Minimization of Non Productive Time in Drilling Rig Operation

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Abstract *— As time goes by, increase in world's energy demand forced oil and gas companies to drill deeper in order to produce more oil and gas for balancing world's offer and demand. Non Productive Time (NPT) is the main cause of delays in drilling projects . There are numerous occurrences or eventualities that cause stoppage of drilling operations or marginal reduction in advancement of the drilling progress leading to Non Productive Time (NPT).*

For any industry cost and time related to production and quality management or wastages reductions have important impact on overall expenditure. Emphasizing on it steps have been taken to investigate and eliminate wastages, that is, non -productive time in drilling rig in order to save time and cost and lessen down time. The focus of the present work is on the causes which are the reasons for down time and will to find out the key cause which causes the down time most of time. An industry may gain higher productivity and profitability by eliminating non-productive activities.

In this work data were collected from eighteen rigs and analysis were done to find out the root causes of non-productive time in rig operations by Pareto analysis.

Keywords — *Non-productive time, Pareto analysis, Root cause analysis.*

I. INTRODUCTION

Over several years oil industry is facing troubles associated with the down time. Mechanical failure is one of the causes of non-productive time that have had a major impact on drilling efficiency and well cost. 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 analysing the data 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.

II. LITERATURE REVIEW

Non-productive time analysis has already proven to be successful in many industries. The concept of this tool has also been very much instrumental for engineers in many fields. Following is a research works dealing with the concept that has been used as reference in this project work.

Alireza, M. et al. (2011) [1] analysed rig time break down of more than 300 wells in south Iranian fields to determine the effective parameters of non-productive time amount. Most common drilling problems experienced by drilling engineers are equipment failure. With increasing downward pressure on oil prices, drilling contractors and operators are becoming more focused on improving rate of penetration by reducing the cost of owning and operating drilling and production asset. Considerable attention is already given to evaluating and reducing non-productive time when an asset is already down, it is not producing and revenue for the owner and is costing the operator time and money in drilling services and production delays.

Equally important to reducing non-productive time, however, in increasing the productivity of the asset during its "productive time", which can have just as large as impact on the overall cost of operating the asset. An asset with higher productivity will cost less to operate, results in shorter drilling campaign and produces increase rate of penetration for the operator.

There is a fundamental and critical difference between the term "productive time" as used in non-productive time and the "productivity" of an asset. Productive time measures if the system is working or not. Productivity on the other hand addresses how well the system in working while it is productive. An asset that has acceptably high productive time but unacceptably low productivity can still lose money for the owner by taking longer than expected to complete a drilling campaign. Productivity determines if the expected amount of work gets done during the available productive time.

III. OBJECTIVE OF THE PRESENT WORK

The objectives of this work are to find out most of the causes of down time. Secondly to find out the

prime causes and then from them find out the root causes.

IV. METHODOLOGY

To fulfil the above objectives, the data of down time collected from eighteen different drilling rigs are analysed again and again with the help of Pareto tool to find the root causes of non-productive time.

TABLE I
DOWN TIME CAUSES ARE TABULATED BELOW

Sl. No	Down time causes	Sl. No	Down time causes
1	Rotary(Mechanical)	10	Production Equipment
2	Mud Pump (Mechanical)	11	Top drive (Electrical)
3	Drilling Equipment	12	Draw Works (Electrical)
4	Draw Works(Mechanical)	13	PCR Unit
5	Others(Mechanical)	14	Rotary(Electrical)
6	Instrument repair	15	Power Pack (Electrical)
7	Mud handling system (Electrical)	16	Power Pack (mechanical)
8	Mud handling system (Mechanical)	17	Other (Electrical)
9	Mud Pump (Electrical)	18	Well control equipment

The causes tabulated above are independent of each other.

Pareto Analysis are done number of times in this project work. Firstly to identify the key contributors of machine down time and secondly to sort out the major causes of equipment breakdown.

To better understand the causes behind equipment breakdown, a root cause analysis was done by doing Pareto Analysis over and over again. The analysis showed us the actual reasons behind failure and also the relationship between different root causes of a problem.

V. DATA ANALYSIS AND DISCUSSION

There are a total of eighteen major downtime loses that are recorded. There are several type of rigs as per the capacity of drilling deeper. At first Pareto analysis had been done on the individual rig basis to see the downtime causes related to each type of rig.

