

## **Influence of Human Factors on Timely Completion of Geothermal Wells; a Case of Menengai Geothermal Project in Nakuru County, Kenya**

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### **ABSTRACT**

Geothermal energy is one of the few renewable energy resources that can provide continuous power with minimal visual and other environmental impacts. Geothermal power is a potential major source of power in Kenya; The Kenyan government with aid from donors has taken deliberate steps towards harnessing this source of power in line with the development goals and vision 2030. This paper is aimed at reporting on findings of a research done in Menengai Geothermal Project whose one of the objectives was to ascertain the extent to which human factors influenced timely completion of geothermal wells in Menengai. A survey was conducted on the employees of GDC working in the Drilling Department 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 the stated hypothesis that human factors did not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project in Nakuru County, Kenya. The results of this study showed that most of the employees were satisfied with the working environment, remuneration and working atmosphere during the night shifts. From the test of hypothesis it was established that human factors did not have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project.

### **1.0 INTRODUCTION**

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. To put itself in line with this mandate GDC is charged with provision of services to the satisfaction of its stakeholders, among them being drilling and supervision of geothermal wells. GDC was entrusted to develop Menengai Geothermal Field 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 with a workforce more than 200 crew. Each rig has four shifts. It is worth to note the need to drill the wells within the planned scheduled as working outside the set frame work would lead to increased cost of the project and delay in other activities that are tied to the timely completion of the wells e.g. construction of the power plant and subsequent transmission of the generated power. It was therefore prudent to study the interaction of the crew with the project as their satisfaction may influence the drilling of the wells. The engineers, technicians, derrick men, floor hands and roustabouts are in direct contact with the project activities and hence any dissatisfaction from their side may lead to slow execution of the project leading to delay in the whole project of drilling the well.

### **2.0 RESEARCH OBJECTIVE**

To ascertain the extent to which human factors influence timely completion of geothermal wells in Menengai Geothermal Project in Nakuru County, Kenya.

### **3.0 RESEARCH QUESTION**

To what extent do human factors influence timely completion of geothermal wells in Menengai Geothermal Project in Nakuru County, Kenya?

### **4.0 RESEARCH HYPOTHESIS**

$H_0$ : Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project in Nakuru County, Kenya.

### **5.0 INFLUENCES OF HUMAN FACTORS AND TIMELY COMPLETION OF GEOTHERMAL WELLS**

In an industrial setup which is similar in a way 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. 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. Job satisfaction can be affected by job characteristics, job environment, and job organization. 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).

**6.0 RESULTS**a) Demographic characteristics of respondents

		Frequency	Percent
<b>Gender</b>	Male	108	96.4
	Female	4	3.6
<b>Age</b>	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
<b>Qualification</b>	O-Level	40	35.7
	Diploma	41	36.6
	HND	11	9.8
	Bachelors	19	17.0
	Masters	1	0.9

b) Job Category

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

c) Level of interaction satisfaction with other drilling employees

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

d) General work environment

		Frequency	Percent
<b>General working environment satisfaction</b>	Dissatisfied	4	3.6
	Quite Satisfied	34	30.4
	Satisfied	55	49.1
	Very Satisfied	19	17.0

e) Night shift satisfaction

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

f) Satisfaction with shift coordination

Shift coordination		Frequency	Percent
	Very Dissatisfied	3	2.7
	Dissatisfied	10	8.9
	Neither dissatisfied	34	30.4
	Satisfied	38	33.9
	Very Satisfied	27	24.1

g) Department change preference.

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

**6.1 Test of hypothesis**

**H<sub>0</sub>:** Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project.

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 i (a) 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<sub>0</sub>: Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project and fail to reject H<sub>1</sub>: Human factors have significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project.

**Table i: Shift coordination**

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

**Table i (a): Chi-Square Tests- shift co-ordination**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.653 <sup>a</sup>	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 ii (a) 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  $H_0$ : Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project.

**Table ii: General working environment satisfaction**

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

**Table ii(a): Chi-Square Tests-working environment satisfaction**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.684 <sup>a</sup>	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 iii (a) which is greater than 0.05 hence there is no significant difference and thus we fail to reject  $H_0$ : Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project.

**Table iii: General working environment satisfaction**

Job Category		<b>Night Shift Satisfaction</b>						Total	
		Very		Quite		Very			
		Dissatisfied	Dissatisfied	Satisfied	Satisfied	Satisfied	Satisfied		
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 iii (a): Chi-Square Tests-night shift satisfaction**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.800 <sup>a</sup>	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.

**Table iv: Summary of hypothesis test**

HYPOTHESIS	RESULTS	REMARKS
$H_0$ : Human factors do not have a significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project 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 Project.

## 7.0 DISCUSSION

Over 90% of the respondents interviewed were satisfied with the way they interacted with fellow colleagues within the drilling department hence reducing chances of creating conflict. This therefore shows some level of satisfaction by the respondents. 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. In general over 85% of the respondents were positive about their working environment. While assessing department change preference, more than 60% of the respondents did not wish to change their department hence they were satisfied in working within their department. 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 with 58% positive with shift change coordination.

## 8.0 CONCLUSION

Human factors were found to have no significant influence on the time taken to complete geothermal wells in Menengai Geothermal Project 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.

## 9.0 REFERENCES

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