Possible Directions of Influence of Artificial Intelligence on the Development of the Pharmaceutical Industry

Airat Izmailov

PhD in Economics, Associate Professor, Department of Scientific and Innovative Technologies in Healthcare, Samara State Medical University of the Ministry of Health of the Russian Federation, Samara, Russia

Received: 27.03.2026 Accepted: 04.04.2026 Published: 28.04.2026
https://doi.org/10.54414/YZUP5934

Abstract

This article presents the results of a study examining the impact of rapidly developing artificial intelligence technologies on various stages of drug development. The paper examines the theoretical aspects of artificial intelligence's influence on business processes in various areas of socio-economic relations; outlines the stages and duration of drug development; identifies the positive and negative aspects of artificial intelligence's impact on the pharmaceutical industry; identifies the possible directions of artificial intelligence's influence at each stage of drug development; highlights the practical application of AI at various stages of drug development and sales; and presents an algorithm for integrating AI technologies into the activities of a full-cycle pharmaceutical enterprise. The aim of the study is to assess the impact of artificial intelligence implementation at various stages of drug development and subsequently forecast its prospects. The economic and general scientific methods used in the study allowed us to identify the possible prospects for the influence of artificial intelligence on the pharmaceutical industry, as well as formulate the positive and negative aspects of the impact of artificial intelligence technologies on the pharmaceutical industry. The research base was provided by the scientific works of domestic and foreign scientists in the field of applied application of artificial intelligence technologies in various areas of economic development.

Keywords: technology, digitalization, artificial intelligence, pharmaceuticals, pharmaceutical industry

1. Introduction

Artificial intelligence-based technologies are now permeating every area of business and manufacturing. The pharmaceutical industry, considered globally one of the most knowledge- and capital-intensive sectors of the economy, is no exception. The pharmaceutical industry develops, tests, and produces various types of drugs. Drugs constitute the majority of the industry's product range (approximately 70%, according to various estimates). In addition to drugs, pharmaceutical companies also produce dietary supplements, parapharmaceutical products, and other products (Qadamova & Xakimov, 2024). The drug life cycle has a number of specific characteristics, including a lengthy development period, a multi-stage, high-risk, and expensive testing process, a costly market launch, and so on. However, advances in modern AI technologies offer significant opportunities for integration into the pharmaceutical industry, across all stages of the drug life cycle.

2. The Impact of Artificial Intelligence on Various Sectors of the Economy

A wide range of scientific papers devoted to the impact of AI on various sectors of the modern economy is now publicly available. Domestic authors, along with international specialists, are exploring the possible diffusion of AI technologies into various areas of socio-economic relations. AI, in turn, becoming part of a unified economic ecosystem, significantly changes the face of modern trade, economic, and industrial relations.

Among the scientific works of international authors, R.N. Alkaied, Sh. A. Khattab, and I.M. Al Shaar highlight key aspects of AI's influence on consumer decisions to make repeat purchases (Xakimova, 2025). It is important to note that the main principles of this work are also applicable to the sale of pharmaceutical products.

The impact of AI on the development of tourism is examined in G. Khakimova's work (Xie, Miao, Tan, 2024). General aspects of the development of artificial intelligence and machine learning are explored in A. Jumayev and J. Shohradova's work (Niazi, 2025). This article pays particular attention to the ethical aspects and development prospects in this area.

The impact of AI on modern business processes is analyzed in the work of Z. Qadamova and A. Xakimov (Vagan, Ashar & Sidra, 2024). This work describes in detail how AI technologies are transforming operational processes, expanding decision-making capabilities, and stimulating innovation in organizations. This study is complemented by the work of H. Eljaji and R. Reshid Mekuria, which details the prospects and potential impact of mathematical models and AI on the organization of logistics processes in business (Jumayev & Shohradova, 2024.

Also noteworthy is the work of P. Xie, J. Miao, and X. Tan, which provides a comprehensive presentation of the results of a study on the impact of AI on the labor market [22]. This work examines the dual nature of AI's influence on personnel selection based on a comprehensive analysis of empirical data and scientific research. Statistics show that AI-based recruiting tools can reduce hiring time by 40–75% and hiring costs by 30–50% (LinkedIn Talent Solutions, 2023).

