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Digital Transformation, Innovation Capability, and Institutional Sustainability in the Petroleum Sector: Evidence from RASCO, Libya

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Index Terms

Digital Transformation, Innovation Capability, Employee Digital Competence, Institutional Sustainability, Petroleum Sector, RASCO, Libya, Technology Adoption, Sustainable Performance.

Abstract

This study examines the role of digital transformation in enhancing institutional sustainability in the petroleum sector, with specific reference to Ras Lanuf Oil and Gas Processing Company (RASCO), Libya. The study is based on a descriptive-analytical review of previous literature related to digital transformation, innovation capability, employee digital competence, and institutional sustainability. It argues that digital transformation should not be understood merely as the acquisition or installation of digital technologies, but as an integrated organizational and managerial transformation that reshapes operational routines, decision-making processes, maintenance practices, safety governance, and sustainability performance. The findings indicate that digital tools such as monitoring systems, predictive maintenance platforms, dashboards, artificial intelligence, and data analytics can support operational reliability, safety monitoring, environmental control, and evidence-based decision-making. However, these benefits are not automatic; they depend on the extent to which digital technologies are embedded into daily work routines, supported by managerial alignment, and connected to institutional sustainability objectives. The study further concludes that technology adoption alone is insufficient to achieve sustainable institutional performance unless it is supported by innovation capability and employee digital competence.

التحول الرقمي، والقدرة على الابتكار، والاستدامة المؤسسية في قطاع النفط: أدلة من شركة رأس لانوف ليبيا

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الكلمات المفتاحية

التحول الرقمي، القدرة على الابتكار، الكفاءة الرقمية للموظفين، الاستدامة المؤسسية، قطاع البترول، شركة رأس لانوف (RASCO)، ليبيا، تبني التقنية، الأداء المستدام.

الملخص

تتناول هذه الدراسة دور التحول الرقمي في تعزيز الاستدامة المؤسسية في قطاع البترول، مع التركيز بشكل خاص على شركة رأس لانوف لتكرير النفط والغاز (RASCO) في ليبيا. تعتمد الدراسة على مراجعة وصفية-تحليلية للأدبيات السابقة المتعلقة بالتحول الرقمي، والقدرة على الابتكار، والكفاءة الرقمية للموظفين، والاستدامة المؤسسية. وتؤكد الدراسة أن التحول الرقمي لا ينبغي فهمه على أنه مجرد اقتناء أو تركيب تقنيات رقمية، بل هو تحول تنظيمي وإداري متكامل يعيد تشكيل الروتين التشغيلي، وعمليات صنع القرار، وممارسات الصيانة، وحوكمة السلامة، والأداء المتعلق بالاستدامة. تشير النتائج إلى أن الأدوات الرقمية مثل أنظمة المراقبة، ومنصات الصيانة التنبؤية، ولوحات المعلومات، والذكاء الاصطناعي، وتحليل البيانات يمكن أن تدعم الموثوقية التشغيلية، ومراقبة السلامة، والرقابة البيئية، واتخاذ القرارات المبنية على الأدلة. غير أن هذه الفوائد ليست تلقائية؛ إذ تعتمد على مدى دمج التقنيات الرقمية في روتين العمل اليومي، ودعمها بالتوافق الإداري، وربطها بأهداف الاستدامة المؤسسية. وتخلص الدراسة كذلك إلى أن تبني التقنية وحده لا يكفي لتحقيق أداء مؤسسي مستدام ما لم يكن مدعومًا بالقدرة على الابتكار والكفاءة الرقمية للموظفين.

1. INTRODUCTION

The petroleum sector is undergoing a profound managerial and technological transformation driven by the rapid diffusion of digital technologies. In contemporary oil and gas organizations, digital transformation is no longer perceived as a limited information technology initiative, but as a strategic requirement for operational continuity, asset reliability, environmental monitoring, safety governance, and long-term institutional sustainability. Petroleum organizations operate in highly complex and risk-intensive environments characterized by capital-intensive assets, hazardous operations, aging infrastructure, strict safety requirements, environmental pressures, and increasing expectations for governance transparency.

