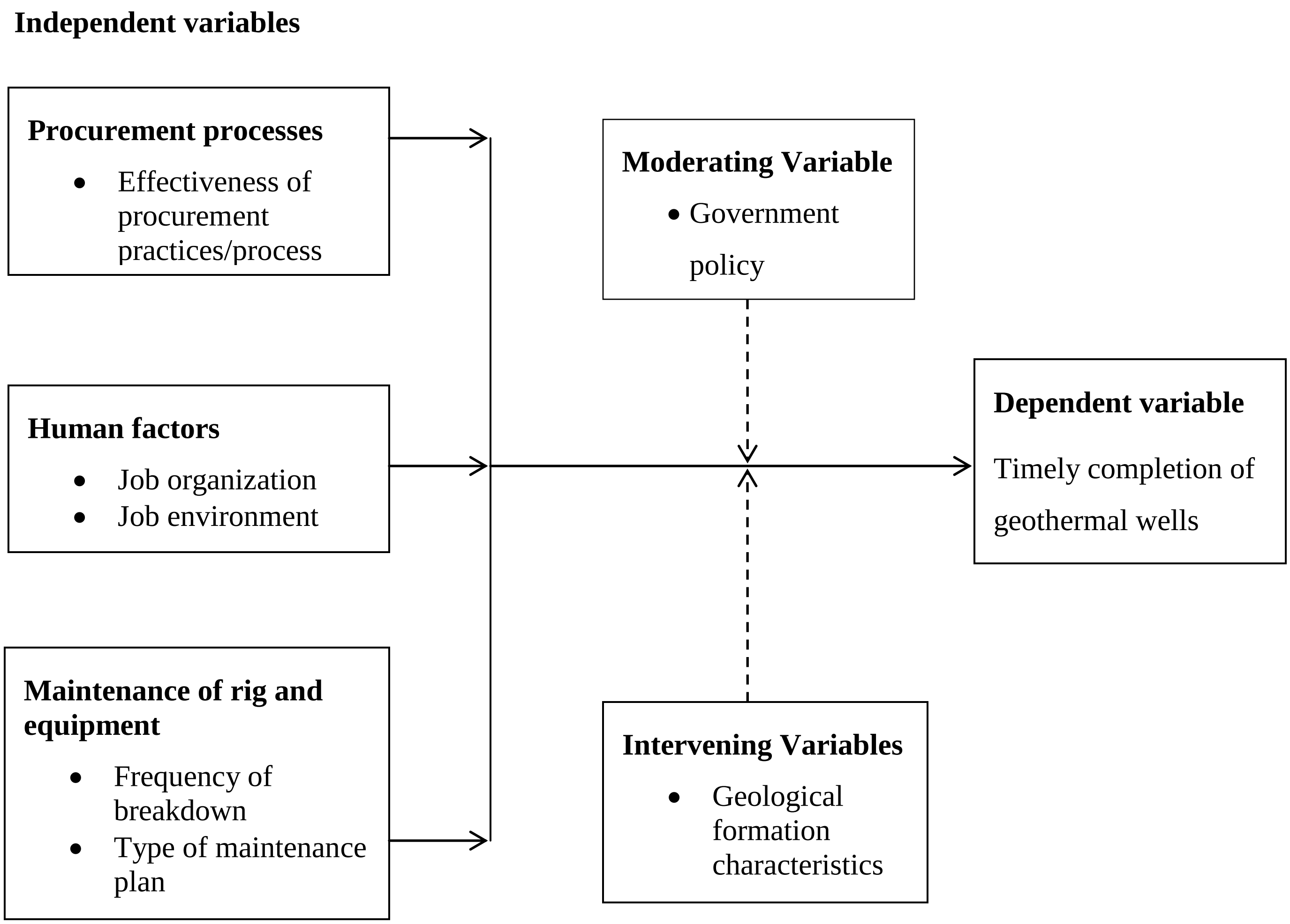

Figure 2: Conceptual framework

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This section of the research explains the research design used, sampling design and procedures, target population, data collection instrument, data analysis and presentation as well as reliability and validity of research instruments. Furthermore, this chapter analyses the operational definition of variables and the method of data analysis that was used to come up with conclusions.

Research hypotheses were drawn to study if human factors, efficient maintenance of rig and equipment had a significant influence on timely completion of geothermal wells in Menengai Geothermal Prospect Site in Nakuru County, Kenya. Data analysis from the samples would provide evidence to support or refute the hypotheses.

3.2 Research design

Cooper & Schindler (2003), summarizes the essentials of research design as an activity and time based plan; always based on the research question; guides the selection of sources and types of information; a framework for specifying the relationship among the study variables and outlines the procedures for every research activity.

This study adopted a descriptive non-experimental research design. Descriptive research is interested in identifying variables and relationships between them; it measures the occurrence of phenomenon without intervening (Hart, 2005).

There are of course different ways of association and different ways of describing a phenomenon. This design was based on a case where the subject was measured only once; a cross section of an attitude or opinion was observed based on a sample from a population. Descriptive studies were also used to identify attitudes, needs and differences between people e.g. job satisfaction and work experience.

3.3 Target Population

Geothermal Development Company is a parastatal under the ministry of energy formed to fast track the development of geothermal resources in Kenya. GDC has been entrusted by the Government of Kenya to develop the geothermal prospect sites that are mainly found along The Great Rift Valley. Among these sites is Menengai Geothermal Prospect Site in Nakuru County, Kenya. This is the first site where exploration and drilling has taken place since GDC inception and hence forms the base of this research. It is in this site that wells have failed to be completed within the planned time.

The target population in this research comprised of employees of Geothermal Development Company drawn from Menengai who were involved in the drilling of geothermal wells. In Menengai Geothermal Prospect Site there are approximately 400 GDC employees of whom 180 are from Drilling Operations Department involved in drilling of geothermal wells and thus formed our target population. These included the engineers (25), technicians (50), derrick men (16), floor men (60) and roustabouts (29). These workers experienced the effects of the factors under study and their response was deemed reliable.

3.4 Sampling procedure and sample size

This section describes the procedure that was used in determining the elements under the study and exactly what size of the elements under the study would be considered.

3.4.1 Sampling procedure

The sampling procedure that was adopted for this research was purposive sampling design. Purposive sampling is discussed below and its justification for use.

Purposive sampling represents a group of different non-probability sampling techniques. Also known as judgmental, selective or subjective sampling, purposive sampling relies on the judgment of the researcher when it comes to selecting the units (e.g., people, cases/organizations, events, pieces of data) that are to be studied. Usually, the sample being investigated is quite small, especially when compared with probability sampling techniques (Laerd dissertation, 2012).

This design was deemed to be most appropriate for this research since the target population was small and not uniformly distributed. The target population was clustered together in four different drilling rigs in Menengai Geothermal Prospects Site.

There are several types of purposive sampling namely; maximum variation sampling, homogeneous sampling, typical case sampling, extreme case sampling, critical case sampling, total population sampling and expert sampling. This study was guided by expert sampling technique discussed below.

3.4.1.1 Expert sampling

Expert sampling is a type of purposive sampling technique that is used when your research needs to glean knowledge from individuals that have particular expertise. This expertise may be required during the exploratory phase of qualitative research or quantitative research, highlighting potential new areas of interest or opening doors to other participants. Alternately, the particular expertise that is being investigated may form the basis of your research, requiring a focus only on individuals with such specific expertise. Expert sampling is particularly useful where there is a lack of empirical evidence in an area and high levels of uncertainty, as well as situations where it may take a long period of time before the findings from research can be uncovered (Laerd dissertation, 2012).

The drilling process of geothermal wells requires expertise and specialized labour, this formed the pool of employees who were privy to the required information since they understood and experienced the effect of the factors under research. Therefore under purposive sampling design, expert sampling was the preferred method for the selection of respondents from the target population for the purpose of data acquisition using questionnaires and interviews.

3.4.2 Sample size

Since the target group in this study comprised of skilled and unskilled expert employees from Drilling Operation Department in GDC, this made the target group quite small and thus an expert sampling technique was adopted. The sample size was calculated using the Krejcie and Morgan table (Krejcie, R. V., Morgan D. W., 1970) in Appendix 3. With a target group of 180 and 95% confidence interval a sample of 118 was returned. This sample was distributed amongst the different skilled and unskilled expert employees by use of a quota system so as to avoid a situation where one or more job category had no representation.

3.4.2.1 Sample Quotas

Using the techniques of purposive sampling that as defined by Glaser & Strauss (1967), subjects were selected to obtain differences in experience and job description. This was done in consideration of the desired target group and representative quotas were created where sampling was done on a rolling basis with respect to these quotas.

3.4.2.2 Respondent Selection

Respondents were selected with the purposive sampling technique and the established quotas in mind. The quotas were meant to diversify the sample since the sample selection was non-probabilistic and a group could miss out if the study was done on a rolling basis.

3.5 Data Collection

There are two major approaches to gathering information about a situation, person, problem or phenomenon. Sometimes, information required is already available and only need to be extracted. However there are instances when the information from a data gathering process is categorized as primary data. According to (Creswell, 2003) data collection procedure in qualitative research involves four basic types: observations, interviews, documents and audio-visual materials. This study used three tools of data collection i.e. questionnaires, interviews and existing documentation as discussed below.

