REDUCING NON-PRODUCTIVE TIME (NPT) IN THE SEVEN WELL DRILLING PROJECT ON THE NORTH BEACH OF JAVAFROM PT MULTI JAYA TEHNIK

THESIS

Submitted to International Program Faculty of Industrial Technology
in Partial Fulfillment of the Requirements for the degree of Sarjana Teknik Industri

By

Adnan Jati Satria (13522203)

INTERNATIONAL PROGRAM
DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF INDUSTRIAL TECHNOLOGY
UNIVERSITAS ISLAM INDONESIA
YOGYAKARTA
OCTOBER 2020

AUTHENTICITY STATEMENT

For the sake of Allah, I confess this work is my own work except for the excerpts and the summaries that each of their sources has already been cited and mentioned. If in the future my confession is proved to be wrong and dishonest resulting the violence of the legal regulation of the papers and intellectual property rights, then I would have the will to return my degree to be drawn back to Universitas Islam Indonesia.

Yogyakarta, October 2020

METERAI TEMPEL
6AE08AHF753211959
6000
ENAM RIBU RUPIAH

Adnan Jati Satria

THESIS APPROVAL OF SUPERVISOR

REDUCING NON-PRODUCTIVE TIME (NPT) IN THE SEVEN WELL DRILLING PROJECT ON THE NORTH BEACH OF JAVA FROM PT MULTI JAYA TEHNIK

THESIS

By

Name : Adnan Jati Satria
Student Number : 13 522 203

Yogyakarta, October 2020

Supervisor

(Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D.)

THESIS APPROVAL OF EXAMINATION COMMITTEE

REDUCING NON-PRODUCTIVE TIME (NPT) IN THE SEVEN WELL DRILLING PROJECT ON THE NORTH BEACH OF JAVA FROM PT MULTI JAYA TEHNIK

By

Name : Adnan Jati Satria
Student Number : 13 522 203

Was defended before Examination Committee in Partial Fulfillment of the requirement for the bachelor degree of Industrial Engineering Department

Examination Committee

Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D. ____________
Examination Committee Chair

Agus Mansur, S.T., M.Eng.Sc. ____________
Member I

Dr.Taufiq Immawan, S.T., M.M. ____________
Member II

Acknowledged by,
Head of Department
International Program Industrial Engineering
Universitas Islam Indonesia

UNIVERSITAS ISLAM INDONESIA
YOGYAKARTA
FAKULTAS TEKNOLOGI INDUSTRI

(Dr.Taufiq Immawan, S.T., M.M.)

DEDICATION

This thesis is dedicatedtomy wonderful mom and my super hero, Arifah Nur Istiqomah,my dearest grandmother, Hj.Afijah, my dear grandparents H. S, Dibyo Sarono and Hj. Surtini, my father, Priyo Susilo, my brothers Anggita Prihadmojo and Afif Riza Ramadhan, TeknikIndustriUniversitas Islam Indonesia, and all of my friends.

MOTTO

□Society grows great when old men plant trees whose shade they know they shall never sit in”

– Ancient Greek proverb

“Entertainmnet is not a waste of time because humans, unlike machines, need the will to live to function”

– Anonymus

“Truly humanity lives in losses.”

– QS Al-Asr (2)

“ For you, your religion and for me, my religion.”

– QS Al-Kafirun (6)

ABSTRACT

Oil and gas as fuel are still the main needs for human needs on energy, and to obtain oil or natural gas, the drilling process should be executed. The drilling process is an expensive investment and requires a very high cost. Drilling cost is critical factor in determining the financial returns from an oil and gas investment. One of the factors that determines the cost efficiency of drilling is reducing the Non-Productive Time (NPT) or downtime. Downtime is an undesirable outcome in any operation. The NPT makes the high cost of drilling process. The higher the NPT,the more expensive the drilling costs will be. Drilling optimization is the key to reduce Non-Productive Time /NPT. There are many factors that cause NPT include natural factors, technical factors, human resources, and availability of equipment. For this reason, this study will examine the NPT in the drilling project undertaken by PT Multi Jaya Tehnik (MJT).

This research is a quantitative study with cross sectional method which was carried out on 7 oil drilling projects by PT MJT. The data collection was carried out during the internship in July 2019.

The research finds that from the 7 well drilling projects of PT. MJT, the result shows from the total operational time, how of 4.144,76 hours is lost due to NPT, of which 2420,25 hours is NPT ER.

By reducing NPT via various means on focus of the equipments which PT. MJT provides, the projects can reduce loss time caused by NPT noticeable while also improving PT. MJT quality of service as an equipment rental company.

Keywords: NPT, NPT ER.

PREFACE

Assalamu'alaikumWr. Wb.

Alhamdulillahirrobbilalamin and gratitude are presented to Allah the Highest and Almighty, while blessings and greetings mahabbah are also delegated to the Prophet Muhammad. With all humility and gratitude let the author to express my gratitude and highest appreciation to all those who have been support and motivating in order to complete my thesis. The author would like to say thanks to:

1. My super hero and wonderful mom, Arifah Nur Istiqomah, dr.Sp.KJ(K).
2. My father Ir.Priyo Susilo, M.T.
3. My grandparent Hj. Afijah, Hj. Surtini and H. S. Dibyo Sarono.
4. My brothers and all of my big family.
5. Muhammad RidwanAndiPurnomo S.T., M.Sc., Ph.D. as the author's supervisor and lecturer that always gives education, direction and motivation.
6. Ir.Ira Promasanti Rachmadewi, M.Eng., who has given the author an opportunity to complete the study.
7. Mrs. Diana, who always help the author and always kind and patient.
8. My friends in university, IP FTI UII 2013.
9. Dr. Kevin Sulay Wijaya, Mr. Tata who helped me as an expert
10. All parties that already support and help the author mentally, physically and financially.

The author realizes this report is not perfect. Thus, suggestions and critics are fully expected.

Wassalamu'alaikumWr. Wb.

Yogyakarta, October 2020

Adnan Jati Satria

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

CHAPTER I

INTRODUCTION

1.1 Background

Oil and gas as fuel are still the main needs for human needs on energy. These needs are increasingly high in accordance with a population and technology enhancement even though the alternative energy sources have been found. Unfortunately, this resource depends on availability in nature. As time goes by, the increase in the world's energy demand forces oil and gas companies to drill deeper in order to produce more oil and gas for quenching the thirst of human needs. The need for oil and gas requires a costly business through a drilling process that is conducted both on the land and at the sea. Expensive costs in the drilling process certainly affect the price of oil and gas. Drilling activities in the oil and gas industry are a shared concern among energy companies, government agencies, and the general publicbecause they can affect both company profitability and the natural environment.(Júlio Hoffimnn et al, 2017)

Drilling cost is critical factor in determining the financial returns from an oil and gas investment. Its critical nature is particularly true when operating costs are high and when drilling problems may be likely to occur. Drilling optimization is the key to reduce Non-Productive Time (NPT). (Moazzeni A et al, 2010).

Therefore an efficient and effective drilling process must be carried out both in terms of time and cost. One of the factors that makes the high cost of drilling process is the presence of NPT or downtime.Downtime is an undesirable outcome in any operation. It not only leads to loss of money in terms of costs but also reputation especially in this era of companies venturing into contract drilling which is very competitive.

PT Multi Jaya Tehnik (PT MJT), a company that rents oil drilling equipment and partner of Pertamina and the tenant company, also plays a role in the efficiency of the drilling process of an oil or gas well. The availability of good and maintained tools from PT MJT plays a crucial role in determining the NPT in the drilling process.

The NPT is defined as that time that the rig is not involved in actual well drilling i.e. not gaining meters. There are several causes of this rig downtime, from bad weather, fire, tripping in and tripping out, wait on water, wiper trips etc. Nyota et al, 2015 established that most wells drilled in Olkaria incur a 24% downtime arising from several factors including but not limited to equipment failure, tripping in and out of hole, drill on cement etc. More than half of this time (15% of the overall) was attributed to equipment unavailability during the drilling, making it as the major cause of downtime at the rig. Rahmati (2018), stated that occurrences are either observable or unobservable and may be due to the physical characteristics of the well, geology, drilling parameters of the well, operator experience, wellbore quality, equipment downtime, well planning and execution, team communication, management, or project management abilities.

A critical analysis therefore has to be made to find out the causes of this equipment unavailability. By asking questions about the maintenance practices, quality of equipment, availability of spares, environmental conditions, handling of the equipment etc. We can gain insight and improve the availability of these equipment (Otieno, 2016).

1.2 Problem Formulation

Based on the description in the background above, the problem that comes up in the research would be formulated and generates a research question as follows:

1. How to properly define which activity type that falls into Non-Productive Time and its contribution to total Non-Productive Time?
2. How to identify the impact of Non-Productive Time in PT Multi Jaya Tehnik projects?
3. How to analyse the Non-Productive Time occurring in the projects of PT Multi Jaya Tehnik?

1.3 Research Objective

Based on the problem formulation above, the objectives of research can be arranged as follows:

1. Defining which activity that falls into Non-Productive Time.
2. Identifying the root causes of the Non-Productive Time in PT Multi Jaya Tehnik projects
3. Analysing the NPT occurring in the projects of PT Multi Jaya Tehnik

1.4 Scope of problem

Every research requires the directed scope and focus of the study. Therefore, this research should be given the restriction, so it can be focused and produce good research. Scope of the problem in this research as follows:

1. This research does not include the financial risk, whereas it is only about the operational risk.
2. Assessing the factors contributing towards NPT derived from the report of the 7 drill well from PT Multi Jaya Tehnik.
3. Analysing and providing recommendation or measures that can be used to help identifying NPT.

1.5 Benefits of research

This research has several benefits, such as increasing the knowledge,

1. Being able to analyse the problems in industrial sector and learn how to solve it using acquired knowledge.
2. Being able to apply the learned theory in college
3. Being able to improve problem identification regarding to NPT, especially in drilling company

For the company:

1. To improve reaction toward unexpected NPT problem equipment related in oil drilling operation.

2. To provide advice to PT Multi Jaya Tehnik regarding quality control of equipment.

1.6 Systematic writing

Writing this study was based on the rules of scientific writing in accordance with the systematics as follows:

CHAPTER I **INTRODUCTION**

This chapter contains a preliminary description of research activities, on the background of the problem, formulation of the problem, the objectives to be achieved, the benefits of research and systematic writing

CHAPTER II **LITERATURE REVIEW**

This chapter elaborates on the theories of reference books and journals as well as the results of previous research related to the research problem which is used as reference for problem solving

CHAPTER III **RESEARCH METHODOLOGY**

It contains the description of the framework and lines of inquiry, the research object to be studied and the methods used in the study.

CHAPTER IV **COLLECTION AND PROCESSING DATA**

It contains the data obtained during the research and how to analyse the data. Data processing result is displayed either in the form of tables and graphs. What is meant by processing the data also includes analysis of the results obtained. In this section is a reference to the discussion of the results to be written in Chapter V.

CHAPTER V **DISCUSSION**

It contains discussion on the results of data processing that have been performed in research. Compatibility with the objectives of research so as to produce a recommendation.

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

It contains the conclusion of the analysis and any recommendations or suggestions on the results based on potential identified problems during the study, so it needs to be assessed in the future studies.

REFERENCES

APPENDIX

CHAPTER II

LITERATURES REVIEW

In this chapter, it will be explained the literature studies about theory and previous research that support this research. This literature review will be divided into several sub chapters.

2.1 Definition of Non-Productive Time (NPT)

Non-Productive Time (NPT) does not have a standard definition. Dave Taylor (2014), defines the NPT is any occurrence that interrupts the progression of a planned operation, resulting in a time delay. It includes the total time required to resolve the problem until the operation is back to the point or depth at which the NPT event occurred. Moazzeni (2010), NPT is time which drilling is ceased or penetration rate is very low. Rabia (2001) in Emhana (2018), defined NPT as the time taken for any routine or abnormal operation that is carried out as a result of a failure or an event that causes the drilling operation to stop. Emhana SA (2018), followingNabaei et al (1989) defined NPT as the time in which drilling rate has stop. This measure of NPT includes any time spent for an activity above the time which that activity was planned to take. The time when the rig does not carry out drilling activities according to the plan or initial plan is referred to as Non-Productive Time /NPT(Saraswati GF et al, 2015).NPT is defined as time which drilling operation is ceased or penetration is very low (Ngosi R, Omwenga J, 2015). While Cochener, defined NPT, time the “Bit is not turning to the right”. (Nyota and Murigu, 2016)

2.2 Drilling

Mother Earth is a huge storehouse of oil and gas. A hole is drilled in the earth to bring hydrocarbons to the surface. Technology used in drilling oil and gas has undergone a great transformation from the ancient spring pole to percussion cable-tools to rotary drilling that can drill several miles into the earth and this transformation is continuously going on. Generally, drilling process is accomplished using tubulars called 'drill pipe' and drill bit. However, since a decade ago, drilling companies started experimenting with another type of tubulars called 'casing' to drill wells. **(**Patel et al, 2019**)**

2.2.1 Types of Drilling

Drilling is a major activity in the oil industry that aims to make a hole from the surface to the target reservoir to produce hydrocarbons.

