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Reducing Non-Productive Time (NPT) in Oil Well Drilling: A Comprehensive Approach using Learning Management Systems

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Abstract

Nonproductive Time (NPT) in the drilling operations is a longstanding inefficiency in the oil and gas industry, leading to well delivery delays, production losses, and reduced profitability. To address these challenges, a new methodology integrates advanced software with a specialized Learning Management System (LMS) designed to minimize NPT while driving continuous improvement in drilling operations. This system enables an automated monitoring and mapping of NPT events, allowing rapid identification of operational issues and their root causes with effective learning. By systematically addressing these issues, it significantly reduces NPT and enhances daily operational efficiency.

The LMS plays a vital role by capturing and sharing learning and root causes from NPT incidents, fostering a culture of learning that prevents repeated errors. This paper introduces a proactive approach to NPT reduction, with a user-friendly interface, the automated investigation system helps to standardizes NPT definitions and centralizes knowledge, reducing the effect of staff turnovers lack of experience.

In initial trials, this methodology has reduced NPT from 24.9% to 17.7%, saving over 450 operational days annually across 26 rigs, equivalent to drilling an additional 14 wells per year. This improvement translates to over $40 million in savings per rig set yearly. Additionally, rig contractor-related NPT dropped from 11.2% to 5.4%, with significant gains in productivity and operational efficiency.

Introduction

Over the past three decades, the oil and gas industry has progressively developed and refined strategies to mitigate Non-Productive Time (NPT) in drilling operations. Initial studies laid the foundation for understanding NPT's impact, while later research contributed innovative methodologies, combining technology and data-driven insights to achieve operational efficiency and cost-effectiveness.

This paper presents a detailed methodology and process designed to effectively control NPT, a critical factor influencing well delivery, timing, and associated costs. The approach was implemented within a leading oil and gas company in the Middle East, resulting in a significant reduction in NPT.

This achievement contributed to substantial savings in both time and financial resources while enhancing overall performance. Additionally, the initiative improved key drilling metrics and measures through the standardization and clear definition of NPT, supported by robust Quality Assurance and Quality Control (QA/QC) protocols. Regular data analysis was conducted to identify the primary contributors to NPT, enabling the team to implement targeted control projects. Key Performance Indicators (KPIs) were established and monitored in collaboration with all stakeholders, including operators, service providers, and rig contractors. By systematically addressing each step of the process, the methodology ensured effective NPT management and control.

The early insights into NPT, such as those presented by Hanni et al. in 1994, underscored the magnitude of the issue, revealing that up to 40% of well drilling time was categorized as non-productive [1].This discovery catalyzed the industry's journey toward identifying precise causes of downtime and exploring methods to address them systematically. By the late 1990s, Swanson et al. (1997) had demonstrated that real-time intervention and responsive decision-making were key to minimizing delays, setting the stage for linking Learning Management Systems with real-time monitoring capabilities [2].These developments marked the onset of an integrated approach to knowledge management, ensuring that past learnings could be effectively applied to ongoing operations.

Robinson et al. (2007) proposed using LMS to monitor contractor performance, which led to enhance accountability and alignment with organizational goals, further minimizing downtime [3]. The ability of LMS to standardize reporting across teams ensured data consistency and reliability, while Cruz et al. (2007) highlighted how innovations in casing technology contributed to wellbore stability, preventing NPT in highly challenging environments [4].

York et al. (2009) documented the role of Managed Pressure Drilling (MPD) combined with LMS, reporting an impressive 25% reduction in downtime through advanced risk management strategies[5]. Concurrently, Rahil et al. (2007) demonstrated the impact of proactive well planning, showing how vibration management in deepwater drilling reduced downtime by up to 30%. This era also saw the proliferation of pre-well planning methodologies, empowering drilling teams to predict and mitigate operational hazards with greater accuracy[6].

Advancements in real-time monitoring continued to play a vital role as Dodson et al. (2009) explored vibration management with AI-enhanced systems, enabling timely responses to downhole fluctuations and enhancing equipment reliability[5]. Pritchard et al. (2009) noted that LMS customization allowed for tailored NPT reports focusing on recurrent issues, facilitating targeted responses to common challenges, such as pipe sticking and tool malfunctions. This period marked the industry's transition toward precision-based response strategies, leveraging detailed and relevant data to drive proactive interventions[7] .

The 2010s brought further sophistication in NPT management through the integration of AI and Machine Learning (ML) with LMS systems. Safi Ullah et al. (2017) demonstrated that predictive maintenance capabilities embedded within LMS could reduce downtime by up to 30%, using real-time analytics to preempt equipment failures[8]. The ability to anticipate equipment issues through AI not only enhanced reliability but also transformed traditional maintenance protocols into proactive, data-driven practices. They demonstrated that long-term tracking of contractor performance enabled teams to identify and retain high-performing providers, enhancing accountability and supporting continuous improvement. This data-driven contractor management approach not only reduced downtime but also encouraged operational consistency across projects.

As the industry encountered increasingly complex geological conditions, novel approaches like liner drilling, combined with structured LMS, allowed operators to maintain wellbore stability even in unstable formations. Jianhua et al. (2010) highlighted the success of integrating learning and technology to reduce downtime, particularly in offshore drilling where geological complexities often exacerbate risks [9].

Handoko et al. (2019) describe ADNOC Offshore's approach to improving drilling performance through the establishment of the Drilling Performance Department in 2017 [10]. This initiative led to a performance-oriented culture within the drilling teams, resulting in significant reductions in Invisible Lost Time (ILT) and Non-Productive Time (NPT). The team enhanced traditional drilling performance roles by incorporating Performance Opportunity Time (POT) and Root Cause Analysis (RCA) processes. By systematically investigating NPT causes and promoting knowledge-sharing across the organization, ADNOC Offshore achieved notable improvements in well duration reduction and operational efficiency.

Early detection of anomalies in drilling is crucial to prevent costly downtime and risks like stuck pipes. Traditional LSTM models face challenges with long-term data prediction, but transformer-based models offer a stronger alternative due to their ability to capture long-term dependencies.

Junzhe et al. (2023) introduced a transformer-based model for real-time drilling data prediction, applied successfully to forecast key parameters. The model's accuracy allows it to act as an early warning system for anomalies, marking it as a promising tool for enhancing drilling safety and efficiency across various petroleum data applications [11].

A. Ciuca et al. (2023) studied the benefits of Continuous circulation in drilling such as improved hole cleaning, solids transport, and stable bottomhole pressure, which reduce stuck pipe incidents and allow drilling in formations with narrow pressure margins. Their Results indicated enhancement in safety, better wellbore quality, and notable reductions in NPT, with significant time and cost savings across various well configurations and geological settings [12].

In conclusion, the progression of NPT management techniques in the oil and gas industry reflects a shift from basic downtime tracking to a sophisticated system of knowledge management, predictive analytics, and real-time responsiveness. This historical evolution illustrates the sector's commitment to optimizing operational efficiency, reducing costs, and fostering resilience in a demanding and constantly evolving industry landscape.

NPT Challenges

NPT poses a significant challenge within the oil and gas sector, adversely affecting productivity, well deliverability, and profitability. This issue is exacerbated by a constant turnover of expertise and a lack of experienced personnel, particularly among younger generations, leading to recurring operational failures and ineffective knowledge transfer.

