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RESEARCH ARTICLE

# The Mitigation of Risk Management: Non-Productive Time Analysis on Drilling Operations in ZY Field

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**Abstract**

Currently, petroleum is still the main energy source in Indonesia. However, since the 1990s, Indonesia began to experience a decline in oil production and an increase in domestic energy demand, which caused Indonesia to import oil to meet domestic energy needs. Through SKK Migas, Indonesia has a target to produce 1 million barrels per day by 2030, with one of the efforts being undertaken by carrying out massive and aggressive drilling. Drilling is the most critical, dangerous, complex and expensive operation in the oil and gas industry. It cannot be denied that in reality many unplanned problems (unscheduled events) which result in non-productive time (NPT) are encountered during drilling operations which sometimes cause unpredictable budget usage and can also result in delays in hydrocarbon production. This research was carried out by analyzing 50 wells that had been drilled in the BR field. This research was conducted using Pareto diagrams to analyze each type of NPT which is the main root cause of problems during drilling activities. In this research, a risk management process was carried out for the NPT categories to determine the level of risk in each NPT category and develop a mitigation analysis to reduce the NPT. Dealing with the finding, it indicates that the NPT rig moving (RMV) and drilling 8-1/2 (DRLG 8-1/2) categories have a red risk level which means unacceptable. The biggest contribution to NPT in the RMV category is location problems, while for DRLG 8-1/2 it is loss of circulation. Recommendations for mitigation that can be carried out for location problems are adding sandstone/gravel for critical road access, installing matting boards at critical point areas and using soil stabilizer in the wellpad during the rainy season. Recommendations for mitigating loss circulation problems are maintaining the right mud weight, using wellbore strengthening material, controlling drilling when penetrating the loss zone.

Keywords: Non-Productive Time, Oil and Gas, Drilling, Hydrocarbons, Mitigation, Risk Management

## 1. Introduction

### 1.1 Background

Currently, petroleum is still the main energy source in Indonesia (Ngarayana et al., 2021). However, since the 1990s, Indonesia has begun to face declining oil production and increasing domestic energy demand (Muhammad Ariyon et al., 2022). Crude oil production fell from 1472 thousand barrels per day in 1990 to 785 thousand barrels per day in 2015 and was the lowest in decades. On the other hand, Indonesia's oil consumption increased by almost 63% from 964 thousand barrels per day in 1999 to 1570 thousand barrels per day in 2015. Because Indonesia will not be able to meet domestic energy demand without importing (Baek, 2021).

In 2030, Indonesia through SKK Migas has a target to produce 1 million barrels per day (Migas, 2020). One of the efforts made to increase oil production and achieve the production target of 1 million barrels per day is to carry out massive and aggressive drilling (Migas, 2022).

Drilling has the most important main objective, namely to reach the reservoir zone safely, quickly and economically (Rita et al., 2019). Drilling is the most critical, dangerous, complex and expensive operation in the oil and gas industry (Novrianti et al., 2017).

The oil field development will focus on cost-efficient well drilling (Novrianti et al., 2022). Therefore, management of oil well drilling operations in the future will face new challenges to reduce the possibility of problems occurring during drilling operations (A. AL-Mahasneh, 2017).

However, it cannot be denied that in reality there are many unplanned problems (unscheduled events) which result in non-productive time (NPT) encountered during drilling operations (Saraswati et al., 2015). Non-productive time (NPT) is a key measure of cost-effective and successful drilling operations. NPT can be caused by various reasons, such as unexpected weather or technical problems (Krygier et al., 2020).

The existence of the NPT not only causes budget usage that is sometimes unpredictable but also results in delays in hydrocarbon production (Eren, 2018).

Recently, risk management methods have become a conducive management style (Saptarini and Nainggolan, 2022). Risk management is an organized process for identifying, evaluating and dealing with all risks (Barakat et al., 2021). Risk management is very important for every activity carried out to prevent potential undesirable events before they occur and to reduce the possibility of their recurrence, so that risk management activities can be planned well (Khalaf and Ela, 2008).

In this research, non-productive time (NPT) analysis was carried out on drilling operations in the BR field using a risk management process to map the risk level for each NPT category and determine the causes of the largest contribution to NPT. So this research can be used as reference material in reducing NPT to create more efficient drilling operations.

### 1.2 Research Objectives

In this research, non-productive time (NPT) analysis was carried out on drilling operations in the BR field using a risk management process to map the risk level for each NPT category and determine the causes of the largest contribution to

NPT. So this research can be used as reference material in reducing NPT to create more efficient drilling operations.
The aim of this study includes the following:
1. Find out the risk level for each NPT category in drilling operations in the BR field.
2. Find out the causes of the largest contribution to NPT in the NPT category with the highest level.
3. Provide recommendations based on analysis to reduce NPT.

