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A Unique Performance Optimization Methodology Leads to Remarkable Improvement in Drilling Operations (success case history)

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Abstract: Drilling operations is the only proven method to extract the oil and gain the profit, during the last decade the oil price decreases, which led to reduce the capital investments, reduces expenses and lied off huge number of expertise in all oil and gas sectors. Ended with reducing the level of competency of most of oil and gas companies. Performance optimization is a key for all companies to evaluate their work plan, magnitude budget and to have more control in oil well expenditures AFE to reduce the overall cost. Strategic planning cannot be effective without strong database for any historical work, successful business-planning team has to collect the assets requirements evaluated and allocate the required resources to complete the assigned tasks. One of the most important operations that require extensive planning in all oil and gas companies is drilling operations, where huge resources are required such as rigs, cementing, bits, mud, directional etc. When the oil and gas crises are resolved, prices increased. Oil and gas companies started to resume drilling activities and maximize their business plan. One of the drilling projects in one of leading companies in the Middle East had been selected to implement new performance methodology to check the method effectiveness. The aim of this study is to provide drilling team with clear and effective methodology and process to improve drilling performance and set up benchmarking process. Share project results to be implemented with other projects. This paper represents one of success case history for a unique performance optimization methodology and well- structured process, resulted in significant cost saving exceed 3.4 MM$. This technique will reduce the number of rigs required per project and save significant number of days. If similar performance is extrapolated to 6 rigs for a period of one year, the potential value addition of USD 26 MM will be achieved. Such performance projects can be initiated across all the assets of any company in the project-planning phase creating a huge and consistent impact on the number of wells drilled per year.

Keywords: AFE, NPT, Bit, BHA

INTRODUCTION

Performance optimization and data management is a key factor to deliver the success and cost saving in any project, especially with high cost projects i.e. oil and gas drilling projects, where time and money are consider the main mover for any drilling project , how to deliver the well in less time and low expenses. The normal drilling analysis is not routinely practices as it should be the need to encourage the best practices, continuous learning and improvement is a key to achieve drilling improvement plan. (Rahhil Amer, Eren, Tuna)[1,2]

Performance review for drilling operations had many phases and steps numerus visions to achieve the required target, a Multiwell drilling campaign was undertaken by one of leading oil and Gas Companies in the Middle East, with a target to drill total 60 wells by March 2017 by allocating six rigs to complete the drilling campaign. Continuous monitoring and optimization of drilling performance through a systematic and unique improvement process, resulted in substantial saving of more than 56 days of rig time in a quarter achieving the Asset requirement successfully.

Performance Improvement Phases

An important factor for enhancement in performance is the continuous monitoring and improvement in the drilling process as per project improvement cycle, which can be explained in major three phases as, mentioned below:

I. Plan, Data Acquisition Stage,

A master database had been made, with comprehensive database enabling the team to gather the most important information, identify the operational gaps and analyze the data.

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The data had been collected for almost 15 Directional wells, creating unconventional powerful dashboard, all the data are illustrated in table from 1 to 5 and figures from 1 to 3, the main objective of this dashboard is to;

- Identify the gaps and operation limitation
- Identify the main road map for all the drilling team and time limit
- Provide best recorded timing, practices, bits and parameters

Also, to represent the whole project details and it contain six elements, which be descried as follow:

1. **NPT distribution pie chart**:

There are always challenges associated with drilling and continues improvement of drilling programs to be in accordance with proper geological and petroleum fluids condition is (NPT). Time lost during drilling operation hence, study of NPT and making risk registers for individual wells and sections drilled in particular reservoir or field can aid in future drilling operations by lowering the severity and also reducing the probability of those NPT incidents (Karlsson, Ziad Sidaoui,)[3,4]

The pie chart existing on the dashboard present the percentage of NPT per each accountable party. Where this chart can easily identify the 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 Hrs, as shown in Figure 1. (20 Days) of NPT was documented for this project. A comprehensive NPT analysis has been carried out to identify the improvement areas.

