International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 6 (2018) pp. 4379-4384

The Effect of LEAN Methodology on the Quality Management System of Land Drilling Companies

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Abstract:

This paper presents the mediate effect of LEAN concept on the relationship between planning of drilling activities and overall performance (Quality Management System) among an Omani oil and gas drilling company. LEAN concept has been implemented in different industries with an overall objective to eliminate the waste from a define process. Hence, it is considered to be one of the key factors to improve and sustain the overall performance by a continual improvement mechanism. This paper presents a comprehensive assessment in the overall performance of a drilling rig before and after implementing LEAN concept in one main critical drilling activity known as tripping connection. The overall trend of time and cost (before and after implementing LEAN) is determined.

Keywords: *Quality Management System, LEAN, Continual Improvement, performance, drilling rigs and tripping connection.*

INTRODUCTION

Recent studies demonstrated the importance of having specific and fit for purpose quality management system which shall be in line with the organization overall activities [1], [2].

One of the sectors which recently started adopting specific quality management system is the oil and gas sector [1] especially with its dynamic nature of challenges and associated risks. Therefore, recent authors concluded the essential of obtaining and developing risk based approach quality management system to enhance the overall performance for land drilling activities [3].

The author on this paper will consider one of the recent studies which were conducted on developing a specific quality management system for land drilling sector to study the mediating effect of LEAN concept on the relationship between activity planning and the overall performance as demonstrated in figure 1 below. The focus area had been highlighted in yellow [1].

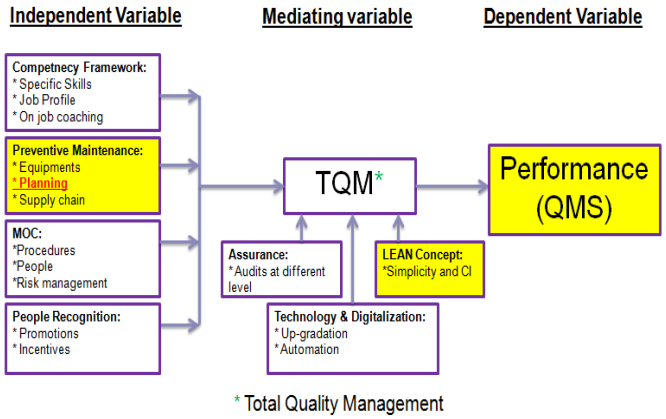

Figure 1: Land Drilling (QMS) Model [1]

LEAN CONCEPT

LEAN concept has been implemented in many sectors all over the world. Authors define LEAN in many aspects. However, they are aligned that the core idea of LEAN is to maximize customer value while minimizing waste [4]. In other words, LEAN means creating more value for the customers with fewer resources [5].

The LEAN concepts depends on eliminating the waste and creates process that requires less human intervention, less capital, less time, less defects which will achieve overall less cost [6].

Oil and gas industry is considered to be one of the industries that LEAN concept has been introduced recently, especially in the land drilling operations. The author will study the influence of LEAN on the overall performance for one of the companies operating in OMAN. However, LEAN has lots of applications in drilling activities. This paper will focus on one of the main critical activities which is considered to be a pain area in that particular company as follow: tripping connections [7].

Tripping activity will either be running tubular in hole or pulling tubular out of hole. However, in both cases, tubular connection and/or dis-connect will require time which is define as tripping connection timing. Simply, pulling the drill string out of the hole and disconnect the stands, is a classic set-up process. This activity will occur in each and every well to be drilled which means that an improvement on this process will have a huge impact. This paper will focus on cased hole activities and will exclude pick up (P/U), lay down (L/D) pipes and/or bottom hole assemly (BHA) tripping connection.

To address the above pain area, the author has selected a drilling unit will be referred as "drilling A" which drills almost 13 wells per year [8] operating in a company referred as "company B". Furthermore, the author will adopt LEAN methodology [9] which will start with project charter, value stream (As-Is), value stream (To-Be) and Standard Operating Procedure (SOP). These are the common steps which are adopted in LEAN methodology.

Project charter is the first step of the project by which the lean practitioner supported by the team will define clearly the following items: problem statement, scope, desired state and target goal. Value stream (As-Is) will define the exact current process whereby the Value stream (To-Be) will define the improved process after defining the gaps and having a better system to overcome them. Finally, SOP will be detailed to sustain and maintain the improvement across the fleet.