### 1.3 Non-Productive Time

Non-Productive Time According to (IADC, 2019) NPT is time spent on activities that do not contribute to well drilling. However, the specific definition of NPT itself is the policy of each company.

NPT is the main cause of delays in drilling projects and excessive expenditure, this is directly proportional to the cost of drilling and if this is not controlled it can cause increased costs that sometimes exceed the budget, that is why operators consider 10 to 25% Authorization of Expenditure (AFE) during well planning to cover unexpected NPT costs that may affect the drilling budget (Alsalat, 2016). Non-productive time (NPT) estimates range between USD 14-37 billion, depending on the NPT category and when the NPT occurs (Jyoti Modak et al., 2017).

Table 1. NPT classification

| No | NPT Category | Description |
|---|---|---|
| 1 | RMV | NPT that occurs during rig moving operations |
| 2 | DRLG 17-1/2” | NPT that occurs during the drilling phase of the 17-1/2 hole section |
| 3 | DRLG 12-1/4” | NPT that occurs during the drilling phase of the 12-1/4 hole section |
| 4 | DRLG 8-1/2” | NPT that occurs during the drilling phase of the 8-1/2 hole section |
| 5 | CSG | NPT that occurs during casing running operation |
| 6 | CMT | NPT that occurs during cementing operations |
| 7 | WH | NPT that occurs during wellhead install |
| 8 | BOP | NPTs that occur during N/you and N/D and BOPTST |
| 9 | LOG | NPT that occurs during logging operations: High formation permeability (Rovig, 1992), Depleted formation (Hossain, M.E., Islam, n.d.), ECD transcends fracture gradient formation (Rabia, 2002). |
| 10 | PERF | NPT that occurs during perforation surgery |
| 11 | COMP | NPT that occurs during the completion operation |

## 2. Research Method

To achieve this goal, the author developed a methodology as in Figure 1 below:
1. Collect daily drilling report data for 50 wells, then rig rental costs, contract labor costs and equipment rental costs and develop an NPT classification based on the daily drilling report data obtained.
2. Carry out quantitative risk measurements for each NPT category and create a risk matrix.
3. Then create a Pareto chart for the NPT category with the highest risk level and
4. Develop mitigation recommendations related to the analysis results obtained to reduce NPT during drilling operations.

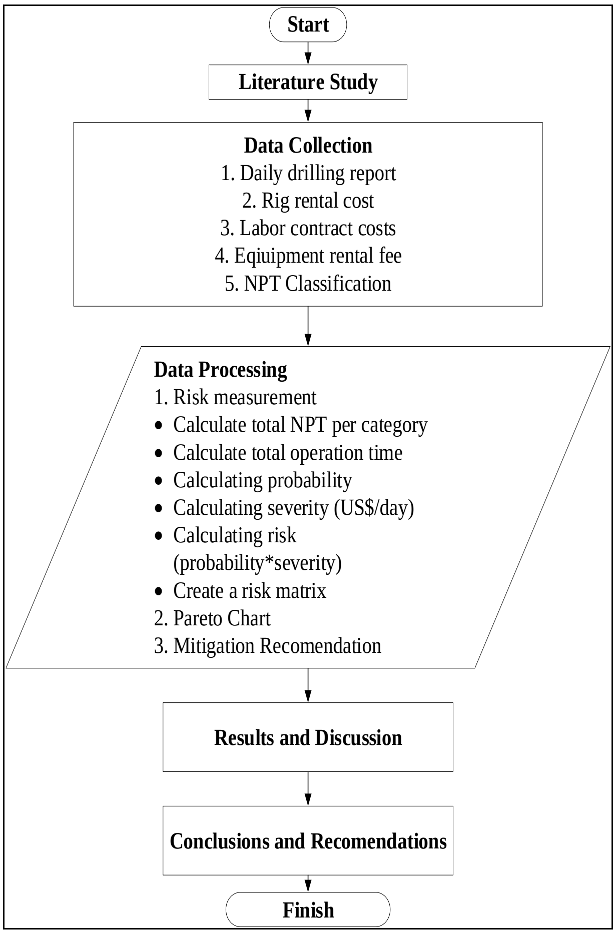

Fig. 1. Research Flow Diagram

## 3. Finding and Discussion

### 3.1 Risk Measurement

In carrying out quantitative risk measurements, daily drilling operational cost data is used as a parameter in risk measurement. The following are the daily operational costs of drilling in the ZY field:

