American Journal of
Accounting
(AJACC)

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American Journal of Accounting
ISSN 2789-3156 (Online)
Vol.7, Issue 1, pp 1 - 33, 2025

www.ajpojournals.org

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Abstract

Purpose: The paper performs an extensive evaluation of production logging tools (PLT) processes while examining small details and assessing shortcomings for maximizing their efficacy in improving oil extraction. The research demonstrates essential functions of production logging tools (PLT) for digital transformation in the oil and gas industry.

Materials and Methods: The work establishes the essential linkages between digitalization strategies with problem detection methodologies in addition to cost reduction models and reveals hidden relationships within the petroleum industry. Operation simplification with root strength and weakness assessment and alternative method analysis will lead to enhanced production management and operational efficiency with sustainable solutions integrated into the digital transformation of this industry. The PLT system enables professionals to track down potential reservoir issues before they arise as well as to scan for upcoming well integrity risks and equipment malfunctions.

There is considerable scope for climate change and environmental activities but the research shows oil production remained the top priority therefore this study creates new pathways to use PLT as a base for digital oil production transformation. The thesis bridges theoretical analyses and simulation research to present stakeholders with strategic guidance about why, where and how to put PLT into use for enhancing future oil production efficiency and market resource reliability alongside sustainability.

Keywords: *Production Logging Tools, Digital Transformation, Oil Production, Production Logging, Flow Regimes*

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INTRODUCTION

The oil and gas industry takes its position among the most essential economic sectors of the world's economy because it allows energy needs to be fulfilled while driving economic expansion. Development. This industry demands elevated complex challenges since it must push forward production levels and optimize industrial procedures in this domain. (avenue, 2016)

The global economy relies heavily on the oil and gas sector because this industry perpetually faces challenges regarding both production enhancement and the attainment of cost savings. The industry needed to adapt its business model because digital evolution introduced technologies such as production logging tools (PLT) and other advanced systems. Such tools hold a vital position by enabling effective system operations and becoming essential for identifying problems while reducing costs in the sector. (2023, January)

Research follows this trail regarding digital transformation in the oil industry by examining how efficiency works out for oil development along with production when PLT techniques operate on wells. The main goal here is to understand the digital transformation practices together with big data strategies that boost production and operational activities and their resulting effects and opportunities. Research and evaluation approaches will analyze the necessity for oil and gas enterprises to use PLT technology followed by a literature analysis which explores the positive digital transformation effects resulting from PLT implementation for problem detection and cost reduction. The study outlines a method for applying empirical research results to demonstrate how PLT joint with digital technology implementations help oil wells industry organizations reach maximum operational outcomes and reduced costs while managing market change dynamics.

Problem Statement

It could be said that now more than ever the oil and gas industry is at a cross roads of increased pressure to achieve greater production and decreased overall costs. Although the Omani oil and gas sector has made good progress in terms of digital transformation especially in the use of PLT, there is still a research gap in systematically evaluating the impact of these technologies on problem identification and cost saving measures within the sector.

As digital transformation introduced new approaches to data acquisition, analysis, and decision-making, the literature lacks specificity in explaining how the PLT implementation affects the problem detection competence in oil production operations.

Research Objectives

The relationship between PLT data needs evaluation regarding different performance elements:

1. Evaluating the cost reduction potential of PLT. Experts need to examine the effectiveness of early warning alerts achieved by PLT systems in minimizing production loss and eliminating avoidable downtime and optimizing production solutions and how PLT impacts boosting production levels. Performance factors:
2. A thorough analysis of PLT solutions for problems appearing during oil production operations takes place. The research investigates the role of Production Logging Tools (PLT) in identifying three key downhole problems including formation damage along with water inflow and flow limitations.
3. Determining the impact of PLT on production efficiency. The research seeks to measure how well management effectiveness improves oil well production rates enabled by analyzing PLT information..

Research Importance

The following work is meant to outline the importance of PLT in the process of digitalization of the oil industry. Consequently, this research may provide added implications to the further development of the PLT technology and its application to the O and G business through emphasizing on the problem identification and dispensation of expenses. On the following bases, it sums up its importance:

1. Problem Recognition Enhancement: This research seeks to determine how much PLT facilitates identification of down hole problems by the engineers so as to encounter minimized shut down incidences and correspondingly increase the production rate from the wells.
2. Cost Savings: The cost savings in this research enable the oil and gas firms to recognize the economic return that comes with the adoption of PLT technology.
3. Data-Driven Optimization: This paper also underscores how PLT information optimizes production plans for the following benefits: This shows an effective way in improving efficiency as well as oil recovery.
4. Levelling up PLT Technology: This study promotes the enhancement of the use of PLT new technological application advancement in the field of oil and gas industries with a remarkable consideration of the detection of problems and cost efficiency goals.
5. Industry Impact: This research contributes to the grounding of the industry to work and cooperation and the best practice in relation to the use

Research Framework

This research presents the effect of digital transformation on the oil production as it examines the problem detection and cost reduction are adopted as the oil production measurement by using production logging tools PLT. The researcher divided the variables into independent and dependent as shown in the figure1 below:

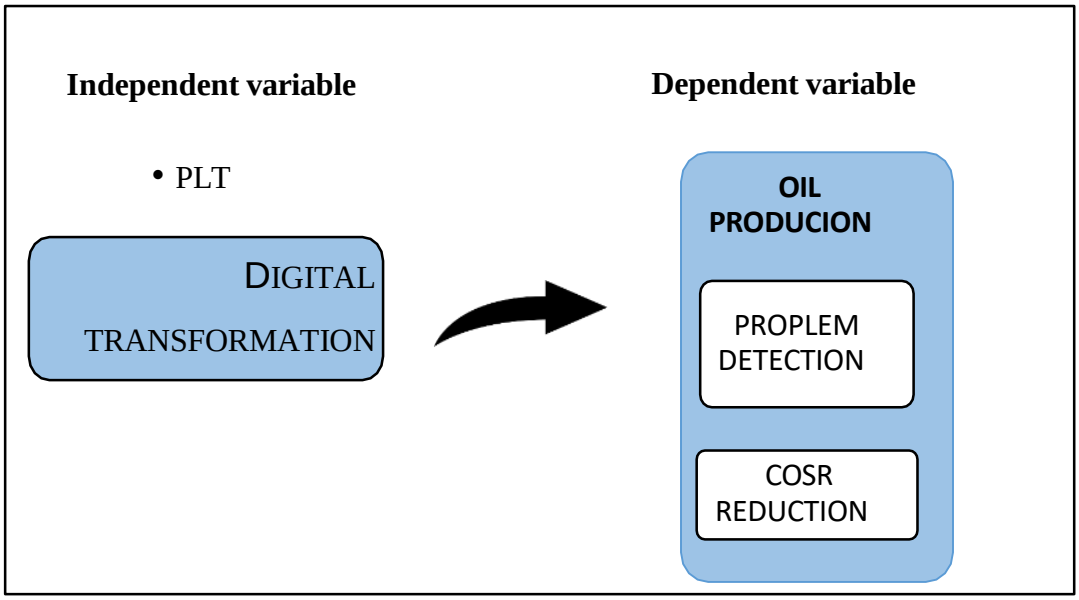


Figure 1 Show The Research Framework Variables

Research Limits

Human limits: production engineers, operations managers, geologists, and a number of company employees.

Spatial research limits: The search was conducted in Weatherford Company (a private company) and Schlumberger Company (a private company).