Scientists have also addressed the impact of AI on industry-specific aspects of healthcare development. Chinese researchers M.W. Shah, U.A. Muhammad, and S. Sidra concluded that the perceived usefulness and ease of use of AI-based projects are influenced by factors related to management, organization, operations, and IT infrastructure (Taylor, 2015).

Among the works of Russian scientists covering specific issues of AI's impact on the development of various economic sectors, the work of I.B. Starostin and O.V. Vershinina, which reveals general aspects of AI's impact on the Russian economy, stands out [10]. This article examines the application of AI in the economy and analyzes the current state and development prospects of this field in the Russian Federation.

Authors A.V. Minbaleev, M.A. Berestnev, and K.S. Evsikov explore the potential for AI application in the extractive industry (Minbaleev, Berestnev, & Evsikov, 2022). Their analysis revealed that most research in this production sector focuses on technological aspects or resource conservation. However, the safety aspects of using digital technologies in geotechnological processes remain unexplored. An analysis of AI use in geotechnological process management reveals challenges in delineating responsibility for accidents and emergencies.

Author I.T. Perova analyzes the potential for AI applications in agricultural development (Andrianov et al., 2024). The findings demonstrate that the spread of modern technologies in agriculture is accompanied by the emergence of new job functions, professions, and, consequently, competencies. This places new demands on personnel training and also impacts working conditions and lifestyle in rural areas.

Authors E.P. Keleda and N.N. Pronkin explore the application of AI in medicine (Kaleda & Pronkin, 2023). This paper examines the main applications of AI in various fields of medicine, provides real-world examples of AI use in healthcare for disease diagnosis, classification, and visualization, and describes various types of medical robots. Using a generalization method, the key advantages of using AI in medicine are identified.

The prospects for using AI in the nuclear industry are presented in the works of authors such as A.A. Andrianov, A.A. Zaluzhny, and A.V. Mitskevich [8]. This paper discusses the areas of application and possible limitations of AI in the nuclear industry. The authors argue that developing AI can be used at almost all stages of the fuel cycle and in related fields. According to their conclusions, AI methods can improve the efficiency of activities in nuclear medicine, science, and the search, systematization, and processing of large amounts of information.

Some issues related to the potential use of AI in the development of the oil and gas industry are discussed in the work of author N.A. Eremina and D.A. Selenginsky (Eremin & Selenginsky, 2023). According to the researchers, AI methods that can be trained using an accumulated database of real experiments, computer modeling, and logs from operating fields have the ability to predict the occurrence of complications and emergency situations. Artificial intelligence tools can help optimize production and improve the efficiency of hydrocarbon production and recovery. As content analysis shows, there is currently a very broad body of research examining the potential impact of developing AI technology on various industries. Given the influence this megatrend is having on the modern world, research into the potential impact of AI on pharmaceuticals also appears strategically important. At least four key factors underpinning the relevance of this topic can be identified.

First, the global and domestic pharmaceutical industries are focusing on the production of innovative drugs. Second, the use of AI capabilities allows for a reduction in drug development and production costs. Given that the pharmaceutical industry is one of the most capital-intensive, AI capabilities are of great interest to manufacturers. Third, it supports the development of personalized medicine. Society is approaching a stage in its development where drugs can be produced not for the mass consumer, but specifically, taking into account the individual characteristics of consumers. Fourth, AI opens up opportunities to improve safety for the end consumer.

3. A study exploring the potential impact of artificial intelligence on various stages of drug production

The Russian pharmaceutical industry today has a number of distinctive features, among which it is worth highlighting several of the most significant. These include a general increase in government attention to the pharmaceutical industry, the government's commitment to strategically pivoting the industry toward the development and production of innovative, high-value-added drugs, the implementation of import substitution policies to counteract sanctions pressure from Western countries, the active development of online drug sales, a shift in focus toward training modern domestic personnel capable of developing the latest innovative drugs, and the active integration of digital technology and AI across all industry niches.

As noted previously, the unique life cycle of pharmaceutical products (in particular, drugs) heightens the interest of pharmaceutical manufacturers in finding ways to reduce both the time and financial costs of production. According to some sources, the time from the start of research into new useful molecules to the launch of a drug on the market can take up to 15 years, with financial costs exceeding several hundred million dollars.