Table 2. Data on Daily Drilling Operational Costs

| Kind | Information | Costs (US$/day) |
|---|---|---|
| Rig | Rig Rental | 15,000 |
| Contract Labor | *Drilling Supervisor (Day)*<br>*Drilling Supervisor (Night)*<br>*HSE Coordinator*<br>*Medical Profesional Service* | 1,837 |
| Daily Equipment Rental | *Satcom & Transmission Link Service, CCTV*<br>*Single H2S Gas Detector, pc/day*<br>*Composite Matting Board* | 1,601 |
| Total | | 18,438 |

The total daily operational cost of drilling in the BR field is 18,438 US$/day, resulting in a severity value of 768 US$/hour. The results of risk measurement for each NPT category obtained are as follows:

Table 1. Risk Measurement

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| No | NPT Categories | Operating Time (hr) | NPT (hr) | Probability (2/3) | Severity (US$/hr) | Risk (5x6) (US$/hr) |
| 1 | RMV | 9056.5 | 2579 | 0.2848 | 768 | 218.77 |
| 2 | DRLG 17-1/2" | 1240.5 | 83.5 | 0.0673 | 768 | 51.71 |
| 3 | DRLG 12-1/4" | 1571.25 | 212 | 0.1349 | 768 | 103.66 |
| 4 | DRLG 8-1/2" | 2661.5 | 825 | 0.3100 | 768 | 238.14 |
| 5 | CSG | 1147.75 | 25.75 | 0.0224 | 768 | 17.24 |
| 6 | CMT | 1493.42 | 32.75 | 0.0219 | 768 | 16.85 |
| 7 | WH | 503.75 | 31 | 0.0615 | 768 | 47.28 |
| 8 | BOP | 1716.58 | 90 | 0.0524 | 768 | 40.28 |
| 9 | LOG | 840.75 | 93.5 | 0.1112 | 768 | 85.44 |
| 10 | PERF | 210.75 | 12 | 0.0569 | 768 | 43.74 |
| 11 | COMP | 875 | 70.25 | 0.0803 | 768 | 61.68 |

In table (3) it can be seen that the largest loss risk value is owned by the NPT drilling 8-1/2 (DRLG 8-1/2) category at 238.14 US$/hour and the smallest is owned by the NPT cementing (CMT) category at 16.85 US $/hour. Because the severity value is constant, the magnitude of the risk of loss in each NPT category is influenced by the probability value. The results of the risk values for each category will later be used as a reference for mapping the risk level (Risk Matrix) for each NPT category.

### 3.2 NPT-Risk Matriks

After measuring the risk in each NPT category, risk mapping is then carried out which aims to determine the risk level for each NPT category from lowest to highest. This risk mapping is carried out to determine the priority scale in risk control. In carrying out this risk mapping, the following assumptions are used:

Tabel 2. Risk Matrix

| Risk Value (US$/hr) | Risk Level | Information |
|---|---|---|
| 0 - 60 | | *Acceptable* |
| 61 - 120 | | *Tolerable* |
| 121 - 180 | | *Inadmissible* |
| 181 - 240 | | *Unacceptable* |

From table (4) above, risk mapping is then carried out for each NPT category. The results of risk mapping can be seen in the following image:

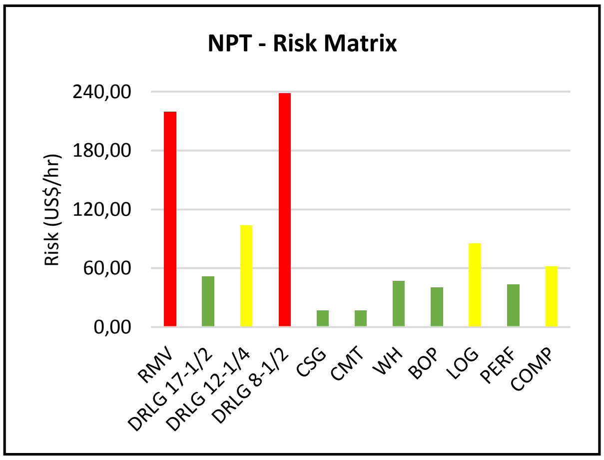


Fig. 2. NPT-Risk Matrix

From figure (2) it can be seen that the NPT rig moving (RMV) and drilling 8-1/2 (DRLG 8-1/2) categories are at the red risk level which means unacceptable risk, then the NPT drilling category 12-1/2 4 (DRLG 12-1/4), logging (LOG) and completion (COMP) are at the yellow risk level which means tolerable. Meanwhile, the NPT drilling 17-1/2 (DRLG 17-1/2), casing (CSG), cementing (CMT), wellhead (WH), blow out preventer (BOP) and perforation (PERF) categories are at the green risk level. which means acceptable.