3.5.1 Existing documentation

This study reviewed the daily logs and documents filled by engineers of daily activities that occurred throughout a drilling shift of twelve hours either day or night shift. This formed a major source of information since all occurrences during drilling were captured in these logs.

A review of documents and logs was done which will included reviewing of daily activities and time in days spent on each well filled by immediate operations supervisors and or shift leaders. Logs and other documentation were used as a source of data and information since they captured most of the drilling site occurrences and most importantly bore the time taken for completion of wells.

3.5.2 Questionnaires

In this study, self-administered survey questionnaires were adopted for data collection, this was particularly important so as to maintain anonymity amongst the respondents as the researcher did not necessarily need to know their responses as in an interview.

The successful respondents completed the questionnaire and the responses that were deemed usable were selected. A structured questionnaire was used as the data collection instrument. The questionnaire was developed through the guidance of the objectives of the study as well as research questions. It contained closed ended questions which were accompanied by a list of possible alternatives from which the respondents were expected to choose answers that best described their views. The questionnaire was designed to assess job satisfaction, employee perception of the procurement process, overall evaluations of the rig and equipment maintenance measured using a five point Likert scales for most of the perception based measures.

Use of questionnaires allowed independent collection of data from the respondents hence reliable information was collected. With questionnaires large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost effective way also the questionnaire can be administered by the researcher or by any number of people with limited effect to its validity and reliability (K. Popper, 2004).

3.5.3 Interviews

The study also included in-depth interviews with shift engineers/supervisors and maintenance engineers. Personal interview was appropriate as this was a technique that gave more deep and detailed information as the interviewer controlled the process hence probing more by adding questions that helped to add more information unlike in an observation method. Moreover, the interviewer adjusted to the language of the interviewee since they observed the problems and effects the interview was having on the respondents.

3.6 Validity and reliability

Last, J., (2001), postulates that while planning a research or interpreting findings from someone's work the impact of the results is dependent or determined by validity and reliability.

Validity entails the question, does your measurement process, assessment, or project actually measure what you intend it to measure? While reliability addresses whether repeated measurements or assessments provide a consistent result given the same initial circumstances.

3.6.1 Validity

Validity is concerned with whether the findings are really about what they appear to be about Saunders et al. (2003). Validity defined as the extent to which data collection method or methods accurately measure what they were intended to measure Saunders et al. (2003). In research, validity has two essential parts: internal and external.

Internal validity entails identifying the degrees of the relations between the variables that affect the phenomenon. This was achieved by identifying and eliminating the other non-sensible variables affected the drilling of geothermal wells.

External validity is the extent and warrant we have to make generalizations from our own studies to the wider population from which our sample was selected. Through the purposive sampling plan, randomization was attempted on the desired group so as to increase the confidence in generalizations.

3.6.2 Reliability

According to Saunders et al. (2003) reliability refers to the degree to which data collection method or methods will yield consistent findings, similar observations would be made or conclusions reached by other researchers or there is transparency in how sense was made from raw data. The research tools were made as simple as possible without eroding the importance of the questions so as to ensure reliability. Reliability was tested using the Cronbach's test of reliability. Cronbach's alpha was computed and found to be 0.75 and compared with the recommended levels of 0.70 (Nunnally, 1978).

3.7 Methods of data analysis

The filled questionnaires were checked for consistency and completeness. The responses were coded and keyed in using SPSS. After keying in data into SPSS frequency tables and cross tabulation for various variables was done and tables were generated. Pearson correlation coefficients were also computed to determine the strength of relationship between several variables. Pearson Chi-square was also computed from cross tabulation of variables determined to test two hypotheses.

3.8 Ethical considerations

Before conducting this study permission was requested from GDC, UON, and KNCST. An introduction letter bearing the permission granted and the identity of the researcher was presented to respondents. The identity of the respondents was protected and the responses and results were not linked to any individual by his or her identity or unique position.

Responding to the questions by the interviewees was voluntary and no coercion or intimidation was used at any point. Utmost integrity was upheld and there were no attempts to tamper with the data so as to favour any other result that would lead to a non-directional or subjective result.

3.9 Operationalization of Variables

The operationalization of a variable means finding a measurable, quantifiable, and valid index for a variable. Both the independent and dependent variables are manipulated in such a way that they become measurable and end up having two or more levels.

Table 3.1: Operationalization of variables.

OBJECTIVES	VARIABLE	INDICATORS	MEASURE	SCALE OF MEASURE-MENT	TOOLS OF ANALYSIS
To ascertain how maintenance of the rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects.	Independent & Dependent	• Frequency of breakdown • Type of maintenance plan	• How frequent • Maintenance plan used	Ordinal Nominal	Mean Descriptive
To establish how procurement process influence timely completion of geothermal wells in Menengai Geothermal Prospects.	Independent & Dependent	• Effective procurement process • Satisfaction with procurement of drilling resources	• Efficiency of the policy • Timely response to procurement of drilling resources	Nominal Ordinal	Descriptive Mean
To ascertain the extent to which human factors influence timely completion of geothermal wells in Menengai Geothermal Prospects.	Independent & Dependent	• Job organization • Job environment	• Shift coordination • Social ties • Geographical location • Night Vs. Day shift	Ordinal Ordinal	Descriptive Descriptive

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter covers data analysis obtained from the questionnaires and interviews that was processed by use of SPSS. The data is mainly presented in tables and an interpretation of each result is explained. Correlation and testing of hypothesis of variables has been done and conclusions drawn from the results obtained in a bid to give light on how human factors, the procurement process and maintenance of rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.

4.2 Questionnaire return rate

Questionnaires were taken to the respondents at their place of work i.e. at the rig site. In cases where work was ongoing at the rig site the researcher was not able to issue the questionnaires and had to wait for another time. In addition questionnaires were administered to the respondents who were resting after working on a night shift, where the researcher waited for them while having their lunch and dinner. Out of the 118 administered questionnaires the returned questionnaires were 112 which was response rate of 95%. There was a high rate of return since the questionnaires were filled while the researcher waited without leaving any behind. Those questionnaires that were not returned were those that respondents promised to fill and return but they did not in the long run.

4.3 Respondents Characteristics

Table 4.1 represents the characteristics of the respondents sampled from the population. The respondents being drawn from a technical background depicts a high number of male respondents compared to the female respondents. Out of 112 respondents 108 were male representing 96.4% while 4 were female representing 3.6%.

Majority age of the respondents ranged between 21 and 30 years representing 50% of the sample. There were 47 respondents with ages ranging between 31 and 40 years translating to 42% of the sample. In addition there were 7 respondents with their ages falling between 41 and 50 years which depicted 6.3% of the total sample. There was only 1 respondent for each of the following age category: less than 20 years and above 50 years which was 0.9% of the total sample.

Academic qualification of the respondents was also analyzed with majority of the respondents being holders of a diploma, in total 36.6% of the respondents had diplomas. 35.7% represented respondents with O-level certification. Those with higher national diplomas were at 9.8% of the total sample. Bachelor degree holders from the sample were 17% and only 1 with a master's degree representing 0.9% of the total sample.

Table 4.1: Demographic characteristics of respondents

		Frequency	Percent
Gender	Male	108	96.4
	Female	4	3.6
Age	Less than 20	1	0.9
	Between 21 and 30	56	50.0
	Between 31 and 40	47	42.0
	Between 41 and 50	7	6.3
	Above 50	1	0.9
Qualification	O-Level	40	35.7
	Diploma	41	36.6
	HND	11	9.8
	Bachelors	19	17.0
	Masters	1	0.9

4.4 Job Experience

It was prudent to find out the job experience of the respondents in a bid to try and tie any conclusions from the findings. The job experience of the respondents after being analysed showed that among the 112 respondents 91 had job experience below 10 years which represented 81.3% of the total sample. There were 15 respondents with experience between 10 and 19 years which reflected as 13.4% of the sample. 4 respondents had experience of between 20 and 29 years resulting to 3.6% of the sample and 2 respondents with experience between 30 and 39 years which was 1.8% of the total sample.

Table 4.2: Relevant job experience

		Frequency	Percent
Experience	Less than 10	91	81.3
	Between 10 and 19	15	13.4
	Between 20 and 29	4	3.6
	Between 30 and 39	2	1.8

4.5 Job Category

The responsibility of the various respondents was sort by allowing the respondents to answer, what best described their position within the drilling operations. The outcome as shown in table 4.3 was that 9.8% of the sample represented drilling engineers, 6.3% maintenance engineers, 23.2% roustabouts, 8% derrick men and 35.7% rig floor men.

Table 4.3: Job description in drilling operations

		Frequency	Percent
Job description	Drilling Engineer	11	9.8
	Maintenance Engineer	7	6.3
	Technician	26	23.2
	Roustabout	19	17.0
	Derrick Man	9	8.0
	Rig Floor man	40	35.7

4.6 Satisfaction with other employees

Interaction with fellow employees within the respondents' shifts and outside their shifts was investigated to find out if there were social conflicts that would have slowed operations. When asked this question, 48 respondents (42.9%) expressed satisfaction and 28 (25%) were very satisfied with the way they related to each other. 27.7% were quite satisfied, 1.8% dissatisfied and 2.7% very dissatisfied as shown in table 4.4.