Time limits: (10\31\2023) – (4\19\2024)

Previous Studies

This section addresses the books and scientific research similar or nearby or related to this research subject and it is divided according to the subjects into two parts a following:

Table 1 Show Previous Studies about Dt

	Authors & Years	Research Subjects	Author Discussion
	Fadwa Zaouia * Nissrine Souissi 2021	Roadmap for digital transformation: A literature review	The research presented a digital transformation roadmap consisting of 10 main categories and 152 separate stages. The research emphasizes the importance of periodically evaluating the digital transformation process, setting clear goals, and developing a solid plan for implementation. Finally, the research indicates that there is diversity in the methodologies used in digital transformation, and emphasizes the importance of adapting the digital transformation plan to the needs of each company.
	Lozić, J. & Fotova Čiković, K. (2024)	Digital transformation: the fundamental concept of Transformation of business activities	The research provides a definition of digital transformation, distinguishes it from digitization, explains the stages of digital transformation and its impact on revenue models, and also analyzes the factors that drive digital transformation by exploring the broader social and individual impacts of digital transformation. Finally, it emphasizes the importance of successfully managing digital transformation projects
	GRIGORY M. BARENBOIM1, VLADIMIR M. BORISOV2, VALENTIN N. GOLOSOV3 & ALEXANDR Yu. SAVECA1 2014	New problems and opportunities of oil spill monitoring system	The research discussed in these documents focuses on various aspects of oil spill monitoring, early detection systems, ecological risk assessment, and environmental management. It includes the development of methods for detecting and monitoring oil spills, assessing the biological hazards associated with spills, analyzing sustainability issues related to water and oil, and utilizing Chernobyl-derived isotopes for sediment studies.
	Vahid Ghorbani Pashakolaie, Shahla Khaleghi , Teymor Mohammadi and Morteza Khorsandi 2015	Oil production cost function and oil recovery implementation - Evidence from an Iranian oil field	The referenced research covers topics such as oil development cost estimation, energy resource substitution and global warming impacts, challenges and opportunities in enhanced oil recovery, insights from economic models of the world oil market, and modeling operating costs for petroleum projects. These studies also delve into econometric modeling of oil supplies, strategies for enhancing recovery in oil reservoirs, and analyzing decline-curve analysis for production forecasting in petroleum engineering.
	Kelsey L. Prestidge 2021	Digital Transformation In the Oil and Gas Industry: Challenges and Potential Solutions	Kelsey Prestige's Master's thesis explores the intricacies of digital transformation in the oil and gas sector. The research illuminate's challenges like technology integration, data security, and workforce readiness. It advocates for clear roadmaps, robust cybersecurity measures, and employee up skilling as key strategies to navigate digitalization effectively. Prestige's work offers valuable insights into how companies can overcome obstacles and harness the potential of digital technologies in the energy industry.

Researcher Desscution

Strengths of the research include defined difficulties, such as the use of technology in work and the presence of suggested approaches to solve them, including the use of digital transformation maps. Nevertheless, literation weakness can be attributed to a limited scope in terms of the depth of the implementation plan concerning the presented ideas.

Independent Variable: Digital Transformation

Introduction The research area of digital transformation (DT) has gained increased attention in strategic information systems (IS) research as well as in practice in the last years. Broadly defined, DT incorporates the societal and industry transformations that are pervaded by digital into society. On the organizational level it has been stated that in order to work with these technologies, the firms have to develop the strategies that will embrace the essentials of the digital transformation and better operation results. (Vial, 2019)

According to (Stolterman, 2004)): Digital transformation refers to change processes related to the use of digital technology in various spheres of social life. According to (Westerman, 2011) : "Digital transformation is the utilization of technology to significantly enhance the operations or extend the scope of entities". According to (Hinings, 2018): According to Boudreau and Bodoff, digital transformation is the accumulation of multiple digital advancements that create new actors or actor constellations, new structures, new practices, new values or beliefs which alter, challenge, replace or supplement existing rules of the game in organizations, ecosystems, industries or fields. Therefore, digital transformation can be defined as the change that goes along with the usage of digital technology to cause a fundamental shift in a way of working and to meet the needs of a wide range of beneficiaries more effectively. Going beyond the definitions used by schools…It is a coordinated process of change in the functioning of an organization, mainly to optimize administrative tasks and the quality of these tasks and their result–to achieve the level of digital readiness (Obaid)2019.

Generations of Digital Transformations

According to (DANIEL SCHALLMO, et al., 2017) the development of digital transformation can be categorized into: Late 1970s; Computer-aided design and manufacturing is introduced which was the first step toward digitalization in organizations 1980s: Enterprise resource planning systems are implemented to make organizations more efficient by eliminating the paperwork process.

In recent years: That is, there is a return to digital initiatives through such factors as online selling as organizations look for ways of attaining competitiveness in the global business environment. This idea has been present in corporate and managerial approaches for a while now, and yet the notion of time-sensitivity increases.

Digital and Sustainability

The Business Areas of Unified Data, Analytics, and Digital frameworks lead to Business and IT alignment, direct Customer Experience and Operational Processes. Thus, boost the efficiency and profitability and cut costs. An example on how Digital capabilities influences-the Customer. Several aspects mentioned within the mentioned framework like representative customer processes, cross-channel unity of communication, Self-service, Performance Improvement, workers are able to work Anywhere Anytime with broader and faster communicating power, such

Operational Transparency, physical to digital transition and Enterprise Integration actually also affect the Sustainability aspect of doing business . (VIKAS, 2015)

Dependent Variable: Oil Production

Introduction

Hydrocarbons found freely under the surface of the earth as thick, heavy liquid which is flammable, petroleum is a complex chemical compound formed over 600 million years of decay of plants and animals. Petroleum formed from microscopic plankton which formed fossil oil trapped under sedimentary rocks before it was converted to the reservoir due to heat and pressure. The term petroleum may have come from the Greek words “Petra for rocks and elaion for oil” or from Medieval Latin in which “Petra for rock and oleum for oil. In earlier time, it was used to paint arches, the sides of the boat, and the soot as a fire weapon with the use of lens and as a source of light. A few decades ago, the fire of the Delphi oracle and the Chinese burning natural gas for boiling water around 500 BC can be mentioned among prominent examples (Jurandir Primo, et al., 2020).

Oil Production Concept

As denoted by OECD, 2016, it defines the extraction of crude oil well from the subterranean formation to the earth’s surface within a commercial oil field as the upstream sector of the oil industry has considerable impacts on the energy, transportation, manufacturing, and trade industries. The volumes of oil production and supplies affect international and domestic systems including employment, investment, government earnings, and of payments.

Oil Production is Important for Several Reasons:

1. Employment and Economic Growth: The industry provides employment opportunities through employment both in the newly established exploration and extraction companies, refineries, transporters and distributors of the oil. See Akinyemi Christopher, et al., October 2023.
2. Energy Security: Oil production goes hand in hand with energy security for countries thus allowing countries to supply energy to the domestic market hence avoiding supply from the foreign market. (Khatib, 2000)
3. Government Revenue: This sector is a source of substantial revenues for the governments of oil-producing countries through taxes, royalties, and licensing fees paid in connection with production of oil and can also be used for public investment and development of infrastructure and social services. (Sunley, .,2003)
4. Trade Balance: Exporting oil can be beneficial for the countries that export oil as it helps to balance the trade deficits because export oil earns them foreign currency which can be used to import other goods that are needed by its citizens. The current study (Umar Bala, et al., February 2022)
5. Industrial and Agricultural Inputs: Petroleum products are a major input in many industries for example manufacturing industries, transport industries and even in agriculture. (Goke Lalude, 2015)

The petroleum industry is organized into the following four broad segments:

Exploration and Production: Exploration and Production (E&P) is the process of obtaining natural gas and crude oil through exploration and, well preparation, and drilling' . Seismic techniques define the prospects with drilling being used to check on the existence of a reservoir.

Specialty muds are used in drilling, while other cuttings are either re-used or removed. There is well testing for potential gas or oil flow for specifications and in completed wells there in an outer annular casing. Production control is done in the use of a "Christmas tree" of high pressure valves. Some of the older wells may have to be offered artificial lift in order to continue to produce some oil.

Processing: Following recovery of hydrocarbons thus from underground reservoirs, field processing is mandatory to address corrosion and subsequent accommodation. Initial processing consists of the fact that produced oil, gas and water, are initially separated from each other by a two-phase or three-phase separation depending on the presence of liquid hydrocarbons in the process. Both vertical, spherical, or horizontal separators use baffles in order to separate gas from liquid hydrocarbons. To determine the type of separator to be used the gasto-liquid hydrocarbons ratio is used where, for large numbers, horizontal separators are used and for small numbers vertical is used while for medium numbers spherical separators are used. Wellhead pressures might be high to a level that sometimes sequential operation, using separators of reduced pressures, becomes necessary. Whereas separators provide only one separation stage, further processing may be required for the separation of water and/or gases from oil emulsion. Oil Processing Water may unintentionally end up in the oil and this can form an emulsion.

