Practical Evaluation Workover Framework (PEWF) for Evaluation and Process Improvement of Workover Rigs in the Oilfields

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ABSTRACT

In this work Practical Evaluation Workover Framework (PEWF) can be defined as a procedure that provides a practical workover maintenance system for workover and production engineers in the Oilfields. This procedure involves operators and technicians in the workover rigs acting as a team to monitor the workover procedures including Electrical Submersible Pump (ESP) processes (installation and nu-installation) and reduce the production losses in the oil wells by returning the oil well to production in the right time. The model's detail and procedures are simple to use and it supports workover rigs to implement the main structures of Total productive maintenance (TPM) to improve the efficiency of the workover rig.

PEWF is built on the collection and analysis of the Overall equipment effectiveness (OEE) data gathered by the workover and production engineers on the workover rig. The OEE monitors the actual performance of workover relative to its performance capabilities under optimal workover conditions. The main purpose of an OEE results is to present essential data against where decisions may be made. These measurements assist the management to evaluate progress and help production and workover engineers identify the sources of problems on ESP processes and workover rigs activities. This method of calculating rig efficiency provides the practical measure of the workover performance which can aid in rig procedures negotiation and workover rig selection.

1. INTRODUCTION

Managers in any companies usually think of re-evaluating and improving their business strategies to help them at least stay in business improving their business is built on the way their production lines function, and the condition of their machines and equipment which will lead them to recognize the need to improve the equipment conditions by thinking of implementing a new maintenance method in their companies [1].

The objective of every oil industry is to make profit and not to encounter loss. It is therefore necessary to look into reducing production losses, operating and maintenance costs, to make way for increased profit. The focus on efficient use of workover rigs has increased during the last few years; a high degree of workover utilisation has a negative impact on the production process [2 and 3].

Every well in the oilfield is as a small manufacturing plant and each plant needs different equipment as the conditions for each plant are unique. Producing from oil need many procedures to keep the well running, well needs equipment to produce, equipment needs tools to install or uninstall [2]. Throughout the productive life of onshore oil wells, workover rigs (or rigs for short) are usually designated to perform maintenances called workovers. The rigs are scarce and expensive resources however their services are important to keep a good production or possibly to improve the productivity.

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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. These activities of develop of wells, maintenance, repair have many wastes that could affect the total production from the oil wells. Developing performance metrics is a significant stage in the process of performance evaluation as it includes related indicators that speed up the performance of the activities [2 and 5]. The reason of selecting the oilfield operations are that the operation and the activities are continuous process and become discrete, that makes them more applicable to improvement tools [2].

In connection with Lean Production, companies today often implement Total Productive Maintenance (TPM) based on Overall Equipment Efficiency (OEE), originally defined by Nakajima [1]. Companies have different traditions of measuring their performance in order to reach and maintain a competitive edge in the market. OEE is the significant measure tool for evaluating performance [1 and 4]. Overall Equipment Efficiency (OEE) should be measured at the constraint step of the workover process [4]. Improving the constraint will improve the overall process of the workover, and ultimately the reason for measuring OEE is to improve the process because it is a good tool for evaluation the process. The OEE measure provides a single number on which to base comparisons of equipment performance [4].

In this work the Practical Evaluation Workover Framework (PEWF) is mainly built on a quantitative measure of performance based on data collection and subsequent analysis of OEE originally introduced by Nakajima (1988). The PEWF method, when implemented in the company, resulted in the operators recognising the benefits that OEE carries in tracking and reducing hidden losses to improve their workover rig's efficiency. In addition, in this research, we show how a simplified version of this OEE measure can be usefully adopted in certain circumstances to calculate the efficiency of workover rigs. Both PEWF and the OEE measure are shown to be effective when used to improve equipment efficiency.

2. WORKOVER PROCESSES

Workover supports oilfields to return oil wells to production by delivering operating equipment reliability and operating equipment risk reduction. The total cost includes the rig expenses (transport, assembly and operation), which are functions of time and distances, plus the losses of revenue in the wells waiting for the rig, which are dependent on time [14]. Therefore, the total cost depends on the ordering of the wells in the itinerary.