Table 4.4: Satisfaction with interaction with other employees

		Frequency	Percent
Interaction Satisfaction	Very Dissatisfied	3	2.7
	Dissatisfied	2	1.8
	Quite Satisfied	31	27.7
	Satisfied	48	42.9
	Very Satisfied	28	25.0

4.7 Work Environment

Bearing in mind that drilling operations are carried out in remote and sometimes under very harsh environments with extreme weather conditions the satisfaction with the working environment for the respondents was one opinion that needed to be understood. Table 4.5 below shows respondents' rating of the level of satisfaction with the job environment on a five point scale ranging from 1-very dissatisfied through 3-quite satisfied to 5-very satisfied.

About 49.1% of the respondents said they were satisfied that is 55 persons and approximately 30.4% of them chose "quite satisfied". "Very satisfied" had 19 (17.0%) of the respondents and 4 (2.3%) were dissatisfied. None of the respondents chose Very dissatisfied.

Table 4.5: Work environment satisfaction

		Frequency	Percent
Working Environment Satisfaction	Dissatisfied	4	3.6
	Quite Satisfied	34	30.4
	Satisfied	55	49.1
	Very Satisfied	19	17.0

4.8 Night shift satisfaction

Drilling operations are carried out for 24 hours day and night nonstop. At one point those working during the day will eventually come to work at night. Based on this mode of operation, it was essential to find out the feel of the respondents towards working at night compared to day operations. At night adverse weather conditions like extreme cold and darkness is mainly encountered. About 33% of the respondents were satisfied working at night while 2.7% were very dissatisfied with night operations as shown below in table 4.6.

Table 4.6: Night shift satisfaction

		Frequency	Percent
Night Shift Satisfaction	Very Dissatisfied	3	2.7
	Dissatisfied	9	8.0
	Quite Satisfied	35	31.3
	Satisfied	37	33.0
	Very Satisfied	28	25.0

4.9 Satisfaction with shift coordination

Proper coordination within shifts plays a very important role when it comes to reduction of time wastage. Poor transition of shifts from may be day shift to night shift may lead to time wastage which later may impact on time spent drilling a well. To rate the level of satisfaction with the way the shifts were coordinated, respondents were asked to rate their satisfaction using five given categories ranging from very dissatisfied as the lowest category through neither satisfied nor dissatisfied to very satisfied as the highest approval rating.

33.9% of the respondents were satisfied with the way shifts were coordinated and 2.7% were very dissatisfied with shift coordination.

Table 4.7: Satisfaction with coordination of different shift

		Frequency	Percent
Shift Co-ordination	Very Dissatisfied	3	2.7
	Dissatisfied	10	8.9
	Neither dis/satisfied	34	30.4
	Satisfied	38	33.9
	Very Satisfied	27	24.1

4.10 Department change preference.

To assess the rate of satisfaction with the drilling department, respondents were asked if they were willing to move from the drilling department to another department in the same organization. The results were summarized in table 4.11 where majority of the respondents (50.9%) stated they would definitely not move followed by those who said maybe constituting 23.2% and 12.5% saying probably not. 9 of the respondents (8.0%) stated they probably would move with 6 (5.4%) stating they would definitely move.

Table 4.8: Department change preference

		Frequency	Percent
Department change preference	Definitely not	57	50.9
	Probably not	14	12.5
	Maybe	26	23.2
	Probably would	9	8.0
	Definitely would	6	5.4

4.11 Remuneration expectation.

To assess remuneration satisfaction, respondents were asked if their remuneration was commensurate to their expectation. Majority of the respondents (51.8%) agreed, 33 (29.5%) disagreed, 13 (11.6%) strongly disagreed and 8 (7.1%) of the respondents strongly agreed as shown in table 4.12 below.

Table 4.9: Remuneration Expectation

		Frequency	Percent
Remuneration Expectation	Strongly disagree	13	11.6
	Disagree	33	29.5
	Agree	58	51.8
	Strongly agree	8	7.1

4.12 Satisfaction with procurement of drilling resources by GDC.

Respondents were asked to rate their satisfaction with the procurement process of drilling resources by GDC on a five point scale comprising of: 1-very dissatisfied through to 5-very satisfied. Surprisingly, most of the respondents (27.7%) were very dissatisfied, followed by 28(25.0%) who were quite satisfied while "satisfied" and "very satisfied" tied to have the least selections at 15 (13.4%) as shown in Table 4.14.

Table 4.10 Satisfaction with procurement of drilling resources by GDC

		Frequency	Percent
Satisfaction with procurement of drilling resources by GDC	Very Dissatisfied	31	27.7
	Dissatisfied	23	20.5
	Quite Satisfied	28	25.0
	Satisfied	15	13.4
	Very Satisfied	15	13.4

4.13 Effect of procurement process on timely completion of geothermal wells

Table 4.15 presents a summary of the extent to which the respondents felt how the procurement process affected timely completion of geothermal wells. Among 112 respondents 77 (68.8%) felt that procurement affected timely completion of geothermal wells very much while 3 (2.7%) did not know if procurement affected timely completion of wells.

Table 4.11: Procurement and timely completion

		Frequency	Percent
Procurement and timely completion	Very Much	77	68.8
	A little	28	25.0
	Don't know	3	2.7
	Not at all	4	3.6

4.14 Approach to equipment maintenance.

Most of the respondents (42.9%) stated that the maintenance approach was a “scheduled maintenance approach”, 34 (30.4%) stated that the approach was “fix it when broken” and 22 (19.6%) believed the approach was “condition based monitoring”. “Detection of sources of failures” had the least selection with only 8 (7.1%) of the respondents choosing it (see table 4.13).

Table 4.12: Approach to equipment maintenance

		Frequency	Percent
Approach to equipment maintenance	Fix it when broken	34	30.4
	Scheduled maintenance	48	42.9
	Condition-based monitoring	22	19.6
	Detection of sources of failures	8	7.1

4.15 GDC response to restore broken down machinery

When asked to rate the company’s response to broken down of machinery using a five point scale, the response was fairly uniformly distributed between the five choices with “quite quick” and “very slow” tying at 22.3% as the most chosen and “very quick” as the least chosen at 15.2% (see table 4.16).

Table 4.13: GDC response to restore broken down machinery

		Frequency	Percent
Response to breakdown repairs	Very slow	25	22.3
	Slow	23	20.5
	Quite quick	25	22.3
	Quick	22	19.6
	Very Quick	17	15.2

Table 4.14 Frequency of drilling related breakdowns

When asked how often they (respondents) experienced breakdown of the machinery, most of respondents at 34 (30.4%) said monthly followed by 33 (29.5%) who said fortnightly, and 17 (15.2%) who chose twice weekly. 16 (14.3%) of the respondents said daily while 12 (10.7%) said weekly.

Table 4.19: Frequency of drilling related breakdowns

		Frequency	Percent
Frequency of drilling breakdowns	Weekly	12	10.7
	Daily	16	14.3
	Fortnightly	33	29.5
	Twice weekly	17	15.2
	Monthly	34	30.4

4.17 Urge to drill within planned time

For a successful project all the involved parties need to be aware of the goals or targets to be achieved. One of the goals while drilling a geothermal, oil or gas well is to drill the well within the projected time. It was therefore important to ascertain if the respondents were well informed of the urge to drill a well within planned time. An overwhelming majority of the respondents (89.3%) expressed that they were aware of the urge to drill a well within planned time as illustrated in table 4.7. Only 12 respondents (10.7%) indicated that they were not aware that there was an urge to drill well in planned or projected time.

Table 4.15: Urge to drill within time

		Frequency	Percent
Urge to drill well in planned time	Yes	100	89.3
	No	12	10.7

4.18 Respondents take on measures to reduce time wastage.

To assess the respondent's commitment to stemming time wastage, five survey items were to assess respondents' perception on measures aimed to reduce time wastage. The results as summarized in table 4.9 below showed that 57.1% of the respondents agreed that achieving timely completion of a well was highly prioritized while 1.8% of the respondents disagreed on the same. 53.6% of the respondents agreed that the drilling team always strived to avoid time wastages while 2.7% strongly disagreed. While responding to site management, 51.8% of the sample agreed that it was essential to manage the site to ensure reduction of time wastage while 1.8% strongly disagreed. 47.3% of the respondents agreed that their team leader always advised them on potential areas where time wasting was possible to occur but 3.6% strongly disagreed that this was the case. It was apparent that 52.7% of the respondents agreed that when planning to drill a well they used measures aimed at reducing time wastage and 2.7% strongly disagreed.

Table 4.16: Respondents take on measures to reduce time wastage

		Frequency	Percent
Timely completion of well is high priority	Strongly Disagree	4	3.6
	Disagree	2	1.8
	Neither agree nor disagree	9	8.0
	Agree	64	57.1
	Strongly agree	33	29.5
Drilling team always strives to avoid time wastage	Strongly Disagree	3	2.7
	Disagree	7	6.3
	Neither agree nor disagree	11	9.8
	Agree	60	53.6
	Strongly agree	31	27.7
Site management essential in reduction of drilling time wastage	Strongly Disagree	2	1.8
	Disagree	7	6.3
	Neither agree nor disagree	5	4.5
	Agree	58	51.8
	Strongly agree	40	35.7
Team leader advice to drilling team on potential for time wastage	Strongly Disagree	4	3.6
	Disagree	10	8.9
	Neither agree nor disagree	18	16.1
	Agree	53	47.3
	Strongly agree	27	24.1
Use of measures by drilling team aimed to reduce time wastage	Strongly Disagree	3	2.7
	Disagree	7	6.3
	Neither agree nor disagree	9	8.0
	Agree	59	52.7
	Strongly agree	34	30.4

4.19 Contribution to untimely completion of wells

Respondents were asked to rate four survey items on how they thought each contributed to the untimely completion of wells. Equipment failure was given the highest rating with 47 respondents constituting 42% of the total respondents giving it the highest rating. Shift change was given the lowest rating with about 41.1% of the respondents constituting of 46 persons rating it as having the lowest contribution to untimely completion of wells as shown in table 4.10.