There are two types of drilling:

a. Onshore: the drilling rig on land
b. Offshore: the drilling rig at sea

2.2.2 Drilling supporting equipment

The drilling rigs are complexes of mobile equipment which can be moved (onshore and offshore) from one drill site to another, drilling a series of wells. The drilling action involves breaking the ground and lifting the rock cuttings from the resulting hole by suspending then in a circulating drilling fluid. In the process of drilling for oil / natural gas on a rig, both on land and at sea, the following tools are required:

a. Main tools

Primary equipment that is required in a drilling operation, such as:

1. Generator set: Used as electric power supply
2. Drilling equipment set:Devices and tools such as hoisting kit which is used to lift, lower, or hang drill pipe set (pipes, collars, etc) and drill bit into and from the drill well. The hoisting kit are comprised of:
   a. Towing machine (draw work).
   b. Overhead Tools comprised of Crown Block, Travelling Block, and elevator

c. Drilling Line: High tensile steel rope which serves as the connector from Draw work, Crown Block, and Travelling Block to lift, lower, or hang overhead equipment drill pipes etc.

3. Mud Pump: Part of the circulating system,which is the primary system in a drill rig, functioning to pump mud towards the drill pipe set and carrying drill waste to the surface.

The purpose of circulating system is to filter the result of the cutting process from the drill mud so that the mud is returned to the suction pit clean of debris.All are done during the duration of the drilling. It also serves as preventative measure to prevent sparks created during the drill impacting the rock bed, where it can potentially ignite gas pockets. Other than that, the mud also serves as lubrication for the drilling process so that the drill bit doesn’t wear off as fast.

b. Support Equipment

Equipment used to help the drilling process such as:

1. Rig/drill tower: to facilitate the pulling, lowering, or hanging the drill pipe into the drill hole.
2. Series of foundation/substructure: to keep the drill bit in position and as a support for a series of drilling machines, as well as a place to monitor the drilling process.
3. Mud ponds used to supply mud. Sludge is made out of special cement for the oil drilling process.
4. Fuel and Water tank.
5. Portable camp: for office, warehouse and rest area.

2.3 Non-productive Time (NPT) in drilling

Non-productive time (NPT) at a drilling operation can be distinguished:(Saraswati GF et al, 2015)

a. Surface NPT: Non-Productive Time that happened on surface.
b. Subsurface NPT or downhole NPT: is a Non-Productive Time that happened under the surface or in the wellbore.

Things that can be categorized as the main features of surfaces NPT are:

a. Human error

   Failure by the drilling crew which causes a delay in work on the rig which will add unproductive time to a drilling operation.

b. Waiting on equipment

   The time spent waiting for the equipment needed to arrive at the drilling location. Waiting on this equipment usually occurs in offshore drilling operations or fields located in remote areas due to the need for additional equipment to prepare drilling equipment.

c. Waiting on weather

   The time spent waiting for bad weather, so it does not interfere with an activity on the rig. Waiting on weather usually occurs in offshore drilling operations due to the possibility of bad weather which causes the helicopter or boat cannot be used as a means of transportation to the rig.

d. Surface equipment failure

   Any damage or problems that occur on drilling equipment that is on the surface or the rigcan be categorized as unproductive time. The damages can be in the form of:

   - Leaks of flowline
   - Problems with BOP during the drilling process or when doing a pressure test

e. Repair time

   The time used to make repairs to the drilling equipment experiencing damage can be categorized as an unproductive time. This time should not have been spent if there were no problems with the drilling equipment.

The problems b, d and e are correlated with equipment for supporting drilling operation.

Things that can be categorized as the main features of non-productive time subsurface are: (Saraswati GF, Ginting M, 2015)

a. Lost circulation

   Lost circulation is defined as the loss of a partial or full drilling fluid during drilling and circulation. The inclusion of drilling mud into the formation can be caused scientifically, due to the type and pressure of the formation which is penetrated by the drill bit or mechanically caused by an error in the drilling operation

b. Pipe stuck

   Pinching of the drill pipe series is the most common problem encountered in drilling operations. There are many things that cause the pinch in a series of pipes in the wellbore.

c. Kick or Blowout

   Blowout is an event the flow of oil, gas or other liquids from oil and gas wells to the surface or underground that cannot be controlled. This event can occur when the hydrostatic pressure of the drilling mud is less than the formation pressure.

d. Wellbore Instability

   Wellbore instability is one of the main problems that are often faced by engineers during the drilling process.

   The causes of instability of wellbore are often classified into two things: mechanical (for example, failure of rocks around the borehole caused by high pressure, low rock strength, or errors during drilling) and chemical effects that cause effects that can damage interactions between rocks, generally shale with drilling fluids. Theseproblemcan cause serious complications in wells and in some cases can cause expensive operational problems.

e. Sidetrack operation

Sidetrack operation is an operation normally carried out in open hole and commonly applied in three scenarios, such as drilling horizontal laterally from a main wellbore; for lateral drilling in multilateral wells; or for unplanned drilling activities, such as collapsed wells; or wellbore instability.

f. Fishing job

One of the drilling activities that classified as unproductive time is fishing activities (fishing jobs) items that are detached and left inside bore hole. Equipment left in a borehole is known as a "fish". Fishes that are left behind or fall into a borehole must be taken because if not taken will disrupt the smooth operation of further drilling. if this tool cannot be retrieved then side tracking operations may benecessary,and the hole cannot be continued.

g. Repair of cement job

Cementing repair or squeeze is a cementing activity, which is conducted to complete and close the cavities that still exist after primary cementing is done.

2.3.1 NPT equipment related in oil or gas drilling

Eren T (2018), mentioned that the main causes of well problem related NPT occurrence are hole problems, drill string and tool failures. According the research from Saraswati (2015), NPT that can be accepted by companies is around 10-15% of the total drilling time of a well and 15-20% which can be tolerated by company. In this research, the NPT equipment related is 8,1% of total NPT, and others are caused by technical or geology condition. According to Emhana (2018), the main challenges of drilling operations are avoiding losses of drilling equipment or drilling process continuity. The non-productive time represents high cost, 150 million USD per year for each drilling contractor, which is due to these categories of issues in order of occurrence (Athens Group, 2010):

- Surface equipment failure
- Subsea equipment failure

- Bottom hole equipment failure
- Rig repairs
- Accident/incident
- Stuck pipe
- Personnel
- Bottom hole problems related to the physical environment
- Weather
- Other (unplanned, waiting, unknown)

In his paper"Evaluation of Non-Productive Time of Geothermal Drilling Operations-A case Study in Indonesia", Marbun B (2013)stated there are many factors and events that impact the time and cost to drill a well, which will affect the overall production time and NPT. The factors are:

- Well characteristics
- Well complexity
- Site characteristics
- Operator preference
- Drilling characteristics
- Formation Evaluation
- Technology

2.4 Related Works:

In the drilling process, one of the causes of NPT is stuck pipe. PT Pertamina (2018) is making efforts to reduce the high NPT by implementing a software innovation called Pertamina Aerated Drilling Simulator (PADsim). The purpose of this PADsim is to optimize the design of aeration drilling parameters for drilling geothermal wells. Optimization is carried out from the pre-drilling phase, during operation and after drilling or post-mortem.The determination of aeration drilling parameters with PADSim, was able to reduce the NPT due to the stuck pipe by 71% (110 hours) from the original total NPT of 56% (156 hours) to 17% (46 hours). In the end, drilling costs were successful in saving up to 59.6% or USD 506,900 / well from USD 849,900 / well, with a total value creation of USD 4.6 million. This PADSim has been applied to nine

PGE geothermal drilling wells in the Ulubelu, Hululais, Bukit Daun, and LumutBalai fields.

Basbar A.E.A et al (2016) has implemented a measure to decrease theNPT for Rigs operation through Competency Improvement. The company has done training program for the quality of engineer and worker, office and field staff. The materials of training course coverage the HSE (Health, Safety & Environment), Technical and soft skills. Raising the morale of the crew was the main factors that has led to reduce the NPT to 0%.

Patel D. (2019) analysed the Casing while Drilling (CwD) as a technique of drilling which has been proven to alleviate many of the problems faced while drilling. By usingthe drilling and casing of a well bore simultaneously, will improve the drilling efficiency by reducing the NPT. It has proven to be beneficial in controlling loss circulation and improving wellbore stability by ‘Plastering’ effect, high quality cement job and increased rig floor safety. During CwD operation, rotation of casing string and smaller annular space cause drill cutting to be smeared into the borehole wall thereby strengthening the well bore. This action is named the plastering effect that restores the wellbore's hoop stress by wedging the created fractures and/or by increasing the fracture propagation pressure. This effect seals pore spaces in the formation to reduce fluid losses and improves cementing to protect well bore integrity in loose formation or drilling in depleted formation. Centrifugal forces can primarily be responsible for plastering effect. The main benefits of CwD technology are the reduction of non-productive times and enhanced well control for complicated areas.

Abimbola M.O (2016), has implemented Manage Pressure Drilling (MPD) to reduce drilling cost due to Non-Productive Time (NPT) resulting from correcting drilling problems such as stuck pipe, lost circulation, and wellbore instability while increasing safety with specialized techniques and surface equipment. MPD is an adaptive process since the annular wellbore pressure is varied according to the pressure condition of the well. The basic techniques (variants) of MPD include Constant Bottom-Hole Pressure (CBHP) drilling, Pressurized Mud Cap Drilling (PMCD) and Dual Gradient Drilling (DGD). It is used to drill safely with total lost returns in highly fractured and cavernous formations.

Alsalat A. (2016), has analysed the performance of the various rigs thathave been employed by OMV company in onshore drilling operations in Austria, Pakistan and Yemen. The aims were to identify ILT and to analyse the causes of NPT by measuring and evaluating the effective KPIs that contribute to the drilling operations. Key Performance Indicators (KPIs), prior to this tool, it was difficult to track, record, and highlight ILT and NPT events. APDM (Africa Petroleum Data Management) analyses and calculates KPIs such as connection times and pipe moving times during tripping and casing; this tool is capable of accurately recognizing the rigs that are not performing around their contractual targets as well as identifying the saving potential of each KPI.

York P. (2009) has analysed the risk of NPT and how to decrease it. He compared and distinguished how these same circumstances have and can be addressed much more efficiently with engineering evaluation processes that help determine the best drilling tool and/or technique to mitigate risks and reduce NPT. Non-Productive Time (NPT) in Gulf of Mexico deepwater operations, exclusive of weather, with data supplied by James K. Dodson Company. The analysis focuses on the total NPT of key drilling hazards created by wellbore instability-stuck pipe, well control and fluid loss; all acerbated by ballooning. NPT associated with drilling trouble zones consumes from 10% to as much as 40% of well construction budgets if a comprehensive philosophy is not implemented when planning and drilling these wells. However, it has also been shown that these trouble zones can be effectively and efficiently drilled or even avoided if good drilling practices are considered, applied, and combined with proven drilling technologies, products, and processes.

Khaled M.S. et al (2018) has identified the NPT's factors. A comprehensive NPT analysis has been carried out to identify the improvement areas. NPT was identified per each accountable party and evaluatethe weak area, divert the team to sort these problems related and reduce the repetitive NPT related to each accountable party. The data showed 63% related to Operator, 26% related to rig contractor and 11% related to service company provider with a total of 447 hours of NPT was documented for this project.

Al-Hameedi et al (2018) who have conducted research on NPT by controlling lost circulation at Hartha formation. These actions have been determined for each kind of the mud losses to provide effective remedies, minimize non-productive time, and reduce cost. Lost circulation strategy to the Hartha formation has been summarized depending on statistical work and economic analysis evaluation to determine the most successful remedies for each type of the losses. These treatments are classified by relying on the mud losses classifications in order to avoid unwanted consequences due to inappropriate actions.