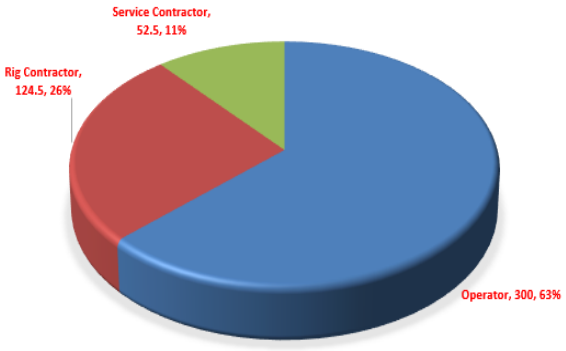

Fig-1. NPT percent per accountable party

2. **Operation Risk Mitigation plan**:

Which represent the operation risks and hazards per section. The recommended mitigation plan used to avoid such problem. i.e 9.5/8" casing unable to pass through high dogleg, resulted in significant delay in drilling time. The mitigation plan was to follow up, enhance the mud properties, conduct wiper trips when assure the well stabilized and clean prior to run with casing Table 1. The mitigation process used to avoid some of the drilling problems such as mechanical and differential stuck and drill string-plugging hazards and well control with Analysis chart of major drilling problems occurred shown in Figure 2.

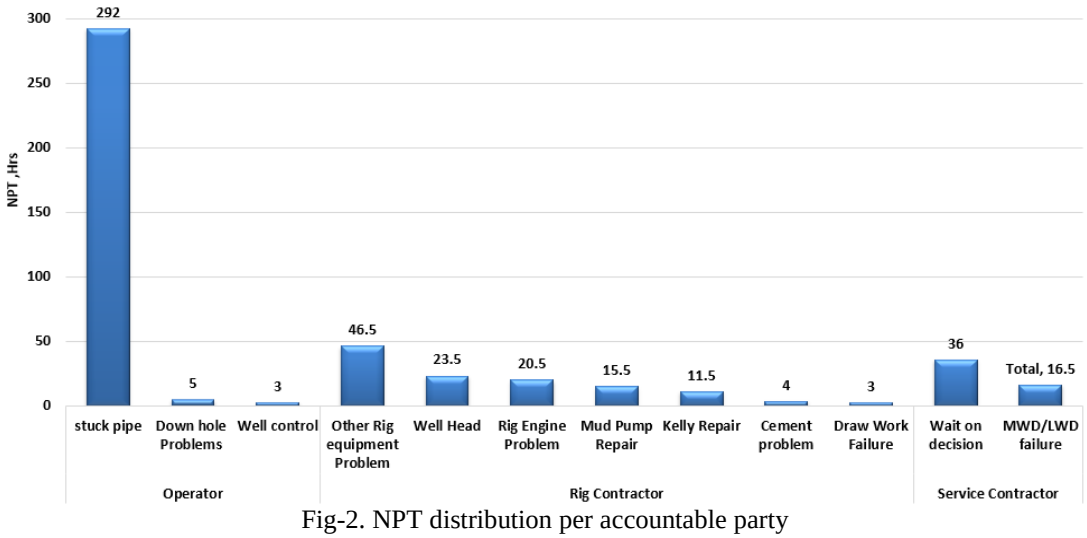

Fig-2. NPT distribution per accountable party

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3. **Executive Summary Table:**

Representing the well delivery timing for all completed wells, and section timing as well, also highlighting the move time per well which could be improved significantly and save more time for both operator and rig contractor Table 2.

4. **Drilling best practices:**

Drilling best practices mention that using diesel while drilling 8.5" section will improve drilling efficiency. Usage of 10-PPG mud weight found to be the best appropriate mud weight that minimizes well bore instability, it is recommended to increase mud weight to 10.2 ppg at TD. Also, continuous break circulation Suring the wiper trips and monitor mud rheology to avoid plugging of nozzles. Maintain low GPM (200 GPM) for the first 100' below conductor pipe (170 FT) to avoid washout. Increase GPM gradually as per directional Company's requirement and drill up to TD, Circulate at 180 GPM (low GPM) Maximum at the time of final circulation after wiper trip.

5. Main Dashboard Backbone:

The Dashboard represent the operation optimization per particular operation, from spud to release for all well drilled, analyze the operation, using percentile formula to calculate the Top10% of the timing meaning best of the best 10% , average 50% , worst last 10% which can be abbreviated and pointed as by P-10,P-50,P-90 Table 4.

In the world of statistics, percentile rank refers to the percentage of scores that are equal to or less than a given score. Percentile ranks, like percentages, fall on a continuum from 0 to 100. For example, a percentile rank of 10 indicates that 10% of the scores in a distribution of scores fall at or below the score at the 10th percentile.