Digital transformation should be distinguished from digitization and digitalization. Digitization refers to the conversion of analogue information into digital formats, while digitalization refers to the use of digital tools to improve existing processes. Digital transformation goes beyond both concepts by reshaping organizational routines, managerial decision-making, resource allocation, accountability systems, and value creation mechanisms. In petroleum institutions, the installation of sensors, SCADA systems, dashboards, enterprise platforms, or cloud-based systems does not automatically lead to meaningful transformation. These technologies become strategically valuable only when digital data are embedded into maintenance planning, operational governance, risk management, environmental monitoring, and sustainability-oriented decision-making (Verhoef et al., 2021; Hanelt et al., 2021).

In the oil and gas industry, digital transformation is commonly associated with advanced technologies such as the Industrial Internet of Things, artificial intelligence, big data analytics, cloud computing, digital twins, predictive maintenance, automated inspection, and integrated operational platforms. These technologies can enhance real-time visibility, strengthen equipment monitoring, reduce unplanned downtime, support predictive maintenance, improve safety control, and enable faster managerial response. However, the petroleum sector often faces structural barriers that limit the effective adoption and integration of digital technologies, including legacy infrastructure, cybersecurity risks, fragmented data systems, high implementation costs, conservative safety cultures, and shortages of digital skills. Therefore, digital transformation in petroleum organizations should not be examined only as a technical issue, but also as an organizational and managerial challenge (Maroufkhani et al., 2022; Bist et al., 2024).

Innovation capability represents a critical mechanism through which digital transformation can be converted into sustainable institutional outcomes. Digital technologies provide data, connectivity, automation, and analytical visibility, but these resources do not automatically produce operational or sustainability improvements. Organizations need innovation capability to transform digital information into improved maintenance practices, redesigned workflows, enhanced safety procedures, better environmental monitoring systems, and learning-based managerial routines. In petroleum organizations, innovation capability is particularly important because sustainability depends not only on environmental performance, but also on operational reliability, asset integrity, process efficiency, safety performance, and continuous improvement (Lu et al., 2023; Ji et al., 2023).

Employee digital competence is another essential condition for successful digital transformation in safety-critical and asset-intensive industries such as petroleum. Without sufficient digital competence, advanced technologies may be underused, resisted, misunderstood, or bypassed. Human capital therefore plays a central role in transforming digital investment into operational, environmental, safety, governance, and institutional performance improvements (He & Chen, 2024; Xu et al., 2022).

The Libyan petroleum sector provides an important context for examining these relationships. Ras Lanuf Oil and Gas Processing Company (RASCO) represents a relevant case for investigating how digital transformation can support institutional sustainability in a petroleum organization operating within a complex operational and institutional environment. Accordingly, this study aims to examine the relationship between digital transformation capability and institutional sustainability in the petroleum sector, using RASCO in Libya as the study context, focusing on technology adoption, innovation capability, and employee digital competence.

2. PROBLEM STATEMENT

The petroleum sector is increasingly investing in digital transformation to improve operational efficiency, asset reliability, safety monitoring, environmental performance, and institutional sustainability. However, the adoption of digital technologies alone does not automatically lead to sustainable institutional outcomes. Many petroleum organizations may acquire digital systems without fully integrating them into daily operations, decision-making processes, innovation practices, and workforce capabilities.

In the context of RASCO, Libya, petroleum organizations in developing and resource-dependent economies often face challenges related to aging infrastructure, limited digital readiness, fragmented systems, skills gaps, and organizational constraints. These challenges may reduce the ability of digital transformation to generate meaningful improvements in institutional sustainability.

The main research problem is that the relationship between digital transformation capability and institutional sustainability in the petroleum sector remains insufficiently explained, especially when considering the roles of technology adoption, innovation capability, and employee digital competence. From a practical perspective, petroleum companies such as RASCO need

clearer evidence on how digital investment can be converted into sustainable institutional performance rather than remaining only a technical upgrade.

3. Research Objectives

This study aims to examine the role of digital transformation capability in enhancing institutional sustainability in the petroleum sector, with specific reference to RASCO, Libya. The specific objectives are:
To examine the role of digital transformation capability in supporting institutional sustainability in the petroleum sector.

