Alternative Method for Evaluation of DaGang Deep Drilling Applications

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ABSTRACT

Deeper oil and gas drilling is one of the main concerns caused by of the exploration and development updated technologies and problems. The high cost of deep drilling followed by the complex geological conditions in deep strata of the DaGang oilfield leads some researchers to suggest some decision making methods for evaluating the DaGang deep drilling applications. This article tries to strengthen the mention studies, with suggesting and testing an alternative decision method. Compare to previous studies with complex multi-criteria mathematical decision making methods, the suggested method of this article is more mathematical user friendly and more suitable for design makers with less mathematical knowledge. This article suggests and tests the Simple Additive Weighting (SAW) method which is a valid accurate method of decision making.

KEYWORDS: Deep drilling; DaGang oilfield; Simple Additive Weighting (SAW).

INTRODUCTION

Zhang Yi and his/her co-researchers from China university of petroleum and Sun Teng-fie from CNOOC Research Institute of China in a recently published study by the electronic Journal of Geo technological engineering, explain that "with the development of exploration and development technology, drilling direction gradually into deeper strata. Manufacturers are also committed to the drill development in deep strata, forming a diverse variety of drill types. But the complexity of deep geological conditions determines the limitation of the application of drill bit. Therefore, a reasonable drill bit selection is an important way to increase drilling speed, reduce costs". They refer to a document which published in 2003 and in Chinese language (Bai et al, 2003), continue that the current drill selection method are in three categories. Firstly, the use of evaluation; Secondly, rock mechanics parameter method; and finally synthesis method. Then, as it is presented in their article (Zhang et al, 2014), targeting the indoor rock mechanical parameters category, the scope of their study is the Dagang oilfield; and the main objective of their study was to introduce Fuzzy Analytic Hierarchy Process of mathematical multi-criteria decision making methods to evaluate the drill.

Fuzzy Analytic Hierarchy Process is a well known method which is development result of application of Fuzzy bases and Analytic Hierarchy Process (AHP). Fuzzy bases firstly proposed in the early of 1960s and its application developed during the years and years (Sorooshian and Azizi, 2013). It is now an advanced mathematical analysis. The Analytic Hierarchy Process method is multi-criteria decision making method with a few matrix based mathematical steps and

calculations (Anvari et al, 2014). A disadvantage of both Fuzzy and AHP is that they need deep mathematical understandings and knowledge. Therefore, the current article tries to propose an alternative method to evaluate the drill problem. There are some other methods under the category of multi-criteria decision makings (Sorooshian and Dodangeh, 2013). This article proposes and tests Simple Additive Weighting method.

SIMPLE ADDITIVE WEIGHTING

The main advantage of the Simple Additive Weighting (also known as SAW) is it's simple application in decision makings. It is one of the most popular techniques used multi-criteria decision making attempts. Scoring method' and 'weighted linear combination' are other terms that have been alternatively used to represent SAW approach in decision sciences (Afshari et al., 2010). The method is based on the weighted average. Advantage of SAW techniques is stated that is that SAW is "a proportional linear transformation of the raw data which means that the relative order of magnitude of the standardized scores remains equal" (Afshari et al., 2010). This article follows the suggested application steps of SAW, based on Afshari et al. (2010) article which explains in SAW, "an evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria".

EVALUATION OF DRILL COMPREHENSIVE PERFORMANCE

Following Figure 1 was presented as a evaluation system of drill bit using (Zhang et al, 2014). From the comprehensive evaluation system diagram, five alternatives (indicators) should be evaluated. The five indicators were crushing work ratio, degree of wear, average ROP, the cost of unit drilling depth, and machinery. Criteria (drilling bits) were T5545SH, TDM1615SU, HCD506ZX, MD9531ZC, and H517G. Formation evaluation and use the drill statistics are presented in Table 1, bellow.