Percentile ranks are useful when you want to quick understand how a particular score compares to the other scores in a distribution of scores. The formula for calculating percentile ranks is relatively simple and straightforward. Knowing only the distribution of scores, you can easily calculate the percentile rank for any of the scores in the distribution by using the following formula:

$$\mathbf{R = P / 100 (N + 1).}$$ Eq- 1(study.com)[5]

Where R- represents the rank order of the score, P- represents the percentile rank, and. N- represents the number of scores in the distribution.

So, for each particular operations calculation was made from all delivered well. Determine just three numbers, Best record (P-10), Average Record (P-50), Worst Record (P-90), As shown in Table 3.

6. Bit and BHA summary section:

The summary of Bit and BHA configuration represents the bits with directional drive used to drill the section and directional company related for both bits, directional company resulted which best ROP with drive configuration (Bit+BHA Drive) used, shown in Table 4.

II. EXECUTION PHASE, WORD OF MOUTH PERFORMANCE METHOD

Clear tasks and effective communication is proven tool behind the success. The road map (Dashboard) , as shown in figure 4, to all drilling contractor and concerned people was found as very effective tool to achieve the required goals.
Conducted large workshop in the field, discussing the methodology and dashboard, limitations and all operational steps, clearly addressed the best timing, average and worst timing for all the planned activities.
All the 6 parts mentions above handed over the road map to the key persons, Rig supervisor, drilling engineers, Tool pusher and drillers. The decision was taken from all operational parties to:

- Improve casing running in speed
- Reduce tripping time
- Improve time required for BHA make up and lay down
- Improve other flat time and Invisible Lost Time
- Reduce overall NPT
- Improve rig move time

Keep discussing performance among all the team, with no shortcut improve the performance awareness and enhance mentality change.

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Avoiding NPT is the major factor had to be addressed when performance discussion comes into account, as NPT occurred performance optimization process would be interrupted.

III. RESULTS CHECK, FOLLOW UP, AND PERFORMANCE REVIEW

Following up the actions and agreed road map is a mandatory step to measure and evaluate the methodology and whole project, day-to-day follow up, sharing the update and feedback, benchmark to all involved participants (DE, DS, SOE, TP, MS) all also are key factors.

It has been observed great immediate impact after workshop, consistent performance outcomes from both rigs attending the workshop and agreed on the process.

On the other side, normal timing was observed for the other four rigs working with the same area with no remarkable change or improvement.

All reported NPT and associated lesson learnt had been collected, shared and discussed on daily basis to avoid problem repetition. Figure-3 represents how much the reduction in well duration after the applied workshop starting from well number 15.

The immediate and consistent Impact of the performance workshop immediately yielded exceptional. Table 5 represents the impact of this workshop and clearly showed that P-10, P-50 and P-90 baselines were revised because of significant improvement Recorded in the subsequent wells.

The performance team followed up the tracking till well number 34 where the methodology was proven and handed over all details to operation team to follow up.