1- To analyze how technology adoption contributes to operational reliability, safety monitoring, environmental control, and evidence-based decision-making at RASCO.
2- To examine the role of innovation capability in transforming digital information into improved maintenance practices, safety procedures, environmental monitoring, and sustainability-oriented organizational routines.
3- To analyze the importance of employee digital competence in enabling the effective use of digital systems, dashboards, predictive indicators, and digital evidence in petroleum operations.
4- To develop a conceptual understanding of how technology adoption, innovation capability, and employee digital competence contribute to institutional sustainability in the context of RASCO, Libya.

4. Research Questions

1 - What is the relationship digital transformation capability and institutional sustainability in the petroleum sector?
2 - How does technology adoption influence institutional sustainability at RASCO, Libya?
3 - How does innovation capability contribute to institutional sustainability at RASCO, Libya?
4 - .How does employee digital competence influence institutional sustainability at RASCO, Libya?
5- To what extent do technology adoption, innovation capability, and employee digital competence explain institutional sustainability in the context of RASCO, Libya?

5. Significance Of The Study

This study is significant because it addresses the strategic role of digital transformation in strengthening institutional sustainability in the petroleum sector. From an academic perspective, the study contributes to the literature by integrating technology adoption, innovation capability, employee digital competence, and institutional sustainability within one conceptual framework. This integration responds to the fragmented nature of previous studies.

From a project management perspective, the study is important because digital transformation initiatives in petroleum organizations should be managed as strategic institutional projects rather than as isolated technology installations. From a practical perspective, the study helps decision-makers understand how digital investments can be translated into institutional value, including operational reliability, safety governance, environmental responsibility, transparency, and long-term resilience.

6. Definition Of Key Terms

Digital Transformation: refers to the strategic use of digital technologies to reshape organizational routines, decision-making processes, operational practices, value creation, and institutional performance (Verhoef et al., 2021; Hanelt et al., 2021).

Technology Adoption: refers to the effective integration and use of digital systems, monitoring tools, dashboards, artificial intelligence, predictive maintenance platforms, and data analytics within daily operational and managerial activities (Maroufkhani et al., 2022; Bist et al., 2024).

Innovation Capability: refers to the organization's ability to convert digital information, data visibility, and technological resources into improved work practices, redesigned workflows, enhanced maintenance routines, better safety procedures, and learning-based decision-making (Lu et al., 2023; Ji et al., 2023).

Employee Digital Competence: refers to the ability of employees, engineers, supervisors, technicians, and managers to use digital tools, interpret dashboards, evaluate data quality, respond to automated alerts, and integrate digital evidence into operational judgment (He & Chen, 2024; Xu et al., 2022).

Institutional Sustainability: refers to the long-term ability of a petroleum organization to maintain operational continuity, asset reliability, safety governance, environmental responsibility, transparency, adaptive capacity, and institutional resilience (Feroz et al., 2021; Wang & Esperanca, 2023; Xie et al., 2024).

7. Literature Review

7.1 Digital Transformation as a Strategic Organizational Transformation

Digital transformation is no longer viewed as a limited technological upgrade, but as a strategic organizational transformation that changes how institutions create value, manage operations, measure performance, and respond to environmental and competitive pressures. In petroleum organizations, the presence of sensors, dashboards, SCADA systems, or cloud platforms does not automatically create transformation unless digital information is embedded into operational planning, accountability systems, maintenance decisions, and sustainability governance. Therefore, digital transformation should be treated as a managerial and socio-technical process rather than a purely technical initiative (Verhoef et al., 2021; Hanelt et al., 2021).

7.2 Digital Technology Adoption in the Oil and Gas Sector

The oil and gas sector has become increasingly dependent on digital technologies to improve operational visibility, asset reliability, process safety, and

environmental monitoring. Technologies such as the Industrial Internet of Things, artificial intelligence, big data analytics, cloud computing, digital twins, predictive maintenance, and integrated operational platforms can support real-time monitoring, reduce unplanned downtime, enhance maintenance planning, and improve managerial responsiveness. However, the petroleum sector often faces specific barriers to digital transformation, including legacy infrastructure, high integration costs, cybersecurity risks, conservative safety cultures, fragmented data systems, and shortages of digital skills (Maroufkhani et al., 2022; Bist et al., 2024).