LEAN METHODOLOGY & RESULTS

As highlighted in above section, the author will adopt the LEAN methodology which is implemented by company B on one of the pain areas defined as tripping connection.

Project Charter:

As described previously, the project charted consists of the following:

I. Problem Statement:

Inconsistency in drilling performance stemming from the varied approaches in carrying out the various activities involved in drilling operations. Each drilling crew on the rig does the job as they think is the best, led by their supervisor on the rig. This leads to inefficiencies in resources utilization and we cannot operate at the optimum. Tripping connection takes in general, for oil producers (OP) 23.3% of the total well drilling time and 25% for Water injector (WI) [10]. Therefore, if we can optimize the tripping time we can save significant cost and this will also accelerate the well delivery and hence early oil production.

II. Scope:

Tripping in drilling activities has many applications. However, the focus on this paper will be on cased hole tripping connection by which the LEAN concept will be piloted on this specific activity. Once it has been proven to be successful, then replication across the other tripping activities and other units will be taken into consideration.

III. Desired state:

The overall aim of this project to develop a structured Standard Operating Procedures (SOP) from the best practices carried out in all rigs. This means, for Tripping Connection, the intention is to establish the best way of performing it and have this explicitly formalized in SOP. All drilling rig team members need to be trained to apply Best Practice and control means are put in place to ensure SOP's are adhered to.

Improved ways of doing the job require updating the SOP's to ensure that improvements will be shared among the entire rig fleet within company B.

However, the structured SOP will mitigate some challenges and risks such as less experienced supervisors or crews and high staff turnover. Hence, it will help create a competent work force by which it will yield to consistent good performance.

IV. Target Goal:

The mina goals of streamlining this process can be summarized as follow:

- Reducing HSE exposure by reducing inconsistency in drilling processes.
- Expedite well delivery and reduce massively the time dependant costs Accelerate competencies for system users.
- Reduce the average drilling connection time by 21% which will have additional production revenue.

The author has used the project charter format which is applicable in LEAN culture as demonstrated in figure 2 below.

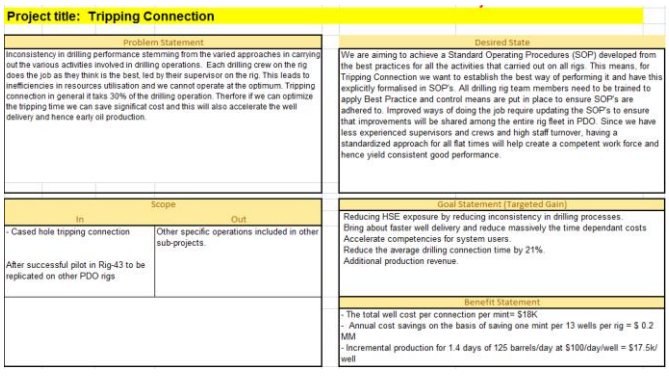

Figure 2: Project Charter

Value stream (As-Is):

The current entire process of making connections will be mapped out involving all stakeholders. A gemba walk in the

form of workshop was conducted at Rig A location and the current process was mapped including the activities and timing required as demonstrated in figure 3 and 4 below.

Figure 3: Value Stream- as is Workshop

Figure 4: Value Stream as is

After mapping the process As-Is, the following conclusion was determined: that the total time required for one connection is 4.3 minutes (min).

Σct = 3.6 min, Σwt = 0.7 min, TPT = 4.3 min.

Value stream (To-Be):

Once the value stream (As-Is) was created, the next step was to create the value stream (To-Be) based on the gaps identifies in each step during the (As-Is) process. The workshop was conducted at Rig A location involving all required stakeholders and the mapping has been completed as demonstrated in figure 5 below.

Figure 5: Value Stream to be

After mapping the process To-Be, the following conclusion was determined: that the total time required for one connection is 3.3 minutes (min).

Σct = 2.6 min, Σwt = 0.7 min, TPT = 3.3 min.

Standard Operation Procedure (SOP):

Based on the value stream (As-Is) and (To-Be), the gaps were identified and improvement was introduced whereby it has been translated into a structure SOP. The detailed standard operating producer is demonstrated in appendix 1.

RESULTS AND CONCLUSION

The LEAN concept has been implemented for the tripping connection activity in land drilling concession areas in one of the rigs working in OMAN concession area.

Rig A has been drilling on cluster X for the last 4 years by which it was assumed that delivering of wells has reached its optimum. However, LEAN concept was implemented in this Rig A, drilling at same cluster by which the effect of LEAN concept in tripping connection was significant.