A critical deficiency in the industry is the absence of a robust Learning Management System and **effective** Quality Assurance/Quality Control (**QA/QC**) processes. This gap restricts teams from systematically identifying and addressing NPT root causes. Moreover, the lack of standardized definitions of NPT across operational teams results in inconsistent reporting and measurement, complicating the assessment of operational gaps and hindering the development of strategies to minimize downtime and associated costs.

Inadequate accountability and investigation processes further perpetuate these issues, as traditional evaluation methods for contractors rely on incomplete NPT data, obscuring weaknesses in critical areas such as equipment failures. The reliance on inefficient **manual systems** to track and analyze NPT undermines the industry's shift toward digital transformation, necessitating a comprehensive automated solution. Such a system would standardize NPT measurement, facilitate real-time data analysis, and enhance operational efficiency.

This paper seeks to address these challenges by proposing a digitalized system that standardizes NPT definitions, captures real-time learning, and systematically mitigates operational inefficiencies. The proposed solution promises **a more accurate assessment** of drilling performance, a reduction in repetitive failures, and improved productivity and profitability. Additionally, the paper will explore tailored strategies for reducing NPT, offering adaptable approaches to meet each company's unique operational challenges. By implementing cost-effective measures, organizations can enhance well deliverability and overall productivity.

Methodology

To effectively manage the NPT, the foremost priority is to establish a structured and systematic approach, complemented by the implementation of an advanced drilling management system. A significant contributor to NPT is the inadequate comprehension of the root causes behind drilling inefficiencies, which hampers the ability to disseminate lessons learned across operational teams. In response, a comprehensive Learning Management System has been developed to introduce innovative methodologies and processes aimed at helping operators achieve drilling objectives, enhance overall efficiency, and minimize associated NPT.

A systematic enhancement initiative was executed at a leading oil and gas company in the Middle East, focusing on capturing all NPT events exceeding 12 hours and conducting in-depth investigations into drilling incidents. This initiative integrated root cause analysis and lessons learned into the LMS, ensuring that historical challenges are systematically addressed.

The initial step for any operator involves establishing a standardized format for NPT data capture, guided by a consensus on clear definitions of primary and sub-causes of drilling issues. This meticulous approach is critical to preventing the oversight of NPT events, which may contribute to Invisible Lost Time (ILT).

Operators must also delineate key operations that diverge from the planned drilling activities, assessing whether these deviations warrant classification as NPT. Subsequently, it is imperative to instruct the drilling team on the proper use of the company’s reporting system to accurately document such deviations, including the appropriate causes and sub-causes for each incident. This process is visually shown in **Figure 1**, illustrating the selection of causes and sub-causes within one of the previous data base systems.

One of the principal shortcomings of the previous system was its inadequate capacity to effectively track and document the comprehensive range of causes and sub-causes associated with drilling issues. This limitation stemmed from the drilling team's tendency to input incomplete information, resulting in inconsistent data. The new system addresses this gap through the establishment of a clear and structured workflow, ensuring that all pertinent information is captured with precision and efficiency.

Standardizing the categorization of causes and sub-causes is essential for effective data analysis in the oil and gas industry, as it minimizes redundancy and enhances data consistency. This standardization facilitates trend analysis and enables the timely implementation of corrective measures.

The newly developed system incorporates a structured, step-by-step process that guides the drilling team through the data entry phases, thereby reducing errors related to incomplete or inaccurate categorization of causes. In contrast to the previous database system, which suffered from disorganized workflows and tracking gaps, the new system provides comprehensive visibility throughout the data management process. This advancement allows for more thorough investigations and analyses of NPT incidents.

The new workflow structure supports improved decision-making and the implementation of more effective preventative strategies in future operations. This improvement not only increases data accuracy but also streamlines communication and reporting, significantly boosting the efficiency and reliability of drilling operations. Detailed processes to mitigate and control NPT are outlined in **Figure 2 Flow chart**, with subsequent sections providing an explanation of the specific steps involved.

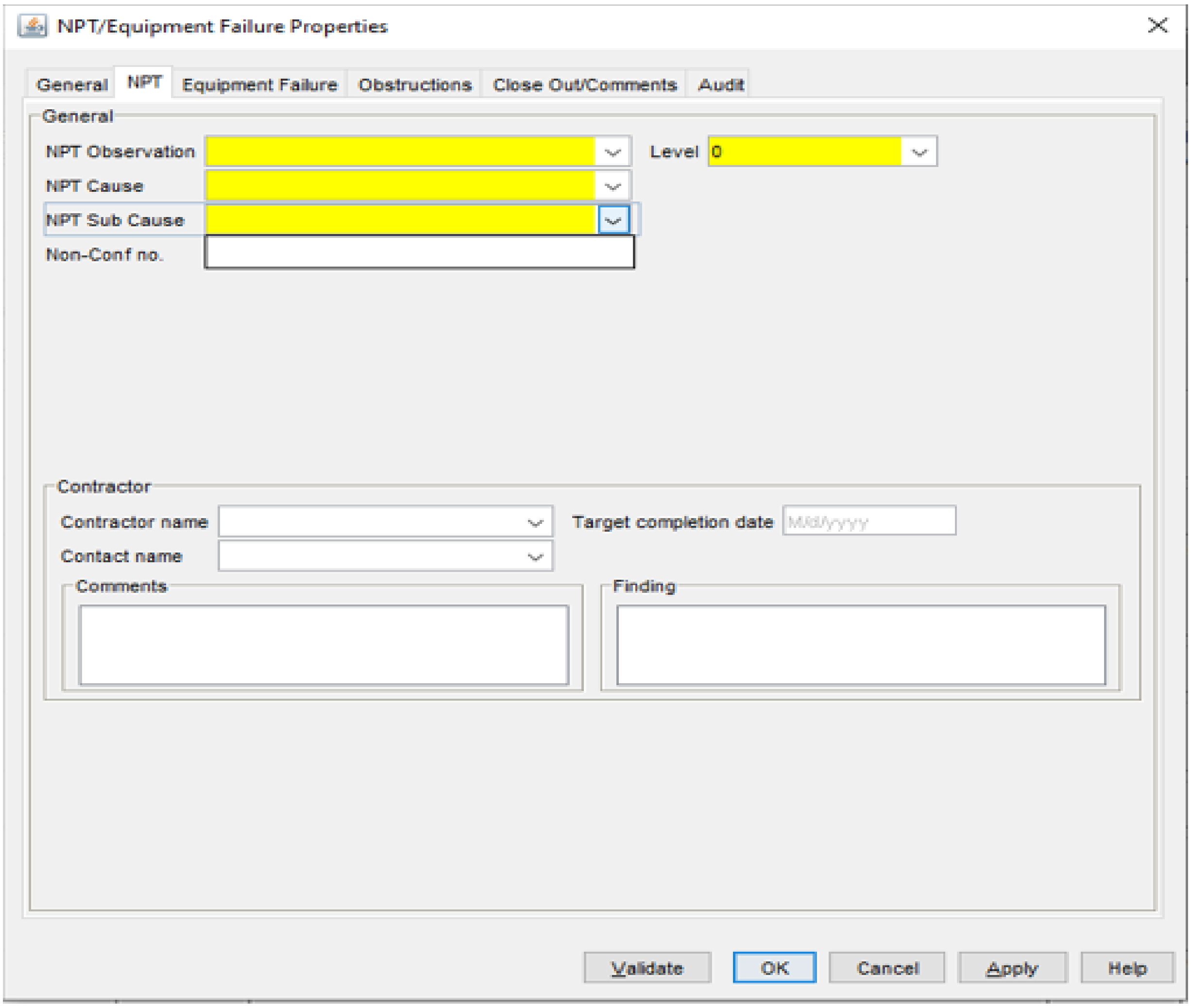


Figure 1 Previous Data base system example for reporting the cause and sub- cause.