Data from Pharmaceutical Research and Manufacturers of America (PhRMA) indicates that the cost of producing a new drug is approximately $900 million (30 years ago, this figure was no more than $300 million), with the average development period ranging from 10 to 15 years (Perova, 2025). It should be noted that biotech drugs are even more expensive and time-consuming. Their development costs often exceed $1 billion, and development periods can reach up to 20 years. The processes associated with the high cost of developing and launching new drugs are fully relevant to the biotech industry.

The range of opportunities offered by AI implementation offers manufacturers a high chance of reducing costs and accelerating the market entry of new drugs. Given the socioeconomic realities in which the modern domestic pharmaceutical industry is forced to develop, the prospect of integrating AI capabilities into individual stages of drug development, testing, production, and sales is becoming even more attractive. The stages of the drug life cycle include: synthesis of new substances, study of new substances, preclinical animal studies, clinical trials, registration, and marketing.

The use of AI at any stage of drug development, testing, or production significantly exceeds the capabilities of human intellectual effort due to its ability to quickly process large volumes of unstructured information, identify connections between disparate information, detect hidden trends and tendencies, and so on. These are the principles upon which the AI training process is built. However, the colossal volumes of information fed to the AI for training purposes may also contain erroneous data. This introduces the possibility of erroneous conclusions during the development of the AI algorithms.

This implies that the quality of the data used during neural network training directly impacts the effectiveness of its subsequent operation. Despite the wide range of positive effects of AI in pharmaceuticals, the likelihood of errors in its operation can be considered a very serious risk and a potential barrier to its further application.

A study of the impact of AI on the development of the pharmaceutical industry has revealed a wide range of positive and negative aspects. The positive and negative aspects of AI application in pharmaceuticals are visually illustrated in Figure 1.