7.3 Innovation Capability as a Link between Digital Transformation and Sustainability

Innovation capability is an important organizational mechanism that explains how digital transformation can be converted into sustainable institutional outcomes. Organizations need innovation capability to transform digital resources into new maintenance routines, improved safety procedures, redesigned workflows, better environmental monitoring, and learning-based decision-making practices. Recent research shows that digital transformation can enhance sustainability performance when firms are able to process information effectively, develop sustainability-oriented innovation, and reconfigure organizational routines (Lu et al., 2023; Ji et al., 2023).

7.4 Employee Digital Competence and Socio-Technical Readiness

Employee digital competence is a core condition for successful digital transformation, especially in safety-critical and asset-intensive industries such as petroleum. Digital systems require engineers, operators, technicians, supervisors, and managers to interpret dashboards, evaluate data quality, respond to predictive indicators, understand automated alerts, and integrate digital evidence into operational judgment. Without sufficient employee competence, advanced digital technologies may be underused, misunderstood, resisted, or bypassed (He & Chen, 2024; Xu et al., 2022).

7.5 Institutional Sustainability and ESG-Oriented Performance

Institutional sustainability in petroleum organizations should be understood as a multidimensional concept that goes beyond environmental compliance. It includes economic continuity, operational reliability, environmental responsibility, workforce safety, governance transparency, and adaptive capacity. Digital transformation can support these dimensions by improving data transparency, enabling emissions monitoring, reducing resource waste, improving predictive maintenance, and strengthening evidence-based decision-making. However, digital transformation contributes to institutional sustainability only when supported by governance mechanisms, innovation capability, employee competence, and strategic alignment (Feroz et al., 2021; Wang & Esperanca, 2023; Xie et al., 2024).

8. LITERATURE GAP ANALYSIS AND POSITIONING

The reviewed literature confirms that digital transformation has become a central issue in contemporary petroleum organizations. However, the existing literature still presents several important gaps. First, prior studies have mainly focused on general organizational transformation, operational efficiency, or technology adoption, while less attention has been given to how digital transformation contributes to institutional sustainability in the petroleum sector. The literature suggests that these technologies do not automatically produce sustainable institutional outcomes unless they are embedded into daily work routines, governance systems, and managerial decision-making processes (Maroufkhani et al., 2022; Bist et al., 2024).

Second, many previous studies treat digital transformation primarily as a technological process, without sufficiently examining the organizational and human capabilities required to convert digital systems into sustainable performance. Third, innovation capability is often discussed separately from employee digital competence and technology adoption. In petroleum organizations, innovation capability alone may not be sufficient if employees lack the digital skills needed to interpret system outputs and apply digital evidence in operational judgment (Lu et al., 2023; Ji et al., 2023; He & Chen, 2024; Xu et al., 2022).

Fourth, institutional sustainability in previous studies is often limited to environmental performance or ESG outcomes. However, in petroleum organizations, institutional sustainability is broader and includes operational reliability, economic continuity, safety governance, environmental responsibility, and adaptive capacity. Fifth, there is limited empirical attention to petroleum organizations in developing economies, particularly in the Libyan context. Based on these gaps, the current study integrates technology adoption, innovation capability, and employee digital competence within one conceptual model applied to RASCO, Libya.

9. RESEARCH MODEL AND STUDY VARIABLES

Based on the reviewed literature, this study proposes a conceptual model in which digital transformation capability contributes to institutional sustainability through three main dimensions: (1) technology adoption, reflecting the operational embedding of digital tools into maintenance, reporting, monitoring, and decision-making activities; (2) innovation capability, reflecting the organization's ability to convert digital technologies into improved routines, problem-solving practices, and sustainability-oriented improvements; and (3) employee digital competence, reflecting the ability of employees to use digital tools, interpret digital information, and integrate digital evidence into operational judgment.