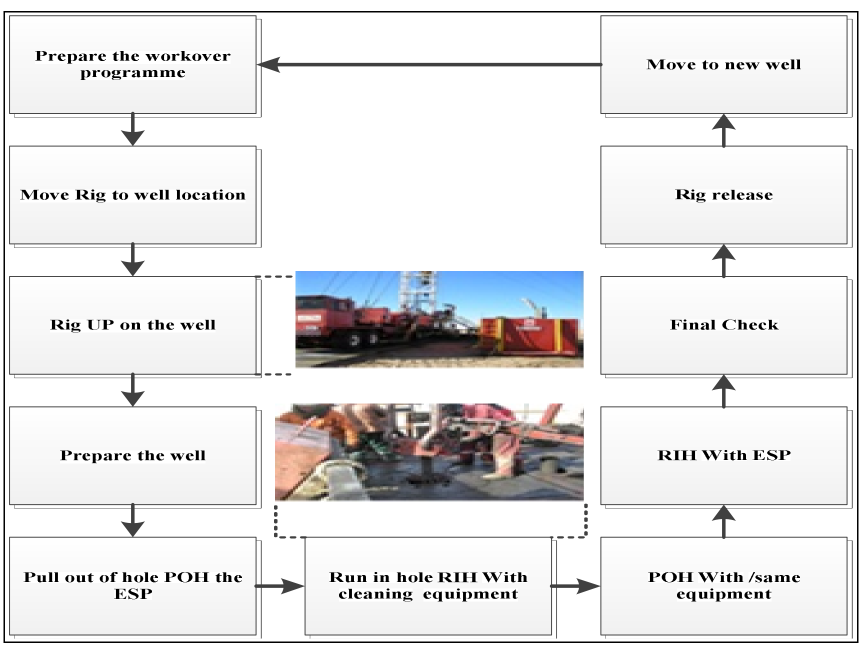

Figure 1. The main stages of workover processes.

Workover program is an orderly step-by-step procedure to be followed in conducting the workover operation. This procedure of the workover include the main stage of workover processes, the first step in the process is to move the rig to the location of the oil well where many procedures must be followed in order to return the oil well to normal production see fig 1. The procedures 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 such as ESP. The program must provide operating personnel with all information necessary to achieve the required objectives safely at the minimum cost and with the minimum expenditure of resources [4 and 5].

3. PURPOSE OF OEE IN OIL INDUSTRY

In the oil industry, every well in the oilfield is a product line to produce the oil; it has many processes to keep the oil well in production [6]. The oil well is as a small manufacturing plant and each plant needs different equipment as the conditions for each plant are unique [1 and 7]. In the field of application of OEE in oil and gas industries, the researcher compares the overall equipment effectiveness in Continuous Production Line of Isomax unit of Esfahan Oil Refining Company with World Class Manufacturing [3].

In this research the workover process improvement opportunities continue to be identified based on OEE results and new variations of these measures can be implemented for other workover activities at Oilfields that use the ESP as artificial lift method. The OEE monitors the actual performance of workover relative to its performance capabilities under optimal workover conditions [2]. The OEE measure can be applied at numerous different levels within a workover operation environment [2 and 4].

. **First**, OEE can be used as a "benchmark" for measuring the initial performance of operation process in its totality. In this way the initial OEE measure can be compared with future OEE values [1].

. **Second**, an OEE value can be used to compare activities performance across the process, thereby highlighting any poor activities performance [1 and 2].

. **Third**, if the operation procedures work individually, an OEE measure can identify which process performance is the worst [1 and 4].

3.1 OVERALL EQUIPMENT EFFECTIVENESS (OEE) FOR WORKOVER

Equipment effectiveness includes equipment availability, performance efficiency and rate of quality of output. Operational performance data collection of the three OEE variables, availability, performance and quality [1 and 2]

$$\text{OEE} = \text{availability} \times \text{performance} \times \text{quality} \qquad (1)$$

The first element of the OEE calculation is process availability: It is the ratio of the workover time to the planned workover time [2].