Storage and Transport: Crude oil and also natural gas fluids have to be stored in storage tanks to facilitate their transportation; and other fluids such as water, brine and other materials, which are produced along with oil and natural gas, must also be stored in similar storage tanks. Crude oil is Hauled to refineries by tank trucks, rail cars, tankers, barges, pipelines and inside pipelines by splash or bottom loading. Natural gas mostly uses pipelines in its transportation. Pipeline operations referred to as pigging involves the use of physical devices known as pigs of different sizes and substance as in product transfer, separation, and maintenance. Pigs can be solid, inflatable, foam or gel depending with the pipeline and operation intended for them. There are mainly three types of pigging operation: product transferring, product transferring for multiple products and other functions like cleaning and gauging. A compressed gas such as nitrogen is used to push a pick – looking like a pig – through the line and captured at the opposite end while in some cases waste is a factor in judging the effectiveness of the pigging operation. (Eastern Research Group, sep 1999)

Three Major Challenges for the Oil & Gas Industry

The oil and gas industry is grappling with three major challenges: reducing cost, improving performance of assets, and concerns of the environment.

1. Cost Reduction: In order to maintain a competitive position, crude oil and refined products are being produced more efficiently. Here there is an emphasis on the rationalization of production systems and environmental utilities at established locations that enable a reduction in extraction and refining costs in order to recover the costs of exploration.
2. Asset Performance Optimization: As the market saturation begins to impact revenues from younger sites and firms look to squeeze additional value out of more mature assets and address complex extraction sources, many are pushing for total reliability in their plants. Such strategic enablers are; Reducing plan losses, increasing rate capacity, and protecting industrial stock so as to obtain a steady supply.
3. Environmental Sustainability: The porter's force of the industry is that there are many imposed pressures towards the environment, especially in areas related to water and

energy. Organizations have to reconsider existing patterns of extraction and creation of goods, as well as the ways they deliver these goods to market to meet the standards in order to remain in operation. This entails, ensuring and ensuring transparency in management of the environment and meeting some strict requirements like for instance, proper quality sewerage discharge questions in areas of significant concern like Beijing, China. (avenue, 2016)

The Effect of Digital Transformation (PLT) in Oil Production

Introduction

The use of technology has transformed different industries, and oil production industry is not an exception. As a result of innovations in technology, activities in oil production have enhanced in efficiency, cost and security. Among the elements routinely practiced and experienced during this transformation process is the use of Production Logging Tool (PLT) software. (Sharma, 2020)

Production Logging Concept

logging tools are run. The measurement related to the production logging tools, involves a wide variety of sensors and measurements tools. This technique has also incorporated interpretation tools which help to determine the formation properties, study the mobility of formation fluids within and around the well bore and estimate the production flow rate for each layer of the formation. (Davarpanah, et al., 2018)

Brief about the Development of PLT

Production Logging Tools (PLT) have played important in oil production since the mid of the 20th century where assessment was done through wireline tools down the hole. These advances culminated in complex PLT equipment absolutely necessary for characterization of the reservoir and enhancing production rates in conventional and particularly, in the unconventional resources. Interestingly, the integration of the new technologies within the PLT environment is also presenting data monitoring and visualizations, predictive analysis for improved decision-making and safety. Today PLT is still important globally, assisting to increase the recoveries of hydrocarbons, lessening costs and helping to maintain the reservoirs. There are the signs of continuous progress in technologies, so the companies expect to gain even higher efficiency in the future. (Shad, et al., May 28,2015,)

In production log it is different from other logs. Several geophysical logs are carried out in the well to measure some properties before production began and during exploration as well as development stages. Production logging is one of the techniques of cased hole logging. This is the logging procedure used to obtain well bore fluid data while in production or injection . If the wellbore has been successfully drilled and,

Typical PL Program:

Shut-In conditions

Perform passes at different speeds across the interest that the well be static that we will make several passes at several speeds and it will maintain constant speed.

- interval of interest
- Perform spinner calibration

The well gives measurements in RBS, but in reality we do not need RBS, but rather a linear velocity. This spinner will help us convert rotate velocity to linear velocity, and this is what we will need, which is the velocity of the fluid.

Determine fluid levels:

We can know the levels of water, gas, and oil,

- Detect Crossflows.
- Flowing conditions

Wait for stable flow

- pressure, spinner, density

Log interval of interest (passes up and down at different speeds)

- Perform spinner coloration
- identify flowing profile & cross-flow
- identify fluid entries

Log stations if requested

When opening the well for production, we need to reduce the flow to have a stable flow by observing the pressure sensor and also the Timber Density spinner. We see if the pressure is stable. After that, we can start pumping at different speeds.

In this case, the purpose of this look is to know the profile to help us with spinner calibration

Production locating tool used in most jobs: (Rider, 2002)

Gamma ray / ccl tool	▪ GR/CCL is run as the combined for depth correlation. ▪ Compatible for SRO and Memory tool ▪ Monitors cable head voltage ▪ Electronic identification of serial number and tool type.
ACOUSTIC DENSITY TOOL	▪ Record the wellbore fluid density ▪ High resolution vibrating, tuning fork senso ▪ Independent of well-bore deviation ▪ Non-radioactive fluid density measurement
FLUID DENSITY RADIOACTIVE	▪ Record the wellbore fluid density ▪ High-resolution vibrating tuning fork sensor ▪ Independent of well-bore deviation ▪ FDR uses a low energy Americium-241 gamma ray source with radiation levels approaching background at a distance of one meter from the tool. ▪ The shielded tool has been designed to be immune to the effects of radioactive scale and the very high count rates provide excellent statistics.
ACOUSTIC DENSITY TOOL (High-resolution)	▪ Record the wellbore fluid density. ▪ High-resolution vibrating tuning fork sensor ▪ Independent of well-bore deviation ▪ Non-radioactive fluid-density measurement
FLUID DENSITY RADIOACTIVE (FDR)	▪ Record the wellbore fluid density ▪ High-resolution vibrating tuning- fork sensor ▪ Independent of well-bore deviation
	▪ FDR uses a low energy Americium-241 gamma ray source with radiation levels approaching background at a distance of one meter from the tool. ▪ The shielded tool has been designed to be immune to the effects of radioactive scale and the very high count rates provide excellent statistics.
FLUID CAPACITANCE	▪ Used as part of fluid identification ▪ Compatible with memory logging system ▪ Cylindrical fluid capacitance sensor
QUARTZ PRESSURE AND TEMPERATURE	▪ High resolution quartz sensor ▪ Fast response external temperature probe
FULL-BORE SPINNER	▪ Spinner collapses to run through tubing and expands to larger diameter in casing ▪ Small, medium and large diameter kits available ▪ Bow-spring conversion kit available ▪ Easily replaceable blades
INLINE SPINNER	▪ Quick and easy access to bearing and blade mechanism ▪ Can be placed anywhere in the tool string ▪ Run in combination with a full-bore spinner to obtain production profiling in a single logging run

Fluid Velocity Measurement:

coefficient of the spinner bearing friction factor on three factors:

- Fluid velocity
- Fluid viscosity
- Friction factor of the spinner bearings

The high velocity of the fluid increases the relative speed while low friction between the bearing elements brings out an increased relative speed. Correction of velocity is required because friction factors and viscosity of the fluid affect the velocity values to be obtained. As a result of correction of the relative tool speed, the spinner velocity is used to determine the absolute fluid velocity. True velocity of a fluid doesn't equate the average speed at which the fluid is flowing through the pipe because of the friction that is involved. Spinner speed is converted to average speed by use of computer modeling while correction factors are applied.