Table 4.17: Contribution to untimely completion of wells

		Frequency	Percent
Contribution of shift change to untimely completion of wells	Highest	20	17.9
	High	26	23.2
	Low	20	17.9
	Lowest	46	41.1
Contribution of equipment failure to untimely completion of wells	Highest	47	42.0
	High	27	24.1
	Low	28	25.0
	Lowest	10	8.9
Contribution of rig management team experience to untimely completion of wells	Highest	20	17.9
	High	38	33.9
	Low	34	30.4
	Lowest	20	17.9
Contribution of formation characteristics to untimely completion of wells	Highest	45	40.2
	High	26	23.2
	Low	24	21.4
	Lowest	17	15.2

4.20: Role played in reduction of time wastage

Respondents were asked to rank among the various job categories that they thought played a bigger role in the reduction of time wastage and the summary of the findings was provided in table 4.17 below. Drilling engineers were given the highest rating at 61 respondents or 54.5%. Roustabouts were given the least at 21.4% constituting 24 respondents.

Table 4.18: Ranking of roles

		Frequency	Percent
Drilling engineer's role in time wastage reduction	Highest	61	54.5
	High	22	19.6
	Low	17	15.2
	Lowest	12	10.7
Maintenance engineer's role in time wastage reduction	Highest	39	34.8
	High	33	29.5
	Low	20	17.9
	Lowest	20	17.9
Derrick man's role in time wastage reduction	Highest	28	25.0
	High	39	34.8
	Low	32	28.6
	Lowest	13	11.6
Floor man's role in time wastage reduction	Highest	25	22.3
	High	35	31.3
	Low	35	31.3
	Lowest	17	15.2
Roustabout's role in time wastage reduction	Highest	24	21.4
	High	28	25.0
	Low	29	25.9
	Lowest	31	27.7

4.21 Career development attendance

More than half 68 (60.7%) of the employees had attended a career development programme with 44 (39.3%) saying that they had never attended any career development programme in their current capacity.

Table 4.19: Career development attendance

		Frequency	Percent
Career development attendance	Yes	68	60.7
	No	44	39.3

4.22 Years of Experience by job category

It was necessary to view the experience of the different job categories found at the drilling site as shown in table 4.20 below. From the results obtained it was evident that majority of the respondents at 91 with different job categories had experience of less than 10 years. Only 2 job categories i.e. technician and derrick man had respondents with experience of more than 30 years.

Table 4.20: Years of Experience by job category

		Job category						
		Drilling Engineer	Maintenance Engineer	Technician	Roustabout	Derrick Man	Rig Floor man	Total
Years of Experience	Less than 10	10	5	19	14	8	35	91
	Between 10 and 19	0	2	6	4	0	3	15
	Between 20 and 29	1	0	0	1	0	2	4
	Between 30 and 39	0	0	1	0	1	0	2
Total		11	7	26	19	9	40	112

4.23 Job category by satisfaction with shift coordination

When shift coordination was checked against job categories of the respondents it was found out that 2 drilling engineers and 1 technician were very dissatisfied with shift coordination, none of the other job categories chose this option. On the other hand 1 engineer, 2 technicians, 6 roustabouts, 5 derrick men and 13 rig floor men were very satisfied with the way the different shifts were coordinated.

Table 4.21: Job category by shift coordination satisfaction

		Shift Co-ordination					
		Very Dissatisfied	Dissatisfied	Quite Satisfied	Satisfied	Very Satisfied	Total
Job Category	Drilling Engineer	2	2	3	3	1	11
	Maintenance Engineer	0	1	2	4	0	7
	Technician	1	0	10	13	2	26
	Roustabout	0	0	8	5	6	19
	Derrick Man	0	2	1	1	5	9
	Rig Floor man	0	5	10	12	13	40
Total		3	10	34	38	27	112

4.24 Job category by department change preference

Generally there was a tendency of the various job categories resenting the idea of changing from the drilling department to another department with 3 drilling engineers, 4 maintenance engineers, 12 technicians, 11 roustabouts, 6 derrick men and 21 rig floor men stating categorically that they would definitely not change to another department. Nevertheless, 2 drilling engineers, 1 technician, 2 roustabouts and 1 rig floor man would prefer to change from the drilling department to another department.

Table 4.22: Job category by department change preference

		Department change preference					
		Definitely not	Probably not	Maybe	Probably would	Definitely would	Total
Job Category	Drilling Engineer	3	2	3	1	2	11
	Maintenance Engineer	4	2	1	0	0	7
	Technician	12	3	6	4	1	26
	Roustabout	11	3	2	1	2	19
	Derrick Man	6	1	2	0	0	9
	Rig Floor man	21	3	12	3	1	40
Total		57	14	26	9	6	112

4.25 Job category by frequency of drilling related breakdowns

A cross tab for job category by drilling related breakdown as shown in table 4.23 was necessary to see the responses from different job categories bearing in mind that maintenance engineers and technicians were the main people when it came to dealing with maintenance issues like break downs and that their opinion was more sort. A general feeling by all the respondents was that the occurrence drilling related break downs was often on a monthly basis. Considering responses from the maintenance engineers and technicians majority were of the opinion that drilling related break downs occurred fortnightly.

Table 4.23: Job category by frequency of drilling related breakdowns

	Frequency of drilling breakdown						
		Weekly	Daily	Fortnightly	Twice weekly	Monthly	Total
Job category	Drilling Engineer	2	2	5	1	1	11
	Maintenance Engineer	1	1	4	1	0	7
	Technician	2	4	8	4	8	26
	Roustabout	2	2	7	0	8	19
	Derrick Man	0	1	1	3	4	9
	Rig Floor man	5	6	8	8	13	40
Total		12	16	33	17	34	112

4.26 Job category by career development attendance

Out of 111 respondents, 68 of the respondents said they had attended a career development programme with 43 saying they had not attended. Out of 11 drilling engineers 7 had attended and 4 had not. Within 40 Rig floor men 21 attended and 19 did not attend. Out of 25 technicians who responded, 19 had attended a career development programme while from 7 maintenance engineers 5 had attended. 5 out of 9 derrick men responded to have attended a career development programme and finally 11 roustabouts from a total of 19 roustabouts also had attended a career development programme.

Table 4.24: Job group by career development attendance

	Career development attendance			
		Yes	No	Total
Job category	Drilling Engineer	7	4	11
	Maintenance Engineer	5	2	7
	Technician	19	6	25
	Roustabout	11	8	19
	Derrick Man	5	4	9
	Rig Floor man	21	19	40
Total		68	43	111

4.27 Correlations

The researcher took further steps to determine the degree of association or the strength of relationships of various variables by determining their Pearson Correlation Coefficient. Correlation coefficient of the following variables was determined;

i. Job category and effect of procurement on timely completion of a well, shift coordination and urge to drill a well in planned time.
ii. Achieving timely completion of a well being a highly prioritized and drilling team striving to avoid time wasting, site management being essential to ensure reduction of time wastage and drilling team being advised by team leader on potential for wasting time.
iii. Experience of the rig management team and shift change management and equipment failure.
iv. Night shift satisfaction and working environment satisfaction and remuneration expectation of the respondents.

4.27.1 Job category and effect of procurement on timely completion of a well, shift coordination and urge to drill a well in planned time.

The table below shows that there is a negative and weak relationship between job category and effect of procurement on timely completion of a well, $p<0.226$; and that there is positive but weak correlation between job category and shift coordination, $p>0.011$; more so there is a negative but weak relationship between job category and the urge to drill a well in planned time, $p<0.117$. The most significant correlation in this case is between job category and shift coordination.

Table 4.25: Correlations between job category and effect of procurement on timely completion of a well, shift coordination and urge to drill a well in planned time

		Job Category	Effect of procurement on timely completion of a well	Shift co-ordination	Urge to drill a well in planned time
Job Category	Pearson Correlation	1	-0.115	0.239*	-0.149
	Sig. (2-tailed)		0.226	0.011	0.117
Procurement and timely completion	Pearson Correlation	-0.115	1	-0.101	0.124
	Sig. (2-tailed)	0.226		.291	.192
Shift Co-ordination	Pearson Correlation	0.239*	-0.101	1	-0.202*
	Sig. (2-tailed)	0.011	0.291		0.032
Urge to drill well in planned time	Pearson Correlation	-0.149	0.124	-0.202*	1
	Sig. (2-tailed)	0.117	0.192	0.032	

***. Correlation is significant at the 0.05 level (2-tailed).**

4.27.2 Achieving timely completion of a well taken as a high priority and drilling team striving to avoid time wasting, site management being essential to ensure reduction of time wastage and drilling team being advised by team leader on potential for wasting time

Table 4.26 shows that there is a positive weak correlation between achieving timely completion of a well taken as a high priority and drilling team striving to avoid wasting time, $p>0.003$; that there is a positive but weak correlation between achieving timely completion of a well taken as a high priority and site management being essential to ensure reduction of time wastage, $p>0.000$; that there is a positive but weak correlation between achieving timely completion of a well taken as a high priority and drilling team being advised by team leader on potential for wasting time, $p>0.037$ and that there is a positive but weak correlation between achieving timely completion of a well taken as a high priority and drilling crew using measures geared towards reducing time wastage, $p>0.001$. All the variables correlated with achieving timely completion of a well taken as a high priority were found to be significant at 0.01 and 0.05 levels.

