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Risk Analysis in Drilling of Oil and Gas Wells in Libya and How to Overcome These Problems

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Abstract

Drilling of oil field is always accompanied with risk factors in regard of safety and investments. A branch of science called as Enhanced Drilling Reach (EDR) is dealing with the steps and procedures to be taken for prevention of risks and enhancement of drilling quality for optimizing the oil projects worthiness i.e. efficiency. EDR is usually involves methods to evaluate the maximum depth of oil well, however, the most proposed methodologies in the related literate can be using the Artificial Neural Network logic to predict the drilling parameters whereas drilling efficiency is maximized. In this article, we proposed a novel approach that proactively analyze the risks of drilling oil wells. The performance of the said approach is tested with various situations and the same is reported a noticeable safety and economical efficiencies. The study that based on Artificial Neural Network is applied on EE123 petrol field in south Libya is aimed to predict the safety of drilling the said well i.e. EE123 before actually it been drilled; the result of this study shows that only 54% is the safety level if this well world been drilled.

Keywords: *Libyan Economy, Oil, Gas, Layers, Field, Assessment, Neural Network, Pre-processing.*

Introduction

Since 1990's, world most advanced technologies of oil wells drilling lies on Extended Reached Drilling (ERD); this technology is commonly used for deep drilling such that a horizontal wells and ultra deep wells. Due to their extensive deployment, the demand is increased for new tools that facilitate deep drilling in Extended Reach Drilling (ERD). Engineers and scientists have designed such equipment for facilitating the ERD (Jia ng S Q, 1999) (Mod i S and Mason C J, 1997); tools such as measurements while drilling (MWD), guided motors (GM), controllable stabilizer; all such tools are developed to enhance the quality of deep wells drilling and other drillings listed under Extended reach drilling (ERD). Drilling specialists (companies) are keep concerning about the failures accompanied with drilling, however, the most efficient method of drilling must be combined with prediction technique that forecast drilling failures before actually drilling is took place.

In this article we comprehensively analyze the factors of risk associated with Extended Reach Drilling; we used Artificial Neural Network for building up our paradigm. Delphi method is deployed to obtain the solution for our Artificial Neural Network to prevent drilling failures of EE123 well of 8 Km depth which is located in south Libya.

Two kinds of risk categories are being treated in this project: it can be the risk of equipment operations i.e. operational level of drilling, rig drilling ability; and risk of control in while drilling and prior drilling such as: operation and concrete design, mechanism of completion, the prosperities of fluid used while drilling, operations of case design as well as some factors related to torque and friction.

Delphi Model

This method commonly known as investigation of exports method where independent experts are participating interactively for predicting an answer for defined problem. Such experts are forecasting the answers in multiple rounds where a given answer is updated in each round on the basis of previous round. The term facilitator is also introduced in this method and has a task to provide judgment for the answers in each round; its produce a summarized anonymous expert in each round. As per this mechanism, revision process is ensured for each expert where answered can be updated base on other experts' feedback (Li Q and Yu L L., 2008). Ultimately, for pool of forecasted answers, it gets decreased by updating (revision) process where the entire pool is shrinking towards accurate answers. This method is involving another concept where it takes responsibility of control the revision process (Fu J H, 2002), in other word, halt criteria must be defined so that updating process can be stopped in given level of accuracy. Stop criteria can be consensus achievement, results of stability, round's number) (Gao D L., 2005) (Zhang Y L., 1999).

As a demonstration example of Delphi method, let us assume a project such as petroleum field and the demand is raised to analysis the risk associated with the said project so that we used the most trending method for analyzing the risks in engineering project that is Delphi method (Markus Hagenbuchner, 2008). The working mechanism of this method can be summarized in categorizing the risks in several groups and limiting the risks in each group to be in minimum and maximum levels (Sitti Nur Alam, 2016). Eventually, group of exports to be hired for judgment job for evaluating the level of each risk on the biases of their experience. However, risk in petroleum field may lie in to the following groups: risk of design (Gredion Prajena, 2009), risk of exploration (those factors related to the first idea of the project and the concepts behind the selection of the field, usually this can term to the concreteness level of hypothesis) (Kei Horie, 2014), risk of constructions (post site selection risk), risk of nature (associated with those incidents that automatically happen due to the physical and chemical nature of project's materials), risk due to environmental intervention (rains, wind, temperature, pressure and extra) (Troy Johnson, 2011) (Yi Shang, 2008).

After putting up the above risks, now leveling is required; in here ten levels of every risks are set so that experts can forecast the risks from level one to level ten. Table 1 demonstrate the process of Delphi method for ten risks and five experts.

Table 1: Risk level forecasting by Delphi method.