Standardization and Building the Guidelines

The foremost step in mitigating Nonproductive Time (NPT) involves establishing a standardized definition of NPT that is universally accepted across all operational teams. This foundational aspect is crucial for creating a consistent framework for identifying, calculating, and reporting NPT incidents.

Definition and Standardization.

A clear definition of NPT must be established and uniformly understood by all stakeholders, including operational, engineering, and contractor teams. This entails the development of a standardized methodology for measuring and reporting NPT, ensuring that the entire organization adheres to the same principles when identifying and categorizing NPT events.

The guidelines should delineate objectives, scopes, and the roles and responsibilities of each drilling team member, such as the Drilling Engineer, Drilling Supervisor, and Senior Drilling Engineer. Furthermore, it is essential to provide precise definitions for Productive Time (PT), NPT, and ILT to facilitate consistent reporting. These Key definitions include:

- PT: This refers to the duration associated with activities defined in the approved Drilling & Workover Program, excluding time spent on issues such as well control or stuck pipe.
- NPT: This is the reported duration associated with a Non-Productive Activity. It includes all time spent from the moment of deviation from a Productive Activity until operations resume at the same point.
- ILT: This represents the difference between the reported duration of a Productive Activity and the benchmark duration for that specific activity.

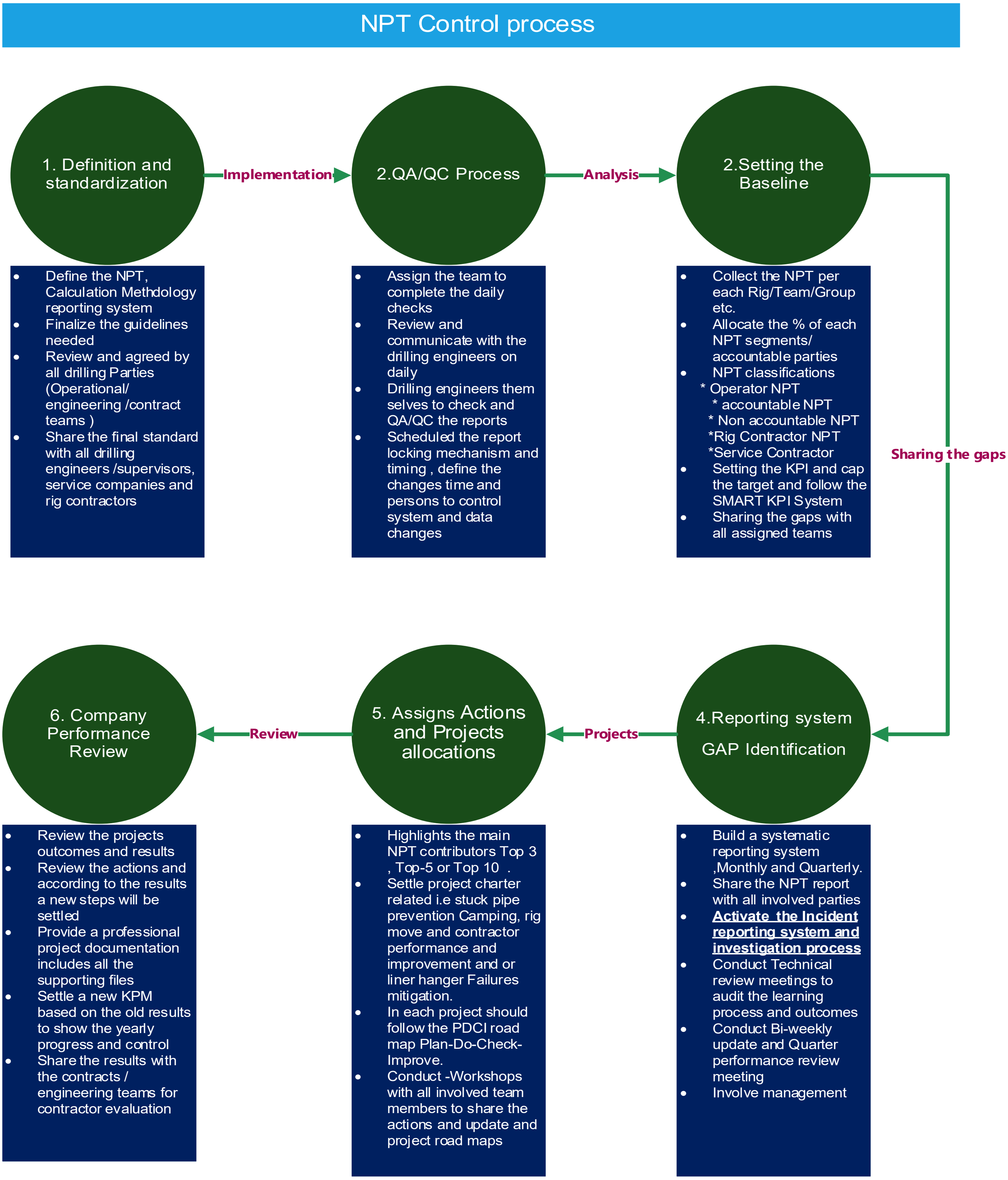


Figure 2 Flow chart Non-Productive time (NPT) Control and Mitigation Process

While ILT is not explicitly reported, it must be noted that regardless of the amount of ILT, if the activity is classified as Productive, the entire duration will be reported as Productive Time.

Establishing clear definitions and responsibilities enables drilling teams to accurately report and track time, thereby enhancing the analysis and management of operational efficiency.

Review, Dissemination, and Implementation of NPT Guidelines

The formulation of NPT definitions, methodologies, and reporting processes necessitates a comprehensive review and consensus among all key stakeholders, including operational, engineering, and contract teams. This collaborative approach ensures alignment across all parties, establishing a cohesive and standardized strategy for NPT management while mitigating inconsistencies arising from varying interpretations.

Following approval, the finalized guidelines must be clearly communicated to drilling engineers, supervisors, service providers, and rig contractors. Effective dissemination is critical for ensuring uniform adherence to the standards, enabling collaborative efforts to minimize NPT and enhance operational efficiency.

A robust reporting system, spearheaded by Drilling Supervisors, plays a pivotal role in accurately capturing and documenting NPT incidents. Supervisors must ensure that all events reported in the Daily Drilling Report comply with the established standards, including detailed descriptions, precise timing, and clear accountability assignments. Adhering to these standards guarantees comprehensive and transparent documentation of all incidents, preventing omissions that could contribute to Increased Lost Time (ILT). By integrating thorough review, effective communication, and accurate reporting, organizations can systematically monitor, control, and reduce NPT, driving significant improvements in operational performance.

