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Determining of Well Drilling Sequence for Investment Analysis using Monte Carlo Simulation in Upstream Oil and Gas Company in East Kalimantan, Indonesia

Yona Vidya Prestiwi
Program Study Master of Business Administration, SBM ITB

ABSTRACT: Electrical construction company that experienced in making Well Head Control Panels (WHCP) has difficulties to decide acceptance of investment in WHCP contracts raised with their client in upstream oil and gas company. The difficulty mostly due to uncertainty of client well drilling sequence. The electrical construction company need to financial investment analysis includes material purchasing, shipping, fabrication and delivery of WHCPs need to be done to make sure they make a profit. It is crucial for electrical construction company used correct forecasting method to determine schedule of client's request. Monte carlo forecasting method is used to predict the well drilling sequence. The well drilling sequence data for 12 months is used to determine 24 months well drilling sequence operation with result 179 wells with normal distribution and 167 wells with triangular distribution.

KEYWORDS: Investment Analysis, Monte Carlo Simulation, Well Drilling Sequence

1. INTRODUCTION

In the current era of information advancement, electrical contractors are required to be more creative in meeting the demands of information needs, in this case the financial information needed for investment analysis projects. In order to calculate the investment analysis project, the first thing that an electrical construction service company needs to do is to map the material requirements that will be purchased to carry out the WHCP project (demand). This is necessary to enable the company to develop a more effective and efficient materials supply strategy. Starting from procurement, shipping, work in progress, distribution to work in the well, so that the project schedule can be completed on time.

Currently, an electrical construction company based in East Kalimantan is conducting a tender process for the work of wellhead control panels in wells owned by oil and gas exploration companies. The assembly or fabrication process of the WHCP is carried out in a workshop in Balikpapan, but the installation of the WHCP is carried out in wells owned by exploration companies spread throughout the East Kalimantan working area. The process of installing the WHCP in the wells must also be in accordance with the drilling schedule (well drilling sequence) set by the exploration company, which is given after the work contract is executed. It is important for the company to know the well drilling sequence for the next two more years of work to ensure that the material requirements and WHCP work schedule in the well are more effective and efficient.

It is widely recognized that petroleum journals often contain articles on the prediction of well construction duration and cost, project schedules, and production rates, which may exhibit random variations due to inherent uncertainties. These variations may lead to significant discrepancies between estimated and actual outcomes. Hence, it is essential for companies to identify potential errors and employ appropriate forecasting techniques to mitigate their impact on the accuracy of these estimates.

2. LITERATURE REVIEW

According to Williamson, Sawaryn, & Morrison (2006), Predictions of the duration and cost of well construction, project schedules, production rates, and cash flows are key inputs into the appraisal, planning, and monitoring of wells projects. These predictions may collectively be termed well forecasts. Monte carlo simulation is rapidly superceding deterministic methods as the preffered technique for many well-forecasting applications. Monte Carlo Simulation has the potential to enhance the reliability of well forecasts.

According to Rachmat Sudjati (2001), One method for petroleum reserves with limited data is the Monte Carlo method. The Monte Carlo method was first developed by J.E. Warren of Gulf Oil Corporation (Warren, 1980-1984, personal communication).

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This simulation is developed from a special form of statistical distribution using random numbers as input parameters. The resulting distribution may be rectangular (uniform), triangular, and normal.