Cochener (2010), has made an effort to minimizeNon-Productive Time (NPT)**.** In the drilling, the basic concept is spent more time working and less time waiting. The waiting time is considered as non-productive time. Reducing NPT is addressed through rig design and efficient work practices. One way for a rig to minimize NPT is to spend more time drilling and less time in transit. Once drilling is finished, the cycle begins again on the way to the next location. New rigs are designed with fewer and simpler electrical connections to facilitate rig up and rig down. Other time and cost savers include rigs designed for assembling at ground level to avoid the use of a crane. In drilling mode, NPT includes pulling out of the hole to change drill bits, inserting additional joints of drill pipe, and conducting logging operations to evaluate progress. One technology to partially avoid these issues is thru-the-bit-logging which avoids the time required to pull the drill string.

Mansour A. (2019) has implemented a new type of smart expandable lost circulation material to reduce and prevent fluid loss and strengthen the wellbore. Lost circulation is a costly problem due to creating non-productive time (NPT) while drilling, and if not controlled, it can cause serious environmental risks such as blowouts. The smart expandable LCM was tested experimentally via static fluid loss and dynamic fluid loss apparatus to evaluate the LCM’s sealing efficiency. These materials can be comparatively cost effective for operators if used as preventive measure to reduce total non-productive time associated with corrective measures.

Modak et al (2017), has implemented Pareto analysis to find out the root causes of non-productive time in rig operations from eighteen rigs. Pareto analysis is a statistical tool in decision making used for the selection of a limited number of tasks that produce significant overall effect. It uses the Pareto principle (also known as 80/20 rule) the idea that by doing 20% of the work one can generate 80% of the benefit of doing the entire job. In the present investigation root causes are found for down time after the data are analyzed with the help of Pareto tool and then solutions are given to eradicate the problem so as to reduce the non-productive time in drilling rig operation.

Talreja R. et al (2018), has investigated three lost-in-hole incidents and other drilling related NPT encountered in two directional wells. This study provides solutions through integration of geomechanics, drilling parameters, and mud rheology to assist in decision-making for future well planning to reduce the NPT.

In a study conducted by Eren T. (2018), using method of coding or labelling for the activities and equipment related to the project. The novelty of the proposed methodology in this study is the possibility to monitor the drilling performance history of the contractors. It is addressed for the improvement of the drilling efficiency that creates value for contractors/operators. With operator performance related to the good application of health, safety, and environment practices. Drilling operations performance is best monitored by means of systematic code registration of each and every operation taking step while drilling, with the code being issued into the daily drilling reports. With the purpose of differentiating the crew with the best performance and find out the invisible NPT occurrences that impedes performance. Eventually, from various operations, the drilling performance is benchmarked to planned vs actual activity by tracking correctly and identifying the NPT occurrences.

Alappat N. (2015) has carried out drilling operations by monitoring the time of nipple up, nipple down and BOP. NPT includes time required to nipple up and nipple down BOP stack, pressure test of BOP, tripping of drill string, slip and cut time, casing run times. Operations such as make up or laid down BHA, logging, fishing, jarring, wait on crew and equipment is also part of NPT. Operational management and engineering can then suggest and implement more planning prior to task to be performed, better equipment, rig modification or upgrades, better experienced crew to meet the target set. Once improvements are achieved on each rig, controls and checks are put in place to maintain these targets, thereby reducing NPT and increase drilling time.

Gazpromneft's Drilling Management Center DMC (2018), has controlled the NPT byusingeDrilling software. This tool has monitored and controlled the drilling operations. This has contributed to increased efficiency and safety. Since introduction of the Drilling Management Center (DMC), NPT has been reduced by percent 8-10%, and drilling rate has been improved by 20%. eDrilling is one of several new technology vendors used and qualified in the DMC.

Recent development in deep Natural Language Processing (or deep NLP) by Hoffman (2017), has automatically classified sentences in thousands of drilling reports and to identifycompaniesbehaviour. The tool can be used offline by an energy company interested in verifying old drilling reports for operation patterns or by a government agency interested in investigating the aftermath of environmental disasters. In the future, this tool could be used in real time to enhance decision support systems, to help mitigate drilling costs associated with non-productive time, and to reduce the risk of accidents. In the work, a methodology was presented for information retrieval on drilling reports with deep natural language processing. Tested with 9670 reports from 303 wells in an actual field with promising NPT sequencing obtained as a result.

Emhana (2018), has analysed the factors of Non-Productive Time (NPT) in drilling operations time for 5 wells in Ghadames Basin. The NPT events in the drilling operations account for 18% of total drilling time in the selected wells and the analysis showed that waiting water and lost circulation are major causes of NPT in the selected wells in the Ghadames Basin.

Ngosi R. (2015), has determined the factors that contribute to Non-Productive Time (NPT) in geothermal drilling.This research sought to find out the contribution of equipment breakdown to Non Productive Time, how geological challenges aid Non Productive Time, ways in which operations planning contribute to Non Productive Time, and how decision making contribute to Non-Productive Time from 32 wells. The result showed that the average total Non-Productive Time is 62%, while 38% of the total drilling duration is productive time. The biggest contributor of Non-Productive Time was operations planning (41%), equipment breakdown contributed 12%, geological challenges 8%, and decision 1%, respectively.

Nyota (2016),hasanalysed of the Non-Productive Time of 20 wells sample taken from total of 89 wells that have been drilled in Olkaria region. The result of analysis was cementing, waiting on cement and drilling out cement contributed to a total of 34% of the total NPT. Tripping contributed to 19% of the NPT, circulating contributed to 16% of the NPT, wait on repairs 7%, other factors 6%.

Otieno (2016), has done research on the location and with the same sample as Nyota, but he has analysedand identified the downtime or NPT regarding drilling equipment. The equipment was selected for study. And the major contributors to downtime occasional by equipment are Top drive (29%), air compressors (25%), Drilling parameters monitoring and control instruments (18%), SCR (15%), draw works (5%), rotary table (2%), Mud pumps (2%), Service loop (1%), generators (1%), and Drill string (1%).

One of the complicating factors in the oil drilling process is geography condition. Therefore, Rahmati (2018) conducted a study on drilling at Azar well in west Karoun, Iran. The Azar well has geographic conditions are quite difficult and it is the most complicated hydrocarbon field in region. In this study, effective factors hindering the process of drilling operations as well as the related NPT are investigated. Rahmati A.S (2018), investigated and analysed the NPT by using secondary data that obtained from drilling logs, daily drilling reports (DDRs) and well completion reports. The analysis showed two factors of stuck pipe that leads to fishing operation and low rate of penetration (ROP) had the most influence on creating waiting times.

Saraswati G.F et al (2015), has analysed NPT on the "NB-AAA" offshore well drilling operation on the XY field, total E&P Indonesia, in East Kalimantan. They collected data about percentage (%) NPT total during drilling operations, NPT in every drilling phase and the main cause of the high NPT, and then compared between planned and actual operational time. And the result is NPT of 32% and occurred in the drilling phase 12-1/4" due to a downhole problem and the need to do a side-track.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Problem Identification

This research was taken place at workshop of *PT Multi Jaya Tehnik (MJT)*in *Jl.RayaKopo KM 12 CikampekJawa Barat*. PT MJT is a specialist company in the field of oil drilling equipment rental, ranging from renting machinery, drilling machines, handlebar, drill bits, mud pumping, genset, rigs, platform, distribution pipes, including tools for safety, securing drilling, safety valves that comply with Pertamina and international standards. Because this company is only engaged in the rental of equipment and machinery, the production process is based onclient's request. PT MJT under the lead manager, together with the client designed the production process with the aim of obtaining raw materials, in the form of oil or gas. After an agreement with the client, PT MJT prepares the tools and machinery needed and prepares human resources to support the activities both in the field and in workshop. This production process involves all divisions within the company according to their respective duties and authorities.

In the operational process of drilling, there are often things that are not according to plan, one of which is non-productive time (NPT). Ones of the causes of NPT is related to drilling equipment. So, it is necessary to analyse NPT related to drilling equipment which is the responsibility of PT MJT. Because there are manyequipment at high risk for damage, it needs to be anticipated prior to operations and there is an evaluation during the drilling process, in order to reduce the NPT equipment related.

3.2 Problem Formulation

This research focuses on assessing the causes of NPT and NPT equipment related in drilling process which is leased by PT MJT. Later after identifying the problem,

problem formulation can be resumed. Problem formulation is being used to direct the solution from the problem and as a foundation to make a conclusion.

3.3 Literature Review

This research is inductive study. The study is started from observations and interviews to find the data from PT MJT. Afterobtaining the data, the author made observation and early analyse to get the exist problem and data patterns in PT MJT.From this description of existing problem, the author begins to perform the literature review that appropriate to the problems, to get the conclusion and then make the appropriate solutions. The literature review has done by searching on the internet according to the topic of the problems.

3.4 Data Collection

In this research, the data were collected by observation and interview to get the primary data. The primary data was obtained from the company manager and workshop staff. The interview was conducted based on interview guidance withoutquestionnaire. The author collected the secondary data from existing data in PT MJT, too. The primary and secondary data were obtained during internship activities in July 2019. Because PT MJT is a rent company for drilling equipment, so the data collection isclosely related to tools for a rent, the maintenance, the quality control and type for equipment and specification**.**

3.5 Data Processing

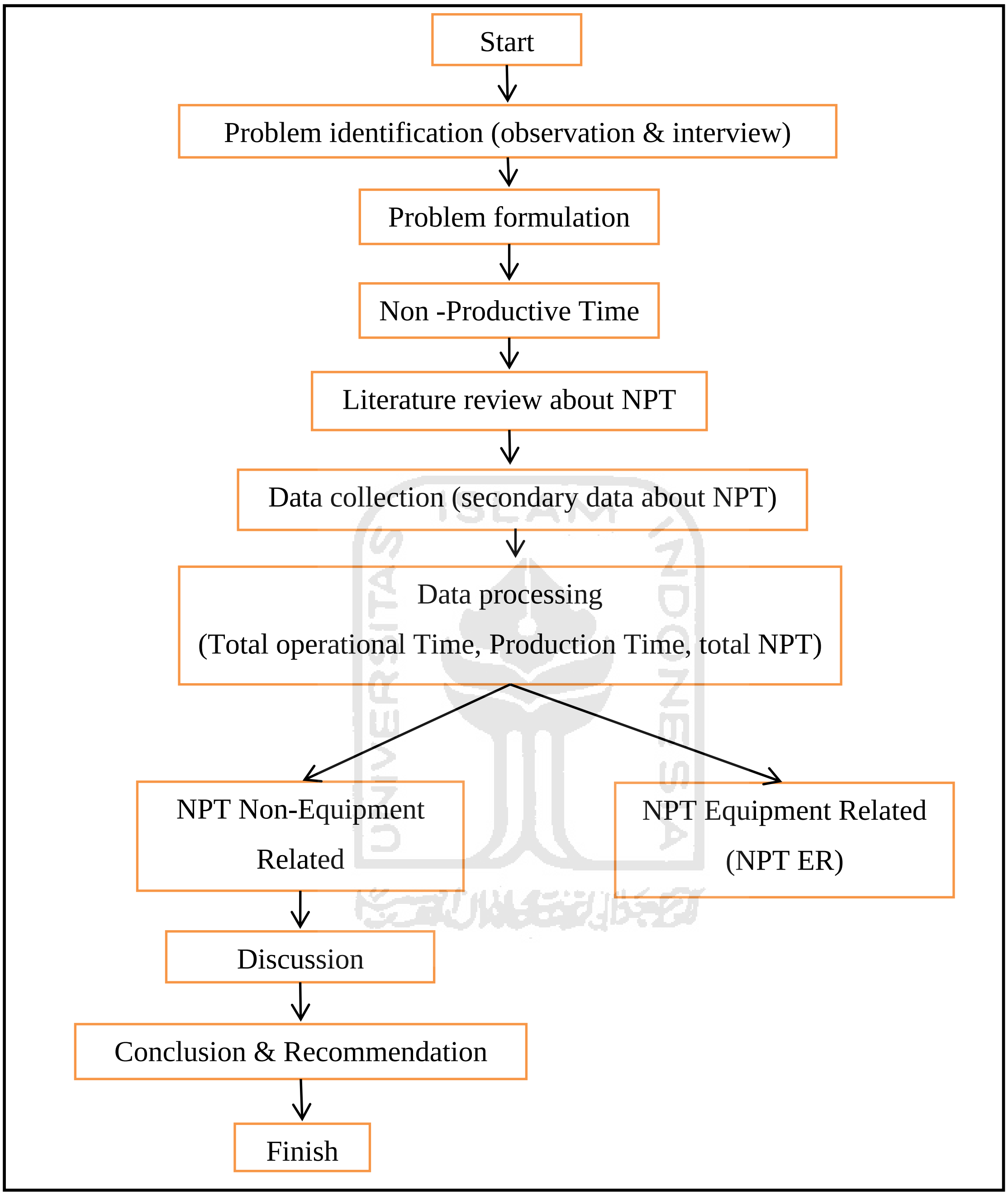

Figure 3.1. Flowchart about data processing

3.6 Discussion

After all the data processing are finished, then discussion was conducted with descriptive analytics and case studies for comparison.

