An investigation into benchmarking of workover activities of rigs in the oilfields

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Abstract

The aim of this investigation is to review the performance and establish Key Performance Indicators (KPI's) for workover activities of rigs in order to increase production of oil wells. As the demand for oil and natural gas increases there is a growing number of workover rigs in the oilfields and the production companies are working at full capacity. Analysis of information gathered from oil wells suggest that there is an enormous loss of production due to inefficient practices adopted during the workover activities of rigs.
The losses are due to the rig move, rig standby, shut down and safety issues. Electrical submersible pumps (ESP's) are also a major contributor to production losses due to their failures in the oilfields. Oil production from the wells increases for some time after the initial completion, then declines over a period of many months, perhaps years. The rate of decline in the production could be occasionally, sudden or unexpected. The root cause of this loss may be mechanical failure, or it may be related to wellbore or reservoir behaviour.
This paper provides analysis of data for five workover rigs. It identifies the losses in time and production for the workover activities of the rigs and oilfields. The paper provide useful tool of KPI monitoring and ends up with a structured methodology in a simple process flow incorporating workover activities of the rigs and oilfields production which could be adopted as a basis way for continuous improvement.

1. Introduction:

The benchmarking often uses a number of key performance indicators (KPIs) for comparisons of performance. The KPI is a number, or value, which can be compared against an internal or external target 'performance benchmark', to give an indication of performance. That value can relate to data collected or calculated from any process or activity [1], [4].

Many oil wells in fields rely on artificial lift methods such as ESP. Maintenance services such as cleaning, reinstatement; others are needed to these wells. These Maintenance services are achieved by workover rigs, which are offered on a limited number with respect to the number of wells demanding service [3]. The decision of which workover rig should be sent to do some maintenance on the well is based on factors such as the well production, the current location of the workover rig in relation to the demanding well, and the type of service to be completed. Minimising the production loss associated with enhanced workover procedures and maintenance service are goal of petroleum engineers. Thus, the production loss associated to wells waiting for maintenance services [11].

Each business has its own key issues that are crucial to its success, and workover jobs are not an exception. A success activity was defined as completion the process within the restraints of time, cost, and performance. Pointed out that project completion should be [1]:

- Within the allocated time
- Within the cost

- At the proper performance
- Without disturbing the main work flow of the organisation

In workover business, there are several key issues, such as: Time, cost, health safety and environment, technology application. Those key issues have to be well managed for a successful workover operation.

Each year, the number of ESP failures is increasing, adversely affecting lifting costs, the workover rigs' utilisation and total oil production. The production loss of each idle well is evaluated as its average daily flow rate under regular operation, multiplied by the number of days its production is interrupted.

1.1 Problem Identification

The analysis showed that 20% of rig downtime was accountable to ESP installation and pulling. This analysis was conducted using performance data taken from 5 rigs. This downtime coupled with high workover operation cost. Total downtime in workover process was found to be related to the following:

- ESP pulling and installation procedures
- Workover procedures (e.g. moving and rig up)
- Others

2. Field workover experience:

Sarir oilfield which is owned by Arabian Gulf Oil Company (AGOCO) in Libya has been selected as case study to investigation of workover and ESP problem. The activities of changing ESP are depending on the workover programme that provides from the engineers. Changing electrical submersible pump (ESP) failures in each well are undertaken by the workover rig, which needs to change the ESP and repair any other failures in the downhole well; workover operations include any number of activities performed on a well, after initial completion, including recompletion and remedial repair work. Workover usually involves a service rig to solve the problems in oil wells with a proposed program. The workover Rigs operated 12 hours from 6 a.m. to 6 p.m. This meant that the rigs had been working at a maximum operation level.

2.1 Workover process

The first step in the process of workover operation is a well kill, where the workers pump heavy material into the well to stop production. The material's density prevents oil and gas from seeping up into the wellbore, clearing it for work. Next, personnel will remove material inside the wellbore so they can access it. Their work may require inserting and removing various equipment such as (ESP). Cleaning and replacing components, and checking on the integrity of the wellbore to determine if issues like leaks or collapses could develop [4].