There are three types of spinner flow meters:

1. Full bore spinner flow meter: It does not localize to the area across the pipe cross section and is usually set at the lower end of the production logging tool string. It flows less than 40% of the casing cross-section and does not have a progressive pitch.
2. Continuous spinner flow meter (or tubing spinner): This type has progressive frequency which again serves the purpose of extracting energy from well fluids.
3. Mini spinner flow meter: Particularly used in horizontal wells with the intent of calculating the rate of flow of fluids in the vertical plane of the pipe.
4. Spinner flow meter comes in different types and each type is used for different purposes depending with the well condition and logging. (Colin, 2013)

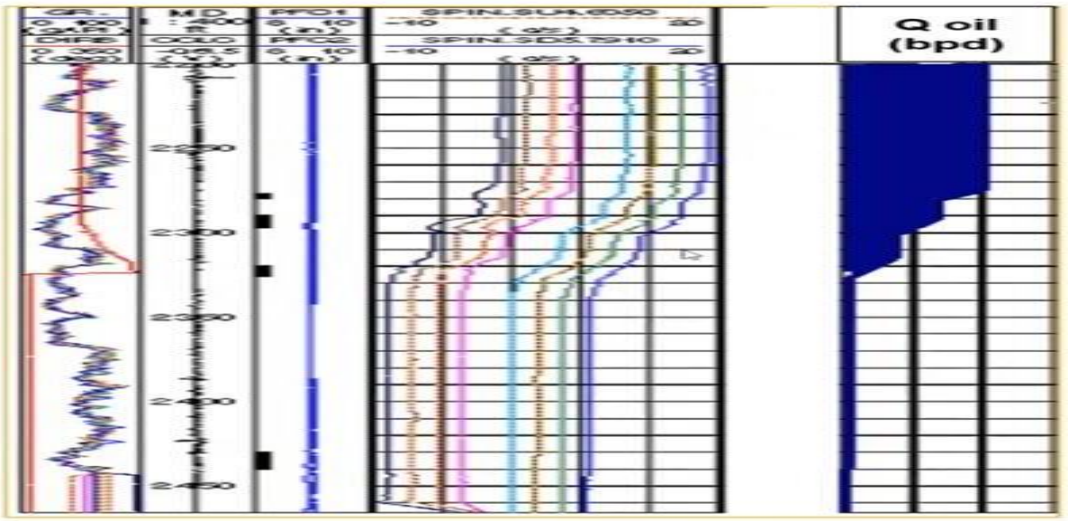


Figure 2 Show the Data of Fluid Velocity Measurement

Fluid Density Measurement

Density measuring forms an important and integral part of the production process. measurement, for instance measurement of mass per volume or volume to mass. The Gradiomanometer is a non-

hazardous instrument that has a differential transducer of improved resolution, which is used by some firms such as schlumberger for this. purpose.

PLT Operation Overview and Delivery:

PLT Pass: is the data set acquired during running the PLT string in the hole.

Peebler present the "Multipass Interpretation Method" in 1982. (may refer to "Production Logging Theoretical and Interpretive Elements. (aldrich, 2018). Based on this method, industry usual practice require at least 6 passes (3 in Up Direction and 3 in Down, Direction), each pair at different speed to have robust PLT data analysis with low statistical error during spinner calibration analysis. The presented animation showing the acquire of two passes across the perforated casing, the first in down direction and the second in the Up direction.

So to have the full data will repeat the passes again at but at two different speeds.

PBU / PFO Recording: Then the well will be Shut-in and the tool static above the perforation at agreed.

Addressing Limitations of Production Logging Tools (PLT) in Digital Transformation for Oil Production: A Comprehensive Discussion

In the context of Afshin Davarpana, et al., on 5 December 2017, the PLT or production logging tools has become one of the essential things in implementing the new change of digital and sophisticated mechanism for handling the production of oil and oil resources that is also dealing with the task of wellbore management. Admitting that there are merits of it, let us consider certain drawbacks of implementing PLT to prevent unwise usage of this method. This section further presents an understanding of the limitations of PLT in a detailed discussion and enlists aids from other sources to enrich the understanding of Research.

Privacy and Security Concerns

As stated by Balasubramaniam .S, et al., January 2014, the gathered wellbore data are thereby ambiguous on issues of privacy and security that come with the accumulation and storage of sensitive information. Mobile tools like PLT systems offer accurate information on flow rates of the formation and wells, the formation properties as well as well integrity and this data is sensitive and can be exploited in the wrong way. To avoid such risks, adequate protective measures must be put in place and practiced in regard to data. Data Security Measures: Adopt advanced methods of security such as encryption to enhance the security of the data both in transit and in storage. It is also important to employ the widely-used encryption methods such as Advanced Encryption Standard (AES) to protect the confidentiality of information. There should also be mechanisms of accessing the data to ensure that only the right people access the PLT data as per their responsibilities, roles, and need. Implement RBAC systems of access control to give access to users based on the roles they play in organization. Policies for Data Storage: It is advisable to set definitive and stringent policies regarding the period, during which the data of PLT is retained. Meet the dilemma of what to do with data that is no longer relevant to an organization so as to reduce the risks that come with storing information.

Algorithmic Bias in PLT Analysis

As noted from (Moritz Hardt, et al., 2016) PLT systems can utilise machine learning (ML) and artificial intelligence (AI) for the analysis of the wellbore data in order to make conclusions. However, using these algorithms may bring in biases that cause producing wrong or even prejudiced results.Training Datasets: It is also important to train algorithms with different and more relativity datasets to avoid favoring a specific dataset or having a biased dataset algorithm. It is important to ensure that these datasets span various wellbore environments, the qualities of the fluids and geological formations. Bias Mitigation: Use bias mitigation techniques to detect for bias in order to reduce the bias in ML models. Incorporate statistical measures or tests, or employ indicators that seek to detect unfairness when evaluating the model's fairness.

Human Oversight: Incorporate human oversight into decision-making processes. Provide the AI-derived results to subject them to further review and validation to ensure that the recommendations that power real-time operations are not influenced by the presence of bias.

Environmental Impact of PLT Technology

As stated by Gary A Knight, et al., 2000 parameters of PLT operations involve energy expenditure to power downhole tools as well as data transmission. This energy consumption may have impacts on the environment especially where there is limited or renewable energy. Several tools have been used, such as energy efficient PLT tools and limiting/optimizing data transmission protocols. Solutions for extension are options such as low-power electronics and compression of data transmission. Renewable Energy Integration: Incorporate renewable energy utilizing the utilization of solar or wind energy to power operations of Plantation timber Limited. This can help in depletion of fossils and thus lessen an impact on the environment Waste management: Adopt proper measures of waste disposal for some of the PLT composites such as batteries and electronic equipment. They should use recycles and other proper approaches to disposal with a view of reducing the impact it will have on the environment.

Comparison with Alternative Production Optimization Methods

According to PLT is not the only method for production optimization. It is crucial to compare PLT with alternative techniques to determine its suitability for specific applications.

Generalizability to Other Industries

By adopting certain principles and technological platforms of PLT, it is evident that it has the potential to be applicable in industries where production follows systems thinking. Product Industry: Determine industries with related production problems; these include mining, manufacturing, and chemical industries. Discuss on the likely possibility of applying PLT concepts and technology on those sectors. Applying the above factors affects an organization in one or the other: Case Studies and Research Examples: Include case studies and/or research examples that show how the principles of PLT apply to various industries. This can certainly be useful for understanding the possibilities for the transfer of PLT technology.

PLT vs. Alternative Production Optimization Methods: Detailed Comparison

Production logging tools (PLT) have helped to changes the way well drilling and management and also production optimization in the oil and gas industry. However, a greater understanding necessitates the comparison of the PLT with current advanced and other technologies. going into

this concept further, this section provides more information as well as references to use in your study.

Traditional Production Improvement Techniques:

Well Testing: Well testing is quite simple whereby a particular well is closed and allowed to flow in order to take pressure, production rate and formation fluid data among others. However, while being cheaper and easier to use as compared to PLT, well testing is not very informative. (Greg D. Frazier, et al., 1984)

Reservoir Simulation: The technique of reservoir simulation entails developing fluid models of reservoirs and using the computer to simulate the behavior of the reservoir over time in the production process with reference to the manners in which the fluids and pressure vary and the mode of production used. This technique is beneficial when comprehensive long-term planning of reservoir's performance is required, but its implementation is time-consuming and highly sensitive to the geophysical and reservoir engineering data. (Michael S. Arnold, et al., JUNE 01 1990)

For this reason, the experience as well as knowledge possessed by the engineers is paramount in enhancing efficiency in production. It also allows the experts to quickly go through the well data, production trends and characteristics of the reservoir that could be of a problem and come up with possible solution. However, inconsistency and subjectivity also do come in these exercises as a result.

