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Digital transformation in the energy sector to achieve sustainable development in Algeria

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Abstract:
This study analyzes the digital transformation environment in Algeria's oil and gas industry for the national company Sonatrach. It focuses on the role of information technology investment in achieving and raising productivity as it contributes to economic integration by improving the connection to global communication networks. It is important to encourage foreign investment in the information and communications technology sector because it allows giant and leading companies to bear the costs of investment. In contrast, national investments are directed well towards the information and communications technology sector by enacting laws that encourage start-ups in this sector. Keywords: sustainable development, digital transformation strategy, energy industry, and digital technology.
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Introduction

The growth of digital infrastructure, technology, and social aspects—collectively referred to as the "digital economy"—is necessary for a seamless transition to sustainable renewable energy sources. This sector has revolutionized how businesses function, interact with consumers, and propel economies. Many industries, including the energy sector, have seen increased productivity, connection, and innovation as a result of the integration of digital technologies like artificial intelligence, the Internet of Things, and big data analytics. Therefore, in the context of renewable energy, digitalization presents hitherto unheard-of opportunities to enhance energy generation, distribution, and consumption. By boosting production capacity in extractive sectors, digitalization improves the use of natural resources and contributes to major advancements in the energy sector, particularly through the growth of renewable energy. This is because the digital economy alters economic production methods and energy structures through its reduced usage of fossil fuels, lower marginal costs, less pollution, and fewer emissions linked to green growth. This indicates that digitalization has a significant impact on renewable energy sources.

1.Digital Transformation of the Oil and Gas Industry in Algeria

Indeed, at an era of low crude oil prices, frequent budget and schedule overruns, substantial demands from climate change, challenges in attracting talent, and the possible effects of the COVID-19 pandemic, the oil and gas industry has the chance to redefine its boundaries through digitalization. In the short term, oil and gas corporations can provide useful solutions. At the same time, digitalization can serve as a catalyst to tackle these issues in the long run, benefiting all parties involved in the sector. Digitalization has the potential to bring about revolutionary change. Given the variety of options and starting points, oil and gas firms can use their knowledge of digital transformation to accomplish their short-term goals..(World economy forum, January 2017)

The Digital Transformation Process Model is a ten-stage roadmap for any digital journey, with cybersecurity and the organization's digital characteristics at its center. Progressing through the stages signifies the accomplishment of particular business goals. The voyage should be broadened and prolonged into an unending loop to incorporate a greater

range of assets or business sectors, even though it is officially finished at the eleventh stage.

1.1Challenges in the oil and gas industry:

On June 15, Mr. Zhang Tiegang, former deputy engineer at the Oilfield Research, Exploration, and Development Institute, identified three major issues with the oil and gas industry's digital transformation at the 2020 Oil and Gas Virtual Summit.(Partners?, 19 August 2020)

- ✓ Exponential data expansion : Other industries manage less data than oil and gas. For instance, seismic data is growing rapidly. As oil and gas exploration grows harder, seismic wave exploration must improve. Broadband and high-density seismic data are needed at 1 TB/km2. The area of exploration keeps growing. More than 17 TB of high-resolution seismic data may have been initially gathered in a single work area. Furthermore, the proliferation of data is being expedited by the continuous extension of historical data records ; (Partners?, 19 August 2020)
- ✓ As data volumes grow, computational burden and complexity rise significantly. Storage capacity and reverse migration before stacking (RTM) computing workloads have increased fiftyfold. To fully understand oilfield production dynamics, thorough reservoir numerical modeling requires more processing power. As a result, oilfield firms need more sophisticated algorithms, including deep anisotropic pre-stack imaging, RTM, and full-wave inversion (FWI) capabilities, and they have higher and higher standards for data processing technology ;
- ✓ In oil and gas industries, the information infrastructure system consists of equipment, computation, storage, and IT operation and maintenance rooms. Most companies designed their facilities with many equipment rooms that were insecure and energy-hungry. Additionally, inadequate usage and server configuration cannot process massive amounts of data. The

shared storage devices used today are from multiple suppliers, have a limited capacity, and cannot store much data. Additionally, there is growing demand for operation and maintenance departments to employ highly qualified staff to guarantee the upkeep and operation of dispersed, autonomous IT systems with low intelligence levels.