2.2 ESP System

The ESP system includes a downhole pump, electric power cable, and surface controls. In a typical application, the downhole pump is suspended on a tubing string hung on the wellhead and is submerged in the well fluid. The pump is close-coupled to a submersible electric motor that receives power through the power cable and surface controls [4].

2.3 Typical Installation

The surface power is transformed to the downhole power requirements by three single-phase transformers. The transformed power is supplied by a power cable to a switchboard and then through a junction box and wellhead/tubing support. The power cable is run in with the production tubing string and is banded to the tubing to prevent mechanical damage during installation and removal. The power cable is spliced to a motor flat cable, which is banded to the external of the pump-protector motor unit. During the life of the ESP equipment figure 1 below, a downhole or surface equipment change often its status condition of the operation [4].

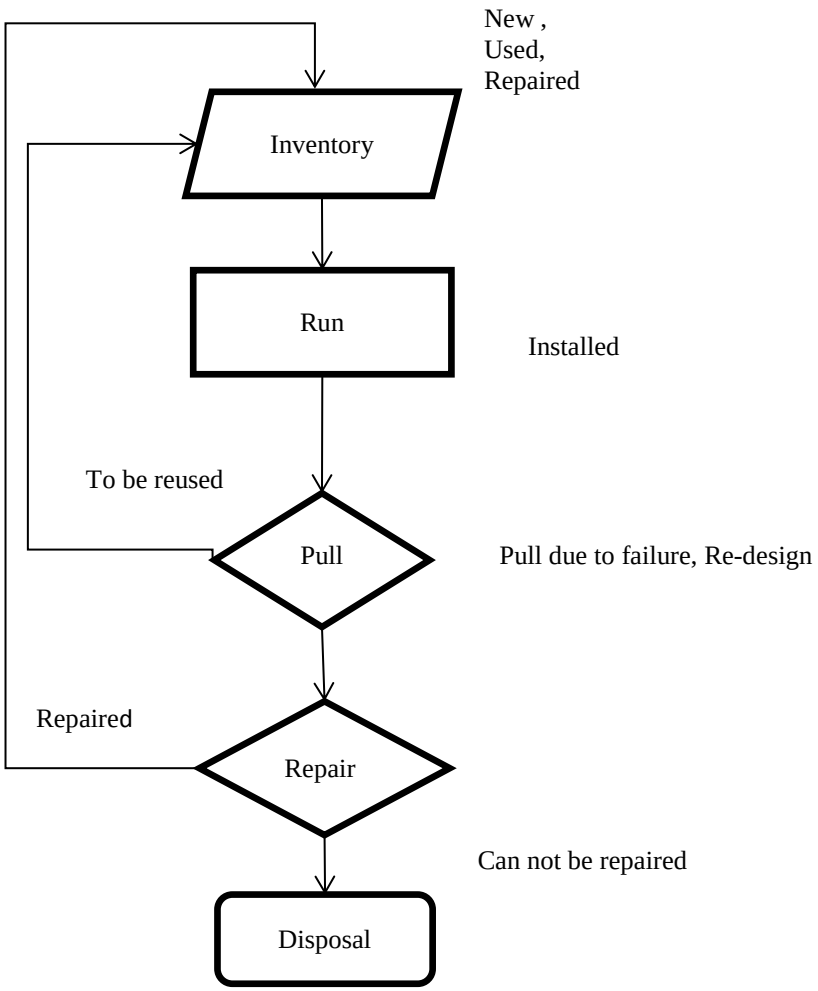

Figure 1: Life of the ESP equipment

3. Workover time and cost

Downtime is an area to be looked at in oil production. It cost oil industries millions of dollars and efforts are made timelessly to address such issues and the most valued approach is the quick identification of a problem accompanied with action plan which is the design of a maintenance strategy not the adoption of remediation approach that is costly [14]. The figure 2, below shows the percentage of the downtime in each workover rig which have strong impact into time loss and production losses. The performance in workover activities are time and cost. Non- productive time (NPT) is one key measure that is closely scrutinized to identify area for improvement [13]. However, historically data from 5 workover rigs' activities were obtained directly from the daily workover activities and number of ESP failures in this in the Sarir Oilfield, have been used in this study.