Rig A was consuming 4.3 minutes as a base line for a tripping connection. However, after implementing LEAN, the same rig was able to reduce the tripping connection time to 3.4 minutes only. One of the main project findings was the importance of monitoring the real-time of tripping duration as the key factor for continuous improvement.

The main key changes for this improvement can be summarized as follow:

- Reduce waiting time while wiping up the pipe by using auto slips and installed pipe wiper in it.
- Pump slug at shoe to avoid wet trip
- Re-centre the well properly to use auto-slip effectively
- Re-centre the well properly to use auto-slip effectively
- If weight less than 35kdaN use low gear and high clutch inside casing.
- Visual Control Board (white board) bought and set up
- Introduction of daily Tripping Time Tracking on VC Board
- Leader Standard Work (LSW) implemented by which it will highlight the responsibilities at different level including top management.

Well Timing trend:

Based on company B, the average tripping connection timing for rig A was done in 4.3 minutes per connection. However, after implementing LEAN concept using specific SOP, rig A was able to complete tripping connection within 3.4 minutes

per connection. This means an improvement of 0.9 minutes per connection.

Well cost trend:

One of the advantages using LEAN concept in this process, that company A did not require any budget for this improvement. Instead, the company was able to improve the overall tripping connection timing and hence, create savings as below:

- Rig A were able to implement this concept by which the Cycle time reduced by 0.9 min which means 21% improvement. This yield to saving of $3850/well. This saving will be only on breaking DP connections and racking them on the mast and does not include BHA handling, L/D and P/U pipes.
- A clear reduction of minimum 21% in the overall cycle time. This means, total savings which can be made by drilling rig A which drills almost 13 to 15 wells annually is around $57,750.
- Hidden cost, such as minimizing HSE exposure, Incremental production.

CONCLUSION

In summary, the author has concluded that LEAN concept in rigs equipments will have a positive impact on the overall performance. This was proven through a case study of one of the omani's oil and gas drilling companies. Company B will be saving around $57,750 annually from one drilling unit if LEAN is implemented. Currently, Rig B has implemented the concept in 7 wells and the overall improvement is sustained.

Further studies are required to explore the option of introducing automation in tracking the tripping connection and introducing an intelligence system whereby the SOP can be adjusted and updated based on learning which is in line with continual improvement mechanism.

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Appendix 1:

The detail SOP which was implemented by Rig A .

Special Requirements	Procedure over view	Instructions and Explanation	Key Point Images
• Tripping sheet • Handling tools • A/D to check tripping tank and compare to tripping sheet. • Ensure the well is centered • After cementing top hole casing and during N/U BOP	• Prepare to break connection • CT=11 sec	• Driller activate to close Auto slips • Driller to slack drill string weight • F/M to move Iron roughneck across DP stand tool joints	
	• Break connection • CT=25 sec	• F/M to operate iron roughneck to clamp around DP stand connection. • F/M to engage and break connection • F/M to open iron roughneck • breaking jaw , close pipe spinner and spin the pipe	
	• Prepare to move the DP stand up. • CT=14 sec	• F/M to unlatch iron roughneck • F/M to move mud bucket (in case of wet pipe tripping) at the same time to push back iron roughneck • F/M to clamp mud bucket.	
• Pump slug at the shoe to avoid wet tripping • Ensure Mud bucket top seals are effective	• Prepare to Rack back DP stand • CT=65 sec	• Driller to P/U DP stand to drain the mud out of the stand • Note: wait until the mud is out and avoid spillage especially when you deal with OBM. • While F/M removes the mud bucket driller to pick-up the DP stand	 
	• Rack DP stand in the mast • CT=16 sec	• Driller to tilt the elevator towards racking area. • D/M to guide the stand with a rope while F/M guiding the stand to the floor. • Driller to release elevator weight • D/M to unlatch elevator	

		• While driller retracting back elevator, D/M to guide and rack the stand in the M/B finger	
• Pulling speed: • In Open hole: depends on hole condition • Incased hole: • If weight less than 35kdaN use low gear and high clutch	• Move elevator down • Engage next stand • POOH next stand • CT=75 sec	• Driller to lower down elevator • F/M to latch elevator to next stand tool joint • Driller to P/U string and release the slips • Driller to POOH at the same time F/M to wipe the DP • Driller space out and close the slips