-1.2.SWOT study of the digital transformation in the oil and gas sector:

SWOT is Strengths, Weaknesses, Opportunities, and Threats. Opportunities and Threats are external, whereas Strengths and Weaknesses are internal. The organization applies SWOT analysis to the oil and gas business (energy sector), which is often described in the literature as its digital environment. The SWOT chart enables an innovative project to be analyzed taking into account all the factors on which the project's development depends.(Kudriavtceva, 2019)

2.Dimensions of Sustainable Development

According to studies and research, the primary obstacle to sustainable development is balancing and achieving the three dimensions—economic, social, and environmental—while simultaneously taking advantage of their interactions and avoiding the drawbacks that arise from them. The following determines these three dimensions :

2.1 The economic dimension : By supplying the highest-quality elements of human well-being, such as food, housing, transportation, healthcare, and education, means maintaining continuity and optimizing economic well-being over the shortest amount of time.

2.2The social dimension : The human being is the center of sustainable development and its ultimate objective, according to the social dimension of sustainable development. Concern for social justice, eradicating poverty, and offering social services to everyone in need are all included in this component.

2.3 The environmental dimension : Since each ecosystem has its boundaries that cannot be exceeded in terms of consumption and depletion, this aspect of sustainable development focuses on the significance of considering environmental constraints. The environment deteriorates as a result of exceeding these boundaries.

Some have linked the economic, social, and environmental components of sustainable development because of its three dimensions. This implies that the land and all of its natural resources must be fully and undiminishedly passed on to future generations. Therefore, the interplay of these three fundamental components—that is, that it must be economically viable, socially desirable, and ecologically achievable—is what leads to sustainable development.(Al-Mahjoubi, 2022)

3.The potential of digital transformation in the Algerian oil and gas industry

The digital economy creates real opportunities for all African countries due to its demographic structure, the less dramatic disruption of traditional industrial production models, and the capacity for innovation that feeds and ensures digitalization.

3.1.Overview of Sonatrach's SH30 digital transformation plan:

With its new long-term plan SH30, Sonatrach intends to exploit the nation's huge shale gas supplies, attract foreign participation, and boost downstream markets to become one of the world's top national oil. By 2030, the ultimate objective is to generate an additional $70 billion in revenue, of which 50% will reinvested in new manufacturing. According to the SH2030 strategy, Sonatrach wants to produce 2 billion cubic feet of unconventional resources per day by 2030 and 7 billion cubic feet per day by 2040. The ERP, which has installed throughout the organization, is responsible for the following road to the new policy that followed to completely overhaul the company and put performance at the center of its operations:(Report, 2020)

- ✓ Oversee operations with a more comprehensive and enhanced perspective, expedite decision-making, boost output, and enhance performance ;
- ✓ Assure the best possible cooperation and communication ;
- ✓ Lower operating and management expenses ;
- ✓ By using financial control and data integrity, you can anticipate and minimize risks.

The Transformation Department oversees HS2030 implementation and was founded for this reason. The company has created a corporate

department to address developing strategic issues and enhance its administration and operations. In this extensive reorganization, new central organizations have been developed inside activities to optimize operations and support the new HS2030 plan. To provide the company's transversal functions more weight and to streamline the operational procedures in this core structure, the Group's communication level has been increased to the management level. As part of this transition, the operational center's organizational, transversal, and expertise responsibilities will be strengthened. Representatives of the central functions in the activities will be tasked with creating dual reports for the activity's line manager.(Sonatrach, Une nouvelle ère s'offre à Sonatrach l'efficacité et la performance au service de la nouvelle organisation)

Following an analysis of Sonatrach's information and communications technology plan and the company's future needs for commercial expansion, Huawei suggested a three-phase digital transformation strategy :

- Huawei Cloud Cluster (HCS) : Resource silos were removed with the introduction of the first enterprise-level integrated hybrid cloud solution and the integration of pre-existing IT resources. Rapid service deployment is made possible by this method, which also provides unified resource management and on-demand resource provisioning for numerous data centers ;
- SAP Enterprise Resource Planning (ERP) system was deployed : enabling unified resource management—including finance, human resources, asset management, budget management, and logistics—across the group and business units on a cloud platform. It encourages thorough cooperation and data sharing between top and bottom businesses, significantly increasing the effectiveness of group operations management and the daily productivity of management staff at all levels.
- Innovative service platforms and big data services are implemented : In order to extract the value of data and establish the groundwork for the development of digitally enhanced oilfields, these services can be swiftly designed and evaluated.