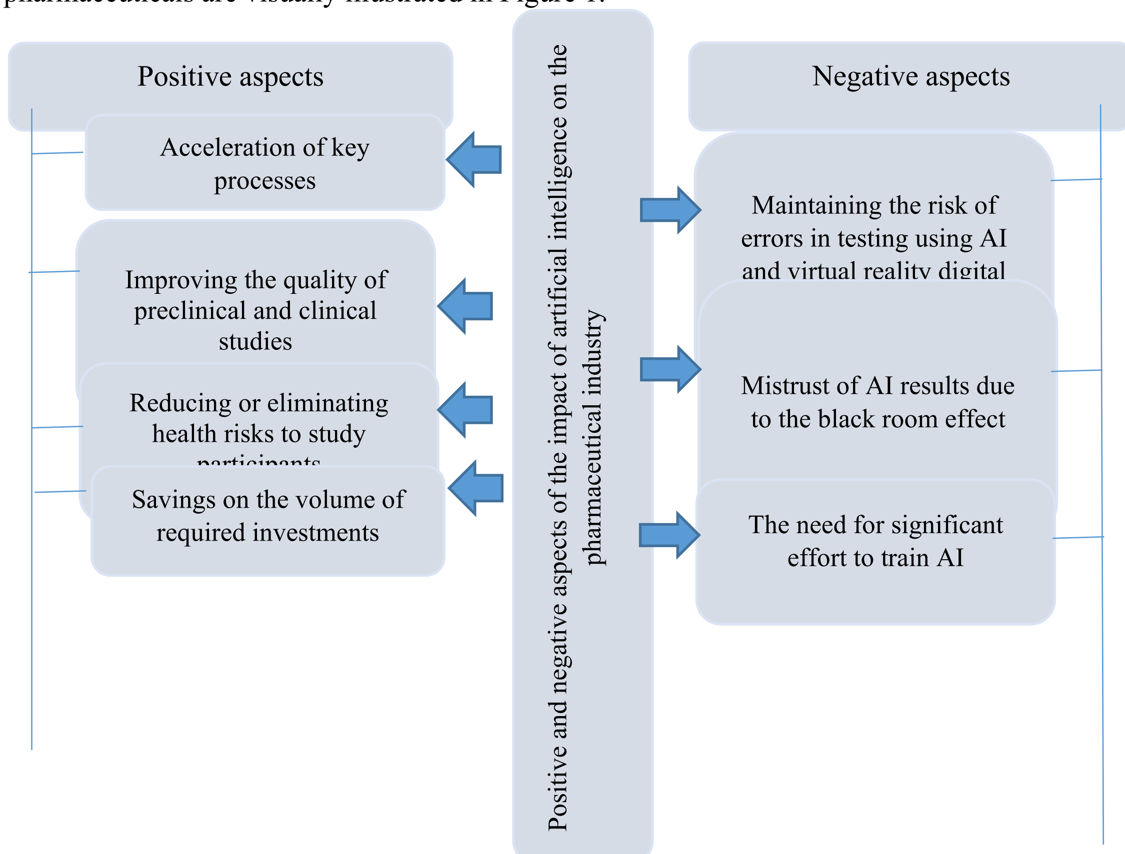

Figure 1. Positive and negative aspects of the impact of artificial intelligence on the pharmaceutical industry

The positive impact of AI on modern pharmaceuticals is outlined by a range of key elements: acceleration of internal processes, time and cost savings, risk reduction, and improved product quality. However, some drawbacks to these processes can be identified, including the critical importance of the underlying data used to train neural networks, the still-low level of trust in the practical application of AI-generated results, and the significant effort required to prepare AI for the required state. When discussing the impact of AI on individual stages of drug development, a wide range of key trends and prospects can be identified, as summarized in Table 1.

Table 1 *– Potential Impact of Artificial Intelligence at Each Stage of Drug Development*

Duration	Название этапа	Важнейшие тренды влияния ИИ на этап	Перспективы влияния ИИ
Duration: 1-3 years	Synthesis of new substances	- Acceleration and optimization of the process of searching for new useful molecules	-Reducing the time from idea to drug candidate from 5-7 years to 1-2 years
	Study of new substances	Accelerated screening and predictive analysis in vitro	- Reducing the number of chemical compounds subject to costly and high-risk testing; - Improving the quality of identifying unpromising and potentially hazardous compounds;
	Preclinical trials	Predictive toxicology and safety	- Reducing the number of animal tests; - Improving the safety level during preclinical trials;
Duration up to 10 years	Clinical trials	Optimization of clinical trial design and planning	- Increasing the success rate of clinical trials; - Reducing the risk of potential adverse effects on human health during clinical trials.
Duration up to 7 years	Registration	Automation of collection and preparation of regulatory documentation	- Reduced dossier preparation time; - Increased accuracy and completeness; - Release of highly qualified specialists;
	Implementation	Continuous pharmacovigilance and patient safety	- Personalization of therapy; - Increased trust in medications

* Compiled by the authors based on [2, 19]

As Table 1 shows, AI can have a multifaceted impact on drug development and production. It's worth noting that this table does not provide an exhaustive list of potential trends and prospects; it focuses on the most significant ones. It is believed that as AI technologies progress, the trends prevalent at any given stage of the drug lifecycle may also change, and the same can be said about prospects.

A content analysis of information covering the potential and prospects for using AI at various stages of drug development and registration revealed a lack of real-world cases of modern pharmaceutical companies using neural networks across all stages. On the contrary, various companies publish their experiences using AI at specific, completely different stages of the drug lifecycle. This suggests that AI is still a relatively new phenomenon, and there simply hasn't been enough time to adapt its capabilities to all stages of drug development, registration, and marketing.

Table 2 below presents case studies of various pharmaceutical manufacturers using neural networks at specific stages of the drug lifecycle.

Table 2. *AI Application Practices at Various Stages of Drug Development and Implementation*

Stage name	Real-life cases of AI applications at various stages of drug development
Synthesis of new substances	Researchers from ITMO University, with support from Sber's Center for Practical Artificial Intelligence, have developed a multi-agent system for searching for new drug molecules. The model not only generates new molecules in virtual space but also fully automates the search and selection process. The program operates with high accuracy—almost 80% of the variants proposed by the system meet the criteria specified by the scientists. The authors have already tested the system and generated molecules with it that could potentially help develop drugs for Parkinson's, Alzheimer's, lung cancer, and other diseases. The scientists presented their research results at the EMNLP 2025 conference in China [11].
Study of new substances	Scientists from the Center for Strong AI in Industry, the Center for AI in Chemistry, and the Infochemistry Research and Education Center at ITMO University, with industrial support from Sber, have developed a multi-agent system for fully automating the process of studying new drug molecules based on natural language queries. MADD (Multi-Agent Drug Discovery) consists of four AI agents that sequentially solve various tasks, such as analyzing a researcher's text query, selecting the

