

DIGITAL TRANSFORMATION OF THE OIL AND GAS INDUSTRY: TRENDS AND PROSPECTS

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Abstract. Modern digital technologies are transforming all areas of industries, in particular the oil and gas industry. To maximize the myriad benefits of digital transformation, it is important that companies commit to upgrading legacy systems and integrating new technologies.

Digital transformation has the potential to significantly affect the oil and gas industry, as well as many other industries. Oil and gas exploration and production, which uses advanced technologies such as touch sensors, automation, and big data analysis, can lead to increased efficiency and profitability of drilling and production operations. In addition, companies taking advantage of automated tools can optimize their supply chains. The use of advanced analytics and data visualization tools can also be used to optimize the performance of refineries and petrochemical plants, as well as to improve monitoring and control of the entire finished product chain and its value.

The purpose of the article is to identify key trends in the use of digital technologies, as well as identify promising areas for their implementation in the oil and gas industry. It is shown that the digital transformation of oil and gas sector enterprises is the main development trend, as it provides opportunities to increase efficiency, reduce costs, ensure the safety and sustainability of enterprises. It was concluded that the capital-intensive and risky characteristics of the oil and gas industry require a special approach to the introduction of new digital technologies, since companies in this sector must have a complete understanding of the expected effect of innovation in order to make an informed decision on implementation.

Key words: digital transformation, oil and gas complex, innovation drivers, digital technologies, transformation factors, innovative development.

Introduction. In the modern energy industry, faced with the growing demand for oil and the need to switch to production in difficult conditions, enterprises are forced to constantly change their business models, combining innovative technologies. The forecasts of the International Energy Agency indicate the expected increase in world oil consumption by 2026, the volume of daily consumption may increase to 104.1 million barrels [1]. To meet high demand, enterprises of the oil and gas sector must actively develop the extraction of hard-to-reach reserves, improve existing technologies and implement innovative solutions, where digital technologies play a key role in this process.

The presence of a high potential for digitalization in ensuring the transformation of the oil and gas industry determines the relevance of the chosen research topic.

The purpose of the article is to identify the main trends in the use of digital technologies, as well as to identify promising directions for their implementation in the oil and gas industry [2].

Materials and methods of research. New trends in the oil and gas industry are changing the industry, making it more efficient, safer and more reasonable. Companies are paying more attention to

digitalization and automation to solve complex engineering problems related to the subsoil. The use of artificial intelligence algorithms will increase productivity in the fields, and the combination of advanced robotics and data management will optimize processes and reduce the need for human labor. At the same time, the industry is adapting to global energy changes, focusing more on sustainable experimental investments in alternative energy sources [3].

The innovation map presents 10 best trends and 20 promising startups in the oil and gas industry (Figure 1).

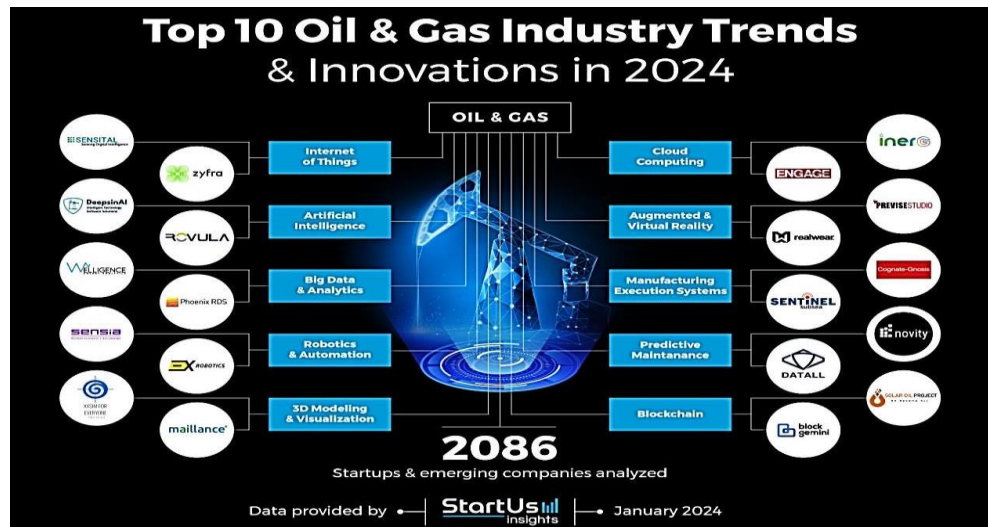


Figure 1. Trends and promising startups in the oil and gas industry

In addition, artificial intelligence allows robots to be used in oil installations and improves oil well imaging processes. Oil and gas startups also develop blockchain solutions that ensure transparency and transparency of the entire value creation chain in the oil and gas industry. Finally, advanced and virtual reality technologies increase the safety of workers and allow remote work and virtual training (Figure 2) [3].

