



## RESEARCH ARTICLE

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

Muhammad Ariyon<sup>1\*</sup>, Bobby Rahman<sup>1</sup>, Ellyan Sastraningsih<sup>2</sup>, Anthony Mayes<sup>3</sup>

<sup>1</sup> Department of Petroleum Engineering, Faculty of Engineering, Islamic University of Riau, Jalan Kaharuddin Nst No. 113 Marpoyan, Pekanbaru, Riau, Indonesia

<sup>2</sup> Faculty of Economic and Bussines, Islamic University of Riau, Jalan Kaharuddin Nst No. 113 Marpoyan, Pekanbaru, Riau, Indonesia

<sup>3</sup> Faculty of Economic and Bussines Riau University, Jalan. HR Soebrantas KM. 12.5, Simpang Baru, Binawidya, Pekanbaru, Riau, Indonesia

\* Corresponding author : ariyomuhammad@eng.uir.ac.id

Tel.: +62-813-2151-4121;

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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 (Alsarat, 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 BOPST
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.

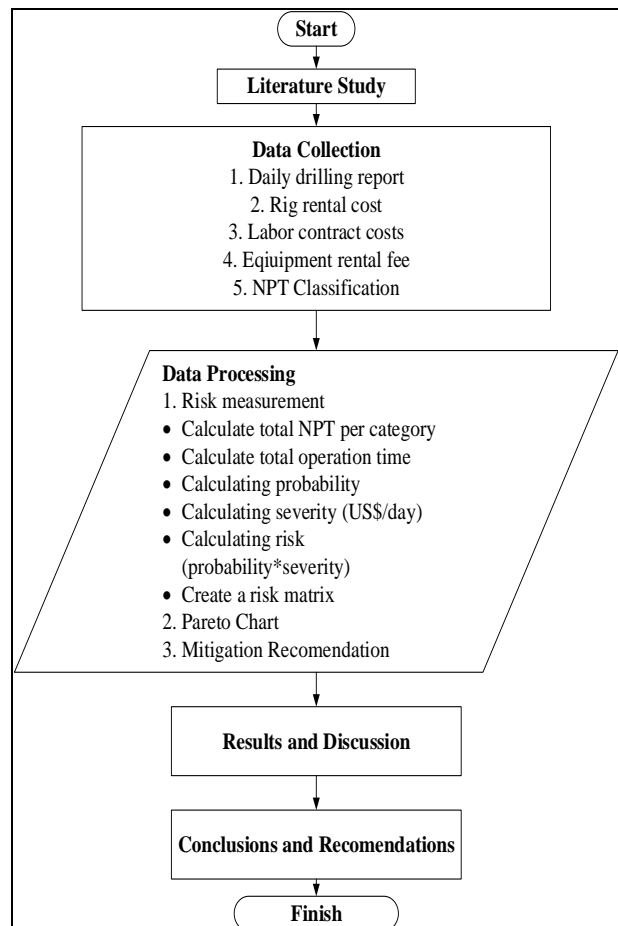


Fig. 1. Research Flow Diagram

## 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	Drilling Supervisor (Day)	
Labor	Drilling Supervisor (Night)	1,837
	HSE Coordinator	
	Medical Profesional Service	
Daily	Satcom & Transmission Link Service,	
Equipment	CCTV	
Rental	Single H2S Gas Detector, pc/day	1,601
	Composite Matting Board	
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	Green	Acceptable
61 - 120	Yellow	Tolerable
121 - 180	Orange	Inadmissible
181 - 240	Red	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:

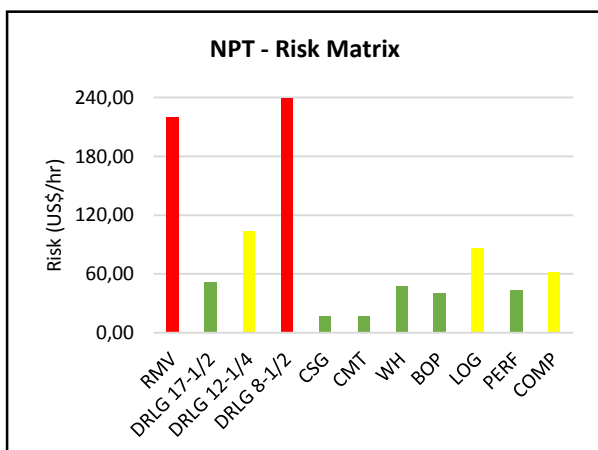


Fig. 2. NPT-Risk Matrix

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:

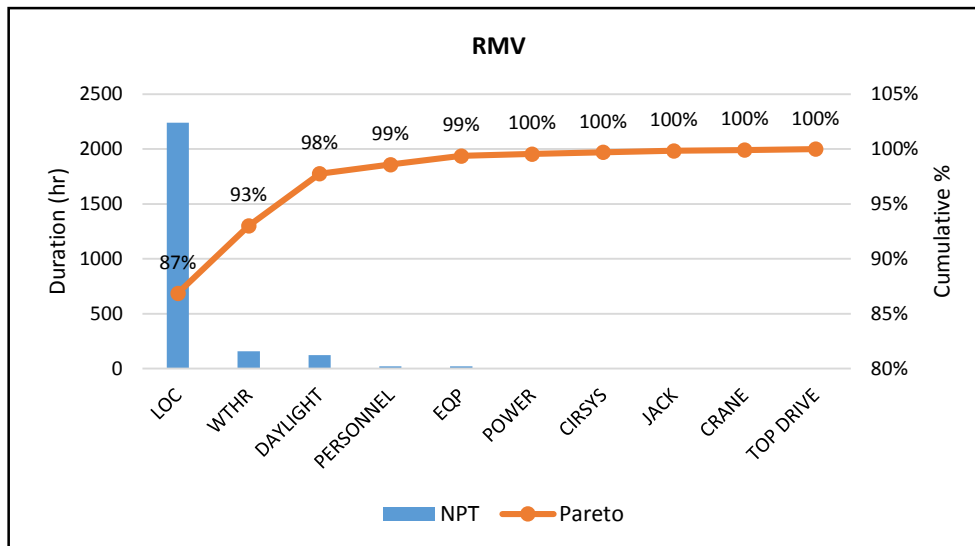


Fig. 3. Pareto Chart RMV

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%
<b>Total</b>	<b>825</b>	<b>100%</b>	<b>100%</b>

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:

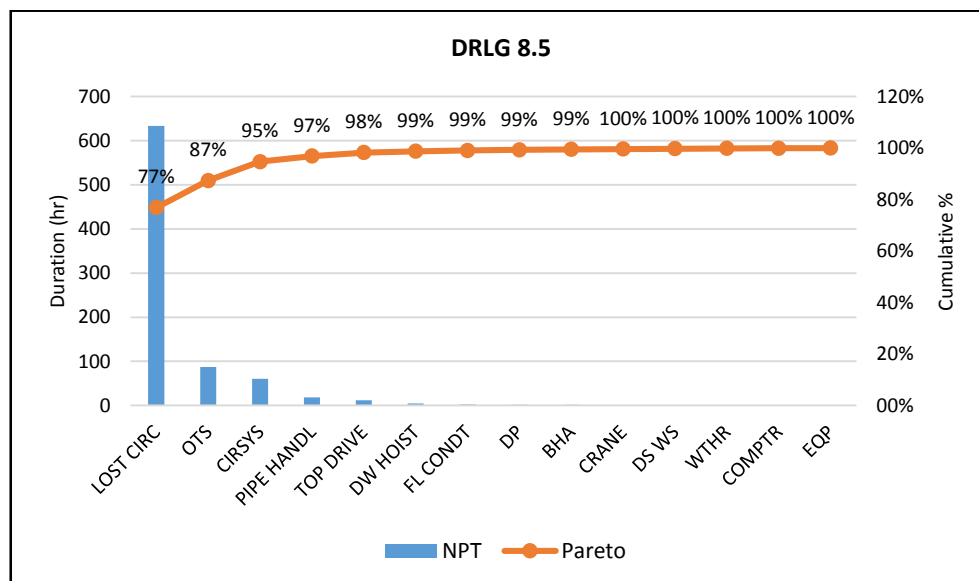


Fig. 4. Pareto Chart DRLG 8-1/2"

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

Table 7. Mitigation Recommendations

Kind	Causes/Problems	Mitigation recommendations
<i>Location</i>	Road access to the location is slippery and muddy <i>Wellpad slippery and muddy</i>	Adding gravel for critical road access
<i>Loss circulation</i>	<ul style="list-style-type: none"> <li>High formation permeability</li> <li>Depleted formation</li> <li>ECD transcends fracture gradient formation</li> </ul>	<ul style="list-style-type: none"> <li>Install matting board on critical point area.</li> <li>Using soil stabilizer during the rainy season</li> <li>Maintain proper mud weight.</li> <li>Using wellbore strengthening material Perform drilling control when breaking the loss zone.</li> </ul>

### 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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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:

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