	appropriate algorithms, generating molecules and calculating their properties, and compiling the results into a single report. Each agent operates on large language models: GPT-4o, Gemini 2.5 Flash-Lite, Llama-3.1-70b, GigaChat, and others [11].
Preclinical trials	Insilico Medicine also announced the completion of preclinical trials of ISM8969, a potent inhibitor for the treatment of Parkinson's disease. And most recently, ISM8001, another drug candidate targeting solid tumors of internal organs, was introduced. It is designed to combat cancer cells that have developed resistance to existing drugs. Since its inception, Insilico Medicine has used AI to create 17 drug candidates, 10 of which have already received approval for clinical trials. These achievements demonstrate that AI is not simply "searching" for, but actively participating in, the development of drugs for complex and severe diseases [1].
Clinical trials	The US Food and Drug Administration (FDA) has issued an Inventory Clearance (IND) for clinical trials of ISM8969. This drug, designed to combat Parkinson's disease, was developed, modeled, and optimized using generative artificial intelligence. The use of neural networks has enabled the development cycle to be reduced to record speed. While traditional candidate discovery takes an average of 4.5 years, Insilico completed the process in 12–18 months, synthesizing only a limited number of molecules for testing. In Phase I clinical trials, which will be conducted in the US, scientists will evaluate the safety, tolerability, and pharmacokinetics of ISM8969 in healthy volunteers [9].
Registration	Experience from the Brazilian Health Regulatory Agency (Anvisa) shows that the use of AI algorithms has reduced registration times by 45–60% [15]
Implementation	To date, not a single drug developed by neural networks has yet been commercially released. However, neural networks are now actively involved in automating regulatory analysis, predicting production deviations, optimizing pharmaceutical logistics, and assessing reputational risks based on open data [12].

* Compiled by the authors based on [1, 9, 11, 12, 15]

It's worth noting that domestic AI developers are currently quite active in collaboration with Russian pharmaceutical manufacturers. However, as content analysis has shown, the use of AI in drug development is also being partially reported by companies from around the world. Table 2 above specifically reflects the experience of the United States (clinical trials) and Brazil (drug registration).

However, given the rapid integration of AI technologies into all phases of drug development, registration, and marketing, it can be argued that the comprehensive use of neural networks, from the generation of a useful molecule model to registration and market launch, can be expected in the foreseeable future. This means that comprehensive AI integration will require a specific methodological and instrumental framework in the near future.

Therefore, the authors of the study believe that proposals for algorithms for integrating AI into the entire range of scientific and production business processes at pharmaceutical enterprises are currently considered timely.

Figure 2 below visually depicts the strategy for implementing AI in a full-cycle pharmaceutical enterprise. The algorithm consists of five steps, divided according to the degree of risk of the processes involved: preparatory, organization of low-risk operations, organization of medium-risk operations, organization of high-risk operations, and the full transition of the enterprise to an AI-oriented business model.

Each of the presented steps of the algorithm involves a series of sub-steps. The first preparatory stage involves a full assessment of the enterprise's readiness for the implementation of AI technologies. This sub-stage is necessarily supported by the formation of a team and management structure. The level of preparedness and competence of the specialists involved directly impacts the success of the planned future activities. The selection of pilot projects at this stage is determined by the database that will underlie the models of the generated digital versions of useful molecules.

The expected results of implementing the first stage of the algorithm include identifying the strengths and weaknesses of the enterprise, a precise understanding of the prospects and risks of implementing AI technologies, and an assessment of the expected costs required to implement subsequent stages.

