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Impact of Drilling Parameters on Cost of Oil Well in Monitoring and Control System

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Abstract
In the past, several methods have been proposed and used in evaluating drilling cost and complexity because of the numerous number of factors and events that affect drilling performance, which makes it precarious to construct predictive models. Ascertaining the cost of drilling and complexity is challenging sequel to restrictions on data collection and availability, constraint related to modelling or combination of these factors. In most cases, drill rates are often not recorded and constrained by factors that are not within the control of drilling personals are made primary by oil companies. Different specialized skills and talents are essential to drilling an oil well safely and economically. The simulator used for the purpose of this work has a voltage input of between 220v to 230v with an output of zero to five volts with various channels that can either increases or decreases pulses received from the sensors for onward transmission to the Data Acquisition System. The Simulator has embedded sensors for HOOKLOAD, SPP, RPM, MD, ROP, WOB, ECD and MSE. This paper aims at studying and analysing the associated drilling parameters with respect to time, and to run a comparative analysis of simulated events and regression model software values by adopting mathematical model of multiple regression that transform into programming techniques for predicting the total cost drilling oil well. Visual Basic Net programming language (front-end) and Microsoft Access Database relational database management (back-end) were used in the research work for the experimental study. The implemented software has a performance accuracy of 92%. The data base series explained that higher the drill depth there exist high cost of drilling due to impact of drilling parameters associated with the oil well

Keywords: Drilling parameter, oil well, monitoring and control, cost implication.

1. Introduction

An **oil well** is a boring in the Earth that is designed to bring petroleum oil hydrocarbons to the surface. Usually, some natural gas is released along with the oil. A well that is designed to produce only gas may be termed a **gas well**. Oil drilling is the process by which tubing is bored through the Earth's surface and a well is established. A pump is connected to the tube and the petroleum under the surface is forcibly removed from underground.Oil well control is a precaution method introduced to ensure smooth drilling of hydrocarbon, well completion and wellover to avert inimical effects caused by the unexpected release of formation fluid. It is a multifaceted endeavour that is meant to ensure commercially successful and environmentally responsible drilling and completion of hydrocarbon wells and subsequent operation of such wells after they are placed into production.

Oil well control involves maintaining pressure on open formations that is exposed to the wellbore, to prevent or direct the flow of formation fluids into the wellbore. The technology encompasses the estimation of fluid pressure, the strength of the subsurface formations and the use of casing and mud density to offset those pressures in a predictable fashion. Oil well control involves preventing formation fluid, usually referred to as kick, from entering into the wellbore during drilling. Formation fluid can enter the wellbore if the pressure exerted by the column of drilling fluid is not great enough to overcome the pressure exerted by the fluids in the formation being drilled Lyons *et al(*2005). Oil well control includes monitoring a well for signs of impending influx of formation fluid into the wellbore during drilling and procedures to stop the well from flowing when it happens by taking proper remedial actions Schlumberger Oilfield Glossary (2011). In other words, included are operational procedures to safely stop a well from flowing should an influx of formation fluid into the wellbore occur. Failure to manage and control these pressure effects can cause serious equipment damage and injury or loss of life. Well control situations that are not properly managed can cause blowouts, which are the uncontrolled and explosive expulsion of formation fluid from the well, which usually result in a fire

In Velavan *et al(*2015), an oil well monitoring and control based on wireless sensor network using ARM is presented. The research was motivated by the need to provide a system for effective control of oil exploration, drilling and pumping units spread over barren hills, mountain and deserts. The need to address the drawbacks associated with manual control in oil exploration and drilling also motivated the research. The specific objective was to provide a power and time saving system for managing numerous numbers of oil well data storage and management. Design of oil well monitoring and control based on Wireless Sensors as well as First Level of Signals (FLS) conversion of all measurements into electrical signal and transportation into corresponding Intelligent System (IS) are the major activities. Though the research provided a platform for experts in Petroleum Engineering and Allied Sciences for sensor-based monitoring of oil well across different terrains and formations, it however failed during cases of network failure or loss of signal which ultimately hamper the monitoring or control action for maintenance.

Evaluation of cost estimation during drilling of oil well in a community has been the primary focus of every drilling company due to the variation of cost in materials, technology and personnel. The prediction of cost and depth estimation is very paramount in an oil preliminarystage is to estimate the cost and depth with minimum project information. The sensor of Mud weight, Hook load, Standard Pipe Pressure, Torque and Rotary per minute are utilised to obtain accurate data for depth and drilling process while cost of rig, bit, mud and auxiliary equipment are used to acquire the cost of materials and parameters like host communities, combination of the true depth of drilling, cost of drilling and host communities consideration which provides a close cost estimate of drilling an oil well. (Atajeromavwo andAkinyokun, 2018). It has been observed that there is a problem of depth estimation in oil and gas industries and, the oil industries needs exigent attention to solve issues. In this paper, the impacts of drilling parameters such as WOB, ROP,TORQUE,MD and HOOKLOAD of the cost of drilling of an oil well during drilling were carried out. An architectural model for oil well drilling and flow monitoring is proposed. A mathematical regression model for predicting cost of drilling an oil well evaluation and drilling indicator performance parameters are developed.

2.1 Research Methodology

This phase looks at how the software that will be built and how the system will operate with particular emphasis on hardware, software, network infrastructure and user interface. The main purpose if this stage is to create a blueprint that will satisfy all documented requirements, then to identify all inputs, processes and outputs needed and also to help avoid misunderstandings by involving the stakeholders such as managers and users. At the end of the design phase, we have a system design specification document (SDS). This is a document that contains all of the information needed to develop the system. This is aimed towards the implementation and testing teams involved as it sets guidelines as to what is expected from the new system. The SDS will include a project scope, a system design, component and process design, data design, user displays and output reports, system files and prototype analysis to name a few.