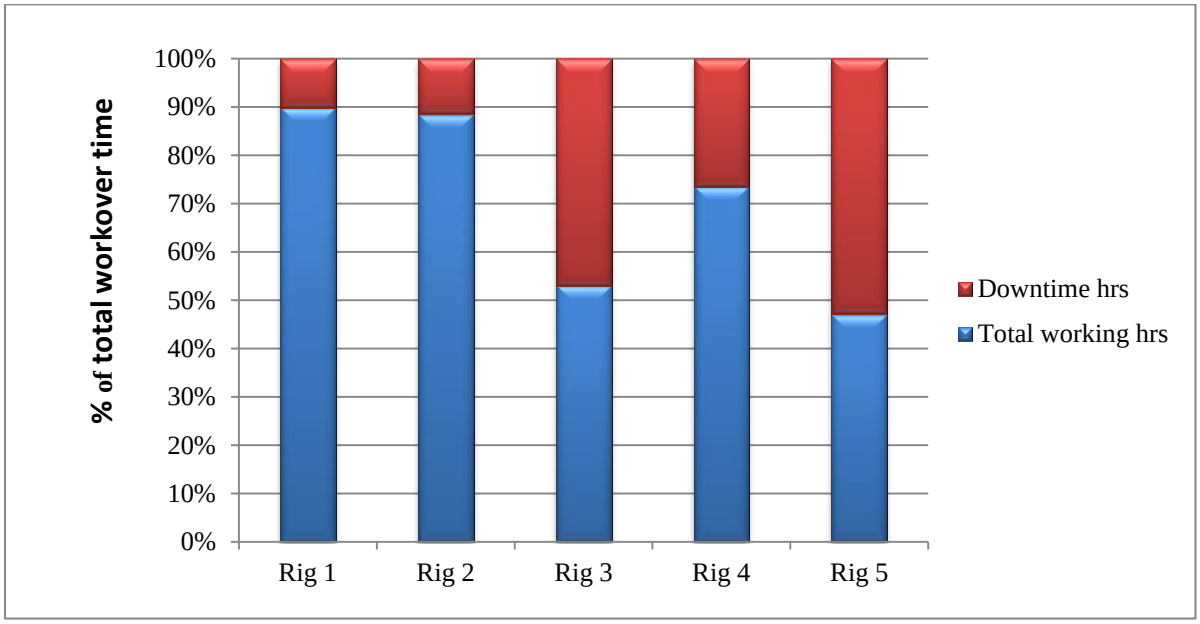

Figure 2: Workover hour's activity for five rigs

The assessment and analysis of the workover operations activities' performance can be introduced. This analysis includes the main stage of workover processes, such as the rig up (R/U), rig down (R/D) and ESP installation, Run in Hole (RIH) and pull out of hole (POH) of the equipment. An example of process steps for the workover process and the cost for workover rigs were categorized; table (1) presents the time distribution for each workover rig used in this study. It can be seen that the biggest sections of the total cycle time are the ESP insulation and the ESP pull out from the oil wells that have been highlighted below.

Table 1: Workover activities and cost

Time and Cost	Rig 1	Rig2	Rig3	Rig4	Rig5
Moving (hrs)	7	8	6	8	8
Rig Up(hrs)	12	7	6	7	6
pull ESP(hrs)	12	10.5	7.5	8.5	13
RIH with equipment(hrs)	6.5	11.5	11	12	9.5
POH with equipment(hrs)	15.5	20	11	6.5	8.5
RIH with ESP(hrs)	10.5	22	14	8	18
Final check(hrs)	8	4	8.5	4	3
Rig release(hrs)	4	2	6	2	2
Workover cost (£)	18496	15373	15520	17334	19828

4. Key performance Indicators for workover activities

The key performance indicators (KPIs) that you use ought to help you to understand what maintenance is doing, what it is achieving for the business and what more it can do to improve operational performance [12 and 3]. Maintenance performance can be improved by making it more effective and more efficient. Effective maintenance is doing the right maintenance: that which brings higher equipment reliability and lower operational risks. Efficient maintenance is doing maintenance right so that reliability and risk reduction are achieved with the least resources and time [13]. The KPI's can be monitored and acted upon using the model shown below figure 3.

