Collaborative Approach Optimizes Automated-Drilling Performance Measurement

This paper discusses the strategy devised, the approach implemented, and the challenges experienced in the adoption and implementation of an automated drilling-performance-measurement (ADPM) system to be used onsite and remotely. The stages of the optimization of the ADPM system are broken down into prespud operations, operations, and post-well analysis. The successful result of this deployment has seen total actual savings of 2.94 days throughout the campaign. From 2016 to 2021, the operator gained 39.03 days of actual savings for their rig fleet.

The ADPM Tool

The ADPM tool was introduced in 2016 as part of the operator's digitalization effort. The tool was integrated into operations at the Wells Real-Time Center (WRTC) and was managed by a wells technical application champion (WTAC). With this integration in place, the operator aimed to deliver all wells, whether vertical, horizontal, or extended-reach, in the most consistent and efficient way without jeopardizing the operation's safety.

This article, written by JPT Technology Editor Chris Carpenter, contains highlights of paper **OTC 31579**, *"A Successful Case Study of a Collaborative Approach in Operational Optimization Through Adoption of Automated-Drilling-Performance Measurement," by* ***Muhammad Afiq Arif Normin,*** *TDE Group, and* ***Azlesham Rosli*** *and* ***Meor M.H.M. Hashim,*** *SPE, Petronas, et al. The paper has not been peer reviewed.*

To ensure the investment bore dividends, this initiative required a major collaborative effort.

The tool's main input is the rig's real-time surface data obtained by mud-logging sensors. The real-time data are transmitted to the WRTC server in Kuala Lumpur and stored. Access to the data is provided to the ADPM tool to extract the necessary data required for rig-state detection.

The secondary input for the ADPM tool is the daily drilling report (DDR) prepared by drilling supervisors at the rig site. The extraction of information from the DDRs serves two purposes: to provide information on the activity performed on the surface not detected by rig-state detection and to provide a reference for ADPM personnel during data processing and quality control. Each activity code and subcode associated with the DDR also is integrated into the ADPM database. Merging both data has provided more insight to the project team because a comparison between the activity reported in the DDRs and the activity detected by the ADPM can be highlighted.

During the initial phase of ADPM deployment, a list of the key performance indicators (KPIs) was defined and established by the WTAC. This set of KPIs covered the tripping, drilling, and casing and liner operations necessary to determine invisible lost time (ILT). For tripping operations, the critical KPIs are slip time, tripping-in speed, and trippingout speed. All KPIs are differentiated as having been performed in cased hole or open hole. Next is on-bottom drilling, with five focused KPIs. Finally, three KPIs were dedicated to the casing and liner operations: slips time, average pipe moving speed, and gross running rate. As with tripping operations, all KPIs were differentiated as having been performed in cased hole or open hole except slips time. All KPIs were computed from a single data source (the real-time data).

A target is set for each KPI in the list when a new project starts. For the target setting, each KPI is analyzed differently based on its type. The first type is rig-based KPI, a classification that stipulates the KPIs be completely reliant on the performance of the rig crew and the equipment used. The second type of KPI is formation-based. For this type, the analysis performed should consider data operated at similar fields because the performance of these KPIs is affected by the formation itself (e.g., formation hardness and swab and surge). After the targets have been defined and registered, the ADPM tool is able to generate a high-level summary of the project ILT and performance trend reports per section, well, and rig.

Drilling-Performance-Strategy Work Flow

Prespud Operations Stage. In preparation for a new project, the data analysis from the ADPM system is used by the WTAC and the operator's Wells Technology and Technical Limit (WTTL) team to prepare a performance analysis based on well and rig historical data. Homogenized KPIs usually are applied for all business units. However, additional KPIs are added at the request of the WTTL team based on project needs. Historical-performance analysis evaluates the performance of each operation according to its respective KPIs and provides proposed targets for the upcoming project. Next, the targets are presented and reviewed by the project team as well as subject-matter experts. These targets also are shared with the WRTC and the rig contractors so that all parties have a common understanding of expected performance for the upcoming campaign.

Operations Stage. At this stage, WTTL engineers at both the office and the rig site work with the WRTC to monitor and analyze the operation as it proceeds. A detailed analysis is performed weekly with the project team, which discusses areas of inefficiency observed during the week's operations. With regard to the rig, the main focus is on the execution portion of drilling optimization. The drilling-optimization plan is communicated to the toolpusher. The role of the WRTC is to monitor operational performance at the KPI level and notify the operations teams if the performance does not meet the established benchmark. The ADPM data are integrated into a real-time drilling console that displays high-quality real-time KPI data.

Post-Well Analysis. Once the campaign is complete, the next step is to perform a performance analysis for each well. This task is handled by the WTAC and is presented to the project team. Every KPI will be evaluated in terms of savings gained throughout the entire campaign and the potential savings yet to be realized. The data are scrutinized to see whether initial targets are relevant to actual performance. This process is crucial because it dictates whether the target is to be maintained or changed for the next drilling campaign. Another use of ADPM data in this stage is the rig scorecard, an evaluation of the rig ranking among the operator's rig fleet. The function and use of the rig scorecard is detailed in the complete paper.