2.2 Software Process Model (Software Developing Paradigm)

To solve an actual problem in an industry, software developers or Team of developers must integrate with a development strategy that include the process, methods and tools layer and generic phases. This strategy is often referred to as a process Model or a software developing Paradigm. This project research work follows the waterfall model which is:

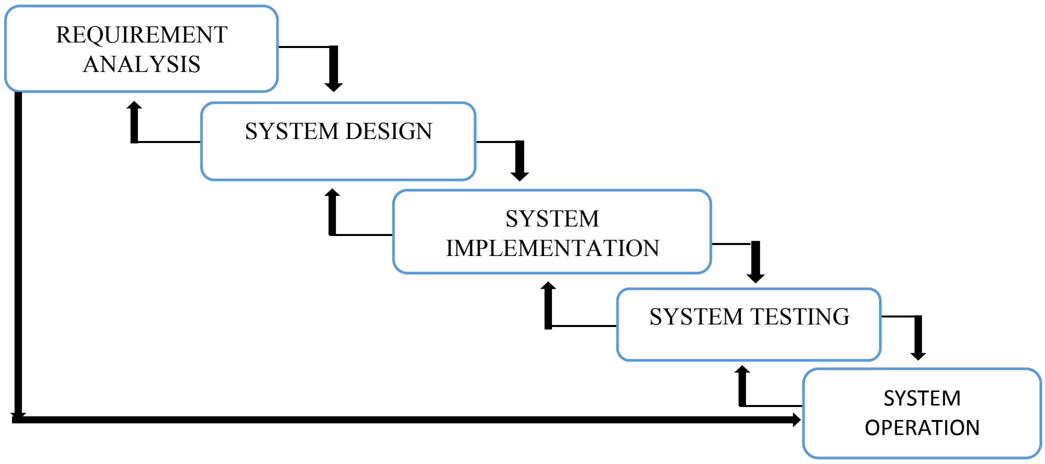

Figure 2.1: Waterfall Model diagram

2.3 Method of Data collection and Analysis

According to (Atajeromavwo, 2011), data collection is a process of collection of numerical facts, whether it is the Government or Organization, statistical data form the basics of its function. However, data used for this research work were collected by simulation of the oil well andanalyzed by using anova method of analysis.

2.3.1 Simulators

Simulators are electrically powered sensors that are usually used to acquire well borehole distances, mud levels, pipe vibrations as well as rotation of strings. These sensors send either pulses or current signals to Data Acquisition System (DAS) which in turn transmits the signals to a computer. The simulator used for the purpose of this work has a voltage input of between 220v to 230v with an output of zero to five volts with various channels that can either increases or decreases pulses received from the sensors for onward transmission to the Data Acquisition System. This simulator has the ability to simulate Hookload, SPP, RPM, MD, Mud Weight, Mud Temperature, SPM and any other digital or analog sensors and in turn send to the Data Acquisition System. The Simulator has embedded sensors for HOOKLOAD, SPP, RPM, MD, ROP, WOB, ECD and MSE. It also has six analog, four digital analyzers and two signal cables for connections.

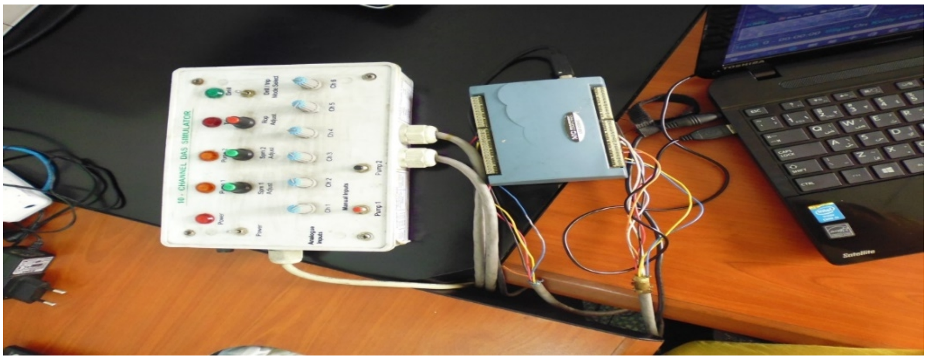

Figure 2.2: Diagram of the Simulator

One cable is connected to the oil well and the other to the data acquisition mechanism. The colour coding for the analogue and digital signals are presented in Table 2.1.

Table 2.1: Colour Coding for Analogue and Digital Signals

Colour	Channels
Analog Signals	
Blue	CH 1
Yellow	CH 2
Red	CH 3
Orange	CH 4
Brown	CH 5
Green	CH 6
Digital Signals	
Red	Trip
Yellow	Drill
Blue	Pump 1
Orange	Pump 2

2.3.2 Data Acquisition

Data acquisition is a tool for data gathering, analysis and real-time decision making for quick effective service in oil well drilling cost estimate system. The type utilized in the architecture of oil well cost estimate drilling system is called 'DAC' which stands for Data Acquisition Center, it has rugged enclosure that contains the central processing unit (CPU), power supplies and hardware that monitors data sensors. This act as interface between the sensor capture parameter such as mud weight, hook-load, stand pipe pressure, torque and rotary per minute, and the depth, drilling, flow monitor and kick control

2.4 Architecture of the Proposed System

The architecture of oil well drilling management system is presented in Figure 3.2. The components are:

a. Simulator which comprises of Mud Weight Sensor, Hook Load (HK) Load Sensor, Stand Pipe Pressure (SPP) Sensor, Torque Sensor, and Rotary Per Minute Sensor.

b. Data Acquisition.

c. Depth Monitor which includes measured Depth (MD), True Vertical Depth (TVD) and Total Cost.

d. Drilling Monitor which is made up of Rate of Penetration (ROP) and Weight on Bit (WoB).

e. Flow Monitor which is also made up of Stroke Per Minute (SPM), Gallon Per Minute (GPM) and Flow Rate