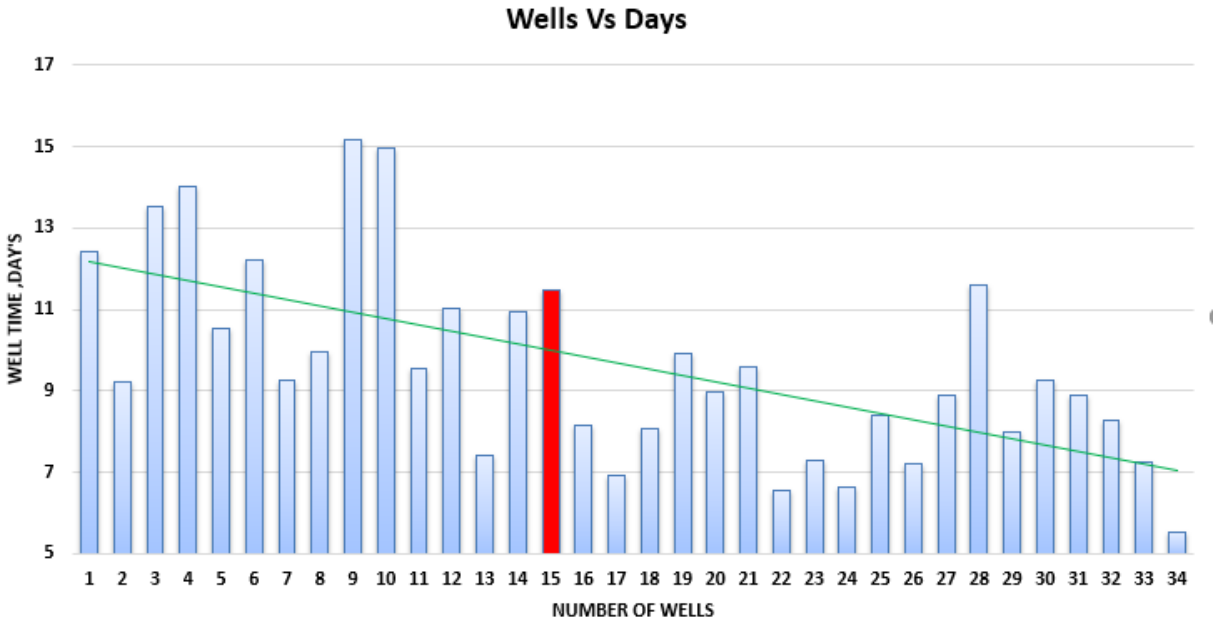

Fig-3. Days Vs. Number of Wells showing significant reduction in the number of days with consistent performance

SUMMARY

Performance optimization could have multi-vision and methodologies to enhance drilling operation

The following key factor could influence any project to achieve the maximum benefits and accomplished the target plan. This succeeded methodology could be repeated with all types of projects resulted in great cost saving in less time (More wells, More production and less number of rigs). The following checklist / steps and/or process had to be followed:

1. Efficient data management, to identify gaps and roadmap. (Timings, Tasks and rules and responsibilities
2. Clear and effective communications between planning and execution teams. With very clear and simple action plan.

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3. Day to day follow up, in master agreed data base, where it has to fulfill the required project objectives
4. Review the Project out comes with all participants, review competency management system for them. (EL-Bishti Abogasem)[6]
5. Awarding system should be structured to encourage all the team to change their mindset

BY conducting all, the required steps for any project will be achieve the required target with great saving

CONCLUSION AND RECOMMENDATION

This paper will highlight the effect of performance optimization methodology, related to one of similar well type project with all the process conducted to reduce the drilling time to more than 30% of total time safely. This technique will reduce the number of rigs required per project and save significant number of days. If similar performance is extrapolated to 6 rigs for a period of one year, the potential value addition of USD 26 MM will be achieved. This study will reduce the average number of days from 12 to 8 per well as represented in the paper. A remarkable improvement of 30% was achieved consistently in the subsequent wells drilled after the performance workshop. The implementation of performance management process reduced rig time by more than 56 rig days, resulting in total value addition of USD 3.4 MM (USD 1.8 MM as cost savings and USD 1.6 MM as early production benefit for the operating company). Such performance optimization methodology can be initiated across all the assets of any company in the project-planning phase creating a huge and consistent impact on the number of wells drilled per year.

ACKNOWLEDGEMENTS

This technique consumed huge amount of work and efforts, the key factor for achieving this success was due to support and response from operation teams at KOC Drilling Group-I, Therefore the Author would like to extend sincere gratitude to all of them.

Nomenclatures

AFE	Authorized for Expenditure
Assy.	Assembly
Bbl.	Barrel
BHA	Bottom Hole Assembly
BOPD	Barrel Oil per Day
BPH	Barrel per Hour
DE	Drilling Engineer
DS	Drilling supervisor
DTL	Drilling team leader
FT	Feet
GPM	Gallon per Minute
MS	Mud Supervisor
NPT	Nonproductive Time
OBM	Oil Base Mud
POOH	Pull Out Of Hole
PPG	Pound per Gallon.
PSI	Pound per Square Inch
RIH	Run In Hole
RM	Rig Manger
SOE	Senior Operation Engineer
TD	Total Depth
TP	Tool Pusher.

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Appendix :

Table -1. The summary of Operation Risk Mitigation plan in the main Dash Board

Casing Size	Depth	Formation	Operational Risks	Impact	Mitigation
9 5/8"	500	F0 Shale	Casing unable to pass through high dog leg	Delay in well delivery	Enhance Mud Rehology , connduct wiper trip , make sure the well stablized prior to run with casing
7"	1750	Lower Shale	1.Shallow gas (H2S) Hazards 2.Losses 3.Mechannical Stuck Pipe 4.Drill string getting Plugged. 5.Differential stuck pipe	1.Gas Kick, HSE Hazard (High) 2. NPT 3. NPT 4.Swabbing of Well, NPT 5. NPT	1. Monitor Trip Tank while Tripping , Maintain Hydrostatic pressure, also Monitor drilled gas level , frequently check sensors . 2. Avoid induced losses. In case of total Losses place Cement plug. 3. follow good drilling Practices for Hole cleaning best Practices 4. Break circulation every 5 Stands, while tripping. Drilling fluid rehology to be As per program 5. Minimize static time , use re-enforcing material .