The conceptual framework positions Digital Transformation Capability as the independent variable and Institutional Sustainability as the dependent variable, supported by Dynamic Capabilities Theory and the Technology-Organization-Environment(TOE) perspective.

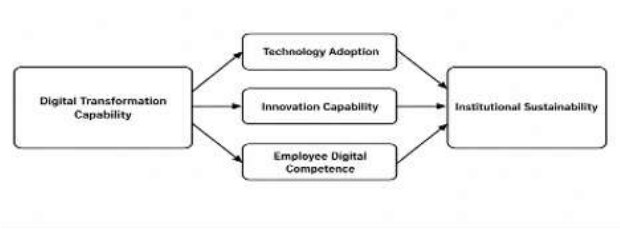


Figure 1. Conceptual Framework Digital Transformationof the Study

10. Research Methodology

10.1 Research Design

This study adopts a descriptive-analytical approach based on an extensive review and synthesis of the relevant literature concerning digital transformation capability, technology adoption, innovation capability, employee digital competence, and institutional sustainability within the petroleum sector, with particular reference to RASCO, Libya. The descriptive component explains the nature of the concepts and their relevance to petroleum organizations, while the analytical component evaluates the relationships and gaps identified in previous studies.

10.2 Analytical Procedure

The research relies on inductive analysis to identify and synthesize key concepts, theoretical frameworks, and empirical findings from previous studies. It further employs comparative analysis to examine similarities and differences across the literature, followed by critical analysis to evaluate existing approaches, identify research gaps, and assess their applicability to the Libyan petroleum context.

10.3 Study Context

The study context is Ras Lanuf Oil and Gas Processing Company (RASCO), Libya. RASCO represents a relevant petroleum-sector context because the company operates within an environment where operational reliability, asset performance, safety governance, environmental responsibility, and institutional resilience are critical. Petroleum organizations in developing economies may face challenges related to aging infrastructure, digital readiness, skills gaps, fragmented systems, and modernization pressures.

10.4 Scope and Limitations

The current study is literature-based and conceptual. The findings should be understood as analytical conclusions derived from the synthesis of previous studies rather than as statistical results from primary survey data. Future empirical research is recommended to test the proposed relationships using questionnaire data collected from RASCO employees and to validate the conceptual framework statistically.

11. Results

Based on the descriptive-analytical review of the literature, the findings indicate that digital transformation can contribute positively to institutional sustainability in the petroleum sector when it is not treated merely as a technological investment, but as an integrated organizational and managerial transformation. Previous studies confirm that digital transformation reshapes organizational routines, decision-making processes, value creation, and operational capabilities (Verhoef et al., 2021; Hanelt et al., 2021). In the petroleum sector, digital tools such as monitoring systems, predictive maintenance platforms, dashboards, artificial intelligence, and data analytics can support operational reliability, safety monitoring, environmental control, and evidence-based decision-making when properly embedded into daily work processes (Maroufkhani et al., 2022; Bist et al., 2024).

The literature also suggests that technology adoption alone is insufficient to achieve sustainable institutional performance. Innovation capability appears as a central mechanism through which digital transformation can be converted into sustainability-oriented improvements, including redesigned workflows, improved maintenance planning, better safety procedures, and enhanced environmental monitoring (Lu et al., 2023; Ji et al., 2023). Furthermore, employee digital competence emerges as a critical human factor; employees' ability to interpret dashboards, evaluate data quality, respond to automated alerts, and apply digital evidence in operational decision-making plays an important role in converting digital investment into sustainable performance outcomes (He & Chen, 2024; Xu et al., 2022).

The results further indicate that institutional sustainability in petroleum organizations should be understood as a multidimensional outcome that includes operational continuity, asset reliability, environmental responsibility, safety governance, transparency, and adaptive capacity (Feroz et al., 2021; Wang & Esperanca, 2023; Xie et al., 2024). The main result is that digital transformation capability is expected to have a positive contribution to institutional sustainability particularly when technology adoption, innovation capability, and employee digital competence operate together as integrated dimensions within a coordinated organizational framework at RASCO, Libya.