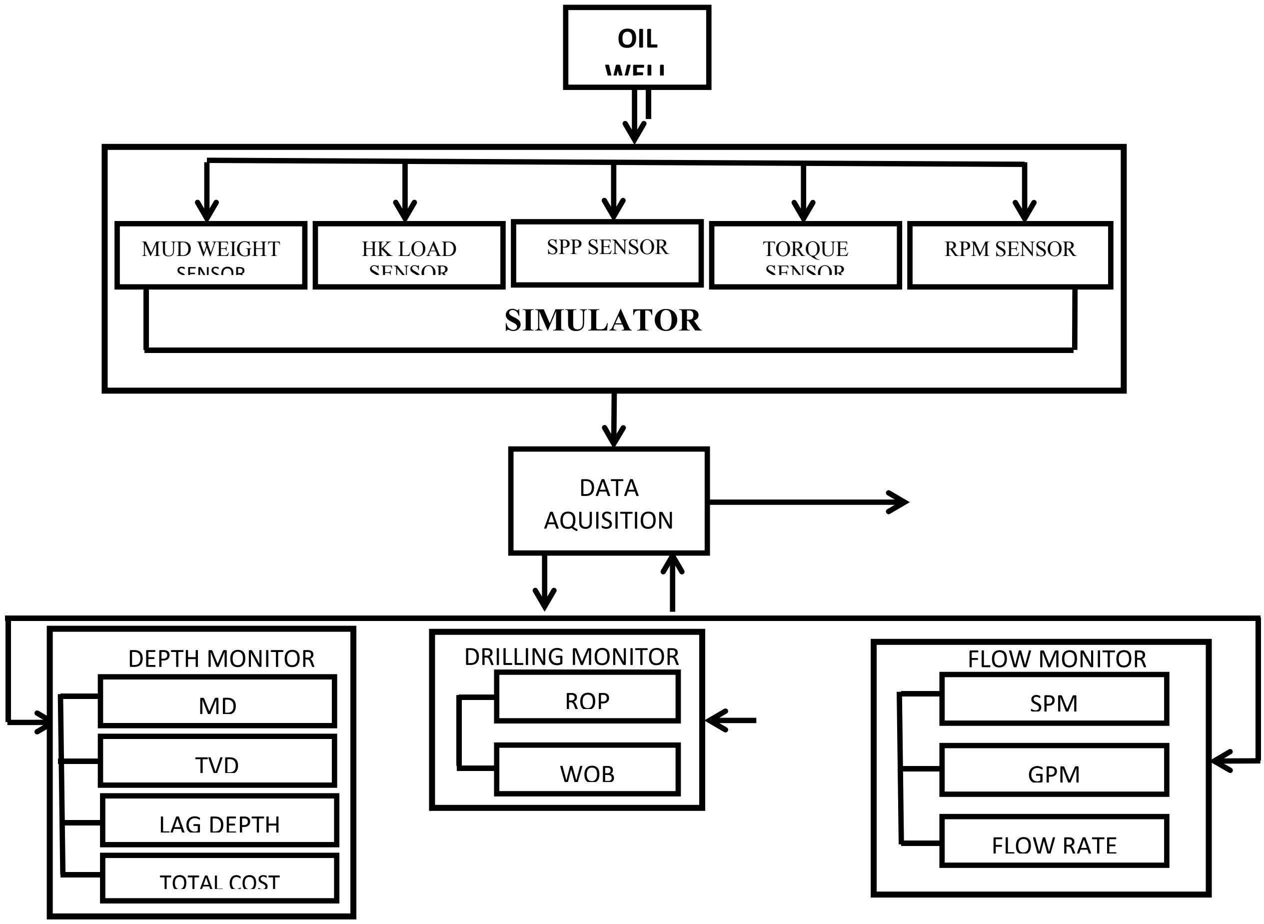

Table 2.2: Meaning of the components of figure 2.3
Figure 2.3: Architecture for Oil Well Control Mechanism

S/N	Abbreviations	Meaning
1	HK LOAD	Hook load
2	SPM	Strokes per minute
3	RPM	Rotary per minute
4	MD	Measured Depth
5	TVD	True Vertical Depth
6	ROP	Rate of Penetration
7	GPM	Gallon Per Minute
7	WOB	Weight on Bit

Oil well control system is primarily made up of sensors embedded in the simulator, data acquisition and monitors of depth, drilling, flow control. The architecture shows the core procedures involved in the effective management of an oil well. Sensor was built and attached to the oil well in order to determine input parameters that would be used to know the status of the oil well. The input parameters are: Mud Weight, HK Load, SPM, Torque, and RPM. After the determination, the Sensor then transfers the data to the Data Acquisition component for further processing. The Data Acquisition component then calls some predefined procedures in order to compute certain needed decision values.

2.5 Implementation Methodology

In order to accomplish the objectives of this research work, Mathematical Regression Model will be adopted. Before this can be attained, it is necessary to consider the tangible cost categories.

A regression model with functional independent variables that associated with cost and drilling monitoring data shown in Table 2.3 is formulated. The model is stated as:

$$\text{Total Cost} = \alpha_0 + \alpha_1\sigma_1 + \alpha_2\sigma_2 + \alpha_3\sigma_3 + \alpha_4\sigma_4 + \alpha_5\sigma_5 + \alpha_6\sigma_6 \quad 1.1$$

α_0 is intercept of the dependent variable, the coefficient variables α_1, α_2, α_3, α_4, α_5 and α_6 are coefficient of independent variables while

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5 and\ \alpha_6$, are the MD, TVD, ROP, hookload, torque and mud weight respectively.

Table 2.3: Stimulated Data generated from Oil well A

MD	TVD	ROP	HOOK-LOAD	TOQUE	MUD WEIGHT	TOTAL COST
63.7684	341	00	299.63	9.55	6.40	130000
364.8311	348	10	298.73	9.54	6.39	132000
365.1578	356	20	299.79	9.51	6.38	134000
368.6258	364	30	296.62	9.52	6.38	136000
369.5247	364	40	297.68	9.52	6.38	138000
371.8911	364	50	296.47	9.52	6.38	140000
374.2575	364	60	300.09	9.52	6.38	142000
375.7007	364	60	300.84	9.47	6.35	144000
376.7136	364	60	291.35	9.35	6.27	146000
389.6589	387	45	299.90	9.54	6.43	150000

402.60412	399	45	300.73	9.56	6.39	152000
415.5494	411	40	300.79	9.58	6.38	154000
428.4946	424	35	296.62	9.6	6.41	208000
441.4399	437	35	297.68	9.64	6.43	224000
454.3851	450	35	296.47	9.5	6.44	240000
467.3304	463	32	300.09	9.53	6.39	256000
570.8924	540	32	300.84	9.56	4.41	382000
674.4544	644	30	291.35	9.59	6.45	508000
778.0163	651	30	304.95	9.54	6.39	634000
881.5783	651	30	299.63	9.52	6.31	760000
985.1403	660	30	298.73	9.56	6.38	886000
998.0856	666	30	299.79	9.56	6.45	900000
999.1483	710	30	296.62	9.59	6.36	902000
1000.2111	724	29	297.68	9.55	6.43	904000
1001.2739	750	30	299.90	9.58	6.46	906000
1003.3995	763	39	300.73	9.61	6.39	910000
1009.7763	740	30	291.35	9.54	4.65	922000
1035.2835	744	29	301.95	9.5	6.41	970000
1162.8195	747	33	299.79	9.54	6.40	1210000
1928.0355	851	32	296.62	9.57	6.51	2650000
2693.2515	854	33	300.84	9.59	6.38	4090000

Table 2.4: A regression model with functional independent variables.