Table -2. Part of The Executive Summary for the drilled wells, section timing, Days

Well	Move ,Days	12.25 Section,Days	8.5 Section,Days	Total Well Duration ,Day
Well-01	5.5	5.4	7.2	18.4
Well-12	10.5	3.4	5.8	19.7
Well-09	10.2	3.9	9.7	13.6
Well-04	5.6	4.5	9.8	14.2
Well-03	5.4	3.9	6.6	10.5
Well-08	7.6	4.1	8.1	12.2
Well-05	3.2	3.0	6.5	9.5
Well-10	1.8	3.8	6.3	10.2
Well-11	1.2	8.9	6.4	15.3
Well-06	2.7	4.2	6.8	11.0
Well-02	2.8	4.7		4.7
Well-07	12.8	3.8	5.7	9.5
Well-13	2.9	3.1	4.4	7.4
Well-14	2.8	3.6	7.9	11.5
Well-15	9.1	24.9		24.9
Well-16	0.9	3.3	14.2	17.4
Well-17	0.8	4.1	11.7	15.8
Well-18	11.6	3.8	4.4	8.2

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Table-3. Represent the operation breakdown and best, Average, Worst timing for each particular operation

Phases	**P-10**	**P-50**	**P-90**
Operation Activities / Total	9	12	15
Spud well and Drill 12-1/4" Hole upto KOP	1.45	2.5	17.65
Circulate and POOH 12-1/4" BHA	0.5	1.5	2
Pick up and Make up 12-1/4" Directional BHA	2	3.5	6.7
RIH W/ Direction BHA	0.5	0.75	2.5
Drill 12-1/4" Direction Hole to TD	24.3	36.5	49.7
Cir. , WIPER TRIP & POOH	8.85	11	15.3
OH. Logging.	0	0	0
Condition Trip.	0	0	0
Run 9-5/8" casing	3	4.75	6.6
CIRC & Cement 9-5/8" casing	1	2	3.5
Perform CMT Top Job	0	0	1.6
W.O.C	0	0	0
NU & Install Well-head & BOP	15	18.25	34
Pick up and Make up 8-1/2" slick BHA and RIH	2	2.5	7.3
Drill-out F.E , CMT & Displace Mud	4.3	6.25	21.85
Cir. POOH	2	3.5	6.05
Pick up and Make up 8-1/2" Directional BHA	1.5	4.5	8.9
RIH W/ Direction BHA	1.95	3.5	6.1
Drill 8-1/2" Direction Hole	38.25	55.75	141.65
Cir. & POOH and Wiper Trip+Scrapper trip for 9-5/8" Csg	12.5	17.5	34.5
OH. Logging.	9	14.5	17
Condition Trip.	6.4	12	16.9
Run 7" casing	6	8	9.3
CIRC & Cement 7" casing	2	3	4.6
Perform CMT Top Job	0	0	0.3
W.O.C	0	5.5	7.5
ND BOP & Cut Casing	3.4	4.5	5.6
Install Well-head	1.5	3	4.1
NU BOP	1.8	2	2.6
SCRAPER RUN	8.3	11	12.6
Cased Hole Log	0	0	5.5
ND BOP & Install Tubing Hanger	1	2.25	3.8
Secure well and release	1.3	2	2.5

Table -4. Represent part of the, BHA and bit optimization record for the drilled wells

Rig				Rig-1	Rig-6	Rig-5
Phases	**P-10**	**P-50**	**P-90**	**Well-01**	**Well-13**	**Well-09**
12 1/4" Section TD ,FT				531	462	518
12 1/4" ROP ,Ft/Hr				10.5	20.09	16.5
12 1/4" BIT Company/IADC				Bit Company2/137	Bit Company-3/215	Bit Company-1/137
12 1/4" Direction BHA/ Company				Motor/Direction company-1	Motor/Direction company-2	Motor/Direction company-2
8 1/2" Section TD,Ft				1877	1820	1655
8 1/2" ROP ,Ft/Hr				31.66	38.25	58.3
8 1/2" " BIT Company/IADC				Bit Company2/137	Bit Company-3/PDC	Bit Company2/137
8 1/2" Direction BHA/ Company				Motor/Direction company-1	RSSl/Direction company-2	Motor/Direction company-2