3.7 Conclusion and Recommendation

This chapter would be briefly explaining the answers of all the problem formulations that already formulated in the beginning of the research. Besides, there are several suggestions that can be used by the institution and further research.

CHAPTER IV

COLLECTION AND DATA PROCESSING

4.1 Data Collection

Data collection was carried out during the internship program in July 2019 at PT MJT. The data was obtained by interviewing Mr. PriyoSusiloas the company manager, and Mr. Saprudin as workshop staff from PT MJT. The data collected is about the inventory of tools available at the PT MJT workshop, types and quantities, methods of purchase, average age of tools, methods of maintenance (protective or reactive), and quality control as well as problems related to the provision of tools, including NPT. NPT, especially NPT equipment related, is one of the problems that must be evaluated by PT MJT because it relates to the trust of clients who rent equipment to PT MJT. This tool is an important tool in the drilling process.

Since the establishment of PT MJT in 2008 until now, it has leased equipment for several oil well drilling. From the data available at PT MJT, there are 9 drilling projects that have been carried out for approximately 11 years. From the results of interviews and data observations, it turns out that only sufficient NPT data areavailable at PT MJT. So that the author is interested in discussing and researching about NPT.However, of the 9 oil well drilling projects, only 7 were available with sufficiently complete NPT data. So that the author only examines the NPT data on 7 drilling wells.

The seven oil drilling wells are listed in the Table 4.1

Table 4.1. The seven Oil Well drilling project of PT MJT with the code

No	Location	Code well Project
1	Patrol, Indramayu	JKL-01
2	MuaraGembong, Bekasi	PDR-01
3	Babelan, Bekasi	PTR-01
4	Karawang	BBS-01
5	Cilamaya, Karawang	BBU-01
6	Cibatu, KabupatenSubang	MHK-01
7	Babelan, Bekasi	PDB-01

The following is secondary data of operational time, total NPT, NPT Non-Equipment Related (NPT NER) and NPT equipment related (NPT ER) in percent (%) from each well site.

4.1.1 Drilling time in JKL-01well site

Figure 4.1 shows the comparison between total NPT and productive time, and in Figure 4.2, it is illustrated the time comparison between NPT NER and NPT ER on JKL-01 well site.

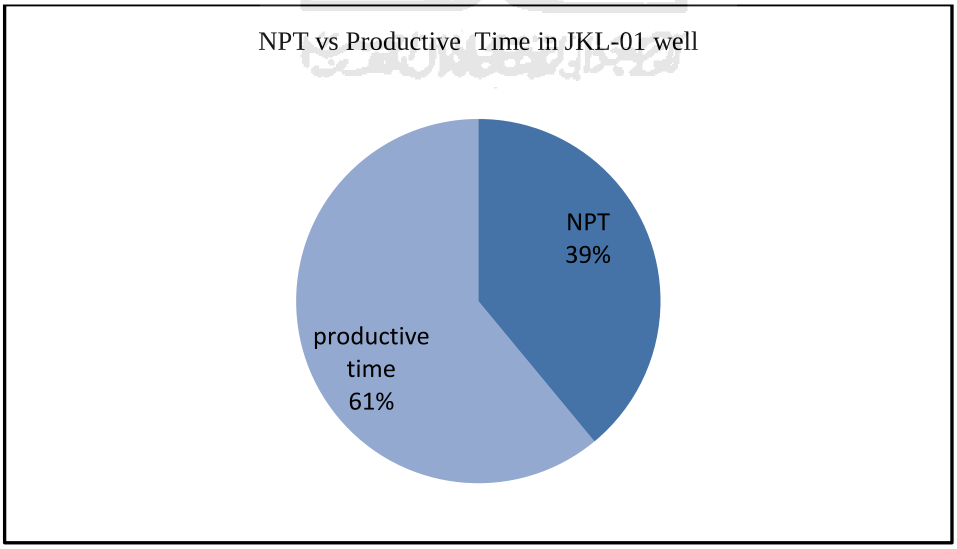

Figure 4.1Comparison between NPT and Productive Time inJKL-01 well

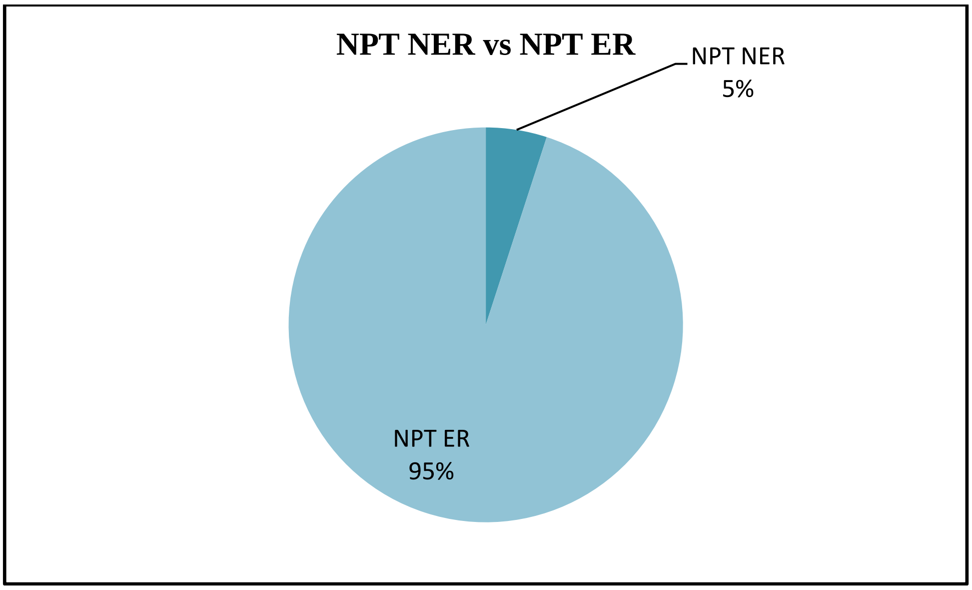

Figure 4.2. Comparison between NPT NER and NPT ER in JKL-01 well

Table 4.2 shows the NPT with details of the time and types of tools that caused NPT in the JKL-01 well drilling project.

Table 4.2. NPT Equipment Related (NPT ER) of JKL-01well

Types of equipment	**Time (hours)**
Top Drive GLN	15.00
Rig GLN	2.00
Wireline SLB	6.00
Mud Motor Anadrill	23.00
DC GLN (broken off)	1041.50
TCP Halliburton	88.50
DST Halliburton	6.00
Total NPT ER	**1182.00**

4.1.2 Drilling Time in PDR-01 well site

In Figure 4.3, there are comparisons between total NPT and productive time, and in Figure 4.4 it is described the time comparison between NPT NER and NPT ER on PDR-01 well site.

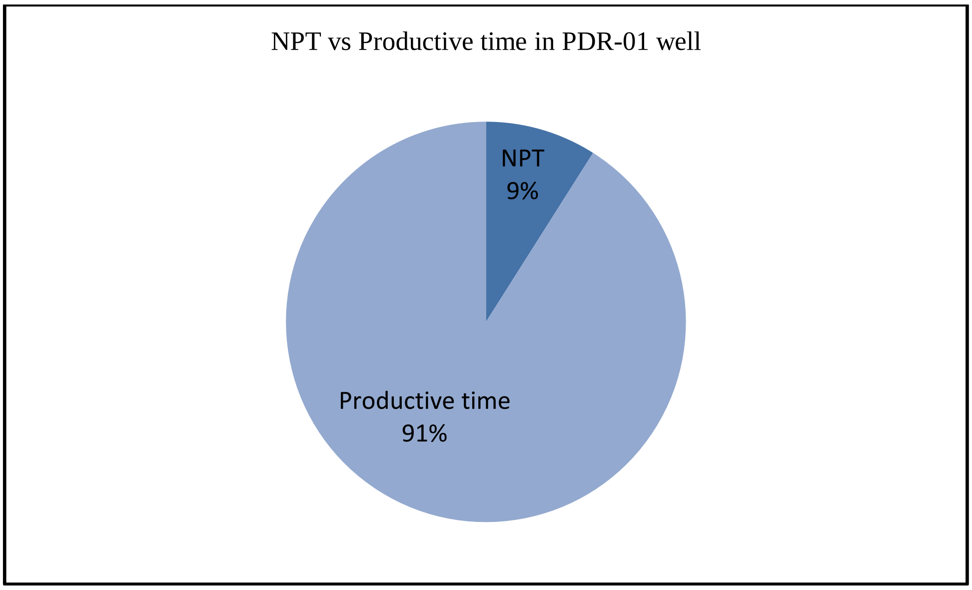

Figure 4.3. Comparison between NPT and Productive time in PDR-01 well

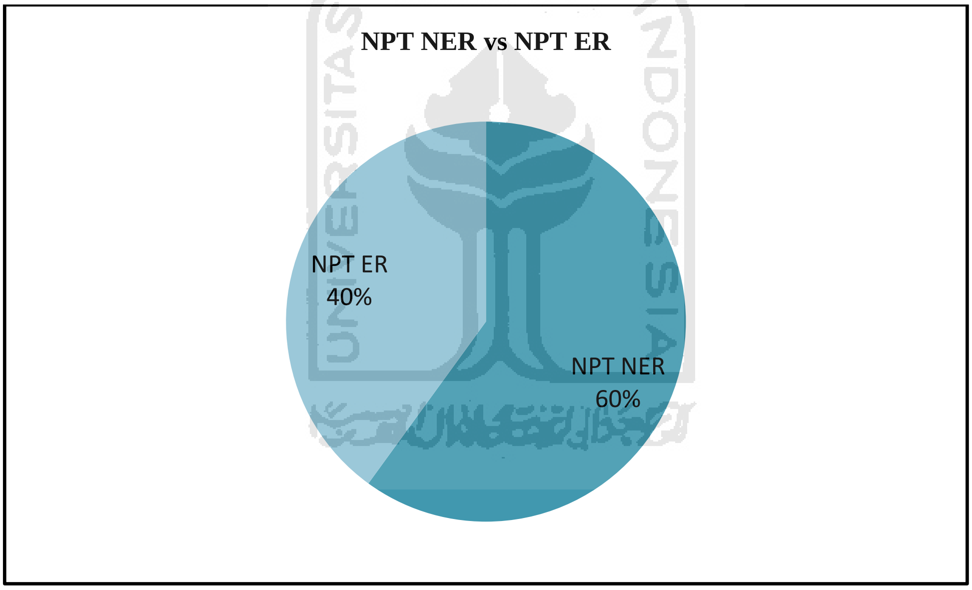

Figure 4.4. Comparison betweenNPT NER and NPT ER in PDR-01 well

Table 4.3 shows the NPT with details of the time and types of tools that caused NPT in the PDR-01 well drilling project.

Table 4.3. NPT Equipment Related (NPT ER) of PDR-01 well

Types of equipment	Time (hours)
Top Drive	51.00
Top Drive Maritim	1.50
Rig KK-01	0,50
MPD weatherford	1.00
Fishing Junk (SWC bullet)	16.00

Coring Yahentama	0.50
Bridge Plug Halliburton	22.00
Total NPT ER	**92.50**

4.1.3 Drilling Time of PTR-01 well site

Figure 4.5 indicates the comparison between total NPT and productive time, and in Figure 4.6 it is illustrated the time comparison between NPT NER and NPT ER on PTR-01 well.