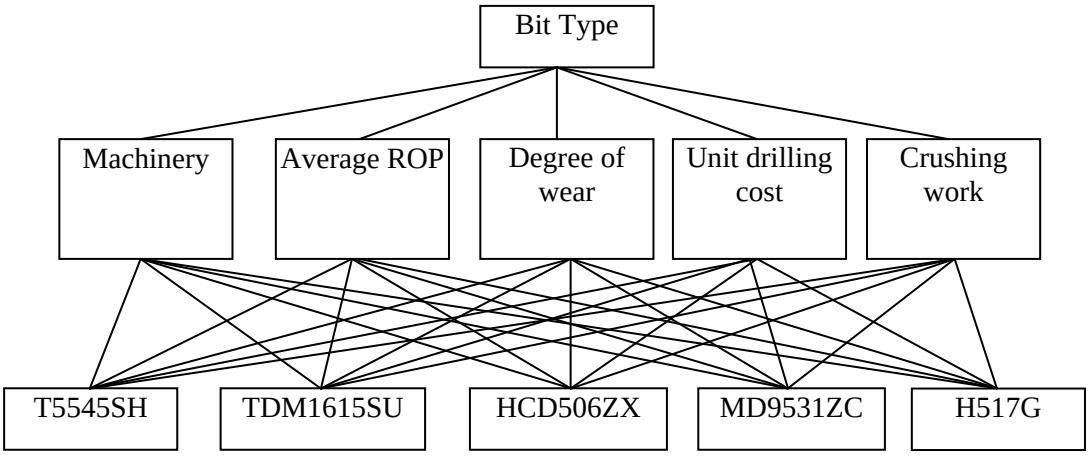

Figure 1: evaluation system of drill bit using (Zhang et al, 2014)

Table 1: Statistics of use of the drill (Zhang et al, 2014)

Drilling Bit	Drillability grade	Financial dimensions	Machinery (m)	Average ROP (m/h)	Unit drilling cost	Bit Wear	Crushing work (KJ/M^2)
T5545SH	6.2	2.31	950	11.05	315.8	Y2	1350
TDM1615SU	6.3	2.30	654.2	14.33	535	Y3	1260
HCD506ZX	5.9	2.26	1145.2	5.29	305.6	Y4	1180
MD9531ZC	6.5	2.33	843	4.86	355.9	Y4	1200
H517G	6.2	2.32	81	0.95	3614.5	Y5	1100

SAW application

Data of this study is the secondary data type. This study used the presented data in previous published article (Zhang et al, 2014), in which data was collected through panel of experts. The 1-9 scale judgment matrix of the data is presented in following Matrix A.

$$A=\begin{bmatrix} 1 & 2 & 3 \\ 0 & 0 & 0 \\ .1 & .25 & .5 & .33 \\ 0 & 1 & 2 \\ .5 & & \\ 0 & 0 & 0 \end{bmatrix}$$

The Judgment matrix is a 5x5 martrix with 25 cells (a_{xy}). Considering a_y^* as the maximum value of a in the colum of y, next step in order to use SAW technique is to normalize the Judgment matrix using following formula (1).

$$N_{xy} = a_{xy} / a_y^* \quad (1)$$

The normalized matrix N is shown bellow. N is a 5x5 matrix with 25 elements (n_{xy}).

$$N=\begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 0.1 & 0.14 & 0.12 & 0.83 & 0.11 \\ 0.5 & 0.57 & 0.5 & .0.5 & 0.66 \\ 0.17 & 0.28 & 0.16 & .16 & 0.16 \\ 0.33 & 0.4 & 0.25 & 0.33 & 0.33 \end{bmatrix}$$

Evaluating the alternatives is based on formula (2). Where, w_x in formula (2) is the average of column x in matrix A.

$$\text{Final SAW} = \sum(w_x.n_{xy}) \quad (2)$$

Therefore the final calculation of the SAW technique based in formula (2) is shown in bellow Table 2.

Table 2: Result of SAW technique

	T5545SH	**TDM1615SU**	**HCD506ZX**	**MD9531ZC**	H517G
	4.705	4.8916	4.601	4.989	4.797
Ranking:	4	2	5	1	3

CONCLUSION

This article tried to suggest alternative methodology for a previous published work. This article suggests an alternative SAW technique for the same decision making which a simple applicable decision making technique. Previously AHP method was suggested for evaluation of evaluation of drill comprehensive performance (Zhang et al, 2014), which was a collocated method compare to SAW technique. Feasibility of the SAW method has been tested in this article with use of secondary data. Based on SAW technique application, the MD9531ZC is the best followed by TDM1615SU and HCD506ZX is the worst of possible alternatives for the Dagang deep drilling.

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