Multiple R	**0.994068455**
R Square	**0.988172092**
Adjusted R Square	**0.985215116**
Standard Error	**100785.4791**
Observations	**31**

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	**6**	**2.03672E+13**	**3.39454E+12**	**334.1832305**	**6.67423E-22**
Residual	**24**	**2.43785E+11**	**10157712800**		
Total	**30**	**2.0611E+13**			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	470661.5848	4076722.786	0.115450966	0.90904823	-7943280.651	8884603.82	-7943281	8884604
MD	1945.694279	70.61674635	27.55287349	1.12168E-19	1799.948478	2091.440079	1799.948	2091.44
TVD	-1391.859311	217.51424	-6.398934207	1.28834E-06	-1840.786635	-942.9319869	-1840.79	-942.932
ROP	-4556.01826	1602.629555	-2.842839286	0.008986435	-7863.68307	-1248.353449	-7863.68	-1248.35
HOOK-LOAD	-1085.412189	6287.113798	-0.172640773	0.864381454	-14061.37722	11890.55285	-14061.4	11890.55
TOQUE	997.3955694	417495.9447	0.002388995	0.998113607	-860671.8782	862666.6693	-860672	862666.7
MUD WEIGHT	-3006.371689	40757.96782	-0.07376157	0.941811445	-87126.68227	81113.93889	-87126.7	81113.94

TotalCost=
$$470661.5848 + 1945.694279\sigma_1 - 1391.859311\sigma_2 - 4556.01826\sigma_3 - 1085.412189\sigma_4 + 997.3955694\sigma_5 - 3006.371689\sigma_6$$

The above result shows that the model is fit to predict cost of drilling oil well A. it also shows that about 99.8% of variation is being accounted by the variable considered in the analysis. The p values show that the variables considered are all significant contributors.

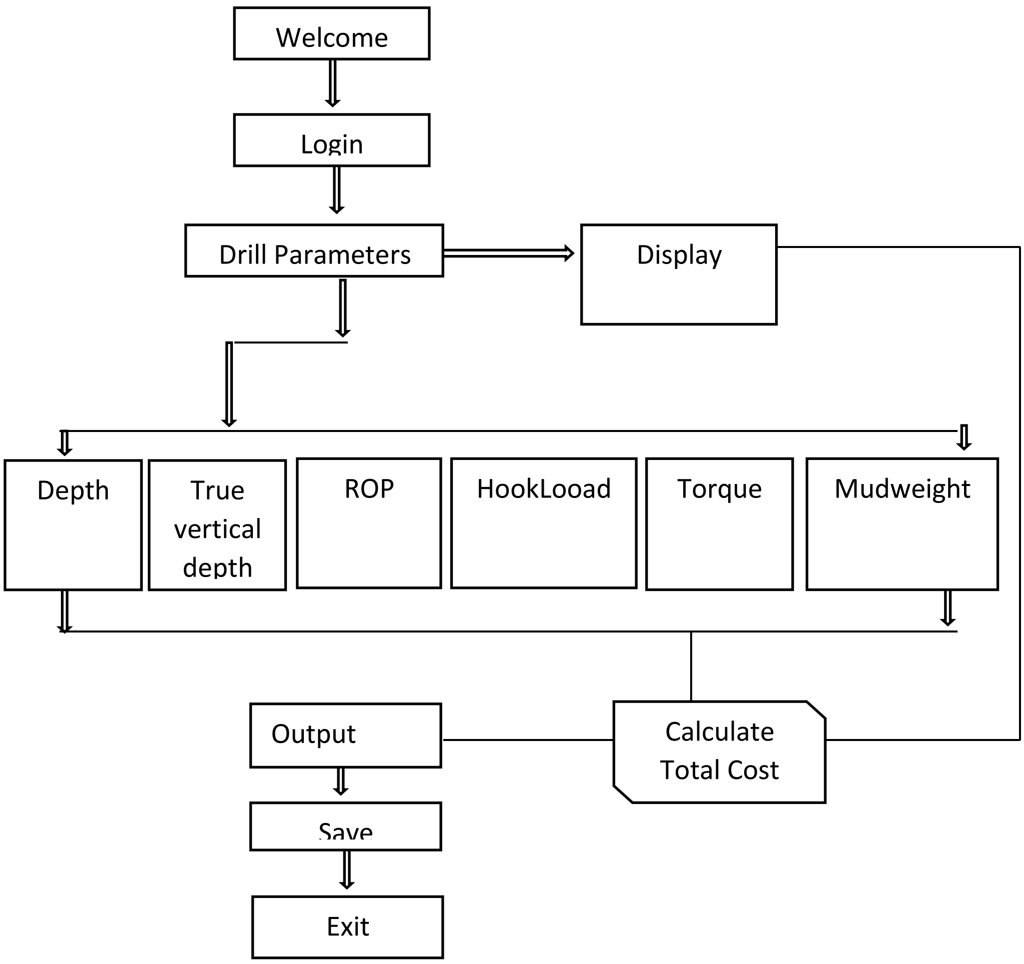

Figure 2.4: Implementation of the program Design

2.5.4 Exit Module

This is the Module responsible for packing up or quitting the program entirely as shown below:

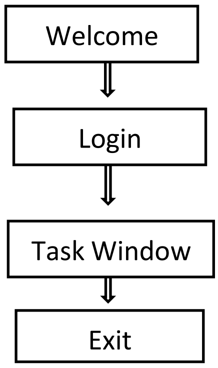

Figure 2.5: Exit base Module

2.5.5 Algorithm of the Program

Start
Input MD
Input TVD
Input ROP
Input Hookload
Input Torque
Input Mudweight

Dim MD as double
Dim TVD as String
Dim ROP as String
Dim Hookload as Double
Dim Torque as Double
Dim Mudweight as Double
Dim Totalcost as String

MD = const * Value of MD
TVD = const * Value of TVD
ROP = const * Value of ROP
Hookload = const * Value of Hookload
Torque = const * Value of Torque
Mudweight = const * Value of Mudweight
Totalcost = 470661.5848 + (MD) - (TVD) – (ROP) – (Hookload) + (Torque) – (Mudweight)
Save

End
Exit

3.1 Implementation of the Design

The input design specifies how and where data are to be entered, captured and accepted by the system for processing. The design specifies how the user interacts with the system to direct the action to be taken.

The types of input controls used in the implementation are:

- Textboxes.
- Combo Box.

3.2 The Input/Output User Interface

Access is gained to the system by supplying a valid username and password, both of which constitute the access mechanism. If access is granted, the user is then presented with the system's main menu and subsequently its submenus.