Availability % = workover operating time ÷ planned workover time

Where:

Planned workover time = TWT – breaks

Workover operating time = planned workover time – downtime

The second element is "performance rate". This element measures the ratio of the best time achieved to the actual time. That has been calculated in the method of evaluation of the workover [2].

$$\text{Performance \%} = \text{BTWT} / \text{TWT} \qquad (2)$$

Where:

$$\text{TWT}\left(\text{hours}\right) = \text{total workover time}\left(\text{actual time}\right) = \text{moving} + \text{Rig Up} + \text{pulling ESP} + \text{RIH with equipment} + \text{POH with equipment} + \text{RIH with ESP} + \text{Final check} + \text{Rig release}$$

$$\text{BTWT}\left(\text{hours}\right) = \text{total best}\left(\text{hostorical}\right)\ \text{time achieved by workover rig}\left(\text{minimum time}\right) = \text{moving} + \text{Rig Up} + \text{pulling ESP} + \text{RIH with equipment} + \text{POH with equipment} + \text{RIH with ESP} + \text{Final check} + \text{Rig release}$$

The third element of the OEE calculation is the “quality rate”, and is used to indicate the proportion of defective time for good workover to the total workover time [2].

Quality % = time for good workover / time for total workover (3)

4. PROPOSED FRAMEWORK

In this research paper, a Practical Evaluation Workover Framework (PEWF) is introduced, Fig 2. The framework’s detail and procedures are simple to use and it supports workover rigs in the Oilfields to implement the main structures of TPM to improve the efficiency of the rig. The oil production company's workforce can implement PEWF steps without the need for external advisers. These steps, as shown in table 1 are flexible and can be tailored by engineers and the management to the individual oil company's capabilities, where each company could develop its plans differently because of different needs and challenges they are faced with, depending on the different artificial methods applied in the oilfield, production equipment conditions, and type of rigs. The fundamental measure of the method is the overall equipment effectiveness (OEE) value, which as described by Nakajima (1989), should be the driving force and provides direction for improvement-based activities within manufacturing organizations.

In the first section, PEWF is defined and its linkage to Nakajima's twelve steps of TPM illustrated. Then each PEWF step is defined in detail and the way it could be used and implemented.

Table 1. Brief description of PEWF steps.

PEWF Steps	Description
One	Determine the gap between target and actual OEE in the workover activities.
Two	Introduction of PMF to staff by the management
Three	Improve relationship between operators and maintenance people
Four	Launch education and training to improve worker's skills
Five	Monitor process performance, set/raise target level
Six	Implement autonomous maintenance
Seven	Implement periodic maintenance