Table 6 Comparison of PLT with Traditional Methods

Feature	PLT	Well Testing	Reservoir Simulation	Expert Judgment
Data Acquisition	Real-time or memory	Short-term, discrete measurements	Long-term predictions	Historical data analysis
Data Detail	High-resolution, downhole measurements	Bottomhole pressure, production rates	Reservoir pressure, fluid properties	Interpretation of well data
Cost	High	Moderate	High (computational resources)	Low
Applicability	Complex wells, troubleshooting	All well types	Long-term planning	All well types

Emerging Production Optimization Technologies:

The general understanding of how to improve production has changed as time goes on. Some possible options that can be considered:

- Distributed Acoustic Sensing (DAS): DAS operates an optical cable which can be permanently placed in the wellbore and it measures the sound waves produced by the fluids flow. This technology involves constant stream of data for the diagnosis of the well bore and advancement of production optimization. (C. F. Alcocer, et al., March 10 1988)

- Downhole Measuring Instruments: These instruments include permanent downhole flow meters which give continuous flow rate and characteristics of the fluids and enable production to be controlled and managed in real time. Besides, the information which is indicated by these tools offers a possibility to avoid traditional well testing. (Berridge, May 02 2011)

Choose the Correct Method:

Optimization of production technology is relevant from some very important factors:

Wellbore Complexity: PLT excels in complex wells with multiple zones or difficult flow conditions.

Thus, the objectives of the project are as follows: Project objectives For the initial evaluation of wells, well testing is appropriate, while reservoir simulation is useful when it comes to the long-term planning. PLT is especially suitable for complex production enhancement and problem solving.

Budget Constraints: As a result, less complex layouts tend to be more cost effective when undertaken by conventional methods while complexity of compression diagrams makes PLT systems beneficial as the areas point toward potential production increases to justify the cost of investment.

Thus, PLT has the potential of enhancing production and, in general, permutations of it with other conventional and innovative approaches need to be synchronised more systematic. When a professional understands the limitations of those techniques and scenarios where they can each be effective, he or she will be in a better position to select the best way to enhance a well performance as well as maximize the production.

Exploring the Practical and Commercial Implications

To understand the performance of production logging tools (PLT), it is essential to have basic technical knowledge but there are also fundamental, practical and commercial factors that need to be analyzed as well. This observation is discussed further in this section where some implications are presented along with the integration of sources to support them.

Financial Benefits:

Higher Production and Revenue: This is due to the fact that with the help of PLT engineers, they are able to identify slow production areas and thus increase the rate of oil and gas extraction. This leads to more revenue streams for companies operating in the oil and gas industry.

Better Operating Efficiency: Stabilizing a good level of performance means less time spent unstable on plant and machinery and thus less cost to the overall operating cost.

Optimal Well Asset Penetration: Through the application of PLT, crucial information about the well and reservoir integrity can be obtained to extend the life of the well and develop the fields effectively.

A Comprehensive Exploration of Production Optimization, Problem Detection, and Cost Reduction

In the dynamic world of the oil and gas industry, production logging tools (PLTs) have emerged as a transformative force, revolutionizing well management and optimization strategies. Capable of collecting high-resolution, real-time data from deep within the well, these advanced tools have

become indispensable assets in identifying and addressing issues that can hinder production and increase costs. Production Optimization: Maximizing Output and Revenue

Cost Reduction: Streamlining Operations and Enhancing Profitability

The impact of PLT goes beyond improving production and detecting problems, as it directly contributes to reducing costs and enhancing profitability. By enabling proactive decision-making, reducing downtime, and extending asset life, PLT plays a critical role in streamlining operations and reducing overall costs.

Optimized Production: Increased oil and gas recovery rates, a direct result of PLT-driven optimization, translate into higher revenue streams and lower production costs per barrel. This improved efficiency directly impacts profitability.

Reduced Operating Expenses: Proactive well management strategies facilitated by PLT data reduce unplanned downtime and the need for costly interventions. This reduction in operational disruptions results in lower overall operating expenses.

Extended Asset Life: Asset management strategies supported by PLT can extend the productive life of wells, delaying the need to abandon costly wells and increasing the return on investment in well development. This extended asset life contributes to cost savings and long-term profitability.

Case Studies: Real-World Examples of PLT-Driven Success

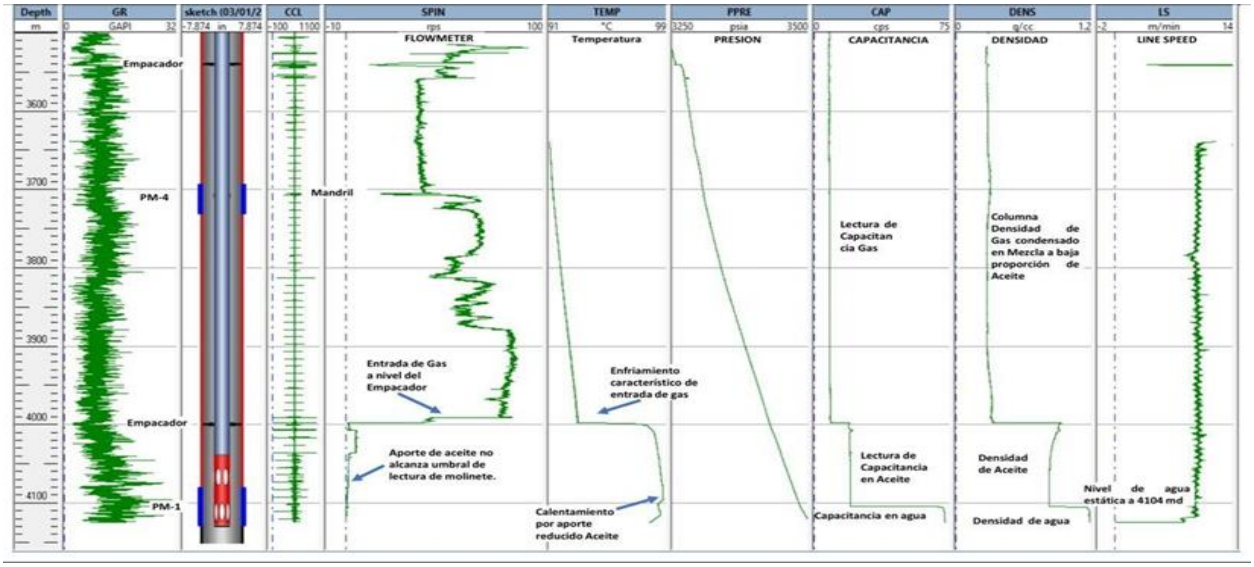
The transformative power of PLT is not just theoretical; it has been demonstrated in many real-world applications in the oil and gas industry. These case studies serve as a testament to the tangible benefits that PLT can deliver.

- ExxonMobil: In its Permian Basin operations, ExxonMobil used PLT to identify and address reservoir anomalies and bypass pay zones. This improvement resulted in significant production increases and cost savings, highlighting the ability of PLT to improve well performance.
- Shell: Shell used PLT to detect and repair reservoir channels in Deepwater fields. By identifying and addressing these flow anomalies, it was able to improve production and reduce fluid loss, resulting in significant cost savings.
- BP: BP leveraged PLT to monitor the performance of downhole equipment in its North Sea operations. Early detection of equipment failures prevented costly breakdowns and production shutdowns, significantly reducing operating expenses.

A Catalyst for Transformation

Production Logging Tools (PLT) have emerged as a transformative force in the oil and gas industry, revolutionizing well management, optimization, and cost reduction strategies. By providing high-resolution, real-time data from well conditions, PLT enables engineers to

Interpretation Example:



Wellbore Schematic and Track Labels:

Depth Track (GR): This track illustrates the Gamma Ray readings with respect to the wellbore.