After doing Pareto analysis of the downtime factors of the rig "E-1400" series, which has been illustrated in Fig 1. we had seen the following listed three factors are responsible for causing more than 80% of the shutdown.

a) Mud Pump (Mechanical)
b) Drilling Equipment.
c) Production equipment.
d) Draw works (Mechanical)

Similarly after doing Pareto analysis for the rig type "E- 2000" series, which has been illustrated in Fig 2. We can observe that the following mentioned factors are causing more than 80% of the shutdown.

a) Mud Pump (Mechanical).
b) Drilling Equipment.
c) Rotary (Mechanical).

And also after doing Pareto analysis for overall all rigs together which had been illustrated in Fig 3. we can see the following mentioned points are responsible for more than 80% of the shutdown.

a) Mud Pump (Mechanical).
b) Drilling Equipment.

From all the analysis it has been observed the two factors are in common which are imparting more than 80% of the shutdown in drilling rig in normal operating condition. These are

a) Mud Pump (Mechanical)
b) Drilling Equipment.

We again converged our study deep into these two factors. Further Pareto analysis has been done on these two points to get the root causes of down time. Now the causes has been studied which are responsible for causing down time of the above mentioned two points.

The sub causes of the cause "mud pump (mechanical)" are:

1. Repairing of Liner and Piston.
2. Repairing of suction and delivery valves.
3. Repairing of fluid end.
4. Repairing of wear plate.
5. Repairing of mud pump suction line.
6. Repairing of super charger gland packing.
7. Repairing of delivery dampener.

And the sub causes of the cause "drilling equipment" are

1. Leakage of H-manifold hammer union.
2. High pressure line leakage repair.
3. Kelly problem.
4. Power tong problem.
5. Repair of Air winch.
6. Repair of easy torque.
7. Cleared choke of flow line.
8. Leakage of riser.
9. Rotary problem.
10. Repair of goose neck.

We had done the Pareto analysis on the above mentioned sub causes which has shown in Fig 4. and Fig 5. and the root causes are identified.

After doing Pareto analysis for the "Mud pump" data it is found that "**repair of liner piston**" contributes for more than 90% of the shutdown. And for drilling equipment "**leakage of H-manifold hammer union**" and "**high pressure line repair**" causes more than 80% of the shutdown.