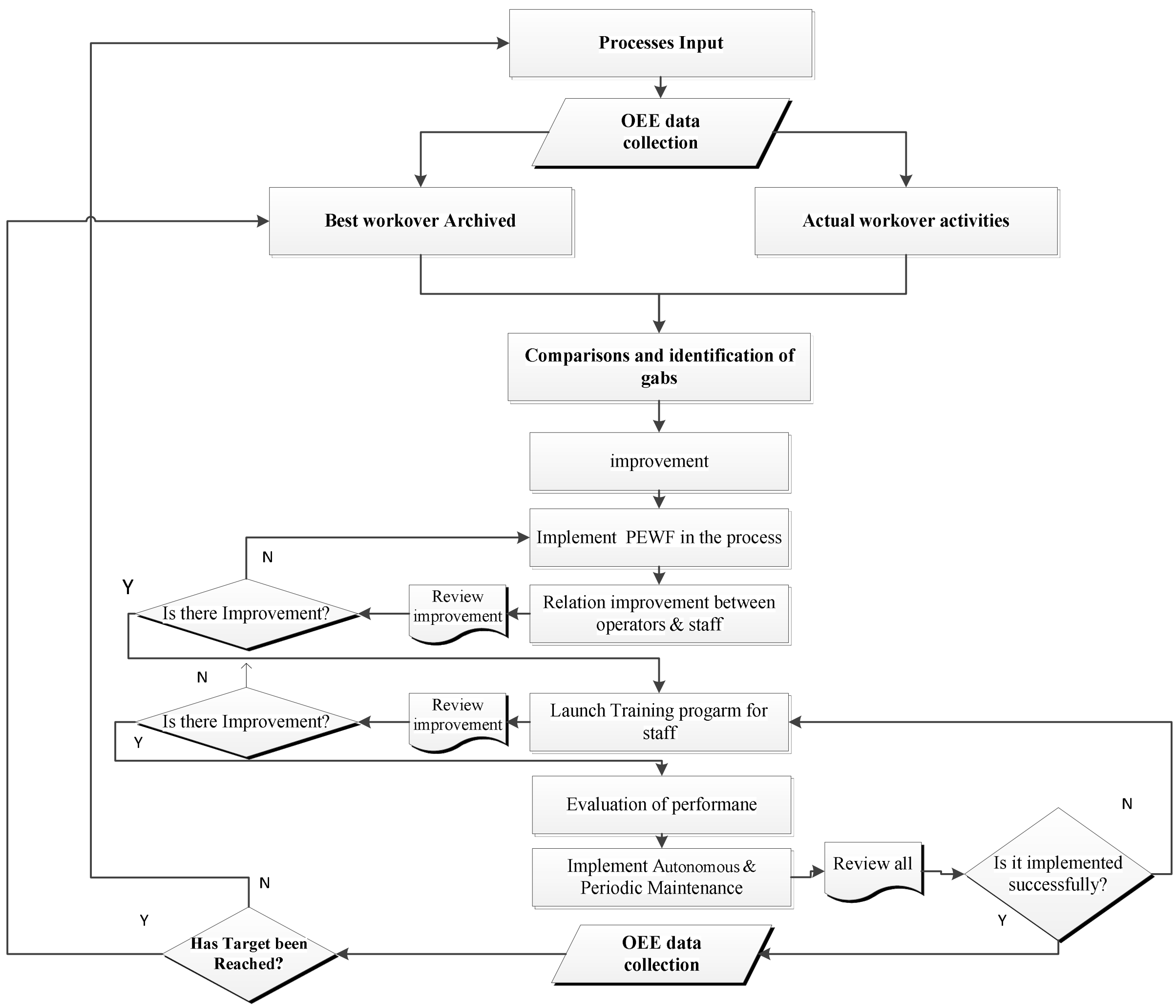

Figure 2. A Practical Evaluation Workover Framework (PEWF).

The PEWF method supports workover rig and production engineering in oil companies in four ways; first, the model is simple and easy to follow as it only has three stages and seven steps. Second, PEWF does not require a significant financial commitment; steps could be implemented by the production engineers at oilfields (there is no need for a consultant to explain and help implement the method) and training is carried out by the crow (operators) and workover engineers at the rig and this reduces the additional financial pressure. The maintenance technicians will train the operators on autonomous maintenance and will be responsible for planning their own periodic maintenance program. This is because maintenance technicians are the best people that have the maintenance skills to train operators, and also have the knowledge and experience to plan their periodic maintenance program [19]. Third, improvements could be achieved shortly after implementation. Fourth, the model does not involve specialist TPM teams and committees; instead there is only a single team to which everyone in the company will be attached. The benefit that companies will gain by applying PEWF is through the reduction of lost time, wasted effort and incurred cost.

The procedures of the oilfield operation are normally affected by some factors which lead to major production losses such as downtime of the operation process [5 and 8]. The workover process improvement opportunities continue to be identified based on OEE results and new variations of these measures can be implemented for other oilfields using the same artificial lift method [2 and 4]. Workover supports oilfields to return oil wells to production by delivering operating equipment reliability and operating equipment risk reduction. Good and bad workover procedures affect both the cost and time of operations [2 and 4].

5. THE CASE STUDY:

The case study has been chosen due to the relationship that we had with the top management in the Arabian Gulf Oil Company (AGOCO) which is the biggest oil Production Company in Libya, The main office of Company is in Benghazi- Libya. AGOCO produces crude oil from eight Oilfields, distributed in the Libyan Desert.

In this case study two workover rigs have been chosen to implementing the PEFW, The introduction and preparation stages took seven working days, and the research was agreed to be applied on only two workover rigs. The ideal cycle time is a standard known value for the machine. The operators and the maintenance technician were responsible for investigating any problems on the workover rig that caused the decline in OEE.

5.1 DATA ANALYSIS

The data from four rigs at Sarir oilfield have been used to explain the framework of the model. The findings have highlighted the factors that impact the workover performance and created downtime. It is suggested that production engineering departments at AGOCO want to implement proactive equipment management and workover programs to minimise the impact of downtime.

The improvement in workover procedures can greatly reduce the downtime (DT) caused by incorrect operating procedures, while a good workover program reduces DT caused by poor operation and poor workover practices [5].