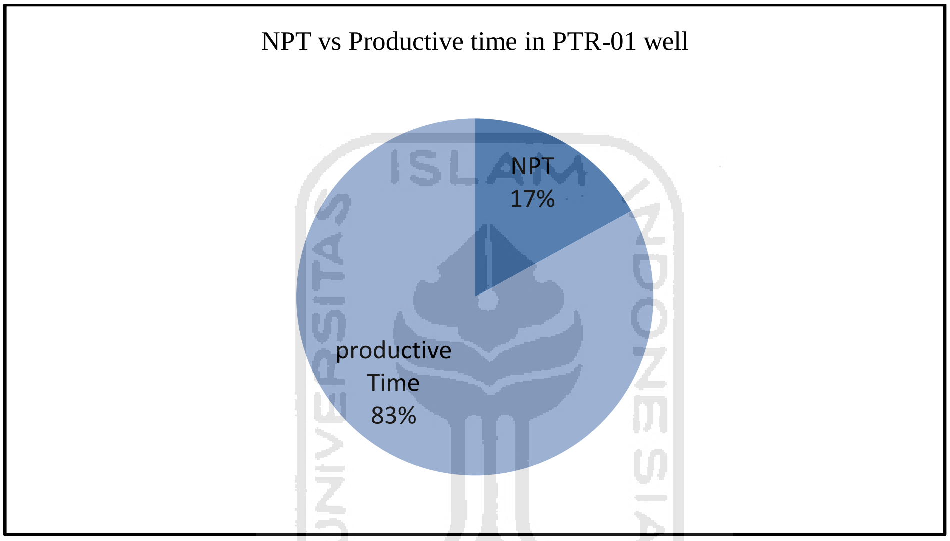

Figure 4.5. Comparison betweenNPT and Productive Time in PTR-01 well

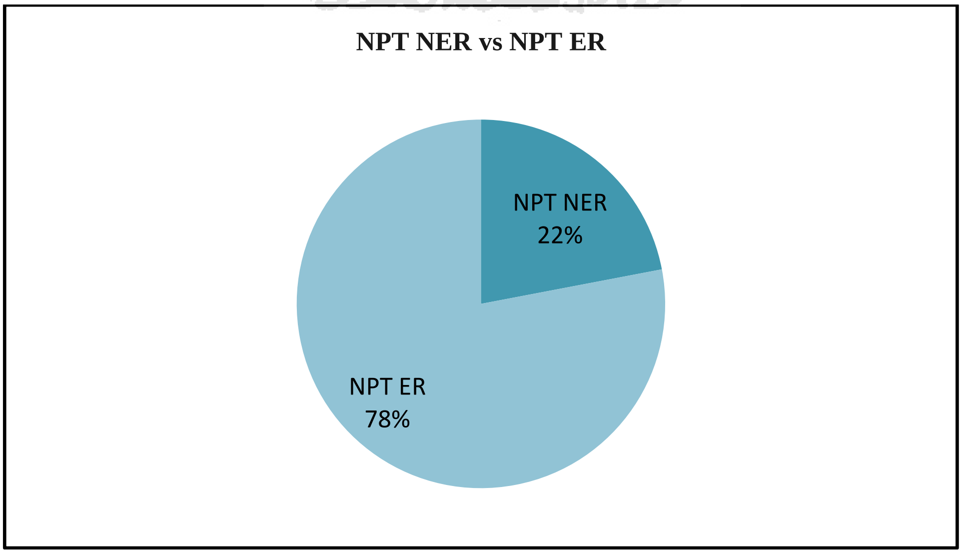

Figure 4.6. Comparison between NPTNER and NPT ER in PTR-01well

Table 4.4 shows the NPT with details of the time and types of tools that caused NPT in the PTR-01 well drilling project.

Table 4.4. NPT Equipment Related (NPT ER) of PTR-01 well

Types of equipment	**Time (hours)**
Rig GLN	4.00
Top Drive GLN	25.00
Top Drive Cakra	24.00
DD Anadrill	18.50
Logging SLB	14.50
MPD Weatherford	6.00
DP Slip Dies (fall)	39.50
Cone (varel) left behind	190.50
Whipstock Baker HI	54.00
CTU BJ	3.50
Total NPT ER	**379.50**

4.1.5 Drilling Time in BBS-01 well site

Figure 4.7 indicates the comparison between total NPT and productive time, and in Figure 4.8, it is described the time comparison between NPT NER and NPT ER on BBS-01 well.

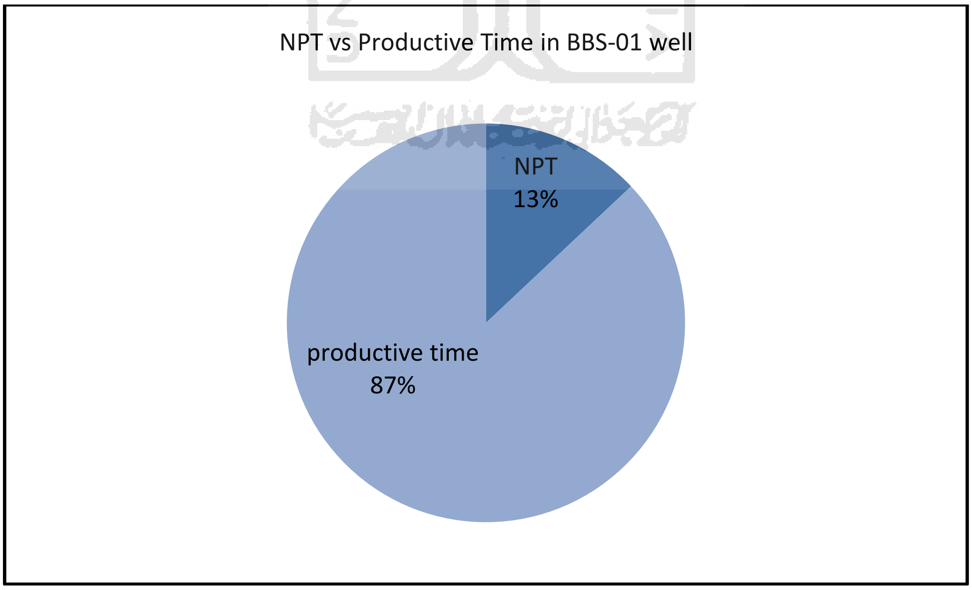

Figure 4.7. Comparison between NPT and Productive Time in BBS-01 well

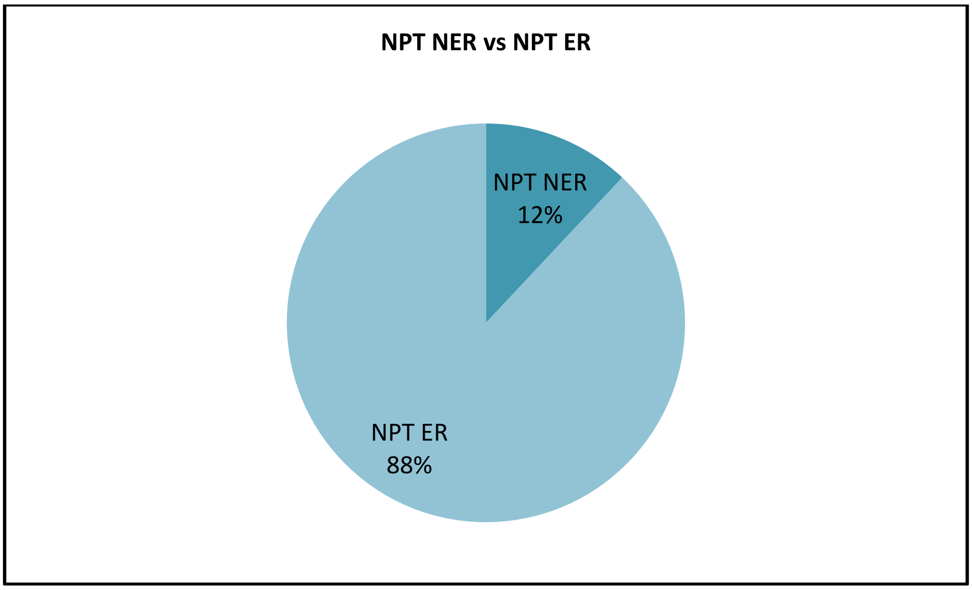

Figure 4.8. Comparison between NPT NER and NPT ER in BBS-01well

Table 4.5 shows the NPT with details of the time and types of tools that caused NPT in the BBS-01 well drilling project.

Table 4.5NPT Equipment Related (NPT ER) ofBBS-01 well

Types of equipment	Time (hours)
Rig KK-001	3.00
Mud Motor Pakarti	20.50
Top Drive	1.00
DC	204.00
Tubing bocor	42.25
Total NPT ER	**270.75**

4.1.6. Drilling Time in BBU-01well site

Figure 4.9 exhibits the comparison between total NPT and productive time, and in Figure 4.10, it is shown the time comparison between NPT NER and NPT ER on BBU-01 well.

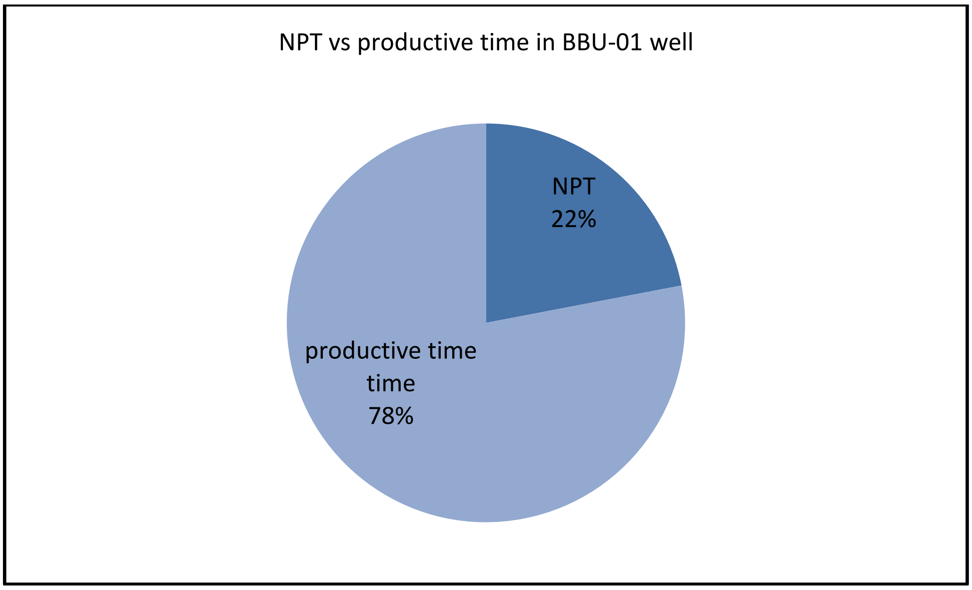

Figure 4.9. Comparison between NPT and Productive Time in BBU-01 well

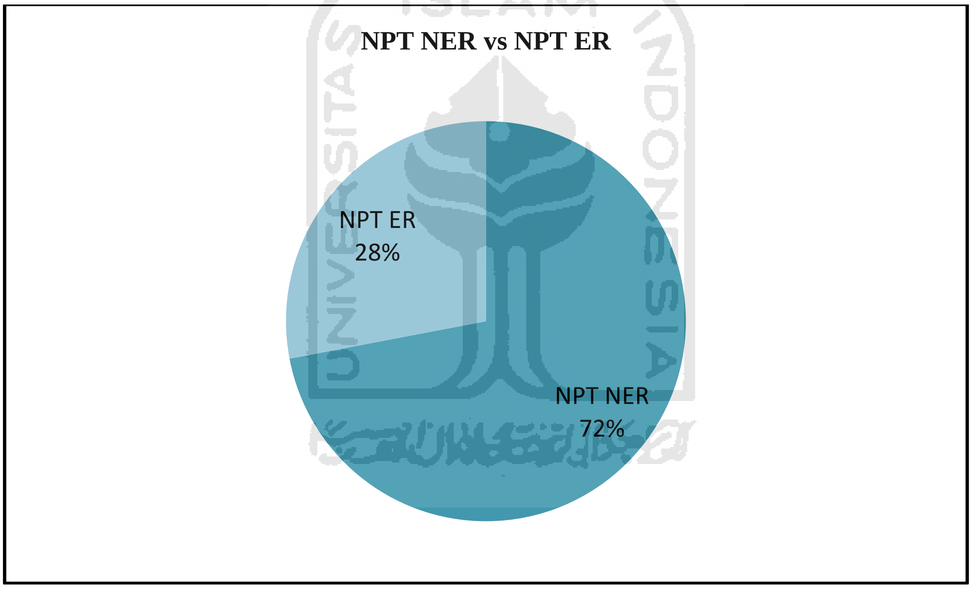

Figure 4.10. Comparison between NPT NER and NPT ER in BBU-01well

Table 4.6 shows the NPT with details of the time and types of tools that caused NPT in the BBU-01 well drilling project.