### 3.3 *Pareto Chart*

After risk mapping, a Pareto chart was then created to determine the highest to lowest frequency of problems in the NPT category. The Pareto diagram is created only for NPT categories that are at the highest risk level or unacceptable risk levels. The following are the results of the sequence of causes of problems in the NPT RMV and DRLG 8-1/2 categories:

Table 5. Details of NPT RMV Category Problems

| Problems | Duration (hours) | Percentage (%) | Cumulative % |
|---|---|---|---|
| LOC | 2240.5 | 86.9% | 86.9% |
| WTHR | 158.5 | 6.1% | 93.0% |
| DAYLIGHT | 122 | 4.7% | 97.8% |
| PERSONNEL | 21.5 | 0.8% | 98.6% |
| EQP | 20.5 | 0.8% | 99.4% |
| POWER | 4.5 | 0.2% | 99.6% |
| CIRCSYS | 4 | 0.2% | 99.7% |
| JACK | 3.5 | 0.1% | 99.8% |
| CRANE | 2 | 0.1% | 99.9% |
| TOP DRIVE | 2 | 0.1% | 100% |
| Total | 2579 | 100% | 100% |

From table (5) we get details of the problems that occur in the NPT rig moving (RMV) category. The form of the Pareto chart for the NPT RMV category can be seen in the following picture:

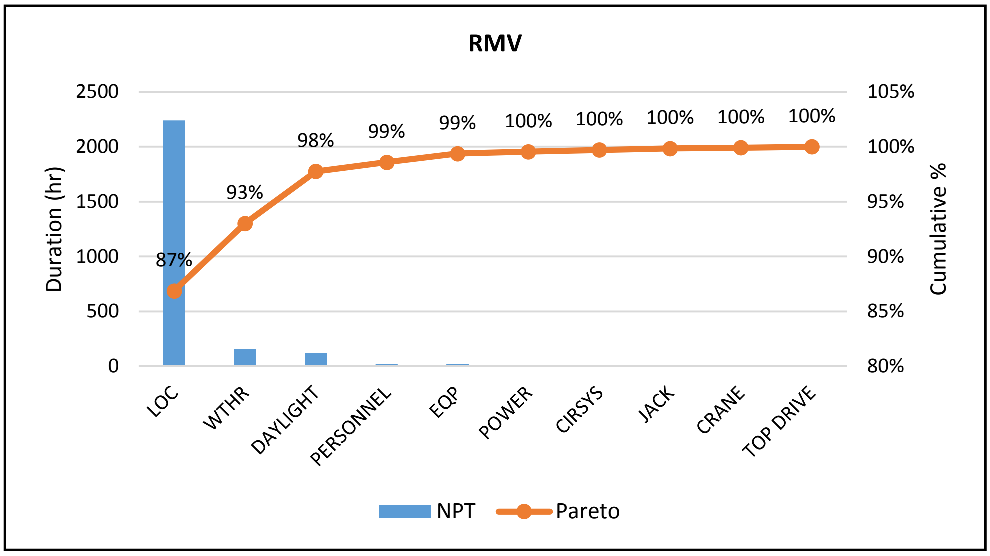


Fig. 3. Pareto Chart RMV

From Fig.3 Pareto chart RMV we get the problems that occur in the NPT rig moving (RMV) category is Location (Loc).

Table 6. Details of NPT DRLG 8-1/2 Category Problems

| Problems | Durations (hours) | Percentage (%) | Cumulative % |
|---|---|---|---|
| LOST CIRC | 633.75 | 76.8% | 76.8% |
| OTS | 87 | 10.5% | 87.4% |
| CIRSYS | 60.25 | 7.3% | 94.7% |
| PIPE HANDL | 18 | 2.2% | 96.8% |
| TOP DRIVE | 11.5 | 1.4% | 98.2% |
| DW HOIST | 4.25 | 0.5% | 98.8% |
| FL CONDT | 2.5 | 0.3% | 99.1% |
| DP | 1.75 | 0.2% | 99.3% |
| BHA | 1.5 | 0.2% | 99.5% |
| CRANE | 1 | 0.1% | 99.6% |
| DS WS | 1 | 0.1% | 99.7% |
| WTHR | 1 | 0.1% | 99.8% |
| COMPTR | 0.75 | 0.1% | 99.9% |
| EQP | 0.75 | 0.1% | 100% |
| **Total** | 825 | 100% | 100% |