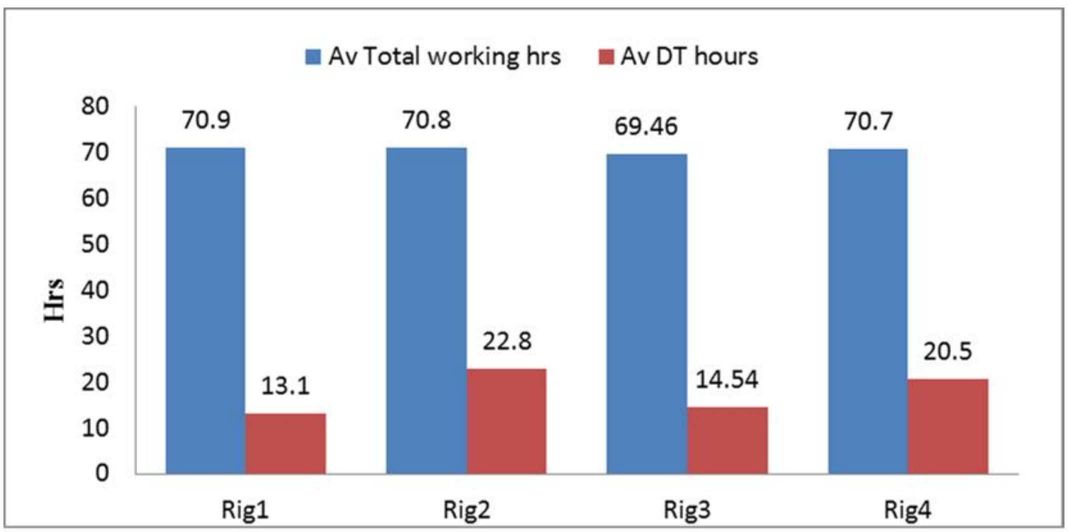

Figure 3. Average Downtime hours for each workover rig.

It is clear from the Fig. 3, the downtime in company rigs was between 13% and 20%. The Standby hours were when the workover was waiting for its water supply or Service Company. This was the main cause of problem in the standby time which is outside of Company control .in most cases and it was still a limited number of hours. The majority of non-productive time is mainly caused by 'ESP installation and pulling'. This could be a result of unnecessary scheduled maintenance procedures and more focus on condition-based maintenance could be implemented [2].

After reaching the oilfield we proceeded to introduce PEWF to the company to begin implementation of the framework at the workover rigs. In this section we will introduce the way PEWF was introduced to the management and the implementation steps. The introduction and preparation stages took seven working days, and the research was agreed to be applied on only two workover rigs.

The results of OEE has been improved, the OEE for the first rig selected has increased from approximately 26 % to 79 %. This is the result of improvement in: availability, performance efficiency and rate of quality as in Fig 4.

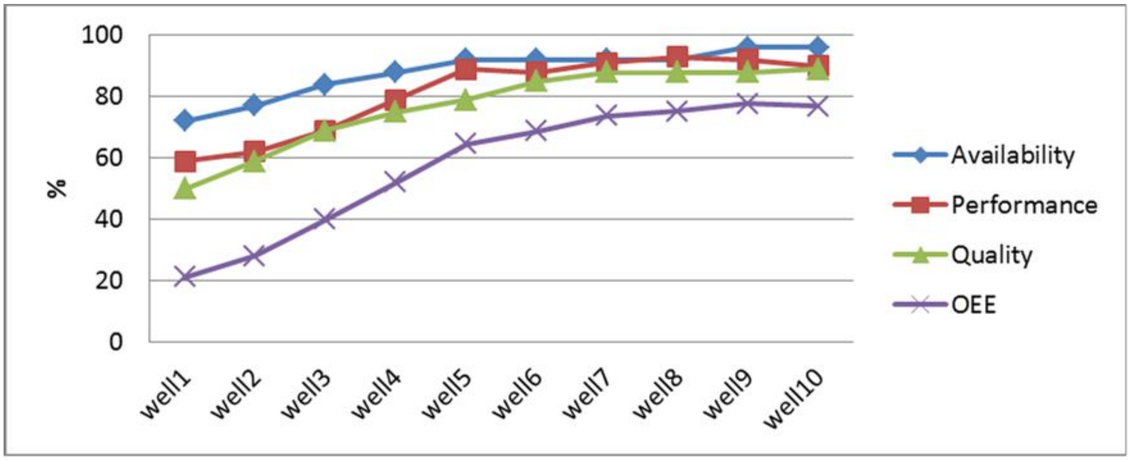

Figure 4. OEE and its factors for Rig 1.