Strengthening the Quality Assurance/Quality Control (QA/QC) processes Process to Minimize NPT and Drive Operational Excellence

The QA/QC process is essential for mitigating NPT by establishing a systematic, transparent, and accountable framework that enhances performance through effective comparisons across rigs and teams. A robust QA/QC framework fosters proactive issue resolution and continuous improvement, creating a culture of precision, accountability, and real-time problem-solving. A key component of this process is the formation of a dedicated QA/QC team tasked with daily monitoring to ensure the accuracy and completeness of operational data, serving as gatekeepers to verify information and promptly report potential NPT incidents. In smaller organizations, drilling engineers may assume these responsibilities to maintain compliance with reporting standards. Daily collaboration between the QA/QC team and drilling engineers is critical, enabling immediate identification of discrepancies and prompt resolution to prevent minor inconsistencies from escalating. Empowering drilling engineers to actively review and validate data before submission enhances accuracy and embeds corrective actions, fostering ownership and reducing NPT risks.

To preserve data integrity, a rigorous report locking mechanism is implemented, restricting unauthorized modifications post-submission and allowing changes only through authorized personnel. Additionally, clear change control protocols are defined, with automatic logging of modifications, formalized requests for system unlocking, and oversight by the QA/QC team to ensure the traceability of all alterations. This comprehensive oversight of the reporting mechanism facilitates informed decision-making, immediate issue resolution, and improved operational efficiency, ultimately minimizing downtime and maximizing productivity.

Setting the base line and Benchmark.

The third critical step in mitigating NPT is establishing a robust baseline and formulating precise, quantifiable Key Performance Indicators (KPIs). This process lays the foundation for benchmarking the performance of rigs, teams, and contractors, enabling targeted NPT reduction and efficient management. Comprehensive NPT data collection from all rigs, teams, and contractors is the first step, providing a detailed performance profile and uncovering significant trends. A thorough analysis of this data is then conducted to identify performance gaps and inefficiencies across various NPT categories. Accurate allocation of NPT percentages to specific segments—such as operator, rig contractor, and service contractor—is essential, with further classification into accountable and non-accountable NPT for operators. SMART (Specific, Measurable, Achievable, Realistic, Time-bound) KPIs are developed to define clear performance targets, ensuring all teams understand expectations and remain accountable for achieving objectives. To foster collective accountability and a performance-driven culture, performance gaps and KPIs are transparently communicated to all stakeholders. This systematic, data-driven approach enhances focus on reducing NPT, optimizes operational efficiency, and drives continuous improvement across all facets of performance.

Organizational NPT Reporting System

The fourth step in managing NPT involves engaging all stakeholders, from operations to management, through systematic reporting and regular reviews. A structured framework for monthly and quarterly reports ensures NPT trends and gaps are consistently identified and communicated, fostering transparency and healthy competition among teams. A dynamic incident reporting system captures and investigates significant events, with findings shared to promote continuous improvement. An innovative Learning Management System further enhances this process by ensuring lessons learned are applied organization-wide. Regular technical reviews and management involvement ensure accountability, align resources, and sustain focus on reducing NPT while driving operational efficiency.

Allocation and Prioritization of NPT Control Projects

The fifth step in reducing NPT focuses on resource allocation and prioritization of control projects based on data-driven insights and organizational priorities. This strategic approach ensures that efforts are directed toward addressing the primary contributors to NPT, maximizing the impact of mitigation strategies. The first step involves identifying the top recurring causes of NPT, such as stuck pipe incidents, liner failures, rig move delays, top drive malfunctions, mud losses, and Bottom Hole Assembly (BHA) issues. Each significant contributor is addressed through dedicated project charters outlining objectives, scope, and key deliverables. For example, the Stuck Pipe Mitigation Project targets wellbore stability and drilling fluid optimization, while the Mud Loss Prevention Project emphasizes improved mud management and utilization of advanced technologies.

To ensure effective implementation, each initiative follows the PDCI (Plan-Do-Check-Improve) methodology: detailed planning, disciplined execution, ongoing performance monitoring, and continuous improvement. Collaborative workshops with drilling teams, supervisors, engineers, and contractors foster alignment, facilitate updates, and ensure collective commitment to NPT reduction goals. By addressing major contributors systematically and collaboratively, organizations can achieve significant reductions in downtime and enhance operational efficiency.

Comprehensive Performance Review and Continuous Improvement

The final phase in controlling NPT involves a comprehensive performance review to evaluate project outcomes, define strategic next steps, and establish pathways for sustained improvement. This ongoing review ensures the continuity of NPT reduction efforts and promotes long-term operational success. Key actions include assessing project outcomes through a detailed analysis of performance metrics to determine the achievement of objectives and identify opportunities for further optimization. Based on these insights, the performance team develops updated action plans and strategies aligned with long-term goals to reinforce progress and drive continuous improvement.

Comprehensive documentation of project methodologies, results, and any modifications ensures transparency, accountability, and effective collaboration among all stakeholders. New Key Performance Indicators are then established to reflect recent achievements, set measurable improvement goals, and enable objective tracking of NPT control efforts for future periods. Finally, the results are shared with contractors and operational teams, fostering a feedback loop that evaluates contractor performance and promotes knowledge sharing. By adopting this structured, data-driven approach, organizations can cultivate a culture of continuous improvement, minimize NPT, and enhance overall operational efficiency.

Learning Management System (LMS)

The oil and gas industry faces persistent NPT issues, largely due to the absence of efficient systems for capturing and applying lessons from past drilling operations. This Paper introduces a specialized LMS that systematically records, analyzes, and applies lessons learned to mitigate recurring operational challenges. The LMS automates workflows, enforces process adherence, and supports structured data capture, enhancing continuous improvement efforts by ensuring critical knowledge retention.

Designed for operational teams and contract management, the LMS improves contractor accountability by providing reliable performance data. The system also facilitates knowledge transfer across generations, bridging experience gaps for newer professionals. By mapping operational issues against data from offset wells, the LMS allows for comprehensive problem analysis and proven solution referencing, fostering a sustainable culture of learning and enhanced drilling efficiency across all levels of operations.

The Learning Management System workflow for incident reporting and investigation in drilling operations ensures precision, efficiency, and thorough documentation. It systematically captures all actions and timelines associated with incident responses, providing a structured framework for addressing Non-Productive Time incidents. As illustrated in **Figure 3**, the process begins with the identification of an issue through historical databases, daily logs, or other drilling records. When NPT exceeds 12 hours, the system automatically generates a report, pre-populating essential details such as well information, rig data, and timing for efficiency. The Drilling Engineer determines the relevance of the incident, closing the report with justification if it is deemed irrelevant.

If deemed valid, the Drilling Engineer conducts a comprehensive root cause analysis, collecting data, identifying underlying issues, and proposing corrective actions. The report then undergoes review by the Senior Drilling Engineer (SDE) to ensure accuracy and completeness. Further refinement is performed by the Drilling Specialist, who verifies the quality of findings and recommends any necessary modifications needed by the drilling engineer. The Team Leader subsequently reviews the report to confirm all critical details are addressed, involving the Technical Committee when additional expertise is required. The Committee validates the report, identifying significant insights for broader organizational learning and classifying exceptional cases as "Best Learning" examples for future application.