CCL / Spinner Track: It would not be surprising if this track shows both CCL (Cement Bond Log) and Spinner data. CCL readings can also define the quality of the cement sheath between the casing and the formation. The spinner data, indicated by the blue curve, gives the pattern of the fluid velocities within the wellbore.

Temp Track: This track marked downhole temperature.

Pressure Track (PPRE): This track reveals how the overburden pressure is distributed along the wellbore.

Capacitance Track (CAP): This track probably corresponds to measurements of capacitance which can be used in measurement of water cut (the percentage of water in the produced fluids).

Density Track (DENS): This track indicates how the density of the hydrocarbon changes with depth recorded at the well bore. Density of the fluids can also be used to distinguish between the type of fluid within the reservoir which maybe, oil, water and gas.

Zone Analysis:

Zone A (3600 ft - 3800 ft):

GR: Using the GR log it can be seen that the characteristic pattern for this formation might be identified in this zone aiding in geological identification.

CCL/Spinner: The spinner data also appears to have a high and fairly steady velocity, implying good flow contribution from this sub area. This is positive factor for well bore productivity.

Temp: The temperature log may indicate a slight rise in temperature in this zone, which can be attributed by the flow of warm formation fluids characterizing oil production.

PPRE: The pressure profile may indicate a relatively constant buildup of pressure in this zone.

CAP & DENS: A low capacitance reading and a high-density reading in this zone would imply in low water cut (oil) and may be used to explain oil production from this zone.

Zone B (3800 ft - 4000 ft):

GR: It would be seen that there is a difference in the GR log visible in the GR plot with respect to Zone A, which also suggests the incidence of formation change.

CCL/Spinner: Spinner data reveals lower velocity than that of Zone A, which implies a decrease in flow contribution from the current spinner data zone. This could be due to lower formation permeability, or there are restrictions in flow which are caused by some other factors.

Temp: In this case, based on the Temperature log a decrease in temperature in this zone may be observed because cool fluids from this zone invade into the well bore perhaps water influx from a zone which has been bypassed.

PPRE: The pressure profile could even depict a decrease in pressure in this zone, which may be attributed to the restrictiveness of the flow by formation damage or difference in formation permeability.

CAP & DENS: If a higher capacitance reading and a lower density reading were obtained in this zone, it will indicate that the water cut (water) is high and may be used to explain water influx in this zone.

Zone C (4000 ft - 4100 ft):

GR: The GR log response in this zone can decide whether this zone belongs to the same formation as Formation 2, Zone B or a new formation at all.

CCL/Spinner: Spinner data exhibited values that can be potential higher velocity than in Zone B. This may be due to more flow contribution from this sector or fluid influx from an inactive sector.

Temp: Temperature record may reveal a slight rise of temperature in this area, however, further examination is required in order to identify the cause of the temperature fluctuation.

PPRE: The pressure profile may illustrate another pressure drop in this zone that can be attributed to restrictions of the flow or the fluid kick from a channel bypass.

CAP & DENS: Interpretation of the capacitance and density logs on this zone is very important in the determination of the nature of the fluid incoming in the wellbore. A high capacitance reading and a low density reading implied that there was water influx while a low capacitance reading and high density reading pointed towards oil production possibilities in a bypassed zone. But it might be necessary to make deeper inquiry to distinguish between them.

Important Considerations:

Data interpretation of PLT is usually difficult and involves integration with data from other logging devices (pressure logs, temperature log, capacitance log, and density log) and well completion data.

Production logging data would best be interpreted in conjunction with geological data ‘ reservoir fluid properties ‘ well completion details.

It would be advisable for one professional to come up with an interpretation of the PLT data based on all the data and well history as possible.

Therefore, it can be conclude from the analysis of the PLT data that Zone A might be a good producer and Zone B might be contributing less due some reason such as water influx or formation.

In general, the foregoing analysis of the PLT data offers useful information on down hole wellbore activity.

Data Analysis and Findings

attempts to describe the research findings using some statistical techniques and instruments on the research variables and their paragraphs in terms of frequency, percentage and arithmetic means for the purpose of ascertaining the level of response of each of the variables and their paragraphs as well as the standard deviation, which gives an indication of dispersion of values in relation to their mean values. In the research, the descriptive statistical analysis was used. Concerning the quantitative method, data was collected through a self-developed questionnaire form completed by the realizes through the use of a five-point Likert scale and statistical means to establish the results. The researcher mainly used the form of a questionnaire because the current questionnaire is made with the necessary elaboration, which defines the research and its hypotheses, and is applicable to the field of descriptive studies in general in the selection of tools.

Questionnaire Analysis

A quantitative research instrument in the form of questionnaires was used; the link to the Electronic questionnaire was sent to the Weatherford and Shlemberger company which yielded 56 response.

Demographic Analysis

Google forms were used to present the study sample from a demographic point of View based on percentages, as follows:

Gender

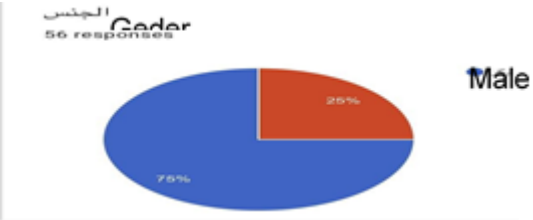
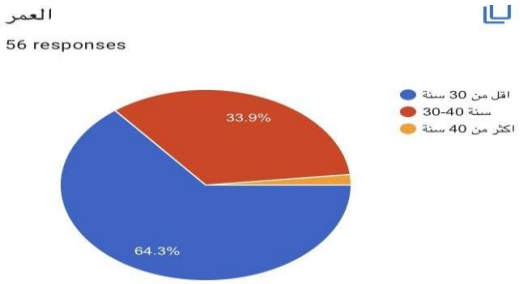


Figure 3 shows that the percentage of males in the research sample was (75%), while the percentage of females was (25%), which indicates a low percentage of females taking up positions in the IOTC

Figure 3 Shows The Sample gender

Age



The results of the questionnaire showed that the majority of those included in the questionnaire were in the age group less than (30 years) with a number of (36) and a percentage of (64%), then followed by the group (30 to 40 years) with a number of (19) Withal percentage of (33.9%), then the category (over 40 years) with a number of (1) and a percentage of (1.8%):

Position

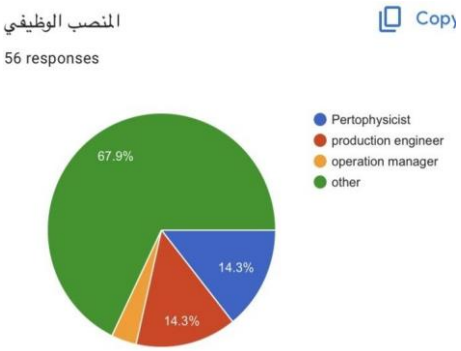


Figure 5 shows that the number of operating managers was (2), at a rate of (3.6%), while the number of production engineers was (8), at a rate of (14.3%), while the number of petro physicists was (8), at a rate of (14.3%). Finally, other positions were the largest in number 38 and rate 67.9%:

Experience

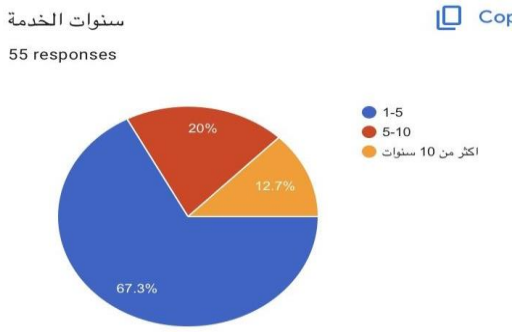


Figure 6 shows the number of those with a number of years of (more than 10 years), which was 7, at a rate of 12.7%. For years (5-10), their number was (11), at a rate of (20%). The largest number was for the number of years (1-5), at a number of 37, at a rate of (67.3%):