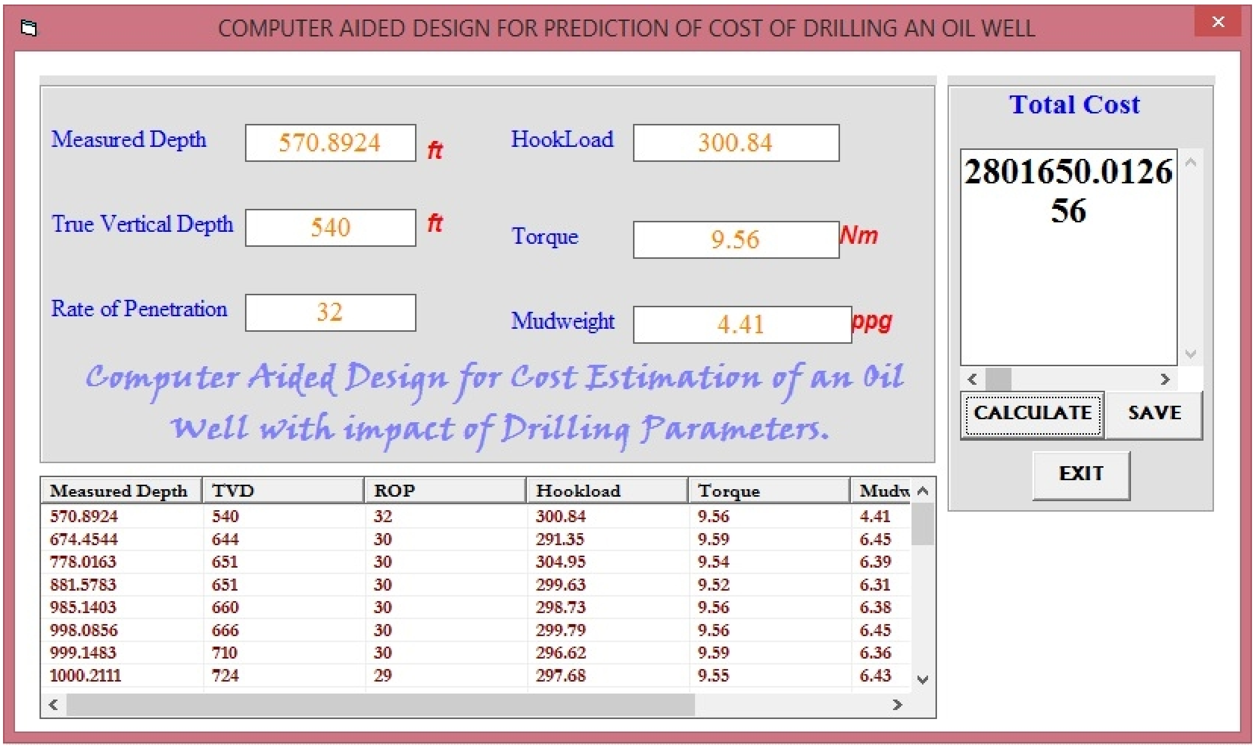

Figure 3.1: The main screen for total cost calculation.

Clicking on the 'Well Info' shown in Figure 3.3 causes a display of the form shown in Figure 3.4. The form presents the oil well identification number, name, location, operator/client, rig name, drilling commencement date, estimated total depth, mud loggers, commencement depth and the daily rig cost. When the submenu 'Create Well Data Tables' shown in Figure 3.3 is clicked, the database schema setup shown in Figure 3.5 is displayed. The schema was used to formulate tables of stored procedure, relation and other relevant features. The 'Set Defaults' submenu shown in Figure 3.3 leads to the interface shown in Figure 3.6 which is used for setting all assigned parameters (such as Rate of Penetration, Torque, Hook load, Weight on Bit, Flow Rate and Drill Depth (Measured Depth and True Vertical Depth) to their default values. This interface allows users to have full influence over the application as well as monitoring and controlling of the drilling process.