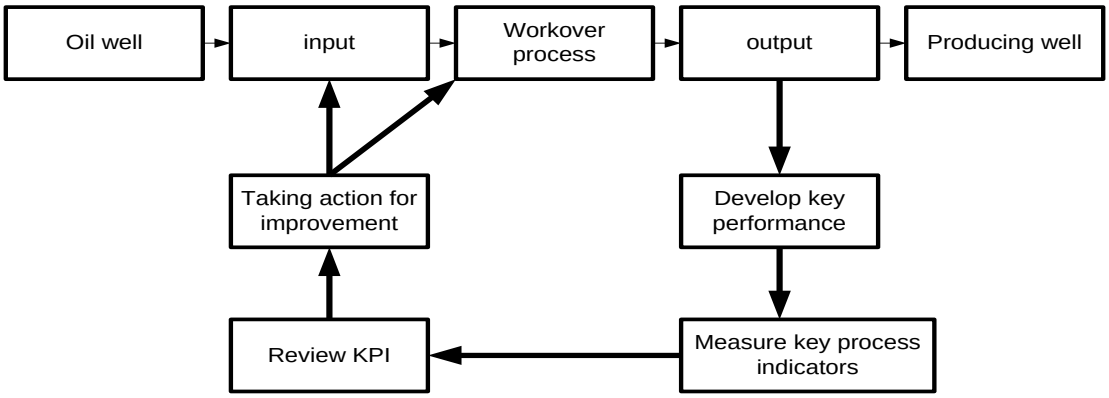

Figure 3: Model for monitor of workover operations

4.1 Way to establish KPI for workover

KPIs can be developed starts from top to bottom of the oilfield management, by connecting activities across the operation together with a corporate purpose. Operational success actually starts on the shop floor by doing those causes that bring success [7 & 8]. The benefits can be achieved by liking the business that maintenance brings to the business and the workover activities needed. The types of maintenance KPIs to develop which are useful to the workover are figure 4:

- Identify what are causing your loss and failure (in both workover activities and ESP system).
- Identify if oilfield is removing the causes of loss and failure (measure the reliability improvement and operating risk reduction results of the workover and ESP pulling and installation effort).
- Drive the process benefits delivered by excellence workover operation.