Once approved, an administrative focal point ensures the report is properly documented and closed within the LMS, assigning it to the appropriate team for organizational learning and implementation. The system operates within strict timelines, including two weeks for Drilling Engineers to complete investigations, one week for reviews by the SDE and Drilling Specialist, and three days for additional approvals. This structured, time-bound approach promotes thorough incident analysis, facilitates knowledge sharing, and drives continuous improvement in drilling operations.

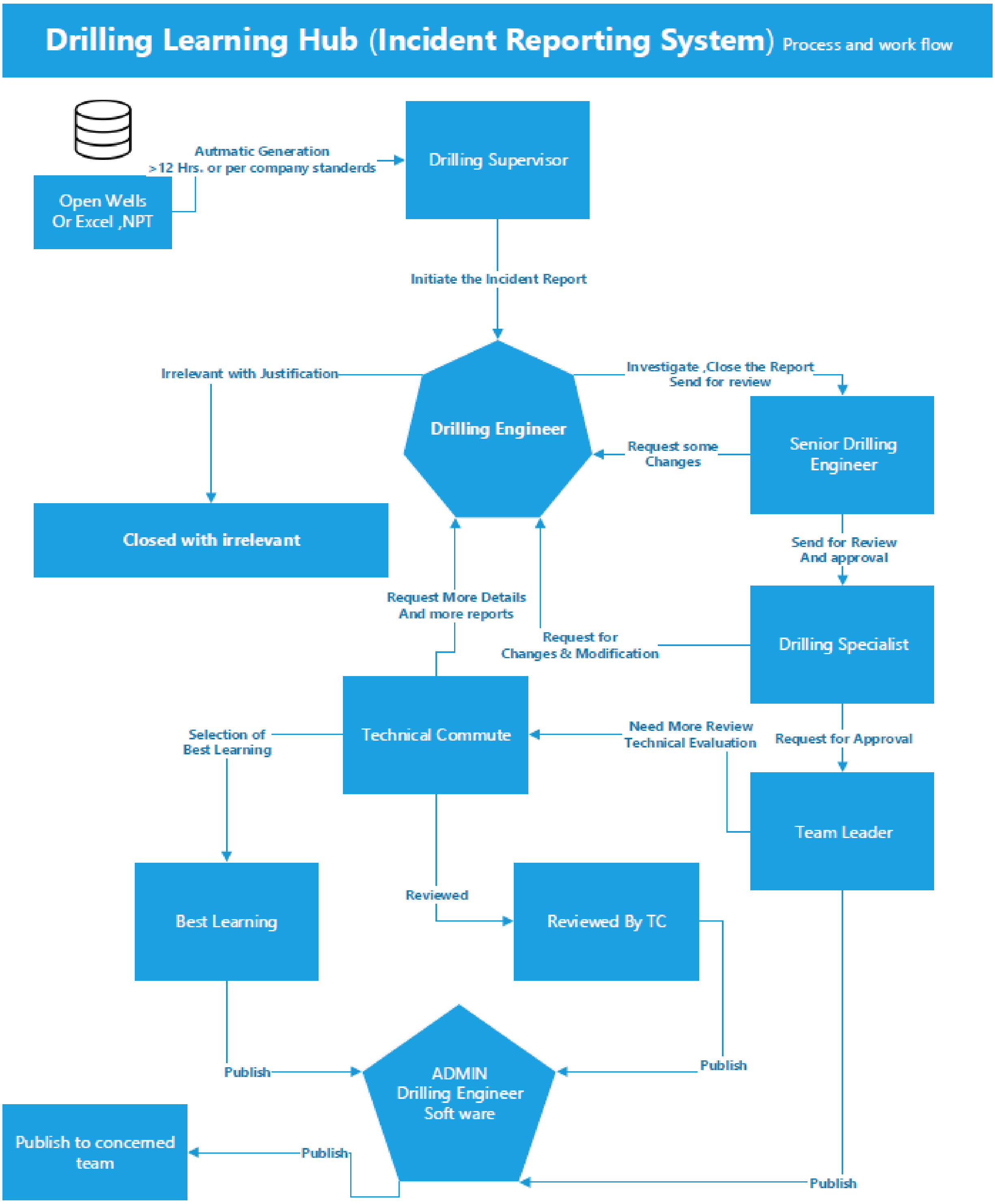


Figure 3 Proposed Learning Management system (LMS) workflow.

The LMS for Incident Reporting (IR) is designed to capture comprehensive and standardized data related to Non-Productive Time (NPT) incidents, with inputs entered either automatically or manually by the Drilling Supervisor. The system imports critical well-specific data, including well name, rig number, geographic coordinates, and operational details, streamlining the documentation process. For NPT incidents, it records start and end times, hours lost, costs, accountability, and observations to facilitate detailed tracking and analysis.

Following initial input, the Drilling Engineer conducts a thorough investigation, performing root cause analysis to identify underlying issues and recommend preventive measures. Incident descriptions, initial observations, and operational context form the foundation for this analysis, ensuring accuracy and actionable outcomes. Lessons learned and follow-up actions are documented to promote knowledge sharing and continuous improvement, with specialized fields available for recurring issues, such as stuck pipe events, HSE incidents, and rig move delays. This structured input process enables effective incident management and supports organizational efficiency.

LMS System Output and analysis (System Benefits and advantages)

The LMS for drilling operations provides advanced tools for improving decision-making and operational efficiency. The Offset Well Mapping Tool enables Drilling Engineers to identify historical challenges within a defined radius of new drilling sites, using past data to anticipate risks and implement preventive measures. The system also supports Risk Identification and Mitigation Strategy Development by analyzing historical incidents to create tailored risk profiles for each wellbore section, proactively reducing Non-Productive Time.

A Powerful Filtered Reporting Engine as shown in **figure 4** allows customizable, organization-specific reports tailored to various analytical needs, such as performance evaluation and cost tracking. The Stuck Pipe Analysis Module captures data on incidents, offering insights for preventive strategies and improving operational safety. The LMS also tracks Cost Efficiency and Technology Implementation, monitoring savings and innovation milestones, while Real-Time Incident Tracking ensures timely management with automated alerts to reduce delays.

