ARTIFICIAL INTELLIGENCE IN THE PROCESS OF MANAGING THE INNOVATION ACTIVITIES OF AN OIL AND GAS COMPANY

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Summary. The article explores the integration of artificial intelligence (AI) into the innovation management processes of oil and gas companies, emphasizing its role in driving technological development and economic growth in the context of Industry 4.0. The authors highlight the transformative potential of AI, neural networks, and digitalization technologies such as the Internet of Things (IoT) in optimizing operational efficiency, reducing costs, and improving production quality. The study underscores the significance of AI as a critical factor in advancing innovation in the oil and gas sector, where the industry faces challenges related to resource constraints, market competition, and technological complexities. The innovation process in oil and gas companies is described as a dynamic, multifaceted system encompassing idea generation, project selection, development, and market introduction. This process is adaptive to economic, geological, and market changes, ensuring continuous improvement in productivity and sustainability. AI tools are shown to enhance this process by enabling advanced data analysis, predictive modeling, and automation. However, the article also identifies significant barriers to AI adoption, including technical difficulties in integrating AI with legacy systems, cybersecurity threats, high costs, organizational resistance, and a lack of qualified specialists. The authors highlight the importance of aligning AI implementation with strategic objectives, such as increasing profitability, maintaining reserves, and ensuring long-term stability. The role of public-private partnerships, regional authorities, and research organizations is emphasized in fostering innovation through the creation of specialized clusters and scientific platforms. These initiatives aim to modernize the industry by accumulating and systematizing knowledge, supporting technological innovation, and promoting sustainable development. Despite the benefits, challenges such as workforce adaptation, unpredictability of outcomes, and potential errors in AI systems remain critical concerns. The article concludes by stressing the need for comprehensive restructuring of management systems, integrating AI solutions within a unified framework to enhance decision-making, streamline processes, and achieve strategic goals. Overall, the study provides a thorough analysis of the opportunities and obstacles associated with AI adoption in the oil and gas sector, offering insights into its potential to revolutionize industry practices and drive innovation.

Keywords: management, innovation, artificial intelligence, digital transformation, economics, neural networks.

1. Introduction

The rapid digital transformation of industries worldwide has positioned artificial intelligence (AI) as a cornerstone of innovation, particularly in the oil and gas sector. As one of the most resource-intensive and strategically vital industries, oil and gas companies face unprecedented challenges that demand innovative solutions to improve efficiency, reduce costs, and maintain competitiveness. The advent of Industry 4.0, characterized by technologies like AI, neural networks, and the Internet of Things (IoT), has brought about revolutionary changes in resource extraction, production optimization, and decision-making processes. In this context, AI emerges as a transformative tool capable of modeling complex systems, enhancing operational workflows, and enabling real-time data-driven decisions. This article explores the integration of AI into the innovation management processes of oil and gas companies, analyzing its potential to drive sustainable development and long-term profitability. It delves into the multifaceted innovation process, highlighting how AI facilitates idea creation, project development, and market introduction. Furthermore, the article identifies barriers to AI adoption, such as high costs, cybersecurity risks, and workforce resistance, which pose significant challenges to the successful implementation of these technologies. By examining strategic approaches to overcoming these hurdles, the article underscores the importance

of aligning AI integration with organizational goals and restructuring management systems to foster innovation. Ultimately, AI is positioned not merely as a tool but as a strategic enabler of digital transformation in the oil and gas industry, with the potential to redefine traditional practices and ensure resilience in an increasingly dynamic market environment.

2. The Innovation Process in Oil and Gas Companies

To improve innovation in oil and gas companies (NGCs), management needs to realize that innovation management is a complex area that requires a variety of skills. Successful innovations should be considered as the result of an effectively built value chain, which is an innovation process. This process combines four key areas: idea creation, project selection, development, and market launch (Figure 1).
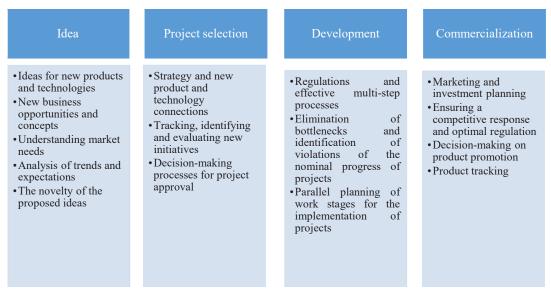
Idea	Project selection	Development	Commercialization
• Ideas for new products and technologies • New business opportunities and concepts • Understanding market needs • Analysis of trends and expectations • The novelty of the proposed ideas	• Strategy and new product and technology connections • Tracking, identifying and evaluating new initiatives • Decision-making processes for project approval	• Regulations and effective multi-step processes • Elimination of bottlenecks and identification of violations of the nominal progress of projects • Parallel planning of work stages for the implementation of projects	• Marketing and investment planning • Ensuring a competitive response and optimal regulation • Decision-making on product promotion • Product tracking