Risks	Expt[1]	Expt[2]	Expt[3]	Expt[4]	Expt[5]
construction	1/10	4/10	3/10	7/10	9/10
Exploration	3/10	5/10	6/10	8/10	2/10
Environment	4/10	4/10	3/10	2/10	1/10
Human	2/10	8/10	6/10	1/10	0/10
Natural	3/10	4/10	3/10	1/10	10/10
Drilling ability	6/10	7/10	8/10	5/10	2/10
Drilling fluid	10/10	9/10	7/10	8/10	9/10
Well's hold	9/10	9/10	10/10	8/10	9/10
Friction	4/10	6/10	9/10	4/10	3/10
Cementing	2/10	2/10	1/10	0/10	9/10

Acquisition of data

Couple of data types are required for this project with is mainly depends on survey-based data. The first type of data which is required for our paradigm is the risk factor evaluation weight index; the second requirement of data is the grading data of the weighted risk factors (grading of first type of data). However, the principle data are acquired from survey. Hence, firstly the questionnaire is generalized to cover the corners of risk factors associated with oil wells (Extended Reach Wells). As questionnaire is ready and survey is established, evaluation process of the risks indexes is beginning. However, the following table of assessment is used for weighting the questionnaire in the survey. The following questions are designed for the survey"

Q1: Robustness of drilling machines.
Q2: The level that used for operating the drilling machine.
Q3: The mechanism that is adopted for completing the drilling procedure.
Q3: The base of drilling machine from the structures engineering perspectives that involves columns and concrete structure.
Q4: The mechanical parameters of the fluid that used to facilitate the drilling operations.
Q5: The material design used in drilling such as string that propagates inside drilling pipe.
Q6: The casing design for drilling and post drilling worthiness (robustness).
Q7: The method that adopted for cleaning the hole while drilling and post drilling.
Q8: The torque and friction properties of drag.
Q9: The hole dimensions and stability.
Q10: The possible control on the all directions inside the hole.

Table 2: Risk level weighting table for Extended Reach Wells Drilling.

Risk index	Weight value
Very substantial index	Five points (5 of 5)
Relatively substantial index	Four points (4 of 5)
Normal substantial index	Three points (3 of 5)
Not very substantial index	Two points (2 of 5)
Very substantial index	One point (1 of 5)

Referring the table 1, for every risk factor each export may produce (fill-up) a weight value that swing between 1 to 5 according the table 2. However, the following generalized form of data will be produced. Table 3 demonstrates six factors of risks that weighted by five exports, the said table can be treated as matrix of six rows and five columns. The further steps of Delphi method include a statistical calculation that will be descried in hereafter.

Table 3: Risk level forecasting by Delphi method in general form.

Risks	$Expt^1$	$Expt^2$	$Expt^3$	$Expt^4$	$Expt^5$
construction	W11	W12	W13	W14	W15
Exploration	W21	W22	W23	W24	W25
Environment	W31	W32	W33	W34	W34
Human	W41	W42	W43	W44	W45
Natural	W51	W52	W53	W54	W55
Drilling ability	W61	W62	W63	W64	W65

In this step (after producing the table 3), row wised weight needs to be obtained. Let W_{total} to be the total weight taken from each risk factor and accumulated from all exports feedbacks. W_{total} can be given in Eq. 1:

$$\mathbf{W}_{\text{total}} = \frac{\sum_{i=1}^{R} Wij}{R} \quad (1)$$

Where,
i is termed to the columns count
j is termed to the rows count
R is termed to the total count of columns

Furthermore, columns wised weight needs to be calculated according to Eq. 2:

$$\mathbf{W}_{\text{column}} = \sum_{j} \frac{\sum_{i=1}^{R} Wij}{R} \quad (2)$$

In here we can calculate the index of forecasting μ as per the Eq. 3:

$$\mu\,(R) = \frac{\text{W total}}{\text{W column}} \quad (3)$$

Where μ (R) is representing the forecasting index per export.

The questionnaire that designed above are given in table form for several exports where each export is being asked to fill up the table according to his experience so that all exports answers are preprocessed using Delphi method that permits scoring and grading of the said survey. The gained data are then forwarded to neural network for learning process.

Artificial Neural Network

As very essential step in this project, neural network is developed to produce these results from any kind of response of the same questions. Using the target that is obtained from calculation of W_{total} step, a Feed Forward Neural Network is designed in two layers as per the table 4 which including the design parameters of this paradigm. Learning of any kind of response to the similar questions after passing the data from preprocessing step can lead to perfect results by letting the neural network doing the same.

Table **Error! No text of specified style in document.** The parameters that used to establish the Neural Network classifier.