The improvement in workover procedures can greatly reduce the DT caused by incorrect operating procedures, while a good workover program reduces DT caused by poor operation and poor workover practices.

For the second rig the rate of quality increased from 59% to 89% as a result of reduction in time loss of the machines and installation of the ESP, as shown in Fig 5. We explained to the PED that periodic maintenance would help reduce major and minor breakdowns on the machine thereby improving the condition of the machine. In addition, we explained how OEE could help the PED to track any causes of reduction in the workover rig's efficiency.

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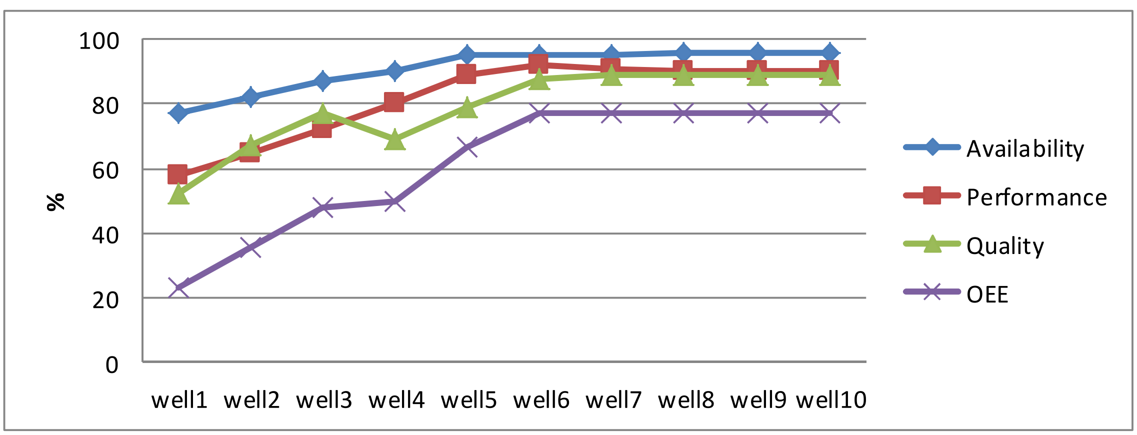

Figure 5. OEE and its factors for Rig 2.

The purpose of these above figures (4 and 5) was to show the PED management can improve the rig's efficiency and quality which allows engineers to return the oil well to production in the correct time to minimise costs and maximise production.

The implementation of PEWF on one workover rig took only a short time to be accomplished in this case study. The total time of the introduction and preparation stages was only seven working days. Each oil well has taken an average of 4 to 5 days from start to return the well to production. On the other hand, the implementation of AM helped in reducing breakdowns on the rig by controlling and eliminating contamination on the machine and in the surrounding area.

6. CONCLUSION AND FUTURE WORK

The result of the study was impressive, in that PEWF helped improve the overall equipment effectiveness of a chosen machine, from 65% to approximately 83%. This was the result of a cooperative effort of the operator and the maintenance staff. The period of improvement was short, being only eight months. Due to this success, the management decided to commit to further implementation of PEWF on other production lines.

The results of the example show that the proposed method of OEE is very effective for doing improvements to increase the effectiveness of the workover procedures within specific time period by identifying the problem exactly. However, the importance of practical workover performance measure which can aid in rig procedures negotiation and rig selection. The improvement in the workover procedures such as pulling and installing of ESP that caused by incorrect operating procedures can be achieved. Improvements tools such as TPM can be applied to enhance the performance of workover activities. Further, the metric OEE for workover activities can be used as a benchmark at various levels to achieve world-class standard.

The management recognised that, with a little effort, a large improvement in the efficiency, and reduction in cost, could be accomplished within a short period. The implementation of the PEWF steps in this case study did not cost the company any extra money.

Extension to this work is to initiate further studies on the effectiveness of PEWF, based on the extension of cost analysis on different rig drilling and workover companies on both onshore & offshore operations with different cultural backgrounds. This would enable a comparison of the applicability of the method to different companies results with the research finding.

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