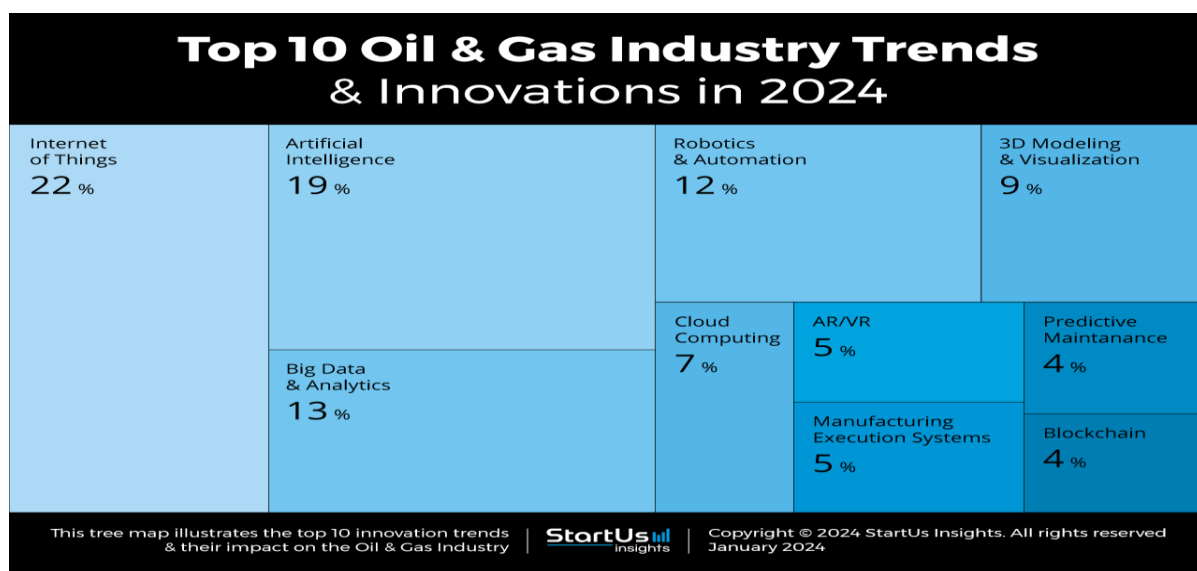


Figure 2. Oil and gas industry trends and innovations

As a result of the analysis of examples of the use of digital technologies at the enterprises of the oil and gas complex, Table 1 was compiled, reflecting the impact of the use of the most popular digital technologies in this sector of the economy.

Table 1. The main directions of digitalization of oil and gas complex enterprises.

Digital technology	Efficiency of technology
Big Data and intelligent analytics	Collecting and analyzing large amounts of data from different bases allows companies to make more informed decisions. Tracking production, consumption, oil prices, as well as meteorological and geological data will help optimize production, logistics and business processes.
Internet of Things (IoT)	IoT systems allow you to monitor the status of equipment in real time, detect malfunctions and prevent accidents. IoT systems allow you to reduce equipment downtime and increase safety at facilities.
Artificial intelligence	Artificial intelligence is used to predict production indicators, optimize production, analyze data and automate a number of tasks. Artificial intelligence allows you to identify patterns and trends that are difficult to identify manually.
Robotization and automation	Automation of production processes from production to logistics allows you to reduce the negative impact of the human factor, increase the accuracy and urgency of actions, and reduce operating costs.
Virtual (VR) and extended reality (AR)	Virtual and augmented reality are used for staff training, visualization of geological data, planning and modeling of new projects.