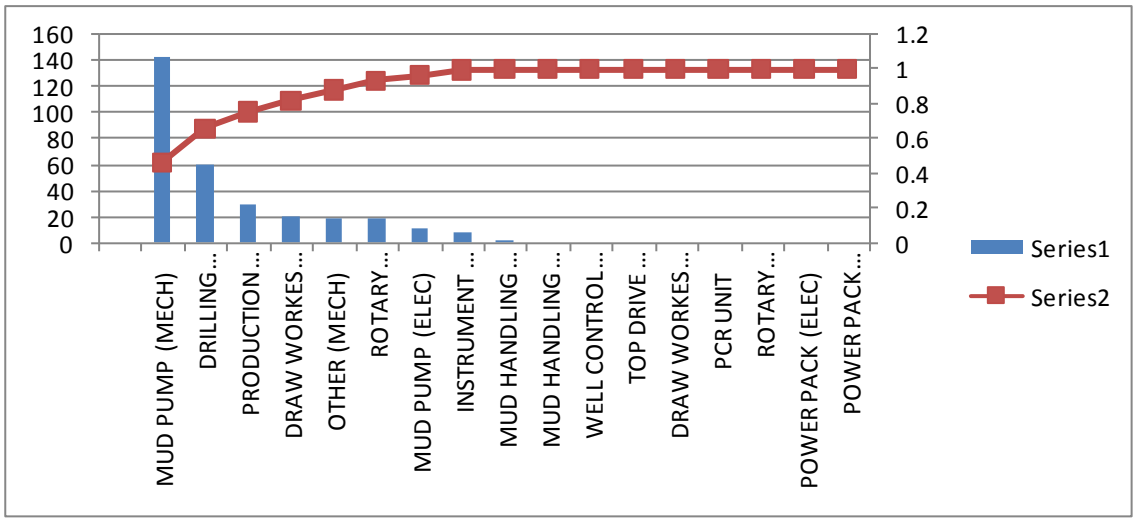

Fig 1. Pareto Analysis of E-1400 series

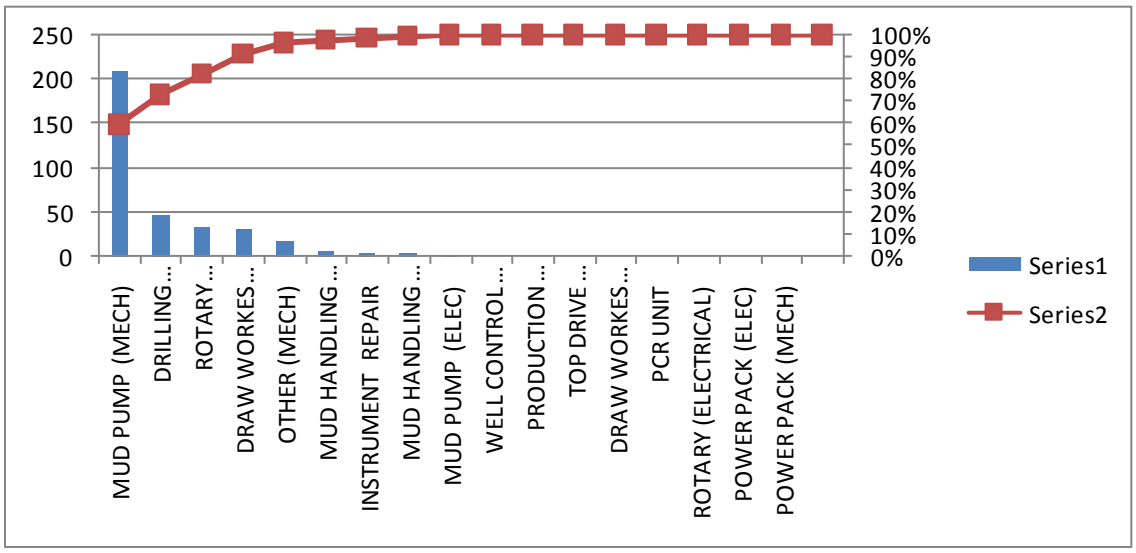

Fig 2. Pareto Analysis of E-2000 series

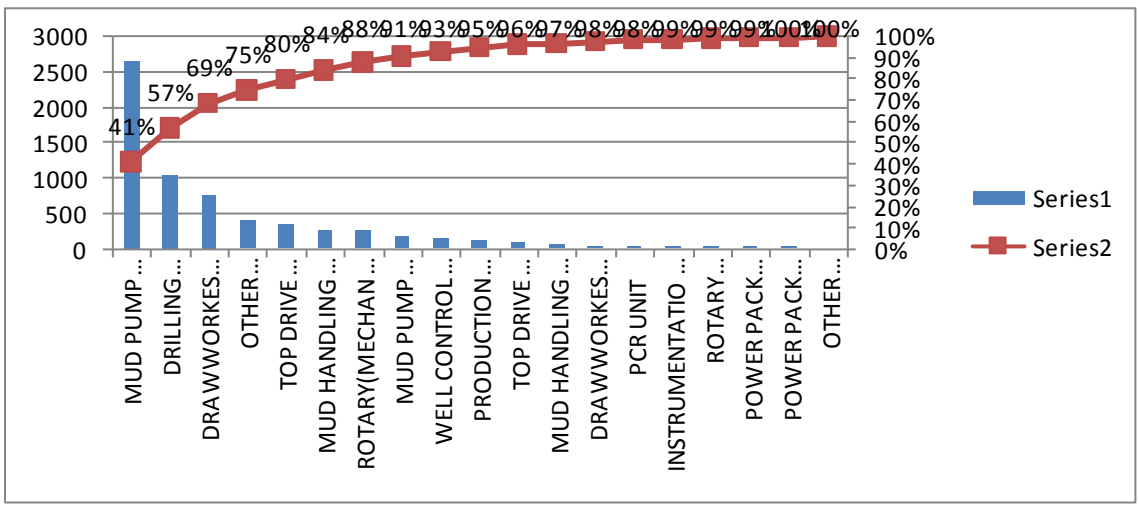

Fig 3.Pareto Analysis for overall all rigs

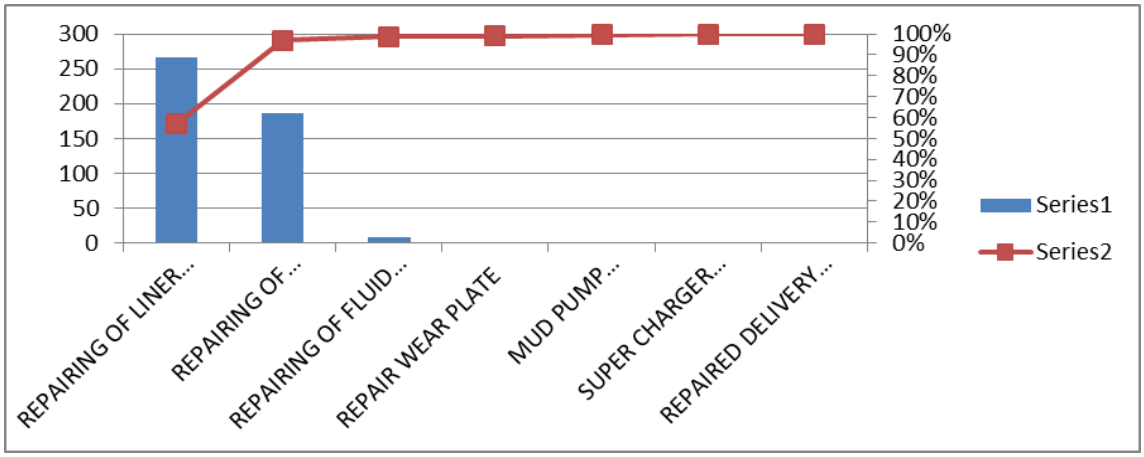

Fig 4.Pareto Analysis for mud pump data

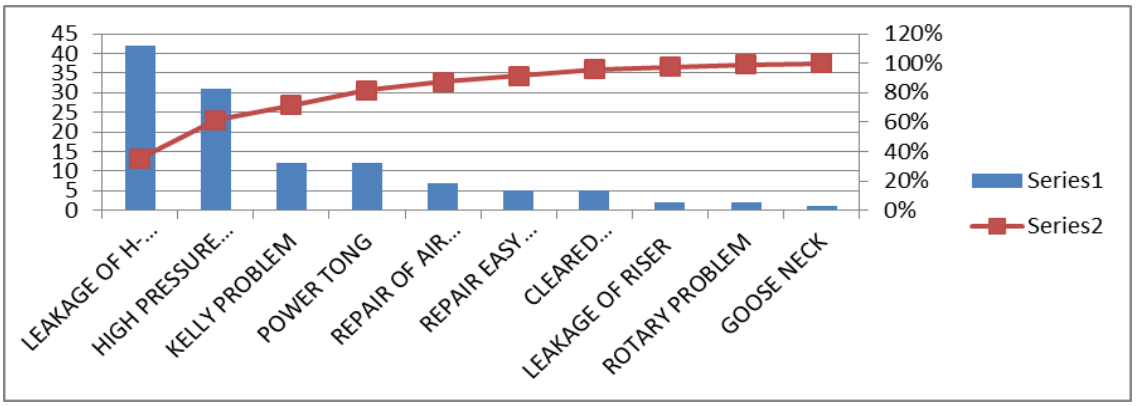

Fig 5.Pareto Analysis for drilling equipment data

VI. CONCLUSION

This project work deals with the idea of finding the root of the root causes of the non-productive time and to find some solutions to solve the problems in order to minimize non-productive time.

In order to increase the uptime of any piece of equipment or machinery, a deep knowledge behind equipment breakdown is essential. This project work converses from eighteen causes of down time to only two causes and after analysing these two causes further it has been seen that three of its sub causes are responsiple for more than 80% of the times to result in shut down situation. One of which is "**Liner and Piston**" of mud pump.

Fig 6. Damaged liner piston

From the picture it can be easily seen, the type of damage which used to occur in "liner and piston" during pumping mud, which can simply imply a loss of pump pressure and further drilling operation cannot be resumed till it replaced. Simply causing non productive time.

So in order to reduce the down time the maintenance type has to be changed from "breakdown maintenance" to "preventive maintenance".

The other two root causes which are also incurring down time are

1. Leakage of H-manifold hammer union joint.
2. High pressure line repair.

The above mentioned two factors are caused only due to the vibration generated while pumping mud which results in disallignment of connecting points between two high pressure lines which transfers mud from mud pump to drill bit. So the allignment of high pressure lines must have to cheak periodically to ensusre no vibration and also it should be redesigned considering vibration as a prime design factor as it is impossible to eliminate vibration fully.

REFERENCES

[1] Alireza.M., Mohammad. N., Ahmad. A., "Reducing Consumed Energy while Drilling an Oil Well through a Deep Rig Time Analysis" Advances in Petroleum Exploration and Development, Vol. 1, No. 1, 2011 PP. 22-31.