Table 4.26: Correlations between achieving timely completion of a well taken as a high priority and drilling team striving to avoid time wasting, site management being essential to ensure reduction of time wastage and drilling team being advised by team leader on potential for wasting time

		Achieving timely completion of a well being highly prioritized	Drilling team striving to avoid time wasting	Site management essential to ensure reduction of time wastage	Drilling team being advised by team leader on potential for wasting time	Drilling crew using measures geared towards reducing time wastage
Achieving timely completion of a well being highly prioritized	Pearson Correlation	1	0.277**	0.389**	0.197*	0.305**
	Sig. (2-tailed)		0.003	0.000	0.037	0.001
Drilling team striving to avoid time wasting	Pearson Correlation	0.277**	1	0.101	0.286**	0.483**
	Sig. (2-tailed)	0.003		0.288	0.002	0.000
Site management essential to ensure reduction of time wastage	Pearson Correlation	0.389**	0.101	1	0.089	0.308**
	Sig. (2-tailed)	0.000	0.288		0.349	0.001
Drilling team being advised by team leader on potential for wasting time	Pearson Correlation	0.197*	0.286**	0.089	1	0.332**
	Sig. (2-tailed)	0.037	0.002	0.349		0.000
Drilling crew using measures geared towards reducing time wastage	Pearson Correlation	0.305**	0.483**	0.308**	0.332**	1
	Sig. (2-tailed)	0.001	0.000	0.001	0.000	

****. Correlation is significant at the 0.01 level (2-tailed).**
***. Correlation is significant at the 0.05 level (2-tailed).**

4.27.3 Experience of the rig management team and shift change management and equipment failure

The study revealed a positive but weak correlation between experience of the rig management team and shift change management, p>0.021 also from table 4.27 there was positive but weak correlation between experience of the rig management team and equipment failure, p>0.041. Shift change management and equipment failure variables were found to be significant at 0.05 level.

Table 4.27: Correlations between experience of the rig management team and shift change management and equipment failure

		Experience of the rig management team	Shift change management	Equipment failure
Experience of the rig management team	Pearson Correlation	1	0.218*	0.193*
	Sig. (2-tailed)		.021	0.041
Shift change management	Pearson Correlation	0.218*	1	-0.167
	Sig. (2-tailed)	0.021		0.078
Equipment failure	Pearson Correlation	0.193*	-0.167	1
	Sig. (2-tailed)	0.041	0.078	

***. Correlation is significant at the 0.05 level (2-tailed).**

4.27.4 Night shift satisfaction and working environment satisfaction and remuneration expectation of the respondents

From table 4.28 there was a positive but weak correlation between night shift satisfaction and general working environment, $p>0.019$. The correlation between night shift satisfaction and remuneration was found to be positive but weak, $p>0.015$. Both the two variables being correlated with night shift satisfaction were significant at 0.05 level.

Table 4.28: Correlations between night shift satisfaction and working environment satisfaction and remuneration expectation of the respondents

		Night shift satisfaction	General working environment satisfaction	Remuneration expectation
Night shift satisfaction	Pearson Correlation	1	0.221*	0.228*
	Sig. (2-tailed)		0.019	0.015
Working environment satisfaction	Pearson Correlation	0.221*	1	0.127
	Sig. (2-tailed)	0.019		0.181
Remuneration expectation	Pearson Correlation	0.228*	0.127	1
	Sig. (2-tailed)	0.015	0.181	

***. Correlation is significant at the 0.05 level (2-tailed).**

4.28 Hypothesis testing

4.28.1 Hypothesis 1

H_O: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

The above hypothesis was tested by looking at the variables that the respondents responded to that sort to look at how human factors affected timely completion of geothermal wells. Shift coordination under job organization, working environment and night shift satisfaction under working environment were tested against job category so as to either reject or fail to reject the null hypothesis.

From table 4.30 below the study has more than 3 categories thus we look at the first row of Pearson chi-square. The 2-sided Asymptotic significance is 0.007 which is lower than 0.05 which means that there is a significant difference hence reject H_O: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects and fail to reject H_1: Human factors have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

Table 4.29: Shift co-ordination

			Shift Co-ordination					
			Very Dissatisfied	Dissatisfied	Quite Satisfied	Satisfied	Very Satisfied	Total
Job Category	Drilling Engineer	Count	2	2	3	3	1	11
		% within Job Category	18.2%	18.2%	27.3%	27.3%	9.1%	100.0%
	Maintenance Engineer	Count	0	1	2	4	0	7
		% within Job Category	0.0%	14.3%	28.6%	57.1%	0.0%	100.0%
	Technician	Count	1	0	10	13	2	26
		% within Job Category	3.8%	0.0%	38.5%	50.0%	7.7%	100.0%
	Roustabout	Count	0	0	8	5	6	19
		% within Job Category	0.0%	0.0%	42.1%	26.3%	31.6%	100.0%
	Derrick Man	Count	0	2	1	1	5	9
		% within Job Category	0.0%	22.2%	11.1%	11.1%	55.6%	100.0%
	Rig Floor man	Count	0	5	10	12	13	40
		% within Job Category	0.0%	12.5%	25.0%	30.0%	32.5%	100.0%
Total		Count	3	10	34	38	27	112
		% within Job Category	2.7%	8.9%	30.4%	33.9%	24.1%	100.0%

Table 4.30: Chi-Square Tests- shift co-ordination

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.653[a]	20	0.007
Likelihood Ratio	40.420	20	0.004
Linear-by-Linear Association	6.349	1	0.012
N of Valid Cases	112		

a. 22 cells (73.3%) have expected count less than 5. The minimum expected count is .19.

Looking at table 4.32 below the Pearson chi-square on the first row fourth column, the value is 0.228 which is greater than 0.05 thus there is no significant difference and thus we fail to reject H_O: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

Table 4.31: General working environment satisfaction

			General working Environment Satisfaction				
			Dissatisfied	Quite Satisfied	Satisfied	Very Satisfied	Total
Job Category	Drilling Engineer	Count	1	5	4	1	11
		% within Job Category	9.1%	45.5%	36.4%	9.1%	100.0%
	Maintenance Engineer	Count	0	4	2	1	7
		% within Job Category	.0%	57.1%	28.6%	14.3%	100.0%
	Technician	Count	0	9	16	1	26
		% within Job Category	.0%	34.6%	61.5%	3.8%	100.0%
	Roustabout	Count	1	4	9	5	19
		% within Job Category	5.3%	21.1%	47.4%	26.3%	100.0%
	Derrick Man	Count	0	0	5	4	9
		% within Job Category	.0%	.0%	55.6%	44.4%	100.0%
	Rig Floor man	Count	2	12	19	7	40
		% within Job Category	5.0%	30.0%	47.5%	17.5%	100.0%
Total		Count	4	34	55	19	112
		% within Job Category	3.6%	30.4%	49.1%	17.0%	100.0%

Table 4.32: Chi-Square Tests-working environment satisfaction

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.684[a]	15	.228
Likelihood Ratio	22.181	15	.103
Linear-by-Linear Association	2.447	1	.118
N of Valid Cases	112		

a. 16 cells (66.7%) have expected count less than 5. The minimum expected count is .25.

The Pearson chi-square for this case was 0.209 as shown on table 4.34 which is greater than 0.05 hence there is no significant difference and thus we fail to reject H_O: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

Table 4.33: Night shift satisfaction

			Night Shift Satisfaction					
			Very Dissatisfied	Dissatisfied	Quite Satisfied	Satisfied	Very Satisfied	Total
Job Category	Drilling Engineer	Count	0	2	4	1	4	11
		% within Job Category	.0%	18.2%	36.4%	9.1%	36.4%	100.0%
	Maintenance Engineer	Count	0	1	1	3	2	7
		% within Job Category	.0%	14.3%	14.3%	42.9%	28.6%	100.0%
	Technician	Count	0	3	8	12	3	26
		% within Job Category	.0%	11.5%	30.8%	46.2%	11.5%	100.0%
	Roustabout	Count	1	2	4	9	3	19
		% within Job Category	5.3%	10.5%	21.1%	47.4%	15.8%	100.0%
	Derrick Man	Count	1	0	3	0	5	9
		% within Job Category	11.1%	.0%	33.3%	.0%	55.6%	100.0%
	Rig Floor man	Count	1	1	15	12	11	40
		% within Job Category	2.5%	2.5%	37.5%	30.0%	27.5%	100.0%
Total		Count	3	9	35	37	28	112
		% within Job Category	2.7%	8.0%	31.3%	33.0%	25.0%	100.0%

Table 4.34: Chi-Square Tests-night shift satisfaction

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.800[a]	20	.209
Likelihood Ratio	28.883	20	.090
Linear-by-Linear Association	.354	1	.552
N of Valid Cases	112		

a. 22 cells (73.3%) have expected count less than 5. The minimum expected count is .19.