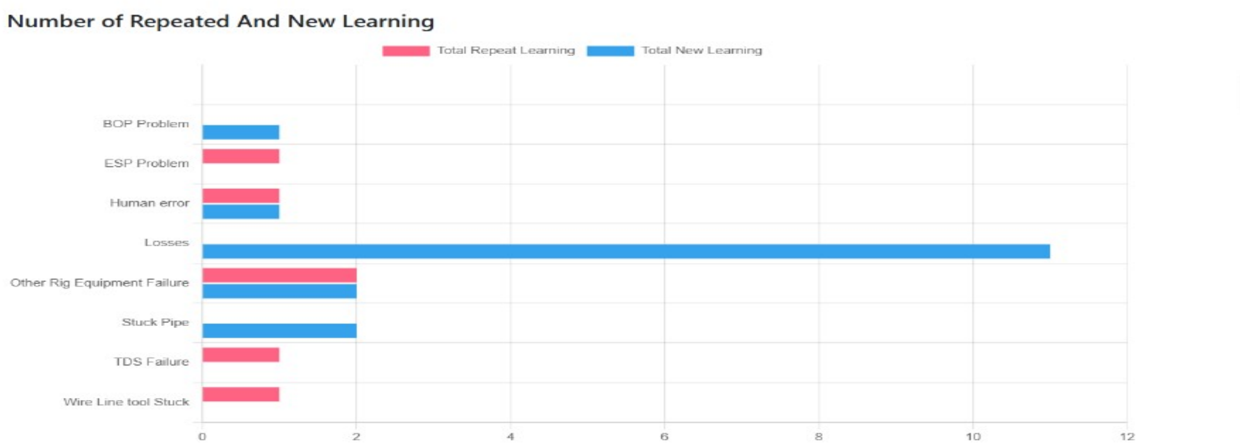
Integration of AI and ML enhances risk management by identifying patterns, suggesting predictive actions, and connecting with RTTDC for immediate alerts. The system's Incident Reporting feature generates comprehensive, structured reports, enabling users to quickly identify key problems, trends, and lessons learned for informed decision-making. A detailed sample report is provided in Appendix-1 for reference.

Implementation and Execution

In September 2023, following organizational restructuring, a targeted initiative was implemented on a high-NPT rig set within a major operator. These rigs, with an average NPT of 25%—significantly higher than the operator's other sets—became the focus of a KPI-driven strategy to reduce NPT to 22%, serving as a performance benchmark for both the operator and contractors. The project applied the outlined processes comprehensively, emphasizing collaboration with contractors and service companies.

Key measures included establishing contractor-specific KPIs based on historical performance, such as a 5% yearly NPT target, ensuring clear accountability. Quarterly management meetings reviewed contractor performance and identified action plans, while monthly performance reports tracked progress in NPT reduction and operational efficiency. Bi-weekly follow-up meetings addressed immediate issues and facilitated swift corrective actions.

Additionally implemented an LMS during this period, delivering transformative results. The system reduced recurring failures, particularly in directional drilling, by analyzing incident data and automating data capture. This automation enhanced pattern recognition and minimized manual effort, creating a centralized knowledge hub for historical data. Additionally, real-time contractor evaluations through the LMS improved feedback and accountability, driving focused efforts on mitigating recurring issues and enhancing overall operational efficiency.



INCIDENT KEYWORD	RIG	WELL	INCIDENT START DATE	TOTAL NPT HOURS	ESTIMATED COST (KD)
Stuck Pipe	Rig 1	Well 1	2024-10-10 00:00:00.000000	595	200.00
Losses	Rig 2	Well 2	2024-10-10 00:00:00.000000	38	200.00

Figure 4 Powerful Filter tool

Results and Discussion

The integrated strategy encompassing structured KPI development, continuous collaboration with contractors, and the utilization of advanced technologies, particularly the LMS, has produced remarkable results.

The NPT reduction initiative has significantly improved operational efficiency across a group of over 26 drilling rigs, referred to as set 3. Throughout the project, the NPT was effectively reduced from 24.9% to 17.4%, amounting to a noteworthy decline of 7.2%. This reduction corresponds to an estimated savings of 450 operational days, achieved through improved drilling methodologies, enhanced contractor management, and the integration of advanced monitoring technologies. **Figure5** illustrates how this reduction in NPT has led to substantial productivity gains.

To further contextualize this achievement, it is important to note that the average time to complete a typical well has been reduced to approximately 30 days, including rig moves. The time saved across the 26 rigs involved in this project allows for the potential drilling of an additional 14 wells within the same operational window. This increase in productivity equates to more than $40 million in annual savings for a single set of rigs.

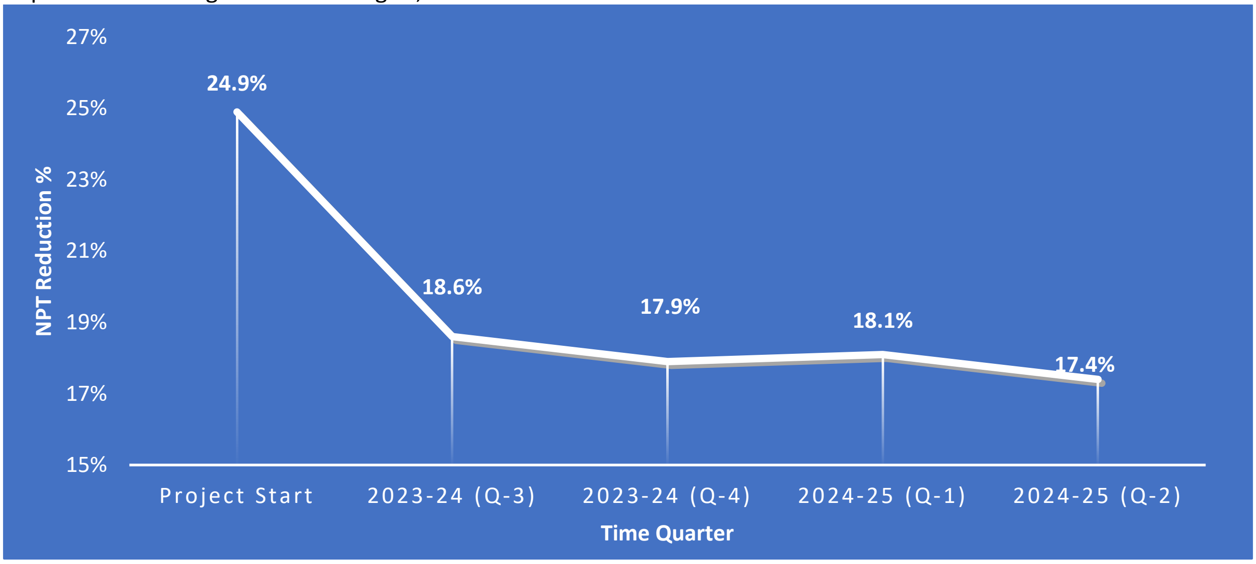


Figure 5 NPT % trend and reduction for different sets.

A significant component of the project focused on the rig contractors, who were crucial in achieving the NPT reductions. Enhanced oversight, improved performance management, and collaboration with rig contractors resulted in a reduction of contractor-related NPT from 11.2% to 5.4%, achieving nearly a 6% improvement, as shown in **Figure6**. One particular contractor experienced a significant drop in NPT, decreasing from 25% to 14%, as shown in **Figure7**. This performance enhancement was driven by tailored KPIs, frequent performance evaluations, and a cooperative approach to addressing operational inefficiencies.

The improvements observed in both overall NPT and contractor-specific NPT can be attributed to several key factors:

Enhancing Planning and Execution:

A more systematic approach to drilling operations, characterized by thorough pre-well planning and real-time data analysis, enabled the rapid identification and resolution of potential issues before they escalated into significant downtime.

Contractor Accountability and Performance Management:

Establishing specific KPIs for each contractor, along with rigorous monitoring of their performance through regular review sessions, proved critical. The introduction of bi-weekly and quarterly meetings ensured timely resolution of emerging issues while fostering continuous improvement through feedback loops.