3.2. Sonatrach SH30 Plan compared to the initiatives of the leading seven oil and gas companies :As stakeholders improve their ability to visualize results and KPI data, oil and gas companies must adopt digital transformation to develop superior customer experiences and maximize value creation throughout asset and process lifecycles. This can improve processes and online reporting, which could have an impact on the process, as the following table illustrates :

Table 01 : Sonatrach SH30 plan vs. Initiatives of the seven largest oil and gas companies

Opportunities and challenges	Partners	The company
In the energy shift, BP is focusing on digital transformation, including blockchain, robots, and cognitive computing. BP has established a business incubator division called Launchpad to establish five firms by 2025. BP has made investments in businesses like Drover, a virtual marketplace; Power Share, a provider of online transportation solutions; and Beyond Limits, an AI startup. The most recent investment was in Grid Edge, a supplier of AI technology that helps clients increase the energy efficiency of their structures. To enhance supply chain management from sourcing and raw materials to planning, scheduling, operations, and distribution, BP is also utilizing AVEVA's industrial software with advanced modeling.	**Launchpad, AVEVA Beyond Limits Power Share Drover Grid Edge**	**BP**
Microsoft is helping Chevron accelerate its digital transformation by integrating "DELFI" AI technologies. The company's digital transformation goal is to consolidate IT around a digital core that links engineers and operations with quick and incremental analytics.	**Microsoft**	**Chevron**
Since digitalization and sustainable development closely linked, Eni is leading the digital transformation of the entire organization, including cultural shifts. The Green Data Center's HPC5 supercomputer, the company's digital technology ce.	**Green Data Center Digital Business Unit Digital Competence Center**	**Eni**
Equinor prioritizes digitalization for low carbon, high value,		**Equinor**

and safety. Digitalization, which is in our DNA, is a good example of a successful digital transformation that leads to sustainability and financial success, according to the organization. The company invests in carbon capture, storage, and renewable energy to "produce oil and gas more efficiently with lower greenhouse gas emissions." The company has a thorough digital strategy and treats digital transformation as a business change.		
ExxonMobil teamed with Microsoft on its Permian Basin operations to boost productivity and create the most oil and gas acreage utilizing cloud computing. ExxonMobil and Fuel Cal Energy have improved carbon fuel cell technology to absorb industrial carbon dioxide and minimize greenhouse gas emissions.	**Microsoft Fuel Cell Energy Inc**	**ExxonMobil**
Shell prioritized digital solutions for its current businesses, such as supply chain optimization and worldwide integration. The company invested in digital projects and used industry experience to create new business models. Shell's artificial intelligence operations will benefit from Microsoft's partnership.	**Microsoft**	**Shell**
The transformation plan with Huawei aims to improve all activities, including ERP updates and organization.	**Huawei**	**Sonatrach**

Source: (Daneeva & others, 2020)

3.3. SWOT Analysis of Digital Technology for the Oil and Gas Industry in Algeria

A- Strengths :

- Algeria has the largest fiber optic network in Africa, with 123,000 km deployed in 2017 and 7,000 km planned to connect 24 southern wilayas. (cybersecurity)
- Algeria plans intra-city fiber optic cables and substantial inter-city and transcontinental links.
- The MPTDT project intends to increase bandwidth and overcome problems in installing two fiber optic cables to connect Algeria to global access points.
- Medex's submarine fiber optic line will transmit 4.4 terabytes from eastern Annaba to the west coast. Along with the Medex Orval cable, it

will connect Valencia on Spain's east coast to Oran in the Mediterranean. By 2019, connecting to the two international lines will raise Algeria's internet bandwidth by 10 to 6.4 terabytes. This boosts connectivity since local content storage is restricted.(Algerian ICT expands on digitisation and cybersecurity)