2.1 Rectangular Distribution (Uniform Distribution)

The rectangular distribution is also known as the uniform distribution. This distribution is employed when the probability value of a variable within in interval is neither predominantly high nor low. In other words, tis distribution exhibits uniform probability density with p(x) being constant throughout the interval. It should be noted that the probability of an event occurring outside the interval is zero. The rectangular distribution is bounded by a maximum value (x_{max}) and a minimum value (x_{min}), as illustrated in Figure 2.1

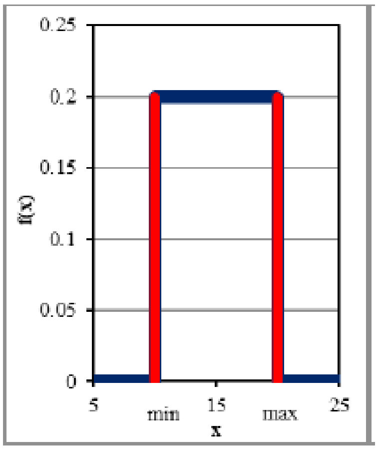

Figure 1. Rectangular Distribution

Mathematically, the determination of variable values can be expressed by the following equation:

$$x_i = x_{min} + RN(x_{max} - x_{min}) \quad (1)$$

Where:

x_i = the x value being sought
x_{min} = the smallest x data value
x_{max} = the largest x data value
RN = a random number with a value between 0 and 1

2.2 Triangular Distribution

The triangular distribution is a triangular continuous probability distribution, as illustrated in Figure 2.2. This distribution is characterised by a minimum value (x_{min}), a most likely value (x_{ml}), and a maximum value (x_{max}). The relationship between the minimum, most likely, and maximum values is as follows:

$$x_{min} \leq x_{ml} \leq x_{max} \quad (2)$$

In order to estimate the distribution parameters of the most likely value within the sample, it is possible to utilise the mean, median and mode values. Due to the limited number of samples, the value of the most likely value fraction (FML) can be calculated as follows:

$$FML = \frac{(X_{ml} - X_{min})}{(X_{max} - X_{min})} \quad (3)$$

The value of the randomly searched variable is determined by dividing it into two parts. If the random number (RN) is less than or equal to the fixed maximum limit (FML), the following equation is used:

$$X_i = 0{,}5\{2x_{min} + [4{x_{min}}^2 - 4({x_{min}}^2 - RN(x_{ml} - x_{min})(x_{max} - x_{min}))]^{0,5}\} \quad (4)$$

In the event that the random number RN exceeds the value of FML, the following equation is employed:

$$X_i = 0{,}5\{2x_{max} + [4{x_{max}}^2 - 4({x_{max}}^2 - RN(x_{max} - x_{ml})(x_{max} - x_{min}))]^{0,5}\} \quad (5)$$

where:

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x_i = the x value being sought
x_{min} = the smallest x data value
x_{ml} = the most likely average or x data value
x_{max} = the largest x data value
RN = a random number with a value between 0 and 1

In the approximate triangular distribution, the mean value is used as the most likely value (x_{ml}).

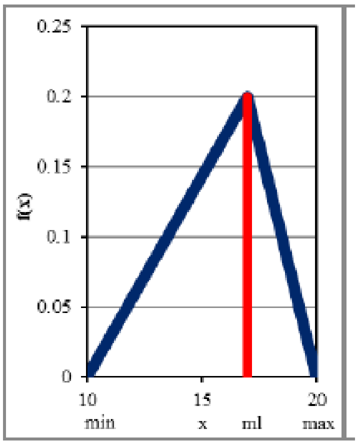

Figure 2. Triangular Distribution

2.3 Normal Distribution

The normal distribution, also known as the Gaussian distribution, is the most common distribution function for randomly generated independent variables. The graph of the normal distribution is bell-shaped and is characterised by two parameters: the mean, which represents the symmetrical axis, and the standard deviation, which expresses the spread of the data from the mean. A small standard deviation results in a graph that is steep. The normal distribution is generated with the normal density function, as follows:

$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2} \qquad (6)$$

to determine the value of a randomly searched variable for the normal distribution is expressed by the following equation:

$$x_i = \mu + \sigma\left[\sqrt{\ln(\frac{1}{RN^2})}\right] \qquad (7)$$

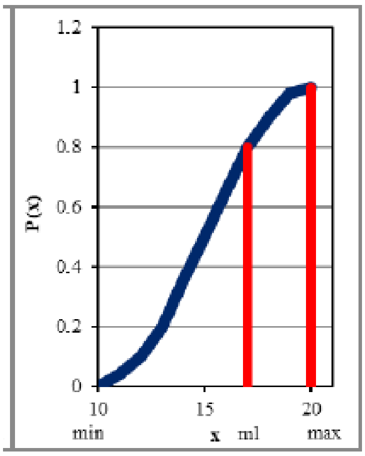

Figure 3. Normal Distribution

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3. RESEARCH METODOLOGY

The research methodology employed to ascertain the optimal well drilling sequence involved the acquisition of historical well drilling sequence data from oil and gas exploration companies over the course of a year. Thereafter, a determination was made of the minimum, maximum, and average values. The application of a Monte Carlo simulation involved the determination of the possible distribution and utilisation of random values (0.0–1.0). The projection was carried out using the normal and triangular distributions. The frequency curve was determined, and the Monte Carlo simulation was analysed, the results of which can be seen in Figure 4 below.

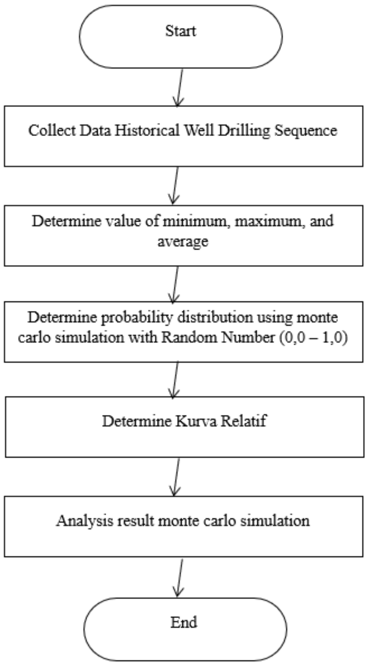

Figure 4. Research Metodology

4. RESULT AND DISCUSSION

Approached using normal distribution and triangular distribution, the distribution result can seen on Figure 5.

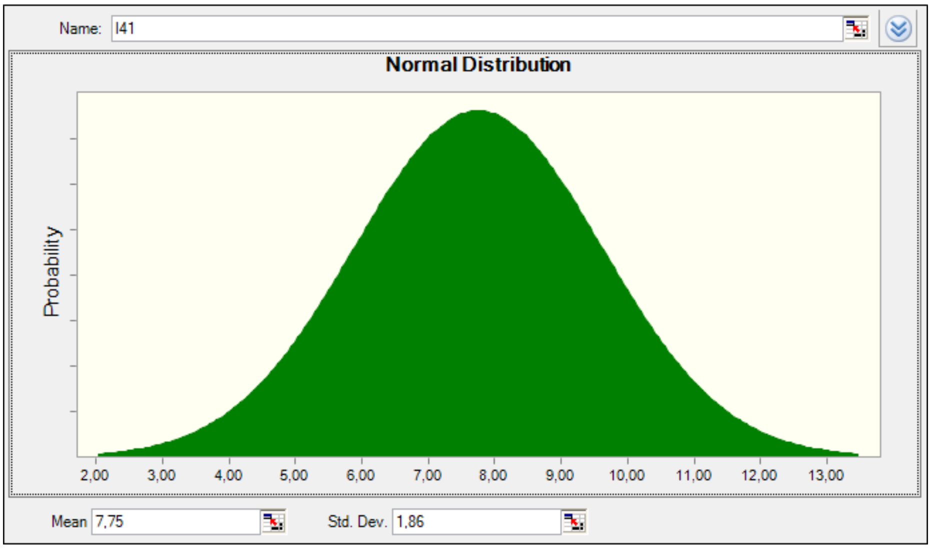

Figure 5. Normal Distribution Approach

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Table 1 presents the results of the well drilling sequence over the next 24 months.