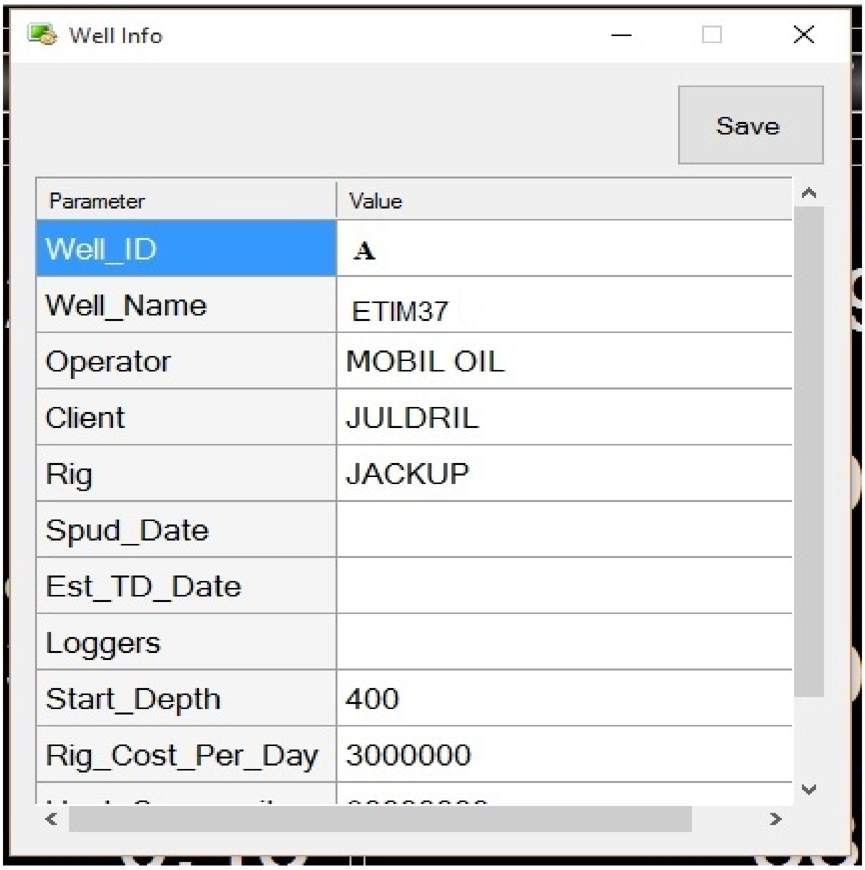

Fig 3.2: Oil Well Info form

3.4 Observations and Findings

Table 3.1: Stimulated Data generated from Oil well A

MD	TVD	ROP	HOOK-LOAD	TOQUE	MUD WEIGHT	TOTAL COST
63.7684	341	00	299.63	9.55	6.40	**130000**
364.8311	348	10	298.73	9.54	6.39	**132000**
365.1578	356	20	299.79	9.51	6.38	**134000**
368.6258	364	30	296.62	9.52	6.38	**136000**
369.5247	364	40	297.68	9.52	6.38	**138000**
371.8911	364	50	296.47	9.52	6.38	**140000**
374.2575	364	60	300.09	9.52	6.38	**142000**
375.7007	364	60	300.84	9.47	6.35	**144000**
376.7136	364	60	291.35	9.35	6.27	**146000**
389.6589	387	45	299.90	9.54	6.43	**150000**
402.60412	399	45	300.73	9.56	6.39	**152000**
415.5494	411	40	300.79	9.58	6.38	**154000**
428.4946	424	35	296.62	9.6	6.41	**208000**
441.4399	437	35	297.68	9.64	6.43	**224000**
454.3851	450	35	296.47	9.5	6.44	**240000**
467.3304	463	32	300.09	9.53	6.39	**256000**
570.8924	540	32	300.84	9.56	4.41	**382000**
674.4544	644	30	291.35	9.59	6.45	**508000**
778.0163	651	30	304.95	9.54	6.39	**634000**
881.5783	651	30	299.63	9.52	6.31	**760000**
985.1403	660	30	298.73	9.56	6.38	**886000**
998.0856	666	30	299.79	9.56	6.45	**900000**
999.1483	710	30	296.62	9.59	6.36	**902000**
1000.2111	724	29	297.68	9.55	6.43	**904000**
1001.2739	750	30	299.90	9.58	6.46	**906000**
1003.3995	763	39	300.73	9.61	6.39	**910000**
1009.7763	740	30	291.35	9.54	4.65	**922000**
1035.2835	744	29	301.95	9.5	6.41	**970000**
1162.8195	747	33	299.79	9.54	6.40	**1210000**
1928.0355	851	32	296.62	9.57	6.51	**2650000**
2693.2515	854	33	300.84	9.59	6.38	**4090000**

Table 3.2: Software calculated cost using the supplied parameters.

MD	TVD	ROP	HK	TOQ	MUDW	TOTALCOST
63.7684	341	0	299.63	9.55	6.40	**1384865.140746**
364.8311	348	10	298.73	9.54	6.39	**2024986.266259**
365.1578	356	20	299.79	9.51	`6.38	**2102648.320232**
368.6258	364	30	296.62	9.52	6.38	**2143479.636802**
369.5247	364	40	297.68	9.52	6.38	**2191939.352143**
371.8911	364	50	296.47	9.52	6.38	**2240790.486859**
374.2575	364	60	300.09	9.52	6.38	**2294884.151875**
375.7007	364	60	300.84	9.47	6.35	**2298546.550533**
376.7136	364	60	291.35	9.35	6.27	**2290337.621234**
389.6589	387	45	299.90	9.54	6.43	**2288186.383341**
402.60412	399	45	300.73	9.56	6.39	**2331117.1814428**
415.5494	411	40	300.79	9.58	6.38	**2350342.039486**
428.4946	424	35	296.62	9.6	6.41	**2366247.062774**
441.4399	437	35	297.68	9.64	6.43	**2410659.086531**
454.3851	450	35	296.47	9.5	6.44	**2452457.567619**
467.3304	463	32	300.09	9.53	6.39	**2486180.652926**
570.8924	540	32	300.84	9.56	4.41	**2801650.012656**
674.4544	644	30	291.35	9.59	6.45	**3122387.346586**
778.0163	651	30	304.95	9.54	6.39	**3348521.808247**
881.5783	651	30	299.63	9.52	6.31	**3544467.536527**
985.1403	660	30	298.73	9.56	6.38	**3757346.405207**
998.0856	666	30	299.79	9.56	6.45	**3791825.194664**
999.1483	710	30	296.62	9.59	6.36	**3851994.464877**
1000.2111	724	29	297.68	9.55	6.43	**3869892.557109**
1001.2739	750	30	299.90	9.58	6.46	**3915054.157391**
1003.3995	763	39	300.73	9.61	6.39	**3979429.534105**
1009.7763	740	30	291.35	9.54	4.65	**3913799.970447**
1035.2835	744	29	301.95	9.5	6.41	**3970614.733415**
1162.8195	747	33	299.79	9.54	6.40	**4238885.387155**
1928.0355	851	32	296.62	9.57	6.51	**5864214.397645**
2693.2515	854	33	300.84	9.59	6.38	**7366810.322885**

From the table below, it is observed that there are changes in values and these changes are due to the impacts of other parameters (MD, TVD, ROP, Hookload, Torque and Mudweight).

Table 3.3: Comparison of values of regression model and simulation model.

S/N	Depth	Event Simulation for Cost (ESC)	Software Cost from Regression (SCR)	Error =/SCR – ESC/
1.	63.7684	130000	1384865.140746	**1254865**
2.	364.8311	132000	2024986.266259	**1892986**
3.	365.1578	134000	2102648.320232	**1968648**
4.	368.6258	136000	2143479.636802	**2007480**
5.	369.5247	138000	2191939.352143	**2053939**
6.	371.8911	140000	2240790.486859	**2100790**
7.	374.2575	142000	2294884.151875	**2152884**
8.	375.7007	144000	2298546.550533	**2154547**
9.	376.7136	146000	2290337.621234	**2144338**
10.	389.6589	150000	2288186.383341	**2138186**
11.	402.60412	152000	2331117.1814428	**2179117**
12.	415.5494	154000	2350342.039486	**2196342**
13.	428.4946	208000	2366247.062774	**2158247**
14.	441.4399	224000	2410659.086531	**2186659**
15.	454.3851	240000	2452457.567619	**2212458**
16.	467.3304	256000	2486180.652926	**2230181**
17.	570.8924	382000	2801650.012656	**2419650**
18.	674.4544	508000	3122387.346586	**2614387**
19.	778.0163	634000	3348521.808247	**2714522**
20.	881.5783	760000	3544467.536527	**2784468**
21.	985.1403	886000	3757346.405207	**2871346**
22.	998.0856	900000	3791825.194664	**2891825**
23.	999.1483	902000	3851994.464877	**2949994**
24.	1000.2111	904000	3869892.557109	**2965893**
25.	1001.2739	906000	3915054.157391	**3009054**
26.	1003.3995	910000	3979429.534105	**3069430**
27.	1009.7763	922000	3913799.970447	**2991800**
28.	1035.2835	970000	3970614.733415	**3000615**
29.	1162.8195	1210000	4238885.387155	**3028885**
30.	1928.0355	2650000	5864214.397645	**3214214**
31.	2693.2515	4090000	7366810.322885	**3276810**

Percentage Error (%error)

Here, Percentage error is calculated as:

$$(\%error) \quad = \frac{ExperimentalValue - TheoriticalValue}{Theoriticalvalue} * 100$$

Our experimental value in this research is the software calculated value gotten from regression while the theoretical value is our known simulated values gotten from the simulator.