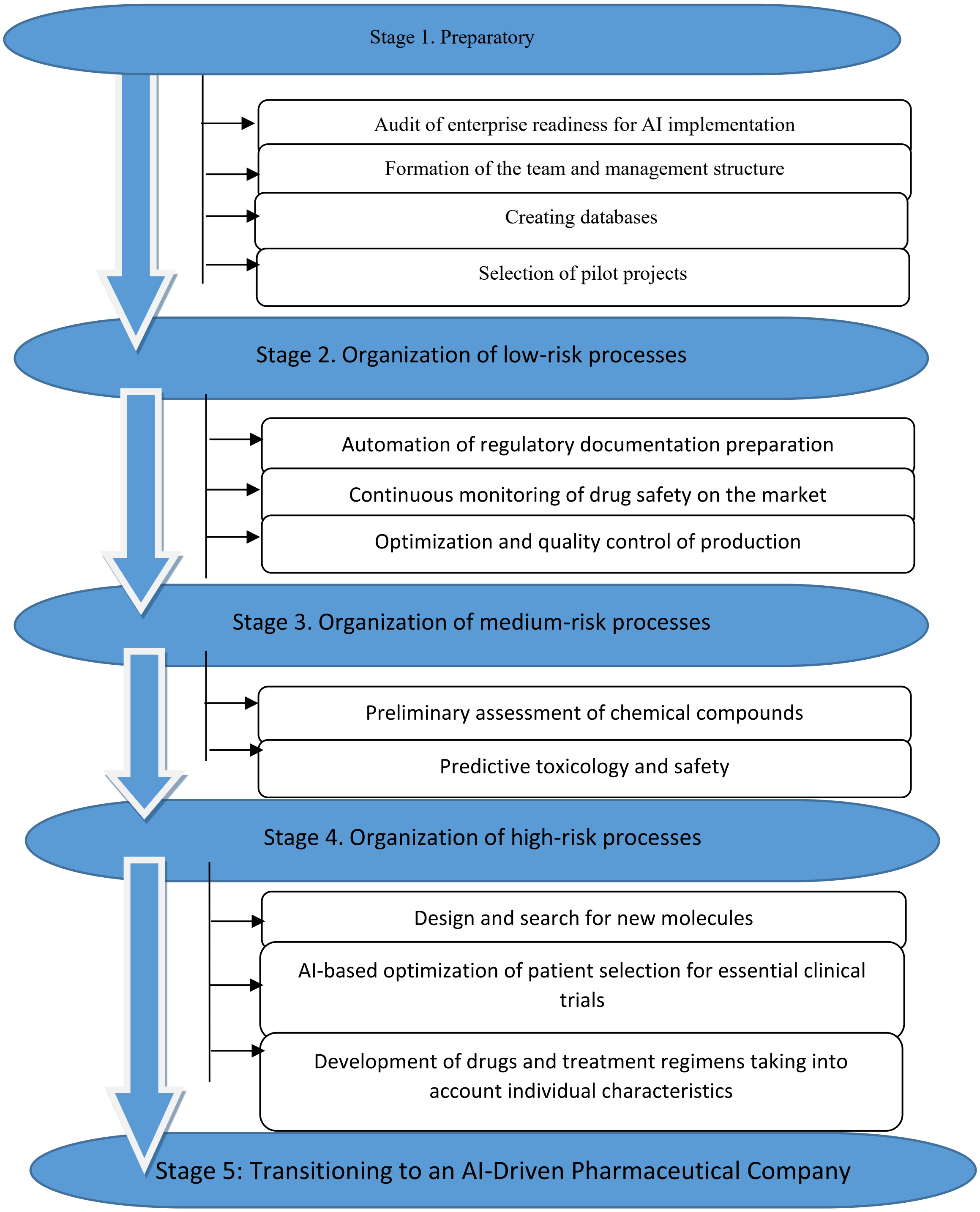

***Figure 2** – Algorithm for integrating AI technologies into the activities of a full-cycle pharmaceutical enterprise*

The second stage of the algorithm is aimed at organizing low-risk processes. This stage includes the automation of regulatory documentation preparation, continuous monitoring of drug safety on the market, and optimization and quality control of production.

Regulatory documentation governing the production of pharmaceutical products plays a fundamental role in the drug lifecycle. Ensuring manufactured products meet all regulatory requirements is fundamentally important due to the need to eliminate any risk to the health of the end user. However, this stage requires considerable time and effort for various approvals and assessments. Therefore, automation at this stage is primarily aimed at accelerating and optimizing processes.

Continuous monitoring of drug safety on the market aims to identify potentially unsuitable active pharmaceutical ingredients used in existing drugs. This thus opens up opportunities to reduce the risk of developing similar, potentially unsuitable, or dangerous drugs.