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Table-5 The impact of drilling workshop and timing change and improvement in baseline performance

Performance workshop	P-10	P-50	P-90	NPT
Before	6.7	12	19	12%
After	5.5	8	16.3	9%
% Improvement	18%	30%	14%	3%

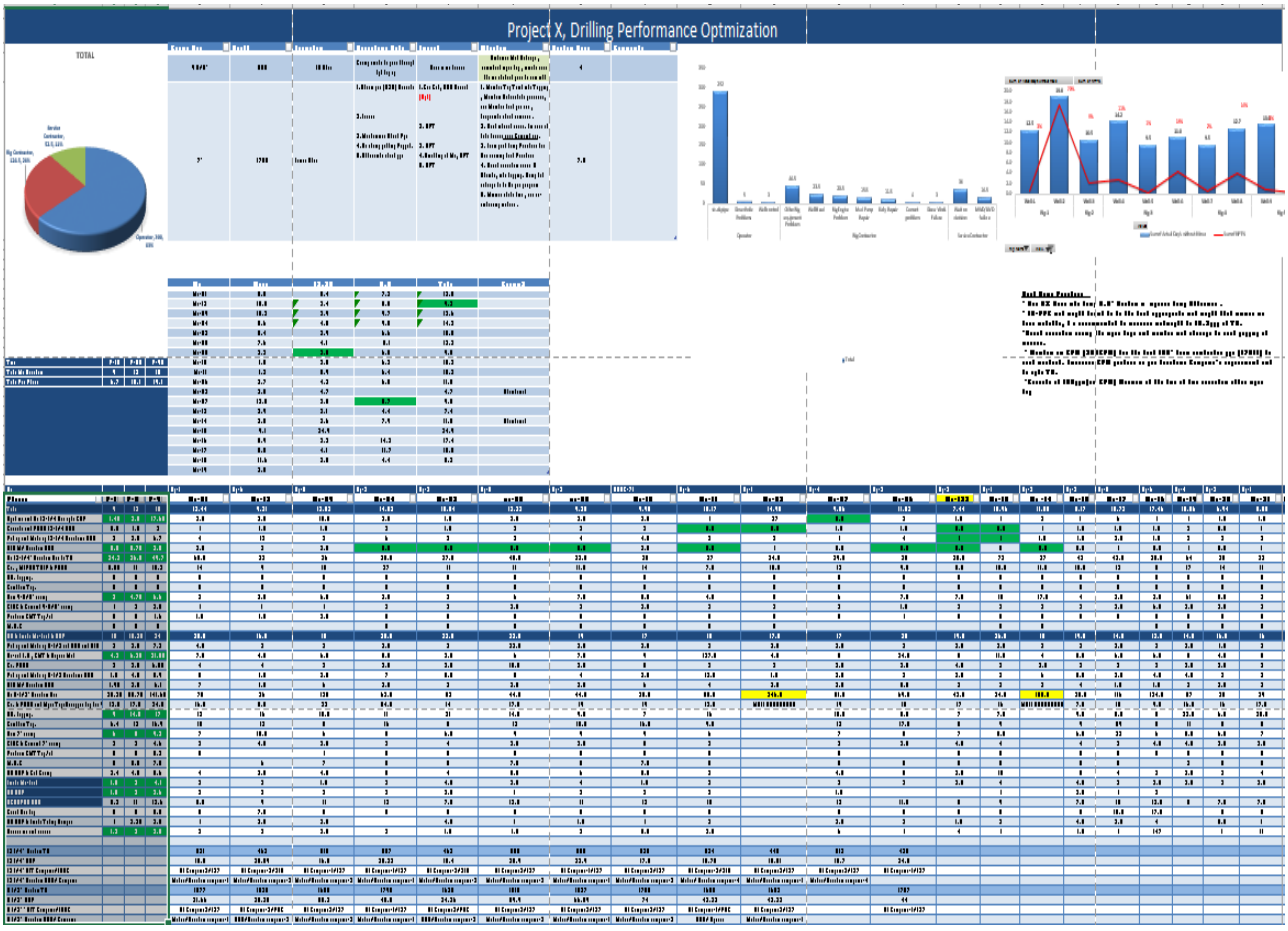

Fig-4 Project Dashboard