Figure 1 – Stages and tasks of the innovation process (Andreev & Sinelnikov, 2008)

The introduction of innovations, or the innovation process, covers the entire life cycle of innovations – from their creation and implementation to use and disposal. This process is adaptive and responds to changes in the geological environment, economy and market conditions associated with the development of oil and gas fields.

The innovation process includes research and development (R&D), in addition, the company provides engineering services. These services, like the "service" functions at the start of any business, focus on translating new concepts and tools into practical implementation of the processes of extraction, production, processing, transportation and marketing of oil and gas.

This is a dynamic update of products, technologies and services, stimulating economic growth and progress in science and technology at the enterprise. During its development, the innovation process in companies in the oil and gas industry has transformed and now represents a complex and multifaceted phenomenon. It guarantees a set of modifications in the tasks, circumstances, essence, tools, techniques, forms of organization of production, economic and administrative activities in the organization, which are characterized by novelty and the possibility of improving performance in the near future and stability of development in the long term. In the modern oil and gas industry, the innovation process is closely interconnected with continuous and close cooperation between industry, technology owners, and research and development organizations (Andreev & Sinelnikov, 2008).

The use of artificial intelligence (AI) is a key vector of technological progress in the process of digital transformation of the oil and gas sector, which determines its importance in the innovative activities of companies. Artificial intelligence has caused the need to determine which boundaries are acceptable in its use, as well as for which AI is most suitable and effective. It took time, starting in the mid-twenties.

In an effort to increase the efficiency of oil and gas production, the states establish cooperation, pursuing common development goals. However, competition cannot be avoided in this area, which is especially noticeable in the confrontation between Arab countries and States engaged in offshore mining.

The oil and gas industry covers a wide range of issues related to the extraction and processing of these critical energy resources. The introduction of scientific research, drilling wells for the processing of hydrocarbons, ensuring high–quality oil production - all this requires both deep scientific knowledge and the availability of qualified specialists.

The key indicator of the effectiveness of innovations in the oil and gas industry is considered to be achieving the maximum positive effect: increasing profitability, maintaining reserves, and significantly improving oil and gas production (Oreshina, 2021).

At the same time, there are limitations associated with a possible shortage of the main types of resources needed for further processing of oil and gas. Such resources include economic, material, labor, energy, and rare mineral resources.

At the same time, the key figures in the formation of innovative work can be called the following:

1. A number of organizations can be classified as innovative: organizations engaged in research and design and survey work, research centers, branches and structural units of large corporations, such as JSC NC KazMunayGas (KMG) (Zinchenko & Torosyan, 2023).

2. Regional authorities are creating clusters, specialized associations designed to solve national problems in the field of the oil and gas industry in the region.

3. The introduction of scientific and technical platforms in the field of hydrocarbons is often carried out within the framework of partnerships, both public and private, with the producing country. These platforms are being created to modernize the economy through scientific and technical achievements, as well as to accumulate and analyze industrial experience in the extraction and use of hydrocarbons. These mechanisms serve as a tool for accounting and systematization of knowledge gained during the development of deposits and processing of hydrocarbons. In this way, they contribute to improving the efficiency and safety of their respective industries, stimulating innovation and sustainable development.

4. A carefully planned and mutually beneficial cooperation aimed at solving specific production tasks in the field of oil and gas production. Innovations are integrated into the technological process, accompanied by various tests, based on the results of which a decision is made on the launch or termination of the production of batches of petroleum products.

Companies continuously monitor scientific and technical achievements in order to integrate the latest technologies into all areas of activity. Innovations can be expressed both in advanced special equipment and technological processes, and in the modernization of business management methods.

3. Barriers and Challenges in AI Implementation

The implementation and development of AI systems in a company requires a thorough analysis of current business processes and technological infrastructure. It is important to anticipate future changes both in the industry and within the organization itself. It is necessary to form a competitive strategy in the market and develop detailed plans for innovative transformations covering all areas of activity, from management to technological aspects. It is also critically important to develop programs for the recruitment, training and development of personnel at all levels to ensure the successful adoption and effective use of new technologies.