Table 1. Result of Well Drilling Sequence Approached Normal Distribution

Monte Carlo Approached Normal Distribution		
Month	Projection	Round
1	7,69	8
2	8,00	8
3	8,67	9
4	8,27	8
5	11,00	11
6	7,83	8
7	7,80	8
8	8,41	8
9	6,73	7
10	6,27	6
11	5,70	6
12	4,92	5
13	9,09	9
14	9,25	9
15	6,51	7
16	8,29	8
17	7,70	8
18	4,33	4
19	5,35	5
20	13,01	13
21	4,62	5
22	6,23	6
23	6,44	6
24	6,91	7
		179

Projecting for 24 months of well drilling sequence with historical data has 179 well work on planning.
Approached Triangular Distribution, the result can be seen on Figure 6

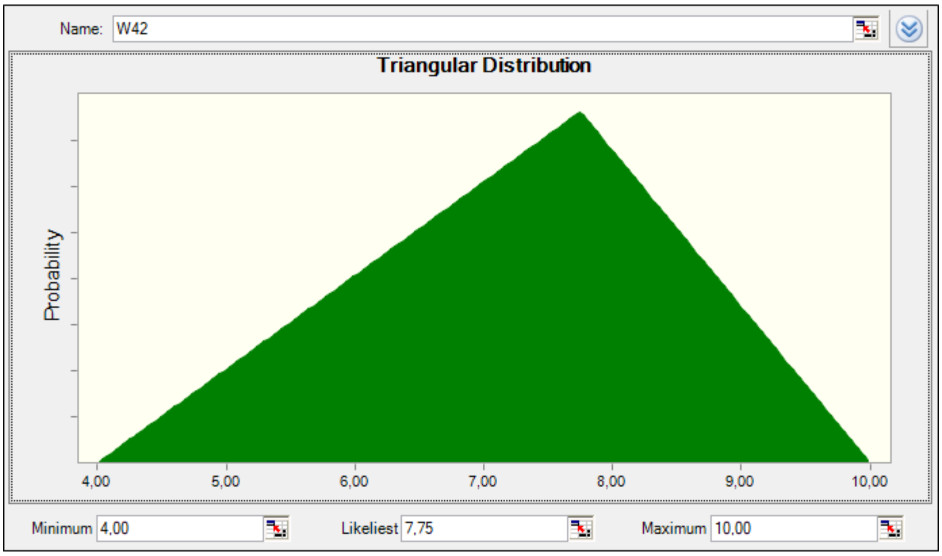

Figure 6. Triangular Distribution Approach

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Table 2 presents the results of the well drilling sequence over the next 24 months.

Table 2. Result of Well Drilling Sequence Approached Triangular Distribution

Monte Carlo Approached Triangular Distribution			
No. Simulation	Random Number	Result/ Projection	Round
1	0,91	8,50	8
2	0,41	7,04	7
3	0,49	7,34	7
4	0,42	7,06	7
5	0,01	4,56	5
6	0,17	5,93	6
7	0,03	4,88	5
8	0,78	8,42	8
9	0,14	5,77	6
10	0,20	6,12	6
11	0,94	8,57	9
12	0,98	8,63	9
13	0,49	7,31	7
14	0,10	5,49	5
15	0,03	4,84	5
16	0,99	8,66	9
17	0,71	8,09	8
18	0,14	5,76	6
19	0,59	7,66	8
20	0,44	7,13	7
21	0,63	7,91	8
22	0,26	6,43	6
23	0,36	6,85	7
24	0,75	8,17	8
			167

5. CONCLUSION & RECOMENDATION

The total projection of well work for the next 24 months, derived from both the normal distribution and triangular distribution approaches, is comparable. Therefore, both approaches can be employed in Monte Carlo simulation. The Monte Carlo simulation utilising the normal distribution approach yielded a projected number of wells for the next 24 months of 179, while the triangular distribution approach yielded a projected number of wells for the next 24 months of 167. The results presented in Tables 1 and 2 above represent the projected work for each month.

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