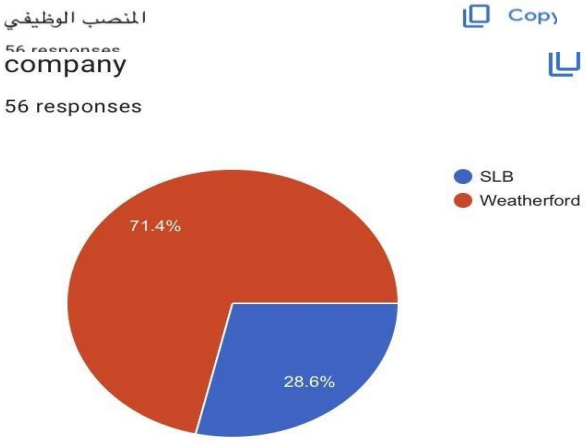


Figure 7 The number of responses from SLB Company was (16) with a percentage of (28.6), while the largest response number was from Weatherford company (40),with a percentage of (71.4%) :

Describe and Evaluate Responses to the Digital Transformation (Independent Variable)

Presenting and analyzing the sample's views on digital transformation indicators as the research sample: This paragraph attempts to present The statistical results on the digital transformation variable (independent variables) for the research sample are as follows:

Questions

Questions	Answer scale					Mean	Std. Deviation	ASST.
	I don't agree at all	I don't agree	Nutral	I agree	I completely agree			
Digital transformation helps a company improve the ability to innovate and apply new technologies	-	1	1	6	47	4.80	0.562	STRONG AGREE
Digital transformation in PLT increases the ease of access to and analysis of data	-	-	-	13	41	4.76	0.432	STRONG AGREE
Digital transformation in the use of PLT tools improves the flexibility of operations	-	-	1	13	40	4.72	0.492	STRONG AGREE
The use of digital technology contributes to expanding the range of data available for decision-making	-	-	1	6	47	4.85	0.408	STRONG AGREE
Digital transformation contributes to improving communication between the company's technical and administrative teams	-	-	2	10	42	4.74	0.521	STRONG AGREE

Analysis of the Results

In the first question, the result shows that the average answer is: (4.80) The t-test shows significant at p-value of 0.000, the ASR is 4.80 and the standard deviation: 0.562, on the other hand the

evaluation records high results with high agreement. This result supports the idea that one of the key areas contributing to digital transformation is valuable towards the company's capacity in innovativeness and the use of technology. New opportunities can be found and innovations can be implemented faster and more effectively hence the following sample opinions on the digital transformation variable ideas The result is that the company can be more competitive in the market and more capable of adapting to changes in fast moving industries. employees can discover new opportunities and implement innovative faster and more effectively Table 7 Sample opinions on the digital transformation variable ideas This contributes to enhancing the company's competitiveness in the market and enhancing its ability to adapt to rapid changes in the industry. Furthermore, technology assists in enhancing better method for producing products, which also enables the company to find other ways of expanding its revenues. In the second question the mea while was calculated to be 4.76 and the standard deviation 0.432. Regarding the evaluation, there were good consensus. This analysis gives credence to the fact that it has to be made easier to address the issue of space, time and effort in the analyses of data. When there is a well-coordinated digital system, then each employee is able to find the information he needs without much delay or mistake. These situations can be identified to enable strategic decisions to be made more quickly and accurately without compromising the organizational effectiveness of business ventures. For instance, using available data, a company may be able to determine some operations that can be well done while others require enhancement. Similarly, in the third question, the average answer was calculated to be (4.72), standard deviation was (0.492) and there was strong agreement with the evaluation. According to this analysis, one gains a finding that digital transformation improves flexibility of operations hence better use of tools like PLT. The observed digital integration facilitates the adaptation of processes at the use of tools in response to the environmental or customers' needs. This change in flexibility may enhance the effectiveness of operations as well as the cost of production, innovation and change can be made easily depending on market conditions. In the fourth question it was revealed that the average response was 4.85 and standard deviation was 0.408. For the evaluation though, there was compounded consensus. This analysis reveals that workers have a very high level of confidants that the scope of the available data strengthens when digital transformation which in-fatly makes strategic decision making easier. Whereas, when additional data is available a company can make more refined choices and can gain improved insight in terms of market or customers. This information is invaluable in enhancing the business's management plans including product variation, starting new markets that help the business expand and make higher profits. In the fifth question, it was found that the average answer was (4.74), the standard deviation was (0.521), and the evaluation was: strong agreement. From this analysis, it is clear that digital transformation leads to better communication between the technical and administrative professionals leading to co-ordination in the delivery of tasks. It can accelerate development and design, enhance direction of the manufacturing process as well as production planning and schedules thereby enhancing the performance delivery of a firm.

	Questions	Answer scale					Mean	Std. Deviation	Asst.
		I don't Agree At all	I don't agree	Neutral	I agree	I completely agree			
Problem detection	The use of digital production recording tools con tributes to accelerating the process of discovering problems in oil production operations	-	-	4	7	43	4.72	0.596	Strong agree
	The digital transformation of production tools reduces the time spent identifying production problems	-	-	1	12	40	4.72	0.492	Strong agree
	Digital tools improve technical teams' ability to identify and solve problems	-	1	1	9	43	4.74	0.589	Strong agree
	The use of digital tools facilitates the process of better monitoring and verifying errors	-	-	3	10	41	4.70	0.571	Strong agree
Cost reduction	Digital tools improve a company's ability to predict potential problems and act effectively to avoid them	-	-	1	11	42	4.76	0.473	Strong agree
	Digital production recording tools reduce overall maintenance costs	1	6	4	8	35	4.30	1.127	Strong agree
	The use of digital production recording tools contributes to reducing daily operating costs	-	5	6	12	30	4.26	0.994	Strong agree
	Digital tools improve planning and scheduling of operations	-	1	6	7	40	4.59	0.765	Strong agree
	The digital transformation of registration tools contributes to improving the efficiency of using human resources and reducing labor costs	-	5	2	9	38	4.48	0.947	Strong agree1
	The use of digital recording tools reduces waste resulting from operations	1	1	4	10	38	4.54	0.862	Strong agree

Problem Detection

In the question (6), the mean was (4.72) while the standard deviation was= (0.596). The degree of agreement level of the expressions where the workers stated that the use of the digital recording tools causes such an impact on the discovery of problems in the oil production operations, was strongly agreed. This means that with the use of digital tools in organizations the chances of identifying issues are easily marked, this is because oil industry is very sensitive to issues and any hold up in the process could also mean losses.

In the question (7), average was (4.48) and standard deviation was (0.947). This analysis shows that digital transformation of recording tools impact positively on efficiency use of human resources, and the cost caused by the use of labour. It also shows that digital tools save time consumed to solve issues in Production in other words increases Production efficiency as well as minimizing on time not well planned for that is called time loss.

The results of the question (8) are the mean is equal to (4.26) and the standard deviation is equals to (0.994). This result demonstrates that with the help of the tools for digital production recording it is possible to decrease the daily operating costs. This result supports the work hypothesis proving that the usage of digital tools improves technical teams' problem-solving capabilities. Due to the data correctness and speed of data processing, it is possible to define the factors that can lead to the occurrence of negativity and take the corresponding measures to eliminate these factors. For the question (9) the result displayed a mean of (4.74) and the standard deviation of (0.589). This analysis proves that the digital tools strengthen the capacity for technical teams to pinpoint and solve the problems. This captures the centrality that these tools play in offering the correct analysis as well as information that the technical teams require for making swift decisions.

n the question (10), it was found that the mean of was 4.30 and the standard deviation was 1.127. With reference to such aspects, this analysis suggests that tools for recording production in the digital environment contribute to reducing overall general maintenance costs, although it is necessary to pay attention to the fact that, in this regard, respondents' opinions show high variability that might be observed from analyzing the standard deviations. This result provides that application of digital tools Strengthens the company's capacity in the prophecy of probable issues and their prevention. By applying the sophisticated digital media analytical tools, businesses are in a position to diagnose conceptual issues in advance and act in response by implementing relevant precautions.