The next substage—optimization and quality control of production—flows smoothly from the previous one. Clearly, the integration of AI solutions into production requires a special approach to quality assurance. It follows that the implementation of neural networks in business processes necessitates the development of a comprehensive set of internal regulatory and legal regulations covering all production processes. Implementation of this stage contributes to the achievement of expected results such as a reduction in defective products, reduced equipment downtime, and more.

Implementation of this stage contributes to the achievement of expected results such as a reduction in defective products, reduced equipment downtime, and more. The next stage is aimed at organizing medium-risk processes. These operations include preliminary assessment of chemical compounds, as well as predictive toxicology and safety.

Preliminary assessment involves determining the suitability and potential of the chemical compounds being developed. Errors at this stage can have extremely serious consequences, especially if they involve toxicology control issues. Expected results of this stage include a reduction in the number of animals used in experiments, reduced preclinical costs, and the identification of safety issues at earlier stages.

The fourth stage is aimed at organizing high-risk operations. This stage involves the implementation of sub-stages such as the search for new types of useful molecules that can be synthesized in vitro, AI-based optimization of patient selection for necessary clinical trials, and the development of drugs and treatment regimens tailored to the individual characteristics of test subjects.

The implementation of these sub-stages is based on the implementation of generative models for creating new chemical structures, AI systems for optimizing molecular properties, and the virtual design of molecules for specific targets.

The key expected results of this stage include the following: a reduction in the time from identifying a target for a synthesized molecule to a viable candidate for clinical trials, the generation of patentable structures with low intellectual property risk, and an increased likelihood of overall project success.

The final stage of the transition strategy is aimed at transforming the company into an AI-driven pharmaceutical company. This stage involves key processes such as the formation of new business models, organizational transformation, and the development of ecosystem thinking.

4. Conclusion

In summary, the following conclusions can be drawn:

The trend toward AI-based technologies is currently pervasive in virtually all sectors and industries. This trend underlies the dynamic changes occurring in modern socio-economic relations. Given the specific nature and development trends of AI, we can predict an acceleration of the most significant business processes in all possible areas of production in the foreseeable future.

AI is also actively penetrating the pharmaceutical industry. The specific development characteristics of the pharmaceutical industry necessitate a reduction in drug development and production costs. This suggests that the diffusion of AI technologies into drug production will only increase.

The overall level of AI technology development today entails risks associated with erroneous data generated by neural networks. This means that pharmaceutical products manufactured using AI may be viewed with skepticism by society in the foreseeable future, due to the so-called "darkroom" effect. This means that the degree of trust in AI-based products is directly proportional to the time spent training them.