Parameter	Value
Number of layers	3
First layer neurons	30
Second layer neurons	10
Maximum variance	1e-31

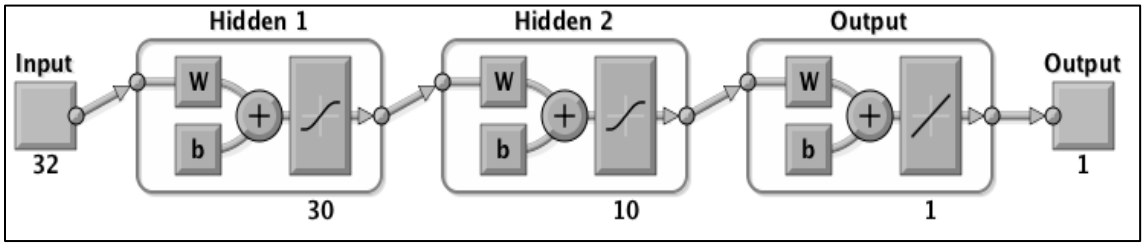

Figure 1: the structural view of feed forward neural network.

The resultant training performance of this network are measured using the mean square error (mse) formula Eq. 4.

mse=(√(I-O))^0.5 (4)

Where "I" is the input vector of data and "O" is the output of the neural network. Further the resulted mse is lesser than 1*e-31 which means very small error in the training is resulted from this network and hereby the performance of the same is good.

Neural network algorithm is implemented to learn over the survey in order to get a way for the performance measure; however, the said neural network are following the herein points:

Firstly, data is preprocessed and null responses are omitted from the said database so that only the useful data can be remained for next processing stage. In order to filter the said data, digitization is done where data are converted from the alphabetic form into number form wit light of Delphi method. The data resulted from previous step are treated in analytical methods with intention to produce assessment value from all exports. This value is reflecting a percentage of ERD success in EE123 well from each export vision; hereafter, the average value of all results may be taken in order to produce overall average performance that reflect the average percentage of ERD success that obtained by all the exports.

Neural network is selected to be feed forward neural network and constructed from two layers. These layers are contained of 30 neurons at the input layer and 10 neurons at the output layer. However, the target that reflects the individually obtained performance from all exports based on their answers to survey questions, is given to the neural network along with all questions for preparing the algorithm to the learning mode. In other word, neural network (Feed Forward neural network) is working in two modes more likely, learning mode and prediction mode. In learning mode of Feed Forward neural network (FFNN), two input vectors are required to be given to the said network i.e. target and response vector; where the network will take each candidates response for every question and the resulted performance for this particular response (the response result to be taken from the target vector).

Learning Mode

In learning mode: neural network may need to study that particular response values for every question in from single candidate (export) is leading to the respective target value. The same concept is applied for all candidates. Learning mode is working on bias and weight values, in other word, Figure below is showing two sides vector (left and right) the left vector is reflecting the response of each question in candidate wise and the right vector is reflecting the target for each candidate that is previously obtained, the intermediate station is reflecting the neurons that connecting the both sides (tying each candidate responses with their particular target) those neurons are simulated in practical as two values (weight (W) and bias(B)). Learning mode is about how to obtain the lesser error value of W and B. Usually, learning functions are defined in Matlab which are designed to obtain the proper less errored values for the data where in our case we had used the LEARNLM function and we obtained the performance of error (mean square error) < 10 e (-30). Figure 2 is demonstrating the FFNN mapping process.

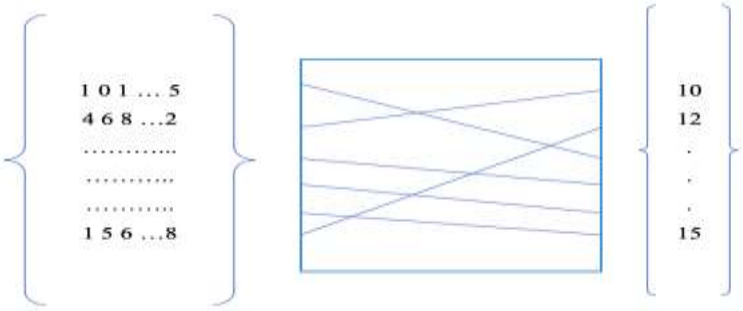

Figure 2: the working strategy of neural network.

In prediction mode: neural network will need only one input which is the response only where it can predict the target for the provided input base on learning stage. Finally, neural network is used over this project to replace the affrontive procedures that may be taken to calculate the performance with different responses where new calculations may be needed.

This is termed as artificial intelligence application as only single step is required that to feed the data to the neural network and last is producing the final Figure directly without needing to obtain any statics.

M already defined with 8000 m depth and termed as extended reach drilling process. The results of neural network paradigm shown that success of drilling in current conditions of the project (EE 123 project) is very poor and may lead to distortion in cost and safety, this was concluded base on the result that gained from our paradigm with is equal to 51.89 % of success.

According to the obtained facts, we proposed to not continue with drilling process of this site unless the required setup and tools is available. The concept of learning and making the decision is based on strong analysis and coding using Matlab software for building up neural network has proved a noticeable performance by reducing the effort and time and increasing the accuracy of the results.

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