Cost Reduction

Question 11 gave a mean of 4.70 and a standard deviation of 0.571. It is thus evidenced in this analysis that digital tools enhance the process of better monitoring and whether or not there are errors. This result can explain the high efficiency of applying digital tools in that they supply the exact and updated information about the processes' statuses, which then can be easily checked for the presence of mistakes or not.

In question (12), the mean was (4.59) SD was (0.765). The above analysis reveals that planning and scheduling operation is enhanced by the use of digital tool. Hence this makes it easier for a company to allocate the resources and time it uses effectively, factoring out the to do list.

In question (13), Mean= (4.76), SD = (0.473). In this case, the study demonstrates that digital tools enhance on the capacity of the company in identifying mishaps and how to prevent them. This

analysis shows that the various tools are better placed in helping the company come up with precise predictive analysis that will help the company in taking preventive measures.

Respectively, for question (14) the mean was equal (4.54) and the standard deviation equal to (0.862). From this analysis, one gets to appreciate that the tools used in recording productions' activities minimize the wasters produced through operations. This is due to the fact that documentation tools are very helpful in offering real time information of the status of operations hence making it easier for the company to fight against waste.

For question (15) the mean was found to be (4.48) and standard deviation was (0.947). From this analysis we can deduce that, utilization of recording gadgets cuts down on costs wrt labor. This result is due to the fact that one of the features of digital tools is their ability to optimize the usage of such a crucial organizational resource as human resources, which in turn help to decrease human resource costs. This might be attributed to better planning, work organization, scheduling or prediction of issues that otherwise would require duplicate effort or Doberman work

Analyzing Questionnaire Data to Determine the Relationship between DT and Problem Detection Components Using the Correlation Analysis Method.

Table 9 The relationship between DT and Problem Detection

DT	Pearson Correlation	1	.547**
	Sig. (2-tailed)		0.000
	N	54	54
PD	Pearson Correlation	0.547**	1
	Sig. (2-tailed)	.000	
	N	54	54

Correlation is significant at the 0.01 level (2-tailed).

The value of the correlation coefficient between digital transformation and problem detection is (0.547). The correlation is positive, which means that there is a positive relationship between digital transformation and problem detection. The correlation is statistically significant at the (0.01) significance level (two-sided level). This means that there is a strong and important relationship between digital transformation and the ability to detect problems in the oil industry. From this table, it can be concluded that digital transformation plays an important role in improving the ability to detect problems in oil production operations. This reflects the importance of using digital technology to improve the effectiveness of operations and increase productivity in the industry.

Analyzing Questionnaire Data to Determine the Relationship between DT and Cost Reduction Using the Correlation Analysis Method

Table 10: The Relationship Between DT and Cost

Correlations

		DT	CR
DT	Pearson Correlation	1	0.524**
	Sig. (2-tailed)		0.000
	N	54	54
CR	Pearson Correlation	0.524**	1
	Sig. (2-tailed)	0.000	
	N	54	54

**. Correlation is significant at the 0.01 level (2-tailed).

The results also reveal that cost reduction has a moderate to strong positive direct relationship with digital transformation with a correlation coefficient of 0.30. The values are highly significant hence meaning that there is significance between the two variables of digital transformation and cost reduction.

Consequently, the evaluation proves that digital transformation helps to enhance the effectiveness of processes and achieve cost savings.

With digital change, organisations can introduce measures to enhance performance and cut expenses even more.

Other than making business operations more efficient, carrying out digital transformation also leads to better control of costs and decline in overall operation costs.

Analyzing Questionnaire Data to Determine the Relationship between Problem Detection and Cost Reduction Using the Correlation Analysis Method.

Table 11 The Relationship between Problem Detection and Cost Reduction

CR	Pearson Correlation	1	.762**
	Sig. (2-tailed)		.000
	N	54	54
PD	Pearson Correlation	.762**	1
	Sig. (2-tailed)	.000	
	N	54	54

**. Correlation is significant at the 0.01 level (2-tailed).

The coefficients that have been calculated in this study to compare the cost reduction are positive and strong to identify problems which are depicted by the correlation coefficient and therefore suggests that there is high relationship between the two factors. The correlation figures are also very high and statistically significant to show that there is indeed a strong relation between cost reduction efforts and early identification of problems.

Hypothesis Testing (Accepting or Rejecting Research Hypotheses) According to the Results Obtained from the Correlation Analysis between Variables

Hypothesis	Test Result	
	Accept	Reject
Enhanced problem detection capabilities: PLT technology enables earlier and more accurate identification of downhole issues (formation damage, water influx, flow restrictions…. e.g).	√	
Measurable cost reduction: Utilizing PLT data for wellbore diagnostics and production optimization contributes to a significant decrease in operational costs associated with oil production.	√	

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Technology is therefore vital in increasing productivity of oil production, cutting costs.
2. These findings offer powerful empirical substantiation for the view that digital transformation is resulting in more efficient problem recognition, better planning and timely scheduling, minimization of cost overruns, optimization of resource utilization and cost cutting.
3. 2.the use of information technologies and technology platforms are crucial in supporting the industry's digital transformation in the oil industry.
4. Digital recording tools can be of paramount help when it comes to problem detection, data analysis platforms can help to make the appropriate decision and the opportunities that can be provided by the software that can predict the outcomes of the decisions made.
5. the case of applying and adopting digital transformation in the oil production process needs to have a strategic approach and support from the organizational structure.
6. To be successful, companies need to know what digital transformation means for them and what type of activities would benefit them based on the type of company that they are and invest in it.
7. Integration between IT and line functions is critical to digitalization of oil production.
8. CIOs must have regular interaction with operational teams to know what they need in digital solutions and how they want it to be delivered.
9. The possibility of receiving great outcomes as a result of digital transformation in oil production thus necessitates the use of data.
10. Any organization requires setting up data acquisition, data analysis and utilize data to optimize processes and make better choices.
11. Sustained optimization is key to sustain overall effectiveness of digital change.
12. While developing their ICT strategies, companies have to review their existing and potential digital transformation processes in response to the emerging technologies, market trends and organizational requirements.

13. It is advisable to consider and develop a clear strategy regarding the effect of the given digital transformation trend for new employment in the oil industry.

Businesses have to commit their resources to reskilling and upskilling initiatives so that the employees can meet today's business challenges.

RECOMMENDATIONS

1. Identify and map digital transformation initiatives to overall business objectives, assess the business's digital readiness state, determine opportunities for business growth and bring clarity to timelines, deliverables, and resources.
2. Encourage digital adoption through the enhancement of a growth mindset through providing training and skills development interventions to prepare and build up workforce digital skills and knowledge and foster cross sectional teamwork and information sharing.
3. Application of digital based technologies in solving management issues by adopting digital recording tools to improve problem identification and data acquisition, data analysis tools for understanding operation procedures, opportunities for enhancement and embracing of modeling programs to forecast potential issues and resource utilization.
4. Promoting IT and operation's integration through having a joint work team as the overseeing body for digital change projects to achieve better communication and information sharing between IT and operation teams as well as making it certain that opportunities are utilized to create digital solutions that are relevant to the operations.
5. Strengthen the physical facilities and communications through the enhancement of the IT structure addressing the need of the digital transformation applications, guarantee the overall connectivity of all operation sites and discover the feasibility of cloud implementation for the effective and efficient mobility of the organization's necessities.
6. Become a data-oriented company and utilize data to drive decisions, increase productivity and efficacy while decreasing expenses and spread the data-oriented culture across the whole company.
7. Measuring the human effects of digital transformation by evaluating future employment and work force specification, acting as a motivator and setting up a system of reintegration and training schemes to prepare employees for the world of digital technology, as well as creating an enabling culture in which employees can be receptive to change and to digital transformation.
8. Creation of sustainable digital transformation plans which entails how digital technologies can be leveraged to minimize the negative impact of production of oil through finding ways on how the consumption of energy can be enhanced, some imperative ways of minimizing wastes can be implemented and avoid the distortion between the creation of sustainable digital transformation and sustainability goals.

Ting a growth mindset and encouraging employees to adopt new technologies by providing training and skills improvement opportunities to equip the workforce with digital skills and encourage collaboration and knowledge sharing across departments.

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