B– Weaknesses

- Algeria trails its North African peers in internet usage (31.9%), e-government advancement (130th in the UN national rating), and business appeal (166th in the World Bank's Doing Business ranking);
- Sonatrach's five interconnected data centers lack consistent scheduling due to resource silos. If one data center is overburdened, services cannot be dispersed. The integration of virtualization with physical machine architecture produces a siloed system that complicates the deployment of new services, as essential services are confined to a single data center lacking disaster recovery protocols, hence hindering service continuity.
-Information Silos: Although Sonatrach has more than 200 subsidiaries and ten horizontal functional divisions، there may be incompatibilities since IT gear is supplied by many vendors. Other electronic reports necessitate manual data transfer via Excel files, which limits mobile access and fosters data silos among subsidiaries and divisions. Consistently collecting and compiling subsidiary and division operational data is impossible. The management team struggles to monitor data, reducing operational efficiency.(Shen Hongyuan, Sonatrach Transforms Its Oilfields in Algeria, IT Ecosystem Cooperation and innovation ICT Insights)

4.Sonatrach's tri-phased digital transformation plan

4.1Huawei's vision for digital transformation

Digital transformation is ongoing. Huawei developed a three-phase digital transformation strategy after analyzing Sonatrach's ICT strategy and future commercial development needs :

-The HUAWEI CLOUD Stack (HCS) : First enterprise-level integrated hybrid cloud domain. IT resource integration eliminates silos. This method provides authorized data centers with on-demand resource allocation and

integrated resource management.Rapid service rollout is also made possible by it.

-The SAP Enterprise Resource Planning (ERP) system : Cloud platforms enable SAP ERP deployment. This unifies resource management across business divisions and groups, including finance, HR, asset management, budgeting, and logistics. The technology improves group operations management by enabling upstream and downstream organizations to collaborate and share data, improving management efficiency across all levels.

-Innovative service platforms and big data services (systems, applications and products in data processing) : Big data services and innovative service platforms are put into place, and they can be swiftly produced and evaluated. Determining the value of data lays the groundwork for the creation of digitally improved oil fields.

After the first phase is finished, Huawei and Sonatrach will proceed to the second and third stages. (Sonatrach, 2024)

By entering into a deal with the Chinese tech behemoth Huawei, Sonatrach Group has bolstered the digitization process. The agreement includes a wide variety of topics, but in particular, cloud computing, cybersecurity, active settings, data centers, and communications networks. Through specialized training programs, the agreement will also fortify the ecosystem that fosters ongoing innovation and advancement in the domains of high technology and the digitalization of the energy sector.

4.2 Huawei Solutions for Securing Sonatrach Pipelines :

It's important to remember that the Sonatrach Windows Group and the Chinese tech behemoth previously collaborated to create a high-performance system to protect the business's oil and gas network. The national oil firm took part in the accomplishments of the smart solution for examining gas and oil pipelines for fiber identification, which was implemented with Huawei, at the World Technology Exhibition that took place in May of last year. By using distributed fiber optic sensing technologies to automatically inspect pipelines, the system guarantees high network security, intelligence, and efficiency.(Sonatrach, 2024)

4.3 Honeywell and Sonatrach’s Sustainability and Digitization Strategy :

Honeywell and Sonatrach Work Together to Digitize, Localize, and Promote Sustainability in Algeria's Energy Sector To investigate prospects to promote sustainability and digitization in the Algerian energy sector, Honeywell and Sonatrach have signed a strategic memorandum of agreement. To improve cybersecurity, operational improvements, system lifecycle management, and predictive maintenance throughout Sonatrach's infrastructure, Honeywell will seek to advance digital transformation projects.

Meziane Ghoul, Honeywell's General Manager for High Performance Materials and Technology, North Africa, and Mohamed Daoud, Sonatrach's Director of Procurement and Logistics, signed the pact at the company's headquarters. In addition to facilitating the growth of technology and talent in Algeria's energy industry, the deal is anticipated to feature a new training and skills development cooperation that will increase the local workforce's capacity to meet Algeria's energy demands.By 2035, Honeywell, a leader in sustainability innovation worldwide, plans to have all of its facilities and activities carbon neutral.(Honeywell and Sonatrach to collaborate on sustainability, digitalization and localization of Algeria's energy sector, 2022)

4.4. Smart Oil Data Project (SOD)

Sonatrach participated in the ESRI World User Conference, which took place in the United States from July 10–14, 2023, and won the SAG2023 Award (Special Achievement in Geographic Information Systems) for its Smart Oil Data initiative. The SAG Award is given annually by the Environmental Systems Research Institute to honor outstanding contributions made to the field of geographic information systems.