Integration of Learning Management Systems (LMS):

The LMS played a vital role in systematically capturing and analyzing lessons learned from each operational phase. This capability significantly reduced the recurrence of operational challenges and facilitated the dissemination of best practices across teams. Furthermore, the LMS provided a standardized method for incident reporting and root cause analysis, contributing to the overall reduction in NPT.

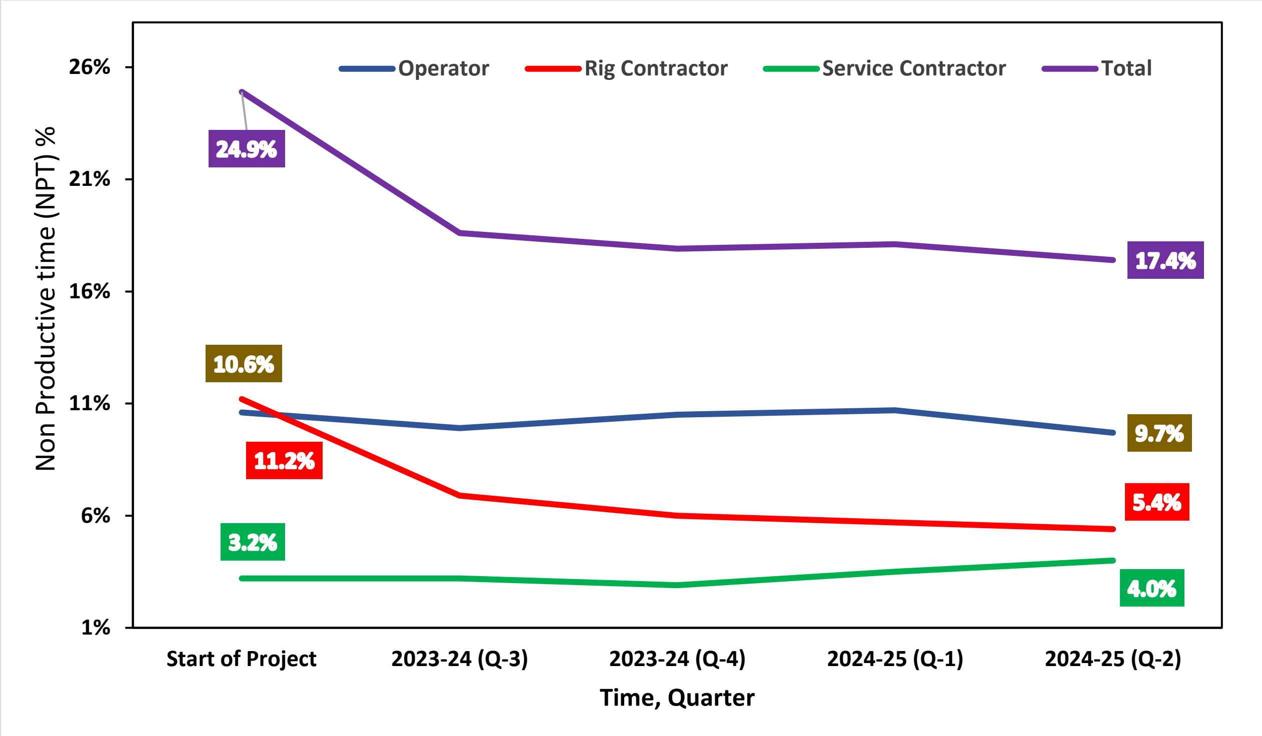


Figure 6 NPT segments trend.

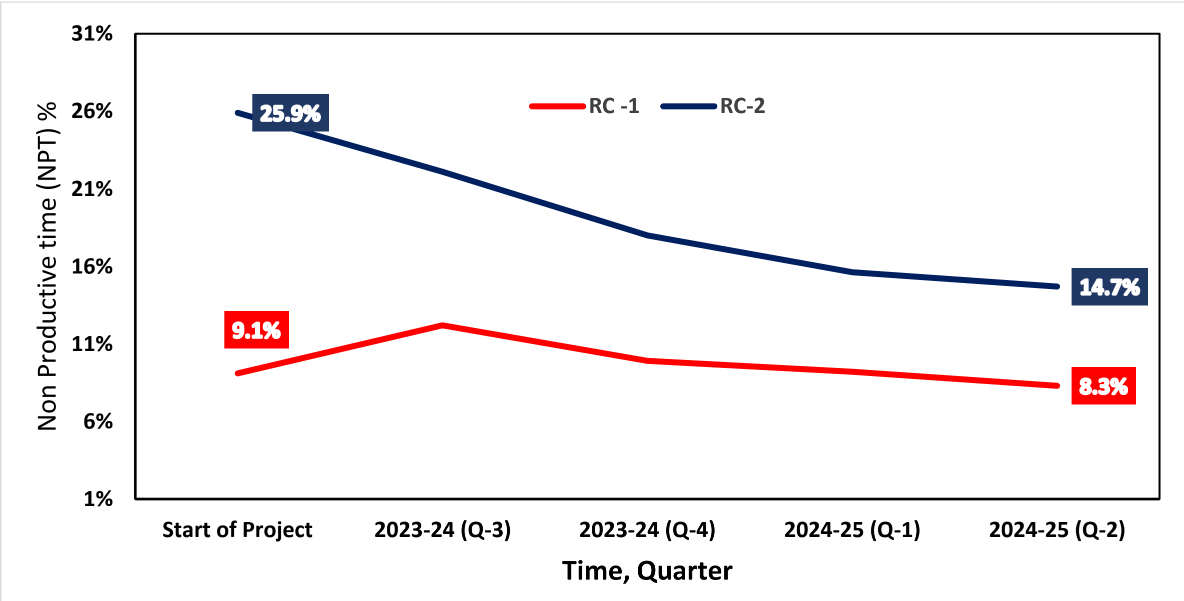


Figure 7 Significant improvement trend for one of the Rig contractors

Conclusions

In conclusion, effective management of Non-Productive Time (NPT) is a comprehensive and multifaceted endeavor that necessitates the integration of several critical elements to achieve sustainable improvements in operational efficiency. This paper demonstrates that the implementation of an integrated strategy, including structured KPI development, continuous collaboration with contractors, and the utilization of advanced technologies like the Learning Management System, significantly reduced NPT. Specifically, the NPT was reduced from **24.9%** to **17.7%**, marking a substantial decline of **7.2% and 30% improvement.** This reduction resulted in a savings of **450** operational days, equating to over **$40 million** in annual savings from just one set of rigs.

The key components for effective NPT management identified in this paper include:

- Accurate, Standardized, and Timely Reporting Systems: These systems were instrumental in the precise identification of NPT events and ensured the accuracy of data entry. By facilitating real-time monitoring and reporting, inefficiencies were swiftly addressed.
- Robust Investigative Framework: A well-defined investigation process was crucial for identifying root causes of NPT occurrences. This led to corrective actions that minimized future incidents.
- Quality Assurance and Quality Control: Implementing QA/QC measures for learning ensured that the intended outcomes were achieved, effectively preventing recurring issues.
- Knowledge Sharing via Automated Learning Management Systems: The LMS system allowed for real-time capture and dissemination of valuable insights, helping map problems and identify operational gaps. This fostered a culture of continuous improvement.
- Focus on Primary NPT Categories: By focusing efforts on the most significant NPT categories, the organization was able to address specific inefficiencies, significantly reducing downtime and improving overall operational performance.