Table 4.6. NPT Equipment (NPT ER) of BBU-01well

Types of equipment	Time (hours)
BBS surface testing	13.00
GLN management	6.00
GLN Rig	14.50
GLN Rig/Halco DST	57.00
Halco DST	23.50
GLN MLU	3.00
SLB CEMNET	8.00
Total NPT ER	**125.00**

4.1.7 Drilling Time in MHK -01 well site

Figure 4.11 shows the comparison between total NPT and productive time, and in Figure 4.12 it is demonstrated the time comparison between NPT NER and NPT ER on MHK-01 well.

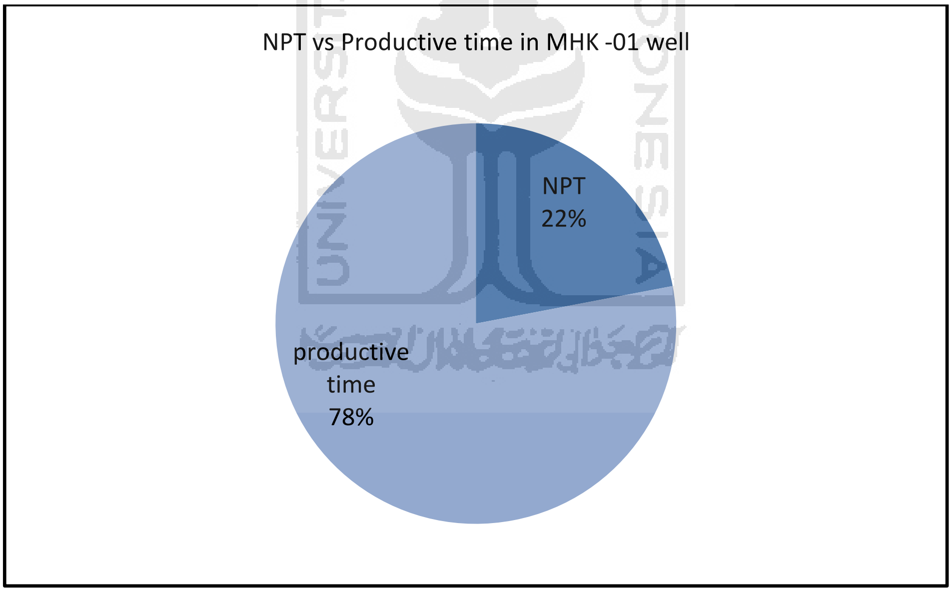

Figure 4.11. Comparison between NPT and Productive time in MHK-01well

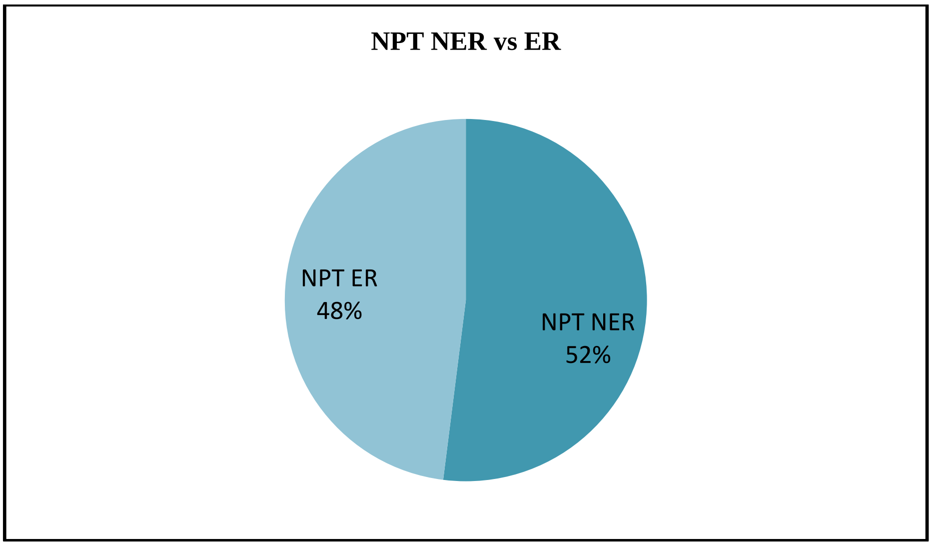

Figure 4.12. Comparison between NPT NER and NPT ER in MHK-01well

Table 4.7 shows the NPT with details of the time and types of tools that caused NPT in the MHK-01 well drilling project.

Table 4.7. NPT Equipment Related (NPT ER) of MHK-01well

Types of equipment	Time (hours)
Wireline Logging (Schlumberger)	19.00
DST tools (Halliburton)	68.50
Cementing (Tucan)	31.50
TCP (Halliburton)	101.00
Total NPT ER	**220.00**

4.1.8 Drilling Time in PDB-01 well site

In Figure 4.13, it is shown the comparison between total NPT and productive time, and in Figure 4.14 it is illustrated the time comparison between NPT NER and NPT ER on PDB-01 well.

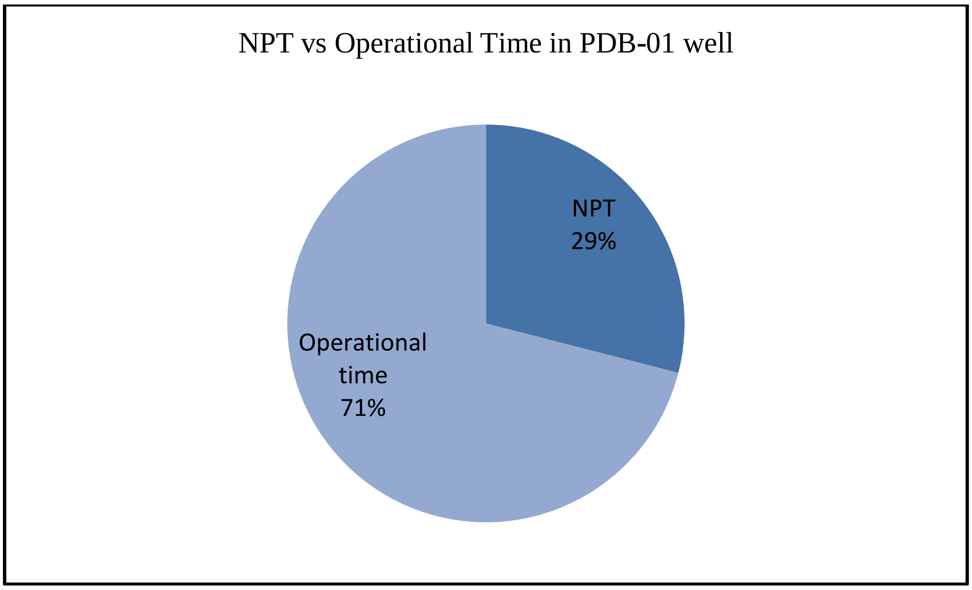

Figure 4.13. Comparison between NPT and Operational time in PDB-01well

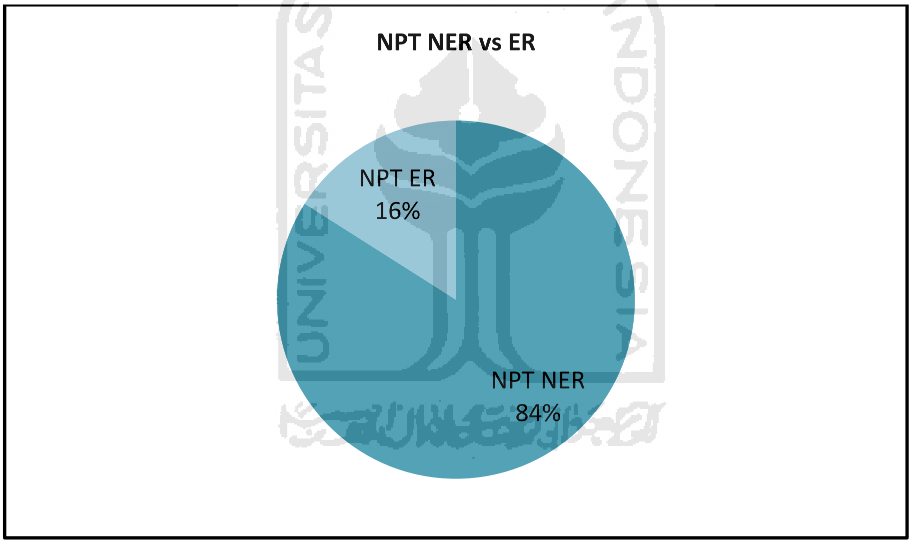

Figure 4.14. Comparison between NPT NER and NPT ER in PDB-01 well

Table 4.8 shows the NPT with details of the time and types of tools that caused NPT in the PDB-01 well drilling project.

Table 4.8. NPT Equipment Related (NPT ER) of PDB-01well

Types of equipment	**Time (hours)**
BBS Surface testing	37.00
Casing Driver (Tesco)	0.50
Cementing (Tucan)	12.00
DD Anadril& RIG	10.50
ECP TAM	1.00
Production Packer	14.50

Rig GLN	63.50
Anadril (Schlumberger)	3.50
Wireline (Schlumberger)	8.00
Total NPT ER	**150.50**

Table 4.9. The data of total operational time, production time and total NPT in 7 drilling well sites

No	Well code	Totaloperational time (hrs)	Productive Time (hrs)	Percentage (%)	NPT total (hrs)	Percentage (%)
1	JKL- 01	3190.3	1946.07	61	1244.23	39
2	PDR -01	2569.4	2338.19	91	231.25	9
3	PTR-01	2861.9	2375.40	83	486.50	17
4	BBS -01	2366.7	2059.10	87	307.6	13
5	BBU-01	2029.2	1582.80	78	446.38	22
6	MHK-01	2083.3	1625.0	78	458.30	22
7	PDB-01	3243.5	2303.0	71	940.5	19

Table 4.10. The Data of Total NPT, NPT NER and NPT ER in 7 drilling well sites

No	Well code	NPTTotal (hrs)	NPT NER (hrs)	Percentage (%)	NPT ER (hrs)	Percentage (%)
1	JKL- 01	1244.23	62.21	5	1182	95
2	PDR -01	231.25	138.75	60	92.5	40
3	PTR-01	486.50	107.00	22	379.5	78
4	BBS -01	307.6	36.84	12	270.75	88
5	BBU-01	446.38	321.40	72	125.00	28
6	MHK-01	458.30	238.30	52	220.00	48
7	PDB-01	940.5	790.00	84	150.50	16

4.2 Data Processing

Secondary data were analysed by statistical analyses. The data analysis resultedin the available data of Total Operation Time, Productive Time, And Non-Productive Time.

Data acquired from field operation are displayed in the table 4.11 below:

Table 4.11. Minimal, Maximal and Mean of Operation time, Productive and Non-Productive Time of 7 drilling wells

No	Well Code	Total Ops. (Hours)	Prod Time	Total NPT	% NPT	NPT NER	NPT ER	NPT ER (%)
1	JKL- 01	3.190,30	1.946,07	1.244,23	39,00	62,21	1.182,00	95,00
2	PDR -01	2.569,40	2.338,19	231,25	9,00	138,75	92,50	40,00
3	PTR-01	2.861,90	2.375,40	486,50	17,00	107,00	379,50	78,01
4	BBS -01	2.366,70	2.059,10	307,60	13,00	36,84	270,75	88,02

5	BBU-01	2.029,20	1.582,80	446,38	22,00	321,40	125,00	28,00
6	MHK-01	2.083,30	1.625,00	458,30	22,00	238,30	220,00	48,00
7	PDB-01	3.243,50	2.303,00	940,50	29,00	790,00	150,50	16,00
	Total	**18.344,30**	**14.229,56**	**4.114,76**	**22,43**	**1.694,50**	**2.420,25**	**58,82**
	Min	**2.029,20**	**1.582,80**	**231,25**	**9,00**	**36,84**	**92,50**	**16,00**
	Max	**3.243,50**	**2.375,40**	**1.244,23**	**39,00**	**790,00**	**1.182,00**	**95,00**
	mean	**2.620,61**	**2.032,79**	**587,82**	**21,57**	**242,07**	**345,75**	**56,15**

Data are gathered from 7 drill well sites, however due to the limited amount of data,researcher assumes the gathered data represent field condition. Data gathered are representation of the field condition that is being studied. Furthermore, for the importance of further analysis, data will be the reference for imaging the condition that are being researched.