From table (6) we get details of the problems that occur in the NPT DRLG 8-1/2 category. The form of the Pareto chart for the NPT RMV category can be seen in the following picture:

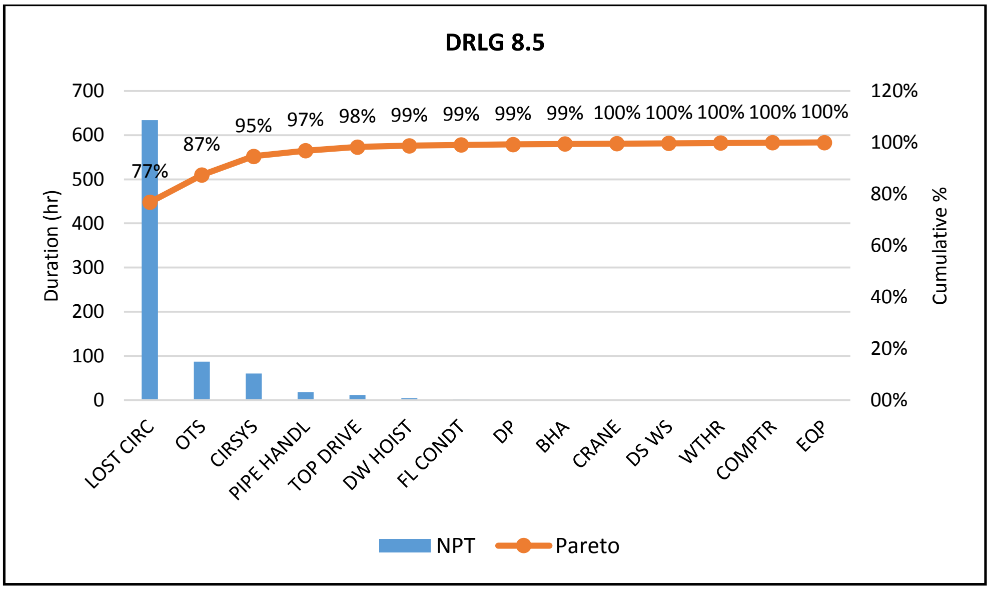


Fig. 4. Pareto Chart DRLG 8-1/2"

From Fig.4 Pareto chart DRLG we get the problems that occur in the NPT rig moving (RMV) category is Location (Loc).

### 3.4 Mitigation Recommendations

After knowing the main causes of NPT in the NPT RMV and DRLG 8-1/2 categories, then an analysis is carried out regarding the causes of the problem and provides mitigation recommendations that can be carried out for each problem. The results obtained are as follows:

Table 7. Mitigation Recommendations

| Kind | Causes/Problems | Mitigation recommendations |
|---|---|---|
| *Location* | Road access to the location is slippery and muddy | Adding gravel for critical road access |
| | *Wellpad slippery and muddy* | • Install matting board on critical point area.<br>• Using soil stabilizer during the rainy season |
| *Loss circulation* | • High formation permeability<br>• Depleted formation<br>• ECD transcends fracture gradient formation | • Maintain proper mud weight.<br>• Using wellbore strengthening material Perform drilling control when breaking the loss zone. |

## 4. Conclusion

Regarding to the results of data analysis and calculations that have been carried out, the following conclusions are obtained:

1. The NPT rig moving (RMV) and drilling 8-1/2 (DRLG 8-1/2) categories are at the red risk level which means unacceptable risk, then the NPT drilling 12-1/4 (DRLG 12-1) category /4), logging (LOG) and completion (COMP) are at the yellow risk level which means tolerable. Meanwhile, the NPT drilling 17-1/2 (DRLG 17-1/2), casing (CSG), cementing (CMT), wellhead (WH), blow out preventer (BOP) and perforation (PERF) categories are at the green risk level. which means acceptable.
2. The cause of the biggest contribution to NPT in the NPT RMV category is location problems and DRLG 8-1/2 is loss circulation problems.
3. Recommendations for mitigation that can be carried out for location problems are adding sandstone/gravel for critical road access, installing matting boards at critical point areas and using soil stabilizer in the wellpad during the rainy season. Recommendations for mitigating loss circulation problems are maintaining the right mud weight, using wellbore strengthening material, controlling drilling when penetrating the loss zone.


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