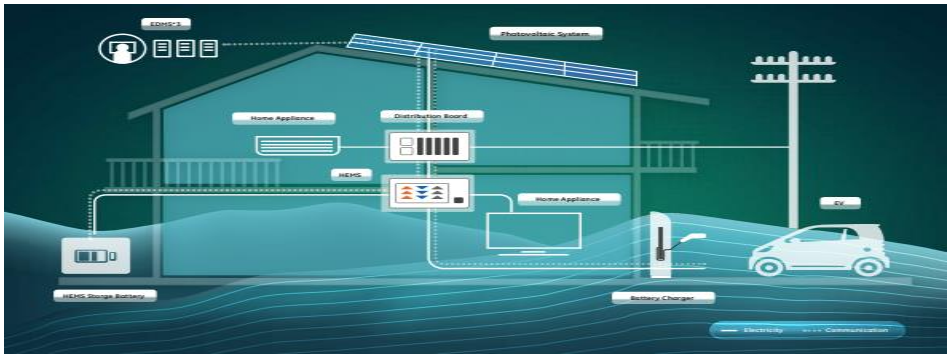
All firm entities and technological facilities can be described and represented using the SOD system, an information system. It addresses the geographic component of the information system's primary function for the numerous Sonatrach activities. Because of the cutting-edge technology employed, the SOD project was chosen to be on a shortlist of the top projects out of a thousand registered projects. Mr. Jack Dangermond, the founder and CEO of the American business ESRI, gave this distinction to the company's representatives. (Sonatrach, 2023)

5.Digital consumption

Changes on the consumption side have greatly expedited the energy system's evolution. Traditional energy consumers are now able to produce their energy because to developments in solar energy and energy storage. Customers now have more control and transparency over their energy use thanks to energy management systems, connected appliances, and advanced meters. By lowering peak energy demand, these trends will assist consumers in lowering their energy costs and improve the system as a whole. In response to price signals from the grid itself, digital energy management can mix the supply sources used, control energy use, and communicate between consumer equipment and the system. The home energy management system reacts to periods of high demand on the grid by either lowering usage or transferring energy from the grid to local generating or, if available, battery storage. This procedure will produce an ongoing flow of data on consumption patterns via the digital network. The system as a whole will function more efficiently thanks to this data, which will also optimize the possible advantages of greater user involvement. Two prerequisites must be met by the energy system of the future :

- A price incentive scheme that rewards system contributions and encourages users to act in ways that optimize system advantages ;
- supplying a control and monitoring system that is adaptable enough to take into account varying levels of client participation based on personal preferences.

Figure 01 : A future version of the smart home to highlight photovoltaic power generation, electric vehicles, control and grid connectivity



Source: (Powering the future leading the digital transformation of the power industry, 2015)

Conclusion:

To modernize Algeria's energy infrastructure and guarantee sustainability over the long run, the country's energy sector is undergoing a significant technological and digital revolution. Notwithstanding the current obstacles, the potential advantages of digital transformation make it worthwhile to keep funding the creation and execution of renewable energy projects in Algeria. This is because the energy sector's digital transformation offers a genuine chance to attain sustainable development in the nation, enhance the standard of living for its people, and lessen the effects of pollution and climate change. Therefore, by putting into practice clear and comprehensive plans and strategies based on increasing investment in renewable energy infrastructure, we can conclude that digital transformation in the renewable energy sector is one of the main solutions to enhance the development of renewable energy and achieve sustainable development. Some results were reached, the most significant of which are as follows :

-In the field of renewable energy، digital and technological revolution is a crucial instrument for attaining sustainable development;

-Implementing digital transformation in the sector of renewable energy requires consideration of the risks and obstacles associated with the process of technological and digital change، including cybersecurity and privacy threats;

-All parties involved in the energy sector's digital and technical transformation—including government agencies، businesses، academic institutions، and civil society organizations—must collaborate and coordinate. To accomplish this transition, the required funding must be made, and human cadres in this field must have the proper training and education.

Based on the above, the following recommendations are made:

-Invest more in communications networks and high-speed internet to build the digital infrastructure required to enable the renewable energy sector's development;

-encouraging businesses and investors، both local and foreign، to fund renewable energy projects by offering suitable incentives، lowering taxes، and streamlining the licensing process;

-establishing digital innovation hubs and quickening the training of digital skills;

- Increasing cybersecurity protections ;

-updating the legal framework and forming global alliances in the fields of technology and digital transformation.

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