The main goal of the digital leap in the manufacturing operations segment is to optimize the performance of assets that have been operating for a long time. Since most of the production in the oil and gas industry has been in resource-producing fields for more than 25 years, digital technologies make it possible to increase the efficiency and duration of their productive work. The implementation of digital solutions can improve the reliability and safety of production operations, prevent failures, improve control over the condition of equipment, and reduce the risk of cyberattacks. The digital direction in this segment makes it possible to optimize operations at production facilities by reducing equipment maintenance and repair costs, as well as power consumption (Table 2) [\[4\]](#).

Table 2. Expected value of promising digital technologies in the oil and gas sector.

Segment	Purpose	Proposed Digital change	Expected result
Seismic exploration	Adjustment of the resource portfolio, including the definition of subcommittee resources, resources that reduce profitability and block significant capital.	Development of tools for in-depth analysis and interpretation of data obtained as a result of intelligence activities.	High indicators of field development, increasing the accuracy of data interpretation.
Drilling	Joint cooperation of companies achieving operational advantages and increasing the profitability of investments in digital technologies.	Integration of data from various information systems, including drilling control systems, drilling systems, cementing systems, etc.	Reducing the costs of drilling and operating deposits. Improving operational efficiency and creating additional revenue streams.
Production operations	Optimization of the performance of assets that have been operating for a long time.	Different levels of digital integration: from the installation of distributed sensors in high-potential fields to the use of standard automated and monitoring solutions at low-potential facilities.	Additional cash, saving on equipment failures, repairs, energy consumption, etc.

Results and their discussion. In the prospects for the development of the IT infrastructure of the oil and gas industry, in the first place is the automation of the full range of all works related to the

development, production, transportation and processing of oil and natural gas. After all, the reduction in the cost of oil and gas production, processing, as well as transportation is of great importance. Automation of basic basic processes in such areas as exploration drilling design and technological control, calculation of drilling parameters, management of geological and geophysical data, etc. will once again help solve this task [5].

Automation of the processes of planning, ensuring and repairing equipment in the oil and gas industry allows you to reduce the costs of the enterprise associated with emergency and planned downtime of equipment.

Recently, special attention has been paid to the development of specialized databases and software for use in geological, technological and industrial departments. In this case, the compatibility of new versions with those existing in the equipment is taken into account. Three-dimensional design and automated monitoring systems for petrochemical and oil refining facilities are created and implemented [6].

All IT technologies in the oil and gas industry are subject to high requirements for the reliability of equipment, systems such as oil and gas production, oil and gas transportation, as well as oil and gas processing. All technical requirements are the Regulatory, Information base, as well as the basis for the development of technical tasks when creating devices in the oil and gas industry [7].

Conclusions

In the oil and gas industry, as in other industries, the choice of optimal digital transformation strategies is a key factor in achieving global goals. However, initiatives in this area are not always successful, due to poor management and lack of communication between different activities.

In the course of the study, the following problems were identified: lack of a clear strategy, fragmentation of approaches, lack of necessary competencies and support from senior management, insufficient communication and resistance to changes [8].

In the context of modern global dynamic changes, the introduction of digital technologies in the oil and gas sector of the economy is becoming especially important. Digital transformation is the main trend in the development of this industry, and its importance is due to the wide possibilities of using digital technologies in ensuring an increase in the efficiency of oil production and use, cost management capabilities, as well as ensuring the preservation of competitiveness in the market.

In the field of production operations, it is important to implement a multi-level digital integration strategy, taking into account the individual characteristics of each field. For example, the use of digital technologies may involve the installation of sensors distributed over high-potential deposits to obtain data on actual mining conditions both from the surface and from below. On the other hand, for objects with low return potential, cheaper standard automated and tracking solutions may be relevant.

The analysis carried out showed that digitalization processes cover various sectors of the oil and gas industry, for each of which there are specific promising areas aimed at improving and optimizing the efficiency of operations.

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МҰНАЙ-ГАЗ САЛАСЫН ЦИФРЛЫҚ ТРАНСФОРМАЦИЯЛАУ: ТРЕНДТЕР МЕН ПЕРСПЕКТИВАЛАР

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Андатпа. Қазіргі заманғы цифрлық технологиялар барлық салаларды, атап айтқанда мұнай-газ саласын түрлендіреді. Цифрлық трансформацияның сансыз артықшылықтарын барынша пайдалану үшін компаниялардың ескірген жүйелерді жаңарту және жаңа технологияларды біріктіру бойынша міндеттемелерін қабылдауы маңызды.