According to the collected data, Total Operation Time in hourly unit with the longest for the drill wells is 3.243,5 hours, contrary to that, the shortest Total Operation Time being 2.029,2 hour. In general, the Total Operation Time in average are 2.620,61 hours and the sum of all the 7 drill sites are 18.344,3 hours.

Related to the Total Operational Time that had been conducted, the time are separated into 2 (two) major classifications, which are time used for (1) productive time and (2) non-productive time. In order to optimize production level, research will be more focused to operational time that caused non-productive time in accordance with research questions.

From all 7 drill well sites, the total of non-productive time are4.114,76 hours or around 22,43% of the total production time whichtotal is 18.344,3 hour. If the average percentage is tested with the standard reference where NPT cannot be more than 1/3 of the operational time, then the hypothesis is as follow:

$$H_0: \mu_{NPT} = \frac{1}{3}$$

$$H_1: \mu_{NPT} \neq \frac{1}{3}$$

Where$\mu$is the average parameter value ofthe NPTpercentage. Based on the data sample acquired, a statistical analysis is acquired as follows:

One-Sample Test						
	Test Value = 0.33					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
npt.perct	-2.995	6	.024	-.1143003	-.207684	-.020916

The mean difference value of the data sample with the test value of 1/3 or 0,3333 is -0,1143 with confidence interval of the difference of 95% in the space between -0,2077 and -0,0209. This space indicates that the average position obtained from the field is much smallercompared to the reference point of 1/3. Next, statistical test indicates a importance level as much as 0,024, or more smaller than α significance level that are generally used which is α=5%. Therefore, it can be assumed that NPT in the drill sites are smaller than 1/3 or 33,33% of the Total Operational Time.

However, to optimize the drilling process that can be conducted, then the statistic regarding NPT needs to be observed more. Reason being to find the factors of NPT. For the majority, NPT is caused because (1) Equipment Related (ER), and (2) Non-Equipment Related (NER). Statistic from the data gathered indicates that from the total NPT of 4.114,76 hour, 1.694,5 hours is because of non-equipment related factor and 2.420,25 hours is caused by equipment related factors. This indicates that from the accumulated factor, equipment have more impact towards the NPT that happens in the drill well as a whole.

If perceived from Minimal or Maximal statistic that both factors have, equipment factor has higher total hour compared to non-equipment factor. In minimal statistic, the comparison of non-equipment and equipment factor are 36.84 hours against 92,50 hours. For maximal statistic, the comparisons between both of those factors are 790 hours against 1.182 hours. For average statistic, the comparison between non-equipment and equipment factor are 242,07 hours against 345,75 hours.

The Total Hour statistic obtained from bothNPTfactorsare enough to indicate that equipment related factor have bigger contribution or more dominant compared to non-equipment factor. Therefore, it is enough to be used as an initial reference to conduct further research into these factors to be able to conduct a more optimal processing and focusing to the key factor that’s more dominant.

To ensure if the available data can support the decision making statistically or not, then an average similarity test between the Mean Time NPT caused by non-equipment factor with Mean Time NPT that is caused by equipment factor. This is done just to find empirical data to strengthen the given argument.

For this testing, the hypothesis for the test is as follows:

$$H_0: \mu_{NPT.ER} = \mu_{NPT.NER}$$
$$H_1: \mu_{NPT.ER} \neq \mu_{NPT.NER}$$

Where

$\mu_{NPT.ER}$ = Mean NPT Time caused by equipment factor

$\mu_{NPT.NER}$ = Mean NPT Time caused by Non-equipment factor

Hypothesis zero (H_0) is the assumption where Mean NPT Time caused by equipment factor is the same with Mean NPT Time caused by Non-equipment factor. For the alternative, H_1 is the assumption where both Mean NPT Time is not the same.

After a statistical test was conducted, the obtained data areshown in the table below:

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	npt.er - npt.ner	103.68	541.24	204.5705	-396.89	604.24	.507	6	.630

The standard deviation test for both of the paired sample indicates that the interval of the difference are between -396,89 and 604,24. The significance test of 0,630 is much higher than the alpha value or significance level that are generally used which are $\alpha = 5\% = 0{,}05$, it can be concluded that both of these averagesare not significantly different. Even though the Mean NPT Time caused by equipment factor is much higher compared to Non-equipment factor, which are 345,75 against 242,07, however the data that currently available are insufficient to support the conclusion that the Mean NPT Time for equipment factor is more significant compared to Mean NPT Time for Non-equipment factor.

To look further into the types of equipment that causes NPT in equipment factor, a deeper analysis must be conducted on the data of NPT time for every equipment available. But because of the limited amount of data, a statistical test cannot be conducted and variation on each type of equipment in the drilling is not obtained.

The data of NPT for each type of equipment can be seen in the table 4.12 below:

Table 4.12 Type of Tools for NPT

Code	**Types of tools**	**Total (hrs)**	**%**	**Cum %**
1	DC broke off GLN	1.041,50	43,04	43,04
2	DC broke off	204,00	8,43	51,47
3	Tralling Cone (Varel)	190,50	7,87	59,34
4	TCP Halliburton	189,50	7,83	67,18
5	Rig GLN	84,00	3,47	70,65
6	DST Halliburton	74,50	3,08	73,73
7	GLN Rig/Halco DST	57,00	2,36	76,08
8	Whipstock Baker HI	54,00	2,23	78,31
9	Top Drive	52,00	2,15	80,46
10	BBS Surface Testing	50,00	2,07	82,53
11	Cementing Tucan	43,50	1,80	84,33
12	Leaking Tubing	42,25	1,75	86,07
13	Top Drive GLN	40,00	1,65	87,73
14	DP Slip Dies fall	39,50	1,63	89,36
15	DD Anadril	29,00	1,20	90,56
16	Wirelines Logging (Schlumberger)	27,00	1,12	91,67
17	Top Drive Cakra	24,00	0,99	92,66
18	Halco DST	23,50	0,97	93,64
19	Mud motor Anadrill	23,00	0,95	94,59
20	Bridge Halliburton	22,00	0,91	95,50
21	Mud Motor Pakarti	20,50	0,85	96,34

22	Fishing Junk (SWC bullet)	16,00	0,66	97,00
23	Logging SLB	14,50	0,60	97,60
24	Production packer	14,50	0,60	98,20
25	SLB CEMNET	8,00	0,33	98,53
26	MPD merk weather ford	7,00	0,29	98,82
27	GLN Manajemen	6,00	0,25	99,07
28	Wireline SLB	6,00	0,25	99,32
29	Anadrill Schlumberger	3,50	0,14	99,46
30	CTU BJ	3,50	0,14	99,61
31	Rig KK-01	3,50	0,14	99,75
32	GLN MLU	3,00	0,12	99,88
33	Top Drive Maritim	1,50	0,06	99,94
34	ECP TAM	1,00	0,04	99,98
35	Coring Yahentama	0,50	0,02	100,00
	Total	**2.419,75**	**100,00**	

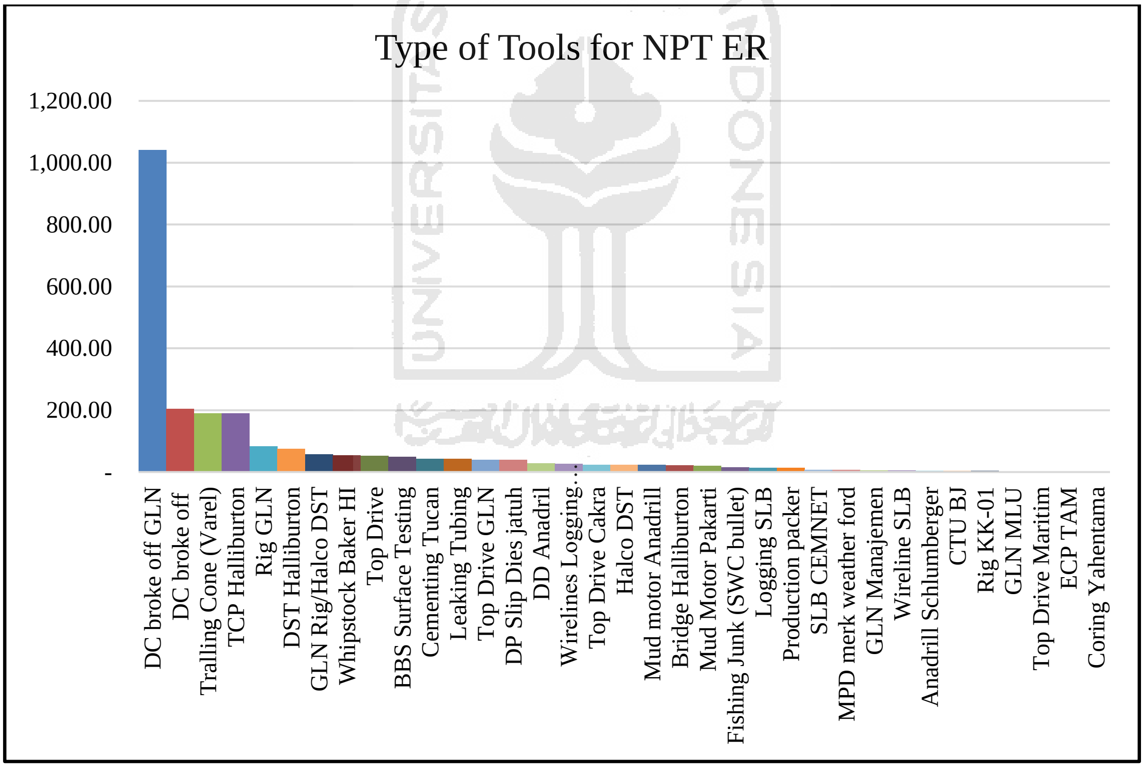

Figure 4.15. Pareto Analysis of Type of Tools for NPT ER in 7 drilling wells

Because statistical analysis cannot be conducted due to the limitation of the available data, the next analysis that can be conducted is Pareto Analysis where it focuses on the factors that contribute more dominantly to a damage or loss. The general rule that is used is 80/20 which means analysis is focused on 80% of total damage factor or process failures and 20% to the root causes that can be identified.

On the table above, it can be seen that 80% of NPT for equipment factor is caused by 9 from 35 type of equipment that are used in the drill wells. If the focus is only to the 20% of the causes, analysis can be done to the type of equipment that have the highest NPT.

Table 4.13. The major contributors of NPT by equipment

Code	Types of tools	Total (hrs)	%	Cum %
1	DC broke off GLN	1.041,50	43,04	43,04
2	DC broke off	204,00	8,43	51,47
3	Tralling Cone (Varel)	190,50	7,87	59,34
4	TCP Halliburton	189,50	7,83	67,18
5	Rig GLN	84,00	3,47	70,65
6	DST Halliburton	74,50	3,08	73,73
7	GLN Rig/Halco DST	57,00	2,36	76,08
8	Whipstock Baker HI	54,00	2,23	78,31
9	Top Drive	52,00	2,15	80,46

The type of equipment that needs attention to minimize NPT primarily in the drilling operation is“DC GLN broken” with the highest NPT percentage of 43,04% and if combined with “DC broken” which is as much as 8,43%, then the total NPT is 51,47%. On the third position, the type of equipment that needs to be focused on to reduce NPT is the “Cone left in the hole (Varel)” with percentage of 7,87%. In the detailed table it couldbe seen that 9 of these equipment types are 80,46% the causes of NPT as a whole from the total NPT.