This comprehensive approach, which also included a reduction of contractor-related NPT from 11.2% to 5.4%, has proven to be effective not only in reducing downtime but also in driving cost savings and improving the overall operational efficiency of the drilling operations. The results clearly demonstrate that targeted efforts, combined with the right technology and performance management practices, can yield substantial financial and operational improvements.

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Conflicts of Interest

In alignment with the policy on Conflicts of Interest, I confirm that there are no conflicts of interest associated with this manuscript. This declaration ensures transparency and upholds the ethical standards of this research submission.

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Appendix-1

Appendix No-1 Sample of Incident Report

INCIDENT REPORT

Title: Drill string stuck due to Tar and coal while drilling 12.1/4" hole section

IR Number: 355 | Well: Well 2 | Rig: Rig 2

| IR Key Word: Stuck Pipe| Hole Section: 12.25"

Well Identification

Well Name	Well 2
Geographic Coordinates	Lat: 48.0769, Long: 29.3339
Rig	Rig 2
Asset Name	Asset 2
Well Type	Well type 2
Section	12.25"

NPT Details

NPT Start Date	2024-10-10 08:12:20.
NPT End Date	2024-10-14 06:12:07
NPT Hours	94
Estimation Cost ($)	200,000.00
NPT Owner	Operator
NPT Cause	Stuck
NPT Sub Cause	Unexpected Tar
Severity Rating	High

Incident Report Details

Incident Description	Drill string stuck while drilling 12.25" section @ 7774 ft at middle of Formation X. due to massive tar section tar formation
Observation & Findings	• Massive inter-layered Tar sections below 13 3/8" Casing in formation X. Drilled the Build & Turn 12 1/4" section with RSS BHA at 11.2 ppg OBM (Oil Base Mud),with utmost caution following Coal / Tar drilling procedures, despite occasional Rotary stall, big pieces of Tar caving and tight hole. Option of Rotary BHA replacing RSS BHA was not exercised due to well trajectory that required build and turn simultaneously. However, at 7778' MD middle of formation-X, at 42 deg Inc and 282 deg Azimus, more troublesome and thick tar layer was encountered and resulted in **Sudden pressure rise** followed by **high torque** while back reaming up at bottom and string got stuck. **Pumped Toluene but without success,** several attempts to free the string with no success. • Conducted Fishing Operations: Backed off with string shot with TOF @ 7672 ft. The open end back off string also was required to ream out stating the bad hole condition due to massive inter layered tar in formation-X. Engaged fish with Screw in sub but cannot release fish. B/Off at 7641 ft. Placed 17 ppg Side-track cement plug. • Conducted Side Track with RSS BHA to Formation-X to 7427 ft. Found tight hole and non-rotating sleeve (almost full gauge) of RSS BHA (Geo-pilot) hindering back reaming: Can rotate but cannot ream out. Drilled to 7458' to get sleeve out of tight hole. POOH RSS BHA with hard back reaming

	• RIH Rotary BHA with MWD and drilled to 7758 ft inside Formation- X, but while hard back reaming for survey, TDS failed (**Took 3 days to repair**) and string got stuck. • String stuck twice almost at same depth in Formation-X which seems to have the worst tar layer that was difficult to drill without getting stuck despite following Coal / Tar Drilling procedure. • Backed Off with string shot. Placed 17 ppg ST cement plug • ST with RSS BHA and drilled to Rumaila top and raised mud weight to 13.7 ppg OBM before POOH. • Employed 12 1/4" x 9 5/8" Casing While drilling (CWD) and safely drilled the section to planned section TD
Root Cause	• Massive Tar / Coal interlayered formations in Formation-X • Formation-X Inter-layered Coal / Tar could be drilled cautiously with down hole issues following Tar / Coal Drilling Procedure developed in-house. **However**, the treacherous Tar layer in formation-X was very difficult with string stuck at same depth twice leading to sidetrack in both instances. • There is No Mapping of Tar / Coal formations existing.
Preventive Actions	• 12 1/4" x 9 5/8" Casing While Drilling (CWD) was selected after engineering analysis because all stuck pipes / tight hole was experienced while pulling up and not going down CWD was used to drill through problematic Tar layers from formation-X top to casing setting depth at Formation-Z. Drilled 582 ft (7470 - 8052') in 2.6 days of drilling at 20 deg Inclination. Set two Benchmarks in CWD: Highest footage ever in the company (582 ft). It was also the first ever recorded application of drilling through Tra / Coal using CWD in the world. • Trajectory was re-planned for hold section to employ CWD, and subsequent 8 1/2" section was re-planned with aggressive DLS to make up so as to make geological objective • Drill Coal / Tar following in-house developed procedure • Change over to Rotary BHA from costly RSS BHA whenever tight hole was encountered. Although first BHA lost was RSS but subsequently the RSS BHA was pulled out on time after Sidetrack, to replace with Rotary BHA that was later stuck preventing huge RSS BHA LIH (Lost in hole) cost • Changed to different RSS that do not have F.G. non-rotating sleeve which prevented reaming leading to almost stuck condition • When all options of conventional drilling, i.e., Coal & Tar drilling procedure / Rotary BHA replacing RSS BHA / Adding surfactants, graphite, soltex, tighter FL control weight increase in mud etc. / placing Toluene pills / etc. failed, CWD is introduced
Learning Outcomes	• Employ Casing While Drilling (CWD) after engineering analysis, when Tar / Coal is almost impossible to drill with Rotary / RSS BHA • Plan Trajectory for hold section to employ CWD, and subsequent section may be re-planned with aggressive DLS to achieve geological objective. • Drill Coal / Tar procedure to be updated revised. • Utilize rotary PHA in case f Tar and coal expected instead of costly RSS BHA, whenever tight hole is encountered to prevent expensive RSS BHA LIH (Lost in hole) cost. • Use RSS that do not have full gauge non-rotating sleeve which prevents reaming leading to stuck condition.

Area of Non-Compliance

Equipment	No
Procedure	**Yes**
People	No

Team Action

Staff involved coached and accountability addressed	Yes

NPT Letter issued to contractor to follow up	**NO**
Drilling Manual update/circular issued	Yes

Signatures

Occupation	**Name**	**Email**	**Received** Date	**Submitted** Date	Days **Since** Report
Drilling Supervisor	Drilling Supervisor	Drilling Supervisor @xxx.com	2024-10-09 12:34:04	2024-10-17 12:34:04	8

Occupation	Name	Email	Received Date	Submitted Date	Days Since Report
Drilling Engineer	Drilling Engineer	Dri11ingEngineer@xxx.com	2024-10-17 12:32:53	2024-10-29 09:50:30	11
Senior Engineer	Senior Engineer	SeniorEngineer@xxx.com	2024-10-29 09:50:30	2024-10-29 09:51:09	0
Specialist Engineer	Special Engineer	Specia1Engineer@xxxx.com	2024-10-29 09:51:09	2024-10-29 09:51:52	0

Attachments

- Daily Drilling reports
- Gelograpgh
- Directional company Investigation Report
- Mud company Analysis and investigation Report
- Technical team New Updated procedures
- Tar and Coal drilling Practices

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