Therefore, we calculate our percentage error as:

$$(\%error) \quad = \frac{SoftwareValue - SimulatedValue}{Simulated} * 100$$

$$(\%error) \quad = \frac{SCR - ESC}{ESC} * 100$$

$$= \frac{\textbf{Error}}{ESC} * 100$$

Example:

$\frac{1384865.140746}{130000} * 100 =$ 9.652809 * 100 = 965.2809%

Table 3.4: Percentage Error

S/N	Depth	Event Simulation for Cost (ESC)	Software Cost From Regression (SCR)	Error = /SCR – ESC/	$\%error = \frac{\textbf{Error}}{ESC} * 100$
1.	63.7684	130000	1384865.140746	**1254865**	**965.2809**%
2.	364.8311	132000	2024986.266259	**1892986**	**1434.081**%
3.	365.1578	134000	2102648.320232	**1968648**	**1469.141**%
4.	368.6258	136000	2143479.636802	**2007480**	**1476.088**%
5.	369.5247	138000	2191939.352143	**2053939**	**1488.362**%
6.	371.8911	140000	2240790.486859	**2100790**	**1500.565**%
7.	374.2575	142000	2294884.151875	**2152884**	**1516.116**%
8.	375.7007	144000	2298546.550533	**2154547**	**1496.213**%
9.	376.7136	146000	2290337.621234	**2144338**	**1468.724**%
10.	389.6589	150000	2288186.383341	**2138186**	**1425.458**%
11.	402.60412	152000	2331117.1814428	**2179117**	**1433.63**%
12.	415.5494	154000	2350342.039486	**2196342**	**1426.196**%
13.	428.4946	208000	2366247.062774	**2158247**	**1037.619**%
14.	441.4399	224000	2410659.086531	**2186659**	**976.1871**%

15.	454.3851	240000	2452457.567619	**2212458**	**921.8573%**
16.	467.3304	256000	2486180.652926	**2230181**	**871.1643%**
17.	570.8924	382000	2801650.012656	**2419650**	**633.4162%**
18.	674.4544	508000	3122387.346586	**2614387**	**514.6432%**
19.	778.0163	634000	3348521.808247	**2714522**	**428.158%**
20.	881.5783	760000	3544467.536527	**2784468**	**366.3773%**
21.	985.1403	886000	3757346.405207	**2871346**	**324.0797%**
22.	998.0856	900000	3791825.194664	**2891825**	**321.3139%**
23.	999.1483	902000	3851994.464877	**2949994**	**327.0504%**
24.	1000.2111	904000	3869892.557109	**2965893**	**328.0855%**
25.	1001.2739	906000	3915054.157391	**3009054**	**332.1252%**
26.	1003.3995	910000	3979429.534105	**3069430**	**337.2999%**
27.	1009.7763	922000	3913799.970447	**2991800**	**324.4902%**
28.	1035.2835	970000	3970614.733415	**3000615**	**309.3417%**
29.	1162.8195	1210000	4238885.387155	**3028885**	**250.3211%**
30.	1928.0355	2650000	5864214.397645	**3214214**	**121.2911%**
31.	2693.2515	4090000	7366810.322885	**3276810**	**80.11761%**

$$Average\ of\ \%error = \frac{\text{Sum of Percentage Error}}{31} = \frac{25904.79}{31} = \frac{835.64}{100} = 8.36\%$$

A percentage very close to zero means we are very close to our targeted value which is good. It is always necessary to understand the causes of the error, such as error due to the imprecision of the simulator or the estimations from our software.

Figure 3.4 and 3.5 presents the graph of the plot of data from monitoring of measured depth (MD), True Vertical Depth (TVD) against Total Cost.

The graph in figure 3.4, depicts a plot of measured depth (MD) against simulated total cost and we observe that the higher the depth, the higher the cost of drilling.

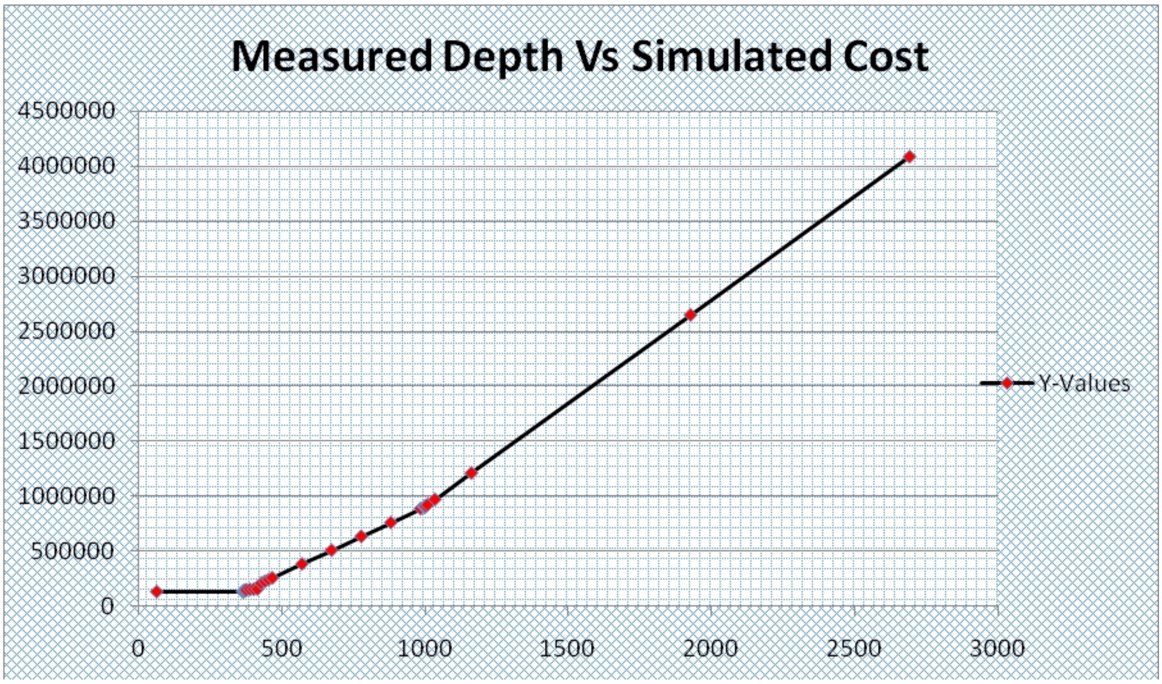

Figure 3.3: Graph of Measured Depth (x axis) against Simulated Cost (y axis).