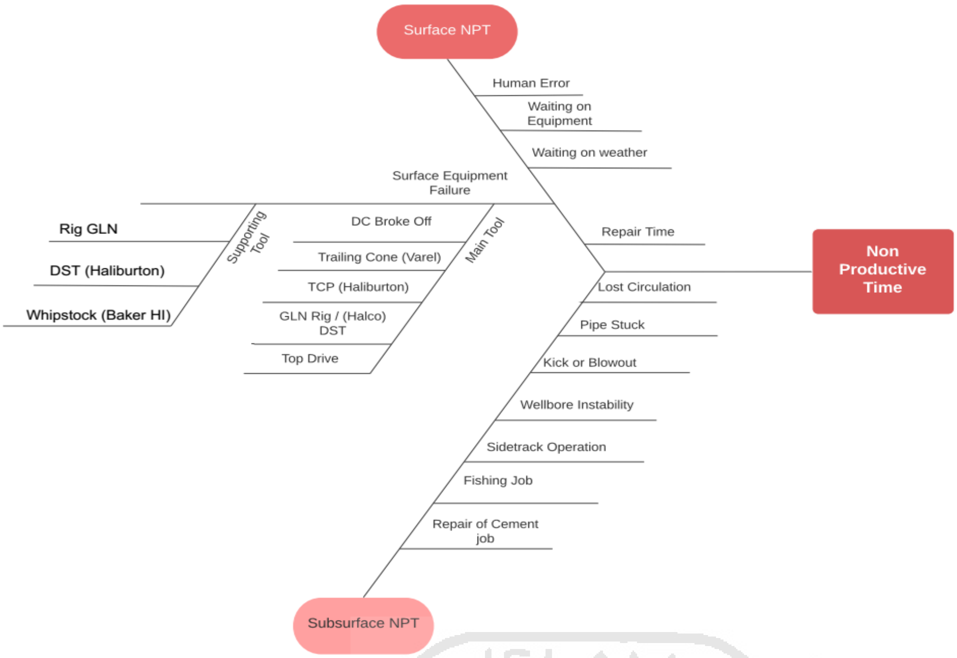

Figure 4.16.Fishbone analysis of NPT ER causes

CHAPTER V

DISCUSSION

From the results of data processing, it was found that the total NPT NER was 1,694.5 hours and NPT ER was 2420.25. While, the total NPT is 4,114.76. So, the NPT ER is approximately 58% of the total NPT. This shows that NPT ER, although not the majority, has a significant influence on a drilling process, especially in this drilling project from PT MJT. Because PT MJT is a company engaged in the rental of drilling equipment, the researcher focuses on NPT ER.

From the table 4.13, it can be concluded that there are 5 major factors that cause NPT equipment in 7 drilling well projects by PT MJT, namely:

- Top drive (80.46%)
- Whipstock Baker HI (78.31%)
- GLN rig/Halco DST (76.08%)
- DST Halliburton (73,73%)
- Rig GLN (70.65%)

This is different from the research conducted by Nyota et al (2016).Nyotaet al (2016), established that 24% of downtime (NPT) is occurred in Olkaria, and 15% of the overall of downtime was attributed to downtime occasioned by equipment failure or unavailability. The major contributors to NPT occasioned by equipment:

- Rotary table (2%)
- Draw works (5%)
- Top drive (29%)
- SCR (15%)
- Mud pumps (2%)
- Service loop (1%)

- Air compressors (25%)
- Generators (1%)
- Drilling parameters monitoring and control instruments (18%)
- Drill string (1%)

And the main reasons for equipment downtime were identified as follows:

- Poor maintenance (33.17%)
- Wrong operation (20.19%)
- Unavailability of spares (12.98%)
- Procurement procedures (14.90%)
- Poor quality (4.81%)
- Unavailability of expertise (11.06%)
- Others e.g fuel quality, drilling mishaps, etc (2.88%)

Unfortunately, the data about main reason of NPT ER in percent are unavailable from PT MJT. From an interview, researcher found that NPT equipment related,which are:

- Poor maintenance, maintenance procedures are reactive.

  PT MJT do not conduct the preventive maintenance because there is limited Maintenance funds.
- Poor quality (PT MJT often buys second hand or non-original brand goods).
- Unavailability of spares

Researcher also needs do gain more detailed data to improve the analysis and being able to extend the root cause analysis.

Modak N.J et al (2017), analysed the downtime factors of the rig “E-1400” and “E-2000” series with Pareto analysis. There were three factors are responsible for causing more than 80% of the shutdown related with equipment, that is drilling equipment (kelly problem, power tong problem, rotary problem, leakage of H-manifold hammer union, etc) and production equipment beside mud pump (mechanical factor). In order to increase the uptime of any piece of equipment or machinery, a deep knowledge behind equipment breakdown is essential.

Mitchell (2006) in Eren T (2018), mentioned that the main causes of well problem related NPT occurrences are hole problems, drill string and tools failures.

The benefit of controlling the factors of NPT's cause is a decrease in NPT, so that it will have an impact on operational costs in drilling to become more efficient.

This is evidenced in several studies as follows:

PT Pertamina (2018) is making efforts to reduce the high NPT by implementing a software innovation called Pertamina Aerated Drilling Simulator (PADsim). The purpose of this PADsim is to optimize the design of aeration drilling parameters for drilling geothermal wells. The determination of aeration drilling parameters with PADSim, was able to reduce the NPT due to the stuck pipe by 71% (110 hours) from the original total NPT of 56% (156 hours) to 17% (46 hours). In the end, drilling costs were successful in saving up to 59.6% or USD 506,900 / well from USD 849,900 / well, with a total value creation of USD 4.6 million. This PADSim has been applied to nine PGE geothermal drilling wells in the Ulubelu, Hululais, Bukit Daun, and LumutBalai fields.

Basbar A.E.A et al (2016), has implemented a measured to decrease of NPT for Rigs operation through Competency Improvement. The company has done training program for the quality of engineer and worker, office and field staff. The materials of training course coverage the HSE (Health, Safety & Environment), Technical and soft skills. Raising the morale of the crew was the main factors that has led to reduce the NPT to 0%.

Gazpromneft's Drilling Management Center DMC (2018), has controlled the NPT by using eDrilling software. This tool has monitored and controlled the drilling operations. This has contribution to increase efficiency and safety. Since introduction of the Drilling Management Center (DMC), NPT has been reduced by percent 8-10%, and drilling rate has been improved by 20%. Drilling is one of several new technology vendors used and qualified in the DMC.

This study reveals that taking the historical drilling performance data set into consideration for drilling performance evaluation rather than a more generalised drilling performance evaluation gives much more efficient evidence on drilling efficiency when comparing the performance of the drilling contractors.

BAB VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

1. From literature review NPT is defined as the time taken for any routine or abnormal operation that is caused by a failure or event that stop the operation. And after analysing PT MJT well drilling project, researcher confirmed the result of literature review where all NPT involving equipment is due to unexpected failure causing major time losses.
2. The researcher analyses the data of 7 drilling projects of PT MJT and conducts interview. Where the result shows, from the total operational time on how the 4.144,76 hours are lost due to NPT, of which 2420,25 hours is NPT ER.
3. In order to reduce NPT efficiently, PT MJT needs to be able to analyse which category or equipment contributes the most to total NPT. By breaking down the activity to identify productive and non-productive time then looking into which NPT falls into equipment related and not, then identifying which equipment contributes the most to the NPT and from which category. Then using Pareto analysis shown to be the mentioned 9 tools, situated at surface equipment in the main tools and supporting tools.

6.2 Recommendation

As a company that rents out drilling equipment, PT MJT has carried out checklists and quality control regularly. However, to improve NPT equipment related and maintain client trust, some suggestions are needed for PT MJT, namely:

1. The availability of manuals or standard operating procedures on how to use the tools, especially for expensive and very important tools. So that every staff or

worker understands it. This is to prevent damage due to incorrect operation of the tool.

2. There is a training or briefing for field workers before conducting a drilling operation, considering that the workers who will go to the field are contracted by project.

REFERENCES

Abimbola M.O (2016). *Dynamic Safety Analysis of Managed Pressure Drilling Operations*.Faculty of Engineering and Applied Science. Memorial University of Newfoundland

Alappat N (2015). *Measuring Non-Productive Time to minimize Drilling Flat Times*.Published on July 15, 2015.https://www.linkedin.com/pulse/measuring-non- productive-time-kpi-minimize-drilling-flat-alappat.

Al-Hameedi A.T., Alkinani HH, Norman SD, Flori RE, Hilgedick SA (2018). *Insights IntoMud Losses Mitigation in the Rumaila Field, Iraq*. J Pet Environ Biotechnol 2018, 9:1. D0I: 10.4172/2157-7463.1000356

Alsalat A (2016). *Performance Measurement and Efficiency Improvement for Onshore Drillings rigs. Operated by OMV*. Thesis.

Basbar A.E.A., Al Kharusi A, et al (2016).*Reducing NPT of Rigs Operation through Competency Improvement: A Lean Manufacturing Approach*. SPE Bergen One day Seminar Bergen, Norway, 20 April 2016.

Cochener J (2010). *Quantifying Drilling Efficiency.Office of Integrated Analysis and Forecasting*. U.S. Energy Information Administration, Initial Release: June 28, 2010)

Emhanna S.A (2018). *Analysis of Non-Productive Time (NPT) in Drilling Operations-A Case Study ofGhadames Basin*, Petroleum Engineering Department, University of Ajdabija, Ajdabija, Libya; Seconds Scientific Conference of Oil and Gas.

Eren T (2018). *Drilling time follow-up with Non-Productive Time monitoring*.International Journal Oil, Gas and Coal Technology, vol 19, No 2.

Gazpromneft's Drilling Management Center, March 2020

Júlio H., Youli M., Avinash W. Et al (2017). *Sequence Mining and Pattern Analysis in Drilling Reports with Deep Natural Language Processing*. ArXiv:1712.01476v (cs.CL)

Khaled S.M, Elfakharany T, Elsalam A. (2018). *A Unique Performance Optimization Methodology Leads to Remarkable Improvement, in Drilling Operations (success case history)*. International Advanced Research Journal in Science, Engineering and Technology/IARJSET. Vol. 5, Issue 2, February 2018

Mansour A, Taleghani A.D, Salehi S, et al (2019). *Smart lost circulation materials for productive zones*. Original paper.Journal of Petroleum Exploration and Production Technology (2019) 9:281–296.

Moazzeni A, Nabaei M, Branch O, et al (2010). *Mechanical Earth Modelling Improves Drilling Efficiency and Reduces Non-Productive Time (NPT)*. Islamic Azad University; SPE, Petroleum University of Technology PUT), YRC.

Modak N.J, Kalita D, Barua P.B (2017). *Minimization of Non-Productive Time in Drilling Rig Operation*.International Journal of Engineering Trends and Technology (IJETT). Volume-44 Number-1 February 2017

Ngosi R, Omwenga J (2015). *Factors Contributing to Non-Productive Time in Geothermal Drilling in Kenya: A case of Menengai Geothermal Project, American Scientific Research Journal for Engineering, Technology and Sciences (ASRJETS)*. Volume 14, No.3, pp16-26.

Nyota B, Murigu M.M (2016). *Analysis of Non-Productive Time in Geothermal Drilling Operations- A case study of Olkaria*. Proceeding, 6th African Rift Geothermal Conference, Addis Ababa, Ethiopia, 2nd-4th November 2016

Otieno P.K.O (2016). *Impact of Drilling Equipment Quality Condition And Expertise Availability On Well Drilling Cost-A Case Study Of Olkaria Geothermal Field*. Proceedings, 6th African Rift Geothermal Conference Addis Ababa, Ethiopia, 2nd – 4th November 2016.

Patel D, Thakar V et al (2019). *A Review on Casing While Drilling Technology for Oil and Gas Production with Well Control Model and Economical Analysis.School of Petroleum Technology, PanditDeendayal Petroleum University, Gandhinagar, 382007, India*. Petroleum journal homepage: http://www.keaipublishing.com/en/journals/petroleum.

Rahmati A.S, Shadizadeh S.R (2018). *Investigation the Non-Productive Time and Related Drilling Challenges in Azar Oil Field*. 4th International Conference of Oil, Gas and Petrochemical, Tehran University, Iran.

Saraswati G.F, Ginting M, Simorangkir (2015). AnalisaWaktu Yang TidakProduktif (NPT) PadaOperasiPemboranSumurLepasPantai "NB-AAA" Lapangan XY, Total E&P Indonesia Kalimantan Timur, Seminar NasionalCendekiawan, ISSN:2460-8696.

Susilo P (2019). PT Multi Jaya Tehnik Profile. Jakarta, 2019

Talreja R, Kumar R.R, Nakhle A, et al (2018). *Challenges and Solutions Associated With Drilling Deviated Wells in Alternating Soft-Hard Formations: A Case Study From Onshore KG Basin, India*. AAPG Asia Pacific Region GTW, "Pore Pressure &Geomechanics: From Exploration to Abandonment," Perth, Australia, June 6-7

York P, Pritchard et al (2009). *Eliminating Non-Productive Time Associated with Drilling Trouble Zones*. Weatherford Int'l. Offshore Technology Conference.

Zainudin (2018).InovasiSimulasitingkatkanEfisiensiPengeboranPanasBumi.Pertamina, Jakarta. https://www.pertamina.com/id/news-room/energia-news/inovasi-simulasi-tingkatkan- efisiensi-pengeboran-panas-bumi