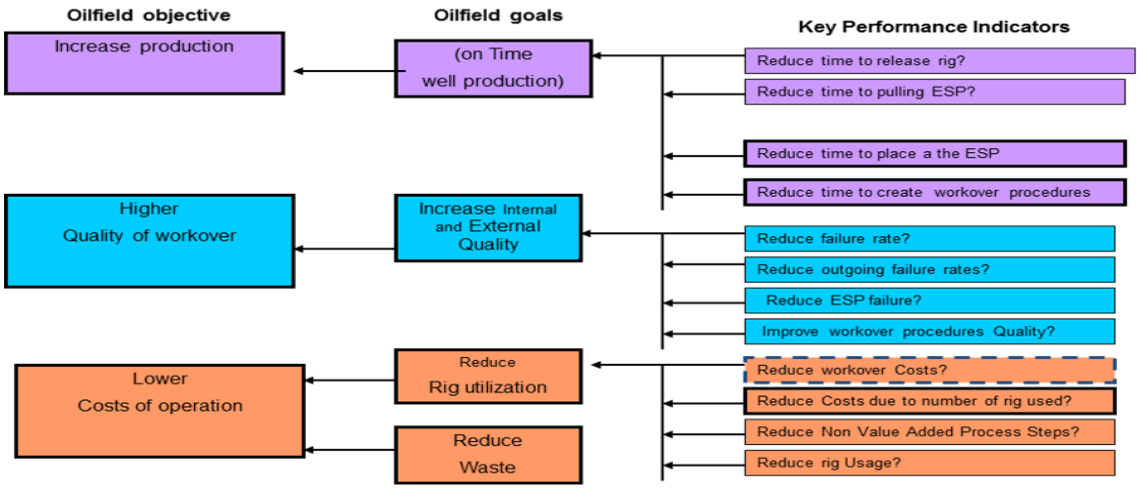

Figure 4: KPI for workover activities and ESP system

5. Measure What Business Benefits Maintenance is Achieving

Workover support oilfields to return oil wells to production by delivering operating equipment reliability and operating equipment risk reduction. Good and bad workover procedures are effect of both in the cost and time of operations. Bad maintenance policies and practices add operating cost whereas excellent maintenance policies and practices add lower costs.

A useful site level KPI to measure is the proportion of operating costs attributable to workover per well [5]. The workover operation at oilfield has bottom level KPIs identifying where the cost contributions come from that make-up the workover proportion of the cost of production.

As an example of not having control over the outcome of a performance measure we can consider the reliability indicator measure of main time between Failure (MTBF) is affected by original ESP quality, by well design, by the quality and accuracy of initial installation, by the severity of operating duty, by the quality of operator practices, by the maintenance procedure activities performed at rig, by the quality of set up the switchboard to do final check to put the oil well on production.

A KPI that shows MTBF is not greatly under maintenance control because of the extent of ESP life span influences that workover process has way to affect it. For the oilfield to greatly improve the MTBF of ESP is aim to achieve, the whole life span needs to be addressed and not only its workover performance. The Oilfield would have to develop training plan to teach people at ESP installation what to do to improve reliability. Useful and relevant maintenance performance indicators are those that drive the actions and behaviors needed to meet the objectives.

Table 2: KPI for ESP and workover activities

Benefits	KPI	First quarter	Second quarter
Process	% Uptime	➢ 75%	74%
	Total workover cost	<£13500 a day	<£13000 a day
Reliability of Equipment	Mean time between failure	518 day	520 day
	Training days	5-10 days / year	-
Quality & Speed of Execution Response	Work days	5-7 days	5-7 days
	% Planned workover	>70%	-
	Rig per planner	-	-
	Schedule compliance	90 %	90%
Low operation costs	Rig cost	+/- 5%	-
	Labour cost as % of total cost	4%	4%

The analysis of results revealed that the workover requires an improvement strategy which can take the performance of the workover operation to the required levels. The operation process also needs to adhere to its oilfield production plan by elimination of workover process variability that causes processes to take longer time, and also reduce downtimes caused by ESP pulling and installation. The absenteeism and training are people issues and both have direct impact in productivity and quality of production.

The investigation of the workover activities In order to help the management to identify the main problems facing the production in the oilfields and identify a suitable strategy for improving the production in the Companies, continuous improvement process is striving for perfection by learning from previous actions and designing modifications to the process to allow for better results [15]. For continuous improvement process examples of approaches to facilitating people involvement are managing by mingling with operators, suggestion program, small group improvement activities, posters, banners, improvement boards and connecting maintenance improvement to organizational learning.

It was also identified that tools such as total productive maintenance (TPM), single minute exchange of dies (SMED), and 5S are some of the most appropriate tools to improve workover performance in this oilfield. In general, a sustainable performance improvement should be aligned to a firm's ability to continually achieve quality, reduce costs, and time [1] and [3].

6. Conclusion

KPIs are useful if they drive the right behaviors that produce good corporate outcomes. It‘s easy to choose KPIs that present information but are not directly actionable. When KPIs are set too high up the corporate objectives structure you make changes by guesswork and live in hope that a desired result will happen.

The methodology used in this paper suggested that there will be a significant opportunity to improve the performance of the majority of the existing assets. KPI is given for top management in the companies on how to introduce process improvements which are realistic and achievable. The paper also has established KPIs to assist oilfield to management in attaining their goals. The results of application of KPI at the selected case study oilfield revealed that there are significant tools to observe the workover procedures from time to time. The improvement in the ESP procedures and time of the process will lead to an increase in the value of the oil production, thus creating financial savings.

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