12. Discussion

The findings indicate that digital transformation can contribute positively to institutional sustainability in the petroleum sector when managed as an integrated organizational transformation. From a project management perspective, this is important because digital transformation projects in petroleum organizations do not succeed through technology acquisition alone; they require strategic alignment, stakeholder readiness, resource coordination, risk management, process integration, and continuous capability development. This result is consistent with Verhoef et al. (2021) and Hanelt et al. (2021), who argued that digital transformation should be understood as a strategic organizational change process.

The findings also support previous studies in the oil and gas sector (Maroufkhani et al., 2022; Bist et al., 2024) which reported that digital technologies can

improve operational visibility, asset reliability, predictive maintenance, and managerial responsiveness. However, the current study differs by emphasizing that the success of digital transformation in RASCO depends not only on technology adoption, but also on innovation capability and employee digital competence. This distinction is significant because petroleum organizations in developing contexts face barriers such as aging infrastructure, fragmented systems, and digital skills gaps.

The role of innovation capability in the current study is supported by Lu et al. (2023) and Ji et al. (2023), who found that digital transformation supports sustainability performance through information processing and sustainability-oriented innovation. The findings further indicate that employee digital competence is a critical condition for the successful implementation of digital transformation, consistent with He and Chen (2024) and Xu et al. (2022). Employee digital competence should therefore be treated as a project-critical success factor in digital transformation initiatives at RASCO.

The current study adopts a broader institutional sustainability perspective rather than focusing only on environmental sustainability or ESG performance, consistent with Feroz et al. (2021), Wang and Esperanca (2023), and Xie et al. (2024). The main contribution is integrating technology adoption, innovation capability, and employee digital competence within one conceptual model to explain institutional sustainability, suggesting that RASCO and similar petroleum organizations can improve institutional sustainability by managing digital transformation as a coordinated socio-technical project.

13. Conclusions And Recommendations

13.1 Conclusions

This study concludes that digital transformation has strong potential to enhance institutional sustainability in the petroleum sector when implemented as an integrated organizational and managerial transformation. The findings indicate that digital technologies can support operational reliability, safety monitoring, environmental control, and evidence-based decision-making. However, these benefits depend on how effectively digital technologies are embedded into daily operational routines, maintenance planning, risk management, and sustainability governance.

Technology adoption alone is insufficient to achieve sustainable institutional performance. Innovation capability plays a central role in converting digital transformation into sustainability-oriented outcomes by enabling organizations to transform digital information into improved workflows, maintenance practices, safety procedures, and learning-based decision-making. Employee digital competence is a critical success factor, as employees' ability to interpret digital systems determines whether digital investment is effectively used or remains underutilized.

Institutional sustainability in the petroleum sector should be treated as a multidimensional outcome including operational continuity, asset reliability, safety governance, environmental responsibility, transparency, adaptive capacity, and long-term institutional resilience. In the context of RASCO, Libya, digital transformation can contribute to institutional sustainability when technology adoption, innovation capability, and employee digital competence operate together within a coordinated organizational framework.

13.2 Recommendations

First, RASCO should manage digital transformation as a strategic institutional project aligned with long-term sustainability objectives, operational reliability, safety governance, and environmental monitoring, requiring clear leadership commitment and structured planning.

Second, RASCO should strengthen the operational embedding of digital technologies into maintenance planning, risk-based inspection, equipment monitoring, safety reporting, and managerial decision-making so that digital information becomes part of daily work routines.

Third, RASCO should develop innovation capability as a key organizational priority by encouraging employees to use digital information to redesign workflows, improve maintenance practices, enhance safety procedures, and support environmental monitoring.

Fourth, RASCO should invest in employee digital competence through continuous training and capability-building programs covering dashboard interpretation, data quality assessment, predictive maintenance alerts, and evidence-based decision-making.

Fifth, RASCO should establish stronger governance mechanisms for digital transformation, including data governance, cybersecurity awareness, monitoring of digital system performance, and transparent decision-making. Finally, future empirical research is recommended after questionnaire data are collected from RASCO employees to statistically test the proposed relationships.

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