4.28.2 Hypothesis 2

H_O: Maintenance of the rig and equipment does not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

On table 4.36 the Pearson chi-square at 12 degrees of freedom was 0.909 which is higher than 0.05 thus there is no correlation between frequencies of drilling related breakdowns as reported by the employees categorized by their years of experience. Thus we fail to reject H_O: Maintenance of the rig and equipment does not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

Table 4.35: Frequency of drilling related breakdown

			Frequency of drilling related breakdown					
			Weekly	Daily	Fortnightly	Twice weekly	Monthly	Total
Years of Experience	Less than 10	Count	10	12	26	14	29	91
		% within Years of Experience	11.0%	13.2%	28.6%	15.4%	31.9%	100.0%
	Between 10 and 19	Count	2	3	5	2	3	15
		% within Years of Experience	13.3%	20.0%	33.3%	13.3%	20.0%	100.0%
	Between 20 and 29	Count	0	1	1	0	2	4
		% within Years of Experience	0.0%	25.0%	25.0%	0.0%	50.0%	100.0%
	Between 30 and 39	Count	0	0	1	1	0	2
		% within Years of Experience	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
Total		Count	12	16	33	17	34	112
		% within Years of Experience	10.7%	14.3%	29.5%	15.2%	30.4%	100.0%

Table 4.36: Chi-Square Tests-frequency of drilling related breakdown

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.141[a]	12	0.909
Likelihood Ratio	7.514	12	0.822
Linear-by-Linear Association	0.037	1	0.848
N of Valid Cases	112		

a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is .21.

The Pearson chi-square value is at 0.436 as shown on table 4.38 which is higher than 0.05 thus we fail to reject H_O: Maintenance of the rig and equipment does not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects.

Table 4.37: Approach to equipment maintenance

			Approach to equipment maintenance				
			Fix it when broken	Scheduled maintenance	Condition-based monitoring	Detection of sources of failures	Total
Years of Experience	Less than 10	Count	30	38	15	8	91
		% within Years of Experience	33.0%	41.8%	16.5%	8.8%	100.0%
	Between 10 and 19	Count	3	8	4	0	15
		% within Years of Experience	20.0%	53.3%	26.7%	0.0%	100.0%
	Between 20 and 29	Count	0	2	2	0	4
		% within Years of Experience	0.0%	50.0%	50.0%	0.0%	100.0%
	Between 30 and 39	Count	1	0	1	0	2
		% within Years of Experience	50.0%	0.0%	50.0%	0.0%	100.0%
Total		Count	34	48	22	8	112
		% within Years of Experience	30.4%	42.9%	19.6%	7.1%	100.0%

Table 4.38: Chi-Square Tests- approach to equipment maintenance

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.017[a]	9	0.436
Likelihood Ratio	11.697	9	0.231
Linear-by-Linear Association	0.479	1	0.489
N of Valid Cases	112		

a. 11 cells (68.8%) have expected count less than 5. The minimum expected count is .14.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the summary of the findings, discussion, conclusion, recommendations and suggestion for further studies. This section of the study concludes the research findings as carried out.

5.2 Summary of the findings

The finding revealed that 96.4% of the respondents were male with 51% being of age 30 and below. 64.3% of the respondents had tertiary education. 81.3% of the respondents had less than 10 years relevant experience with most of the respondents being rig floor men at 35.7% which constitutes 40 individuals and maintenance engineers were the least represented at 6.3% or 7 individuals.

The main objectives of the study were to ascertain how human factors, procurement process, maintenance of the rig and equipment influenced timely completion of geothermal wells in Menengai Geothermal Prospects Site. The first objective was to ascertain the extent to which human factors influenced timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. The main human factors in the survey which were studied were interaction with other employees, work environment, shift coordination and satisfaction with night shifts formed the backbone of this objective. Most of the respondents were satisfied with employee interaction at 95.6%. Majority of the respondents (96.5%) expressed satisfaction with the general work environment. Most of the respondents said they were satisfied with the coordination of different shifts at 58.1%. An overwhelming 89.3% of the respondents were satisfied with working on night shifts. When asked about the awareness to drill wells within planned time 89.3% of the respondents were in the know that there was the urge to drill the wells in projected time.

Other human factors under study were relevant job experience where 81.3% of the respondents had less than 10 years relevant job experience, job categories in the drilling department where most of them were rig floor men at 35.7% and the last were maintenance engineers at 6.3%, department change preference where majority of the respondents at 63.4% did not wish to change department however more than half of the drilling engineers (6 out of 11 drilling engineers) entertained the idea to change department and contentment with remuneration where 58.9% agreed that they were comfortable with what they earned.

The second objective was to establish how procurement process influenced timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. To achieve these respondents were asked to rate using a five point scale how satisfied they were with the procurement of drilling resources. Slightly more than half of the respondents 51.8% were satisfied with procurement of drilling resources while 48.2% were not satisfied. When asked the extent to which procurement process influenced timely completion of geothermal wells, 68.8% or 77 respondents felt that the procurement process affected timely completion of geothermal wells very much.

The last objective was to ascertain how maintenance of the rig and equipment influenced timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. To assess this a few survey items were used; Respondents were asked to state the approach of the company to equipment maintenance. Most of the respondents (42.9%) stated scheduled maintenance followed by 30.4% who stated “fix it when broken”. Detection of sources of failures was the least selected at 7.1% or 8 respondents. When asked to rate the company’s response(top management) to break down of machinery using a five point scale, the response was fairly uniformly distributed with most of the respondents choosing very slow and very quick at 22.3%, slow at 20.5%, quick at 19.6% and very quick at 15.2%.When asked how often they experienced breakdown of machinery, most of the respondents i.e. 30.4% said monthly, 10.7% said weekly, 14.3% said daily, 29.5% said fortnightly and 15.2% said twice weekly.

The test of hypothesis 1 established that human factor do not have significant influence on the time taken to complete geothermal wells in Menengai geothermal prospects. Test of hypothesis 2 established that maintenance of the rig and equipment do not have significant influence on the time taken to complete geothermal wells.

More so when the respondents’ opinion was sort on influence of formation characteristics to timely completion of geothermal wells in Menengai Geothermal Prospect Site in Nakuru County, Kenya an overwhelming 40.2% of the respondents felt that formation characteristics had very high influence on timely completion of geothermal wells.

Table 5.1 Summary of hypotheses tests

HYPOTHESIS	RESULTS	REMARKS
H_O: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.	Shift coordination: P value is 0.007; p>0.007 General working environment: P value is 0.228; p<0.228 Night shift satisfaction: P value is 0.209; p<0.209	REJECT THE NULL HYPOTHESIS. FAIL TO REJECT NULL HYPOTHESIS. FAIL TO REJECT NULL HYPOTHESIS. Of the three variables used to test the hypothesis on human factors 2 out of 3 results have it that we fail to reject the null hypothesis depicting that there is no significant relation between human factors and timely completion of geothermal wells Menengai Geothermal Prospects.
H_O: Maintenance of the rig and equipment does not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.	Frequency of drilling related breakdown: P value is 0.909, p<0.909 Approach to equipment maintenance: P value is 0.209, p<0.209	FAIL TO REJECT NULL HYPOTHESIS. FAIL TO REJECT NULL HYPOTHESIS. Therefore the conclusion is that there is no significant relation between maintenance of the rig and equipment and timely completion of geothermal wells Menengai Geothermal Prospects.

5.3 Discussion

The aim of this research study was to determine how human factors, procurement process and maintenance of the rig and equipment influenced timely completion of geothermal wells in Menengai Geothermal Prospect Site in Nakuru County, Kenya. According to Siti et al., (2011) job satisfaction is the key to establishing a healthy organizational environment in an organization, and the most important evidence that indicates the worsening conditions of an organization is the low rate of job satisfaction. Nonetheless, factors related to job satisfaction are relevant in the prevention of employee frustration and low job satisfaction because employees will work harder and perform better if they are satisfied with their jobs.

Questions directed towards answering job satisfaction produced varied results for instance while assessing department change preference majority of the respondents did not wish to change department showing they were satisfied with whatever work their department was involved in, however on category basis it was discovered that more than half of the drilling engineers entertained the idea to change department. This depicted that they were more or less not satisfied with work within their department. Another question posed to assess satisfaction was contentment with remuneration where majority agreed that they were comfortable with what they earned.

The job environment is another factor under human factors that was investigated. Parsons (2000) suggests that air temperature, noise, humidity, and light were four environmental factors that could influence job satisfaction. Environmental factors such as temperature and humidity can have important effects on psychological parameters such as level of arousal and motivation. Job environment is defined as "the condition of mind which expresses satisfaction with the thermal environment" Parsons (2000). When the respondents responded to the take on general working environment, majority of the respondents expressed satisfaction with the general working environment. More so quite a large number of the respondents were satisfied with night shifts.

On job organization, work method describes how tasks are being organized (Rouse et al., 1991) and according to Quirk (1999), the methods could include procedures, instructions and documentation that define how processes or tasks are accomplished. One crucial task that can contribute to time wastage is shift change coordination. Respondents were of the view that shift coordination was done in a manner that that they felt it was satisfactory in terms of time management.