References

1. iXBT Live. (2025, September 1). *Algorithm against diseases: The path of AI in pharmacology*. https://www.ixbt.com/live/sw/algoritm-protiv-bolezney-put-ai-v-farmakologii.html
2. Береговых, В. В., & Ковалева, Е. К. (2013). Разработка системы обеспечения качества с анализом критических стадий в производстве ЛС из растительного сырья. *Ремедиум. Журнал о российском рынке лекарств и медицинской технике*, (10), 62-65.
3. Eremin, N., & Selenginsky, D. (2023). O vozmozhnostyakh primeneniya metodov iskusstvennogo intellekta v reshenii neftegazovykh zadach [On the possibilities of applying artificial intelligence methods in solving oil and gas problems]. *Izvestiya Tulskogo Gosudarstvennogo Universiteta. Nauki o Zemle*, *1*(1), 201–211. https://doi.org/10.46689/2218-5194-2023-1-1-201-211
4. Kaleda, E. P., & Pronkin, N. N. (2023). Zadachi iskusstvennogo intellekta v meditsine [Tasks of artificial intelligence in medicine]. *Sinergiya Nauk*, (83), 618–624.
5. Minbaleev, A. V., Berestnev, M. A., & Evsikov, K. S. (2022). Regulyirovanie ispolzovaniya iskusstvennogo intellekta v dobyvayushchey promyshlennosti [Regulation of the use of artificial intelligence in the extractive industry]. *Izvestiya Tulskogo Gosudarstvennogo Universiteta. Nauki o Zemle*, (2), 509–525. .– DOI 10.46689/2218-5194-2022-2-1-509-525. 6. Official website of PhRMA. [Electronic resource]. URL: https://www.phrma.org. (date of access 06.03.2026).
6. Perova, I. T. (2025). Osobennosti vnedreniya tekhnologiy iskusstvennogo intellekta v otechestvennoe selskoe khozyaystvo (Obzor) [Features of introducing artificial intelligence technologies into domestic agriculture (Review)]. *Ekonomicheskie i Sotsialnye Problemy Rossii*, (2), 122–136.
7. Andrianov, A. A., Zaluzhny, A. A., Mitskevich, A. V., Ponomarev, A. V., & Ptitsyn, P. B. (2024). Perspektivy primeneniya iskusstvennogo intellekta v atomnoy otrasli [Prospects for the application of artificial intelligence in the nuclear industry]. *Atomnaya Energiya*, *137*(5-6), 304–309.
8. Pharmprom News. (2026, January 24). *Neural network breakthrough: FDA approves trials of AI-created drug for Parkinson's disease*. https://pharmprom.news/proryv-nejrosetej-fda-odobrilo-ispytaniya-sozdannogo-ii-preparata-ot-bolezni-parkinsona/
9. Starostin, I. B., & Vershinina, O. V. (2025). Vliyanie tekhnologiy iskusstvennogo intellekta na ekonomiku Rossiyskoy Federatsii [The impact of artificial intelligence technologies on the economy of the Russian Federation]. *Vestnik Moskovskogo Gumanitarno-Ekonomicheskogo Instituta*, (2), 73–76.- DOI 10.37691/2311-5351-2025-98-2-73-76.
10. ITMO University & Sber. (2025). *ITMO and Sber scientists have created a multi-agent AI system for the rapid development of new drugs*. https://news.itmo.ru/ru/news/14597/
11. Shestakov, V. N., Pyatigorskaya, N. V., & Brkich, G. E. (2026). Using artificial intelligence in drug export management. *Farmaciya (Pharmacy)*, *75*(1), 39-47. https://doi.org/10.29296/25419218-2026-01-05
12. Eljaji, H. Mathematical models and algorithms in logistics: real-world applications and AI impact / H. Eljaji, R. Reshid Mekuria // Alatoo Academic Studies. – 2024. – No. 2. – P. 412-421. – DOI 10.17015/aas.2024.242.33.
13. Jumayev, A., & Shohradova, J. (2024). The evolution and impact of artificial intelligence and machine learning. *Matritsa Nauchnogo Poznaniya*, (10-2), 40–43.

14. Niazi, S. K. (2025). Bridging the regulatory divide: a dual-pathway framework using SRA approvals and AI evaluation to ensure drug quality in developing countries. *Pharmaceuticals*, *18*(7), 1024.
15. Mordor Intelligence. (2026). *Pharmaceutical manufacturing market size & share analysis: Growth trends and forecast (2026–2031)*. https://www.mordorintelligence.com/industry-reports/pharmaceutical-manufacturing
16. Qadamova, Z., & Xakimov, A. (2024). The rise of artificial intelligence and its impact on businesses. *Universum: Technical Sciences*, (6-6), 27–29.
17. Vagan, Sh. M., Ashar, M. U., & Sidra, S. (2024). The influence of artificial intelligence on the key factors that determine the success of projects in China's health sector. *Vostochnaya Aziya: Fakty i Analitika*, (3), 92–115.
18. Taylor, D. (2015). The pharmaceutical industry and the future of drug development. https://doi.org/10.1039/9781782622345-00001
19. Alkaied, R. N., Khattab, S. A., Al Shaar, I. M., Zaid, M. K. A., & Al-Bazaiah, S. A. (2024). The impact of artificial intelligence on re-purchase intentions: the mediation approach. *Бизнес-информатика*, *18*(3), 87-107. https://doi.org/10.17323/2587-814x.2024.3.87.107
20. Xakimova, G. (2025). Turizm menejmentida ma'lumotlarni tahlil qilish: Sun'iy intellekt va big data texnologiyalarining ta'siri [Data analysis in tourism management: The impact of artificial intelligence and big data technologies]. *Economic Development and Analysis*, 3(9), 277–282. https://doi.org/10.60078/2992-877x-2025-vol3-iss9-pp277-282
21. Xie, P., Miao, J., & Tan, X. (2024). The application of artificial intelligence in higher education: opportunities and challenges. *Bulletin of Kyrgyz State University Named After I. Arabaev*, (2/1), 28–34.