In figure 3.4, we have a graph depicting a plot of Measured Depth against Total Cost. Total Cost increases as well as MD, due to the impact of other drilling parameters MD, ROP and Mudweight.

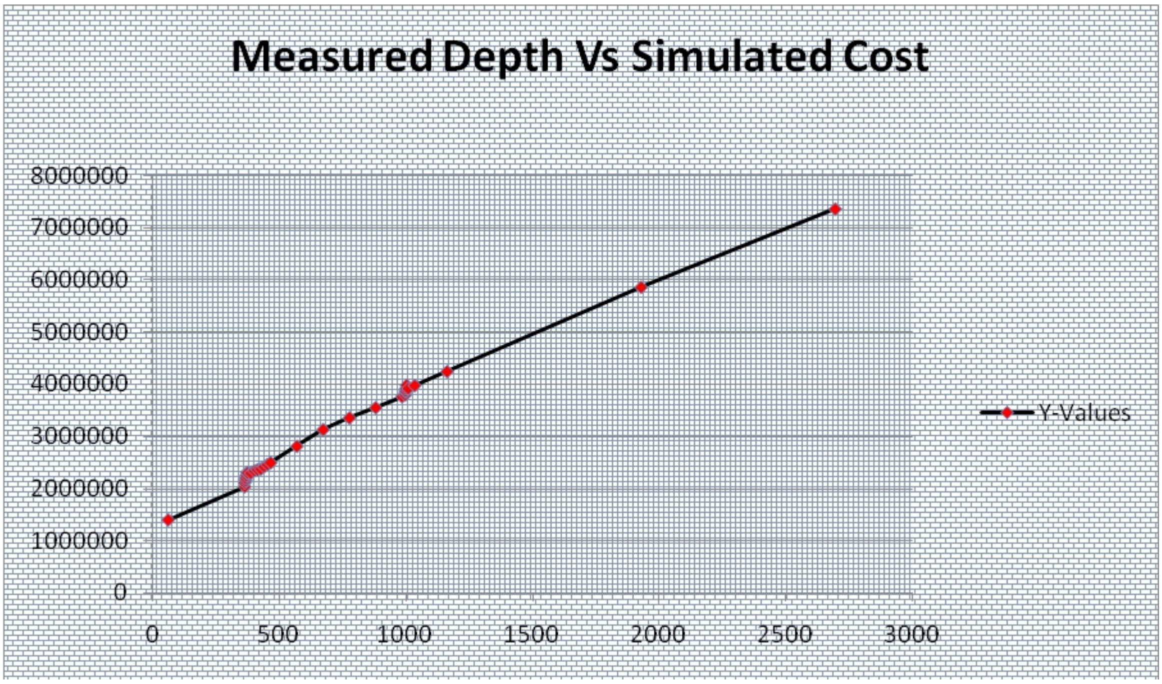

Figure 3.4: Graph of Measured Depth (x axis) against Software Cost (y axis).

4.1 Summary

Well **A** which the simulated data are gotten from was a shallow well which was drilled from 63.7683761ft to 2693.2515ft. Efficient and competent evaluation of total cost using implemented regression based computer software is the goal of this research work. In order to achieve the desirable result, an anova table was formulated from the simulated values. A comparative analysis was also carried out between the simulated values and the regression model based software. This set mission has been confirmed positive with 8.36 percentage error.

4.2 Conclusion

In this research work, it has been concluded that there Total Cost of drilling increases as Depth also increases for each drilling carried out. Because of the initial depth and final depth that varies from location to location, the True Vertical Depth also changes as drilling process is being carried out thereby giving the value for the Measured Depth. I hereby recommend a computer aided approach to drilling companies who is concerned with having an accurate total cost of drilling for evaluation of cost estimate before or during oil well drilling operation. This research has contributed to knowledge in the following ways:Integrating software for easy estimation of cost of drilling an oil well, the regression-based software developed can be adopted by oil drilling companies and experts in this field of study.

References

Atajeromavwo E.J (2018). Development of oil well monitoring and control system. Department of Computer Science, Federal University of Technology, Akure, Nigeria. PhD Thesis Unpublished

Atajeromavwo EJ, Iwasokun GB, Akinyokun, OC, Adetumbi. O(2018). Development of oil well Monitoring and control system. International Journal of Current Advanced Research.2018;7(3):2341-2349. Available: www.journalijcar

Atajeromavwo EJ, &Akinyokun, OC, (2018). Impacts of drilling parameters on depth of oil well in Monitoring and control system. Current Journal of Applied Science and Technology. 28(5):Article no. CJAST 43221.

Jack (2015).“Drilling Cost Estimates”Oil & Gas Drilling EngineeringAvailable online athttp://www.oilngasdrilling.com/drilling-cost-estimates.html

Lyons, WC, Plisga, GJ.(2005) Standard Handbook of Petroleum and Natural Gas Engineering (2nd Edition) Elsevier.

Mark J. Kaiser, (2007). "A Survey of Drilling Cost and Complexity Estimation Models" International Journal of Petroleum Science and TechnologyISSN 0973-6328 Volume 1, Number1(2007),pp.1–22. availableAthttp://www.ripublication.com/ijpst.htm

Mark J. Kaiser, (2009). "Modelling Time and Cost to Drill an Offshore Well" journal homepage: www.elsevier.com/locate/energy.

Peterson, S.K., J.A. Murtha, and F.F. Schneider,"Risk analysis and Monte Carlo simulation applied to the generation of drilling AFE estimates," SPE 26339, Houston, TX, October 1993.

Sercan Gul and Volkan Aslanoglu, (2018). Drilling and Well Completion Cost Analysis ofGeothermal Wells in Turkey. Proceedings from the 43rd Workshop on Geothermal Reservoir Engineering StanfordUniversity, Stanford, California, February 12-14,2018 SGP-TR-213.

Schlumberger Oilfield Glossary, (2011). Hydrostatic pressure, Schlumberger Oilfield Glossary online, retrieved on 9 April 2011, pp 11 – 24.

U.S. Department of Energy/Energy Information Administration, Indexes and Estimates of Domestic Well Costs 1984 and 1985, USDOE/EIA-0347 (84-85), Washington, D.C., November 1985.

Velavan V. V, Chandralekha R, Multitech V, Rangarayan and Sakunthalal, (2015). Oil well Monitoring and Control Based on WirelessSensor Network Using ARM. International Journal of Electronic and Computer Science Engineering ISSN – 2277 – 1956. Available online at: www.ijese.org. pp 2439-2446

Wikepediaformation, (2011). Wild well control, Inc Houston-Texas experience Available online at: http://www.wildwell .com.