Цифрлық трансформация көптеген басқа салалар сияқты мұнай-газ саласына айтарлықтай әсер етуі мүмкін. Сенсорлық сенсорлар, Автоматтандыру және үлкен деректерді талдау сияқты озық технологияларды пайдаланатын мұнай мен газды барлау және өндіру бұрғылау және өндіру операцияларының тиімділігі мен табыстылығының артуына әкелуі мүмкін. Сонымен қатар, автоматтандырылған құралдарды пайдаланатын компаниялар жеткізу тізбегін оңтайландыра алады. Жетілдірілген деректерді талдау және визуализация құралдарын пайдалану мұнай өңдеу және мұнай-химия зауыттарының өнімділігін оңтайландыру және дайын өнім мен оның құнын құрудың бүкіл тізбегін бақылау мен бақылауды жақсарту үшін де пайдаланылуы мүмкін.

Мақаланың мақсаты цифрлық технологияларды пайдаланудың негізгі үрдістерін анықтау, сондай-ақ оларды мұнай-газ саласына енгізудің перспективалық бағыттарын анықтау болып табылады. Мұнай-газ секторы кәсіпорындарының цифрлық трансформациясы дамудың негізгі тренді болып табылады, өйткені ол тиімділікті арттыруға, шығындарды азайтуға, кәсіпорындардың қауіпсіздігі мен тұрақтылығын қамтамасыз етуге мүмкіндік береді. Мұнай-газ индустриясының капиталды көп қажет ететін және тәуекелді сипаттамалары жаңа цифрлық технологияларды енгізудің ерекше тәсілін іске асыруды талап етеді деген қорытындыға келді, өйткені осы секторға кіретін компаниялар енгізу туралы негізделген шешім қабылдау үшін инновациялардың күтілетін әсері туралы толық түсінікке ие болуы керек.

Түйін сөздер: цифрлық трансформация, мұнай-газ кешені, инновация драйверлері, цифрлық технологиялар, трансформация факторлары, инновациялық даму.

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ НЕФТЕГАЗОВОЙ ОТРАСЛИ: ТЕНДЕНЦИИ И ПЕРСПЕКТИВЫ

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Аннотация. Современные цифровые технологии преобразуют все сферы отраслей, в частности и нефтегазовую. Чтобы максимально использовать бесчисленные преимущества цифровой трансформации, важно, чтобы компании взяли на себя обязательства по модернизации устаревших систем и интеграции новых технологий.

Цифровая трансформация потенциально может существенно повлиять на нефтегазовую отрасль, как и на многие другие отрасли. Разведка и добыча нефти и газа, в которых используются передовые технологии, такие как сенсорные датчики, автоматизация и анализ больших данных, могут привести к повышению эффективности и рентабельности операций по бурению и добыче. Кроме того, компании, использующие преимущества автоматизированных инструментов, могут оптимизировать свои цепочки поставок. Использование передовых инструментов аналитики и визуализации данных также может быть использовано для оптимизации производительности нефтеперерабатывающих и нефтехимических заводов, а также для улучшения мониторинга и контроля всей цепочки создания готовой продукции и ее стоимости.

Целью статьи является определение ключевых тенденций использования цифровых технологий, а также выявление перспективных направлений их внедрения в нефтегазовую отрасль. Показано, что цифровая трансформация предприятий нефтегазового сектора является основным трендом развития, поскольку предоставляет возможности для повышения эффективности, сокращения затрат, обеспечения безопасности и устойчивости предприятий. Получен вывод о том, что капиталоемкие и рискованные характеристики нефтегазовой индустрии требуют реализации особого подхода к внедрению новых цифровых технологий, поскольку компании, входящие в данный сектор, должны иметь полное представление об ожидаемом эффекте инноваций для принятия обоснованного решения о внедрении.

Ключевые слова: цифровая трансформация, нефтегазовый комплекс, драйверы инноваций, цифровые технологии, факторы трансформации, инновационное развитие.