Case Study

The results of ADPM implementation have shown significant results in terms of drilling-performance improvements for the operator. The high level of KPI overview, which caters to management needs, illustrates that the adopted drilling-performance

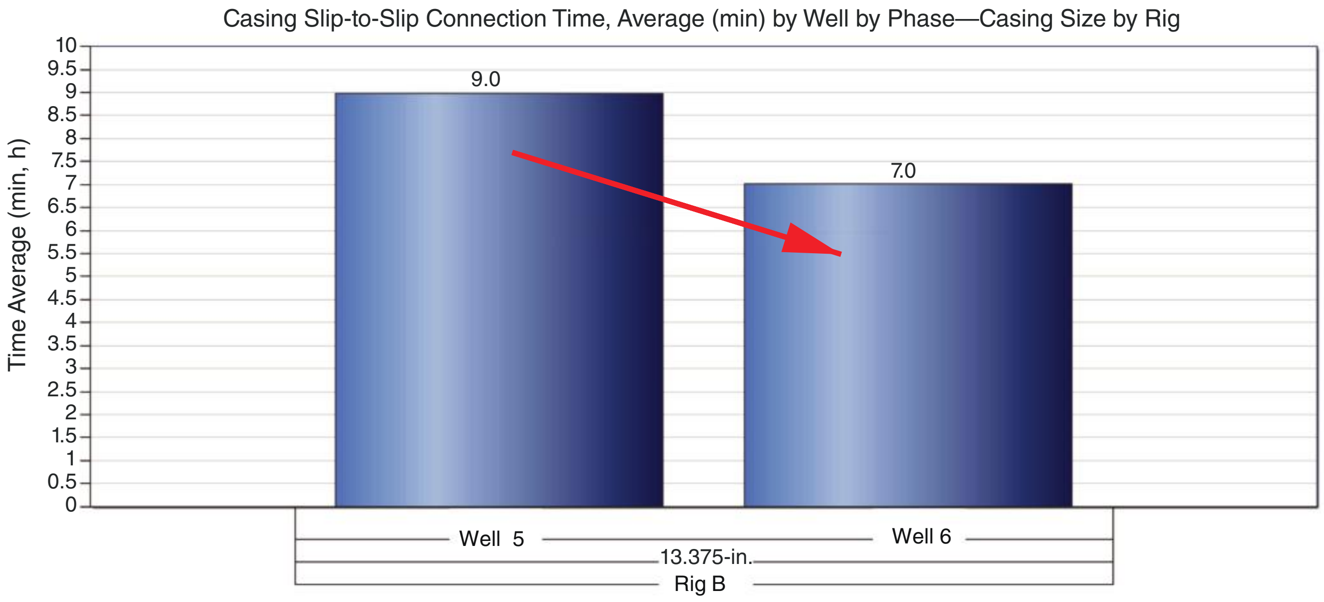

Fig. 1—13.375-in. casing running performance on a sectional basis throughout a drilling campaign.

strategy has been effective. One example is the tripping in slips time performance for the entire rig fleet; this includes both domestic and international operations. The average tripping in slips time in the cased hole has been reduced by 16%, and the average tripping in slips time in the open hole has been reduced by 19.3%, in the 6 years of ADPM implementation. In total, the operator saved approximately 39 days across their entire rig fleet from 2016 to 2021.

Project teams also can benefit from the ADPM analysis, especially in monitoring a long development campaign with multiple wells. A development drilling campaign usually has similar well profiles, bit programs, and mud programs because the formation properties are similar. Thus, a drilling-performance comparison analysis can be performed. For example, on-bottom drilling performance was monitored in a development campaign. Rig A was contracted to drill three wells in Field B offshore Sarawak. In the case of this campaign, Well 2 had a slightly different strategy when drilling the 8.5-in. section, which the operations team had to time-drill when drilling the sidetrack window to ensure that the kickoff was at the correct trajectory. The controlled rate of penetration (ROP) necessary to achieve this had resulted in a low average ROP for Well 2. Nevertheless, the performance trend of on-bottom drilling shows a positive trend in which the instantaneous ROP was recorded at 47.7 m/h in Well 1 with a gross ROP of 28.4 m/h. During the last well of the development campaign, the rig managed to improve instantaneous ROP to 60.9 m/h and gross ROP to 36.5 m/h. This translated to a 28% improvement for instantaneous ROP and a 29% improvement for gross ROP.

A sectional analysis was performed with the operations team before a new section was begun. In this analysis, all operations KPIs were reviewed and analyzed to improve performance in the upcoming section. One example of this process involves the 13.375-in. casing running operation in the 17.5-in. section for Well 5 and Well 6. The first well to be run with 13.375-in. casing was Well 5, with an average casing in-slips performance of 8.99 minutes. For the last well, Well 6, the casing crew managed to cut the casing in-slips time by 28%, to 7.01 minutes **(Fig. 1).** P-50 values also were reduced from 4.33 minutes for Well 5 to 3.87 minutes for Well 6. **JPT**