Wang et al., (1998) postulates that the tendering system proves effective in shortening completion time, improving quality, and lowering costs of construction works. Respondents were in the view that the procurement process adopted by GDC affected very much timely completion of geothermal wells in Menengai Geothermal Prospects Site. The tendering process adopted by GDC is competitive tendering, where urgent procurement is required then it might be not the case since the Public Procurement Act has to come into play for government companies like GDC. Bidders have to be invited to bid and

A study by Van Thuyet N & Ogunlana S. O., (2007) in oil and gas revealed that poor evaluation criteria setting and unethical behaviour of bidders were the two main reasons for tendering risk in the oil and gas industry in Vietnam. This scenario was also cited by engineers doing procurement. Often, the lowest bidder is chosen in order to save on project cost. In addition, since tendering is a very sensitive issue, accepting the lowest-price tender may help the public owners to defend themselves from criticisms and to show accountability (Wong et al., 2000). However, in some cases, bidders submit the low prices in order to win the bid and at the later stage they negotiate for higher pay, this makes the procurement process lengthy and in the long run affect timely completion of projects. When interviewed the engineers involved in procured cited this examples that trickled down to affect timely completion of geothermal wells in Menengai Geothermal Prospect Site.

Hisham B J & Perkasa S. B S, (2003) define maintenance as any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions, or to repair any equipment that has failed, or to keep the equipment running, or to restore to its favourable operating condition. There are various approaches to maintenance of equipment with their merits and demerits. Respondents were in the view that the maintenance strategy approach by GDC was scheduled or planned maintenance which as Peak Industrial solutions, (1999) put across is a well-intended strategy. Quite a good number of the respondents felt that also break down maintenance was in play, a strategy that requires repairing, restoration or replacement of components in an environment where procurement is quite a process.

5.4 Conclusion

This study researched on factors influencing timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. The study objectives were successfully addressed using the methodology described in chapter three and the following conclusions were made:

Human factors were found to have no significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. The human factors under job satisfaction, job organization and job environment depicted a level of satisfaction from the respondents as assessed through the questionnaire and final analysis of the data.

The procurement process was found to influence very much timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya. A balanced response on satisfaction with procurement process in relation to drilling resources was returned with half of the respondents being satisfied with the process and another half being dissatisfied with the process.

Maintenance of the rig and equipment did not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya as the outcome from the test of hypothesis showed. More respondents were in the view that there was a quick response to restore broken down machinery whereas scheduled maintenance approach was adopted. More so, break down maintenance was viewed to be an approach practised in GDC.

Opinion on how formation characteristics contributed towards timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya was sort. From the results obtained its significant influence could not be understated by the response from the respondents, hence it is worth to conclude that the formation characteristics have a significant influence on timely completion of geothermal wells in Menengai Geothermal Prospects Site in Nakuru County, Kenya.

5.5 Recommendations

From this study the following recommendations are made;

i. GDC should find a way to streamline its procurement process for drilling resources as the respondents overwhelmingly agreed that the procurement process affected timely completion of geothermal wells.

ii. When the respondents were asked who played the most important role in reduction of time wastage, the drilling engineer emerged with the highest score while on career development more than half of the drilling engineers had not attended any career development programme. Therefore GDC should take deliberate steps to train more drilling engineers to equip them with skills that they can be able to effectively run drilling operations.

iii. Approach to maintenance was deemed to be scheduled maintenance approach, however quite a good number of the respondents were in the view that break down maintenance was also a practice, it is therefore recommended that a planned or scheduled maintenance culture be instilled in GDC and where necessary detection of sources of failures be adopted to avoid break down maintenance.

5.6 Recommendation for further study

While carrying out this study the formation characteristics were hard to measure and hence treated as an intervening variable. However, a scientific research should be done to ascertain how formation characteristics influence timely completion of geothermal wells in Menengai Geothermal Prospect Site.

REFERENCES

August, Jim . Applied reliability-centered maintenance. s.l. : PennWell, 1999.

Ben-Daya, Mohamed, O. Duffuaa, Salih and Raou, Abdul. *Handbook of Maintenance Management and Engineering* . s.l. : Springer, 2009. p. 420.

Bertani, R., 2010. Geothermal Power Generation in the World, 2005-2010 Update Report. Proc. World Geothermal Congress 2010, Bali, Indonesia, 25-29 April 2010, p 41

Bloom, Neil B. 3 Day In-house RCM Training Seminars. *RCM Training Seminars.* [Online] 2005. [Cited: 02 February 2011.] http://www.rcmtrainingseminars.com/index.html.

Chilingarian G., and R. Vorabutr 1983, Drilling and Drilling Fluids, Appendix G, New York, Amsterdam: Elsevier, p.765–778.

Choy DS , Siam Yoke . TPM Implementation Experiences .*Maintenance Resources.* [Online] [Cited: 02 February 2011.] http://www.maintenanceresources.com/referencelibrary/ezine/tpmimplementation.htm.

Dunn, Sandy. Maintenance Terminology - Some Key Terms. *Maintenancere Sources.* [Online] 2010. [Cited: 10 November 2010.]http://www.maintenanceresources.com/referencelibrary/maintenancemanagement/keyterms.htm#RCM.

Eyal, S., Dov, L., Ran, G., & Ezra, Z. (2008). Assessment of Geothermal Resources in Israel (Report GSI /29/ 2008). Jerusalem, November 2008.

Geothermal energy Annual Report 2010 International Energy Agency 27 January 2012

GIA Papers Presented at WGC2010

Girdhar, Paresh and Scheffer, Cornelius. Practical machinery vibration analysis and predictive maintenance. s.l : Elsevier,2004.

Gupta, Sorabh, Tewari, P C and Sharma, Avadhesh Kumar. TPM Concept an Implementation Approach. *Maintenance World.* [Online][Cited: 02 February 2011.] http://www.maintenanceworld.com/articles/sorabh/research_pap er.pdf.

Hartmann, Ed. Prescription for Total TPM Success.*Maintenance Technology* . [Online] 01 April 2000. [Cited: 02 February 2011.] http://www.mt-online.com/component/content/article/178-april2000/573-prescription-for-total-tpm-success.html?directory=90.

Hisham B J, Perkasa S. B S, (2003) Plant Maintenance Strategy: Key for Enhancing Profitability

Jabar, Hisham Bin and Bhd, Segi Perkasa Sdn. Plant Maintenance Strategy: Key for enhanceing Profitability. *Maintenance Resources.* [Online] 2003. [Cited: 10 November 2010.] http://www.plant-maintenance.com/tzd.shtml.

Kennedy, Ross. Examining the processes of RCM and TPM.*Plant Maintenance.* [Online] January 2006. [Cited: 19th January 2011.] http://www.plant-maintenance.com/articles/RCMVsTPM.pdf.

K. Popper, *The Logic of Scientific Discovery* (1959), reprinted (2004) by Routledge, Taylor & Francis S. Ackroyd and J. A. Hughes, *Data Collection in Context* (1981) Longman. Retrieved from (libweb.surrey.ac.uk/library/skills/.../page_51.htm.)

Krejcie, Robert V., Morgan, Daryle W., "Determining Sample Size for Research Activities", Educational and Psychological Measurement, 1970.

Last, J. (Ed.). (2001). International epidemiological association. A dictionary of epidemiology (4th ed.).New York: Oxford University Press.

Laerd dissertation. (2012). Purposive Sampling.

Retrieved from http://dissertation.laerd.com/purposive-sampling.php

Lingham, Leo. Management Consulting/Maintenance Management. *AllExperts.* [Online] 09 March 2010. [Cited: 03 February 2013.] http://en.allexperts.com/q/Management- Consulting-2802/2010/9/MAintainance-Management.htm.

Lindell. K, Perry. Preparedness for Emergency Response: Guidelines for the Emergency Planning Process. Disasters. Volume 27, Issue 4, pages 336–350, December 2003

Mongillo, M.A., 2005. Savings factors for geothermal energy utilization. IEA Geothermal Implementing Agreement document, January 2005. (available on IEA-GIA website: Savings Factors.pdf)

Moubray, John. *Reliability-Centered Maintenance.* 2. s.l. : Industrial Press Inc, 1997. p. 320.

Moubray JM, (2000), Maintenance Management – A New Paradigm, Maintenance Resources.Com

Murthy, D N.P and Kobbacy, K A.H. Complex System Maintenance Handbook. s.l. : Springer, 2008, pp. 34-35

Nigel Fielding, Jane L. Fielding linking data 1986

Ogoye, H. K (2002). Alternative Sources of Funding KenGen Investments. In "Gearing up for Competition". Proceedings of the 2nd KenGen Technical Seminar, Safari Park Hotel, Nairobi, Kenya, 13th – 15th November.

Peak Industrial solutions (1999). Streamline Your Maintenance Operation for Optimum Performance. Retrieved from http://www.reliableplant.com/Read/28975/streamline-maintenance-operation

Ray, R.S., Hornibrook, J., Skitmore, M. and Zarkada-Fraser, A. (1999), "Ethics in tendering: a survey of Australian opinion and practice", Construction Management and Economics, Vol. 17, pp. 139-53.

Robert D. Grace, Jerald L. Shursen &Richard S. Carden, Drilling Practices 2008.

Sinha, Dr.Pradip Kumar. *Manufacturing and Operations Management.* 1. s.l. : Prakashan, December 2008.

Technology, Reliability and PdM. Reliability Centered Maintenance Advantage and Disadvantages . *PM-PdM Technology for Manufacturing Industries.* [Online] 06 January

2010. [Cited: 16 December 2010.] http://preventive-predictive-maintenance.blogspot.com/2010/01/reliability-centered-maintenance.html.