The introduction of artificial intelligence (AI) solutions in industry faces a number of barriers that can slow down or complicate the integration process:

− Difficulties in connecting AI to the existing IT infrastructure and production devices of the enterprise create technical obstacles to its implementation. Integrating artificial intelligence with legacy systems is a significant challenge. The difficulty of adapting AI tools to established corporate platforms and technological base is one of the key factors hindering the spread of these innovations. The need to ensure compatibility and efficient operation in the existing environment requires considerable effort and expertise;

− Protection of information resources and countering computer threats. Ensuring data security and preventing unauthorized access. Reliable protection of information from cybercriminals. Preventing digital attacks and ensuring data integrity. Comprehensive protection against malicious software;

− Significant monetary costs are a key problem in the development of AI. The introduction of artificial intelligence entails the need for large investments in the modernization of the technical base, professional development of employees and the design of innovative working algorithms;

− The introduction of artificial intelligence can be complicated by the resistance of staff and management, as well as an incomplete understanding of the positive aspects of this technology. These organizational obstacles can significantly slow down or even block the process of integrating AI into work processes. The lack of a common understanding of the benefits of using AI, both among ordinary employees and among managers, generates a conservative attitude towards innovation and an unwillingness to adapt to new conditions. Overcoming these barriers requires focused efforts to inform and convince staff of the need and usefulness of AI implementation;

− Lack of experienced specialists. There is an urgent need for highly qualified employees. The labor market is experiencing a shortage of professionals with the necessary knowledge and skills to perform complex tasks. Companies face difficulties in finding and hiring competent employees, which negatively affects productivity and competitiveness. The lack of a sufficient number of qualified personnel hinders the development of many sectors of the economy and creates obstacles to the implementation of innovative projects. Investments in education and training are becoming critical to overcome this deficit and ensure sustainable growth;

− The probability of errors and malfunctions in the functioning of artificial intelligence. There is a possibility of inaccuracies and irregularities in the operation of AI-based systems. The introduction of artificial intelligence is fraught with the danger of failures and incorrect results. The possibility of errors and malfunctions during the operation of AI technologies cannot be excluded. The development and application of AI does not guarantee error-free operation, and there is always a risk of problems;

− Complexity of goals – innovative approaches in the field of artificial intelligence involve overcoming difficult problems, the answers to which may be unobvious or difficult to implement;

− Unpredictability of the final result – despite significant assets, it can cause fluctuations on the part of financiers and the company's management. The outcome of using AI tools is difficult to predict, which provokes uncertainty among stakeholders;

− The introduction of AI solutions is often driven by the desire to meet current trends, demonstrating the technological advancement of the company. However, senior managers often do not fully understand and accept the potential benefits of these technologies. Moreover, it may not be clear enough to them how these tools can be effectively used in real business processes. Subjective factors such as lack of awareness and biased attitudes create obstacles to successful AI integration.

4. Conclusion

It is also necessary to consider approaches to restructuring the management systems of companies in the oil and gas industry when integrating solutions based on artificial intelligence and Industry 5.0 principles:

The integration of artificial intelligence and other digital solutions is advisable as part of an integrated company management system. This approach forms a common basis for analyzing information, developing strategies, and coordinating work processes;

The introduction of artificial intelligence systems should be focused on improving work efficiency, reducing costs and improving the consumer properties of manufactured goods. AI deployment should pursue the goals of optimizing workflows, minimizing costs, and improving the quality of manufactured products. The use of AI technologies should contribute to a more rational use of resources, reduce financial costs and improve the characteristics of manufactured goods;

When integrating innovative solutions, it is necessary to take into account possible risks, including unauthorized access to information, compromise of personal information and other factors that may negatively affect the stability and security of the company's operations.

The importance of production facilities is increasing, where it is possible to use advanced solutions based on artificial intelligence, both technologically and administratively. Corporate governance and strategic planning will become particularly important, which will lead to a reduction in the traditional management structure due to robotization and automation of routine tasks using AI. This trend illustrates the classic process of polarization: the average level of management functions is declining, leaving only the most important strategic tasks in focus, requiring in-depth analysis of large amounts of information. At the same time, modernization and optimization of production processes are taking place.

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