Telang, A D and elang, Amit. *Comprehensive Maintenance Management: Policies Strategies and Options.* s.l. : PHI, 2010. [15] *Reliability Centered Maintenance.* Rausand, Marvin.

Tesdahl, SA and Tomlingson PD, (1999), Breakthrough Maintenance Strategy for the 21st Century, Equipment Management.

Venkatesh, J. An Introduction to Total Productive Maintenance. *Plant Maintenance Resource Center.* [Online] 03 August 2009. http://www.plant-maintenance.com/articles/tpm_intro.shtml.

Wang, S.Q., Tiong, R.L.K., Ting, S.K., Chew, D. and Ashley, D. (1998), "Evaluation and competitive tendering or BOT power plant project in China", Journal of Construction Engineering and Management, Vol. 1998, pp. 333-41.

Waeyenbergh, Geert and Pintelon, Liliane. 2000. *A framework for maintenance concept development.* International journal of production economics, pp. 299-13

Wong, C.H., Holt, G.H. and Cooper, P.A. (2000), "Lowest price or value? Investigation of UK construction clients' tender selection process", Construction Management and Economics, Vol. 18, pp. 767-74.

World Bank report. (2012).

Retrieved from http://www. http://thinkgeoenergy.com/archives/15033

APPENDIX 1

Table showing wells with their estimated completion days and actual drilling days

WELL NUMBER	SPUD IN DATE	COMPLETION DATE	ESTIMATED COMPLETION DAYS	ACTUAL DRILLING DAYS
MW-01	12.02.2011	01.05.2011	80	79
MW-02	28.02.2011	02.07.2011	80	125
MW-03	01.06.2011	09.09.2011	80	100
MW-04	15.07.2011	08.10.2011	80	83
MW-06	26.10.2011	29.01.2012	80	96
MW-07	03.02.2012	01.06.2012	80	120
MW-08	17.02.2012	20.06.2012	80	120
MW-09	17.07.2012	31.10.2012	60	107
MW-11	28.09.2012	10.02.2013	60	135
MW-12	14.10.2012	16.01.2013	60	93
MW-05A	13.12.2012	28.03.2013	60	106

APPENDIX 2

Table showing types of Maintenance Strategies

Maintenance Strategy	**Maintenance Approach**	**Signification**
Breakdown Maintenance	Fix-it when broke	Large maintenance budget
Preventive Maintenance	Scheduled Maintenance	Periodic component replacement
Predictive Maintenance	Condition-based Monitoring	Maintenance decision based on equipment condition
Proactive Maintenance	Detection of Sources of Failures	Monitoring and correcting failing root causes

APPENDIX 3

Krejcie and Morgan sampling table

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Where: “N” is population size, S” is sample size.

APPENDIX 4

Questionnaire

Dear Sir/Madam,

I am currently undertaking a Masters Degree in Project Planning and Management at the University of Nairobi. In fulfilment of my dissertation I am required to research a topic area. The topic I have chosen is *factors influencing timely completion of geothermal wells; a case of Menengai Geothermal Prospects in Nakuru County*. I am investigating how human factors, procurement process and maintenance of the rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects Site and thereafter recommend the necessary interventions. The questionnaire is structured to research the perceptions of the project stakeholders especially those staffs who are directly involved in drilling of the wells.

I will be very grateful if you complete the questionnaire as provided. Needless to say all information provided will be treated with strict confidence and individual identities will not be disclosed.

1. Gender
    - Male ☐
    - Female ☐

2. What is your age in years?

Less than 20 years	
21-30 years	
31-40 years	
41-50 years	
Above 50 years	

3. What is your academic qualification?

O-Level	
Diploma	
Higher National Diploma	
Bachelors	
Masters	
PhD	

4. How many years of job experience do you have?

Less than 10 years	
10-19 years	
20-29 years	
30-39 years	
40 years and above	

5. What best describes your position within the drilling operations? (tick appropriately)

Drilling engineer	
Maintenance engineer	
Technician	
Derrick man	
Rig floor man	
Roustabout	
Other (please specify)	

6. Thinking about your interaction with other employees within the Drilling Department, what is your level of satisfaction with the way they relate?
   Where 5-Very satisfied, 1-Very dissatisfied

Very dissatisfied	1	2	3	4	5	Very Satisfied

7. How would you rate your satisfaction with your working environment on a 5-point scale where 5-Very Satisfied t and 1- Very dissatisfied?

Very dissatisfied	1	2	3	4	5	Very Satisfied

8. What is your satisfaction level on night shifts compared to day shifts? Circle appropriately. Where 5-Very satisfied, 1-Very dissatisfied

Very dissatisfied	1	2	3	4	5	Very Satisfied

9. Are you aware of the urge to drill a well within planned time?

Yes	
No	

10. How satisfied are you with the co-ordination of the different shifts? Circle appropriately. Where 5-Very satisfied, 1-Very dissatisfied

Very dissatisfied	1	2	3	4	5	Very Satisfied

11. Please rate the following statements: (Please answer all). Tick as appropriate.

	Strongly Disagree	**Disagree**	**Neither agree nor Disagree**	**Agree**	**Strongly agree**
Achieving timely completion is high priority during the drilling process					
Drilling team always strives to avoid time wastages					
Site Management is essential to ensuring the reduction of drilling time wastages					
Drilling team is always advised by the team leader where there is potential for time wasting?					
When planning to drill a well I use measures aimed to reducing time wastage?					

12. To what extent does procurement process in your view affect timely completion of geothermal wells? Tick as appropriate

Very much	A little	Don't know	Not at all

13. Rank in order who you think plays the most important role in the reduction of time wastage (Please answer 1-4, where 1 is the highest and 4 being the lowest). Circle appropriately.

Drilling engineer	1	2	3	4
Maintenance engineer	1	2	3	4
Derrick man	1	2	3	4
Floor man	1	2	3	4
Roustabout	1	2	3	4

14. How often do you experience drilling related breakdown? Tick as appropriate

Daily	Twice weekly	Weekly	Fortnight	Monthly

15. In your opinion, how would you rate the company's response to restore broken down machinery on a five point scale. Where 5-Very quick, 1-Very slow. Circle appropriately

Very Slow	1	2	3	4	5	Very Quick

16. Among the factors listed below, Rate appropriately according to how it contributes to untimely completion of wells? (Please answer 1- 4, where 1 is the highest and 4 being the lowest)

Shift change management	1	2	3	4
Equipment failure	1	2	3	4
Experience of the rig management team	1	2	3	4
Planned maintenance of equipment	1	2	3	4
Formation characteristics	1	2	3	4

17. Would you prefer a move from Drilling Department to any other department in GDC? Tick as appropriate.

Definitely not	Probably not	Maybe	Probably would	Definitely would

18. My remuneration at GDC is commensurate to my expectation. Tick as appropriate.

Strongly Disagree	Disagree	Agree	Strongly Agree

19. Which of the following actions best describes your company's approach to maintenance of equipment? Tick as appropriate

Fix-it when broke	
Scheduled Maintenance	
Condition-based Monitoring	
Detection of Sources of Failures	

20. How satisfied are you with the procurement processes by GDC in relation to drilling resources? Where 5-Very satisfied, 1-Very dissatisfied. Tick appropriately.

Very dissatisfied	1	2	3	4	5	Very Satisfied

21. Have you attended any career development programme (s) in your current role?

   a. Yes ☐

   b. No ☐

22. If Yes when?

Last 3 months	
Last 6 months	
Last year	

Thanks for your valuable time and effort.

APPENDIX 5

Interview schedule

Dear Sir/Madam,

I am currently undertaking a Masters Degree in Project Planning and Management at the University of Nairobi. In fulfilment of my dissertation I am required to research a topic area. The topic I have chosen is *factors influencing timely completion of geothermal wells; a case of Menengai Geothermal Prospects in Nakuru County*. I am investigating how human factors, procurement process and maintenance of the rig and equipment influence timely completion of geothermal wells in Menengai Geothermal Prospects Site and thereafter recommend the necessary interventions. The questionnaire is structured to research the perceptions of the project stakeholders especially those staffs who are directly involved in drilling of the wells.

I would like to ask you a few questions regarding your job. Needless to say all information provided will be treated with strict confidence and individual identities will not be disclosed.

1. What are the challenges that arise when procuring for an item?
2. What is the average time that it takes from tender advertising to delivery of resources requested?
3. Are there times when you hasten the procurement process to avoid wastage of time?
4. In your opinion does procurement affect the rate of completion of geothermal wells?
5. What type of tendering system do you use?
6. How many suppliers do you have when it comes to machinery and equipment?
7. What do you think of electronic procurement?
8. What in your opinion can be done to hasten the tendering process?
9. Do you have any reason why you are satisfied or not satisfied with night shifts?
10. Looking at shift coordination expound to me why you think they are satisfactorily or not satisfactorily coordinated.
11. How does the drilling team strive to avoid time wastage?
12. What is the reaction by senior management when cases of drilling breakdowns are reported to them?

13. Are the breakdowns that you experience large enough to halt drilling operations always?
14. What are the reasons that would lead you to leave the drilling operations department?
15. Has the career development programme(s) assisted you to carry out your duties efficiently and effectively? Please expound.