Saint Petersburg 2024

volume 3 issue 1

An international journal

TECHNO ECONOMICS

TECHNO ECONOMICS

An international journal

EDITORS OFFICE PUBLISHER
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Development Manager: *Anastasia Levina*
Layout designer: *Dayana Gugutishvili*

PUBLISHER
Peter the Great St. Petersburg Polytechnic University
Corresponding address: 29 Polytechnicheskaya st.,
Saint-Petersburg, 195251, Russia

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Saint Petersburg
2024

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Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 4–13.
Техноэкономика. 2024, Том 3, № 1 (8). С. 4–13.

Scientific article
UDC 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.1

ESG BUSINESS TRANSFORMATION: CHALLENGES AND OPPORTUNITIES

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Abstract. Kazakh business perceives sustainable development as a collection of goals that are more related to environmental problems. However, at present the focus has shifted towards recognizing the need for increased investment. This article aims to assess the main current trends in enterprises, ESG commitment, reporting and document management. The research invites systematic and comparative analysis, combined with the qualitative assessment as key methods. Based on reports on the sustainable development in companies, the main approaches to the generation of reports have been identified, differing both by industry and by the legal status of companies. The main sources of problems associated with the spread of ESG commitment have been identified, together with the main directions for stimulating and developing evolution of the ESG principles in business.

Keywords: ESG principles, business transformation, sustainability, ESG reporting, ESG agenda, software engineering

Citation: Adambekova A., Adambekov N. ESG business transformation: challenges and opportunities. Technoeconomics. 2024. 3. 1 (8). 4–13. DOI: https://doi.org/10.57809/2024.3.1.8.1

Научная статья
УДК 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.1

ESG ПРИНЦИПЫ В РАМКАХ СОВРЕМЕННОЙ БИЗНЕС ТРАНСФОРМАЦИИ: ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ РАЗВИТИЯ

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Аннотация. В настоящее время бизнес Казахстана рассматривает устойчивое развитие, в первую очередь, как совокупность целей, в большей степени связанных с экологическими проблемами. Однако постепенно акцент смещается в сторону признания необходимости увеличения инвестиций в ESG для оптимального развития предприятий бизнеса в целом. Данное исследование посвящено оценке основных современных тенденций в деятельности предприятий бизнеса, требований в области ESG отчетности и документооборота. В качестве основных методов исследования предлагается использовать систематический и сравнительный анализ в сочетании с качественной оценкой. На основе отчетов об устойчивом развитии в компаниях были выявлены основные подходы к формированию отчетности, различающиеся как по отраслям, так и по юридическому статусу компаний. В результате исследования были выявлены основные источники проблем и вызовов, связанных с распространением ESG-принципов, а также основные направления стимулирования и развития предприятий ESG.

Ключевые слова: ESG принципы, бизнес трансформация, устойчивое развитие, ESG-отчетность, ESG-повестка, программная инженерия

Для цитирования: Адамбекова А., Адамбеков Н. ESG принципы в рамках современной бизнес трансформации: проблемы и перспективы развития // Техноэкономика. 2024. Т. 3, № 1 (8). С. 4–13. DOI: https://doi.org/10.57809/2024.3.1.8.1

Introduction

The modern global community perceives sustainable development goals as something beyond target indicators for the functioning of national economies and businesses. Today, existence and development in the context of ESG, SDG and CSR are becoming a culture, that can be compared to the basic principles of human existence. Unfortunately, despite the fact that international experts note Kazakhstan's significant progress in this direction among the countries of the Central Asian region, ESG for Kazakh business is fashionable, might be even cool, but still is expensive. We are forced to note the absence or minimal amount of ESG information about activities of business entities in Kazakhstan. According to the results of 2019 annual reports' review, conducted by the QRA rating agency, specializing in the assessment and ranking of Kazakh companies, out of 100 companies whose annual reports were studied, only 19 produce a report on sustainable development in different forms (QRA report, 2022). At the end of 2022, according to Kursive Research, the situation has not improved, but at some point, has even worsened comparing to 2020 and 2021 (Domnin, 2023). According to experts, Kazakh companies have changed their attitude to the ESG agenda, and there is even a slight decrease in interest in this area.

As part of this research, the goal is to assess the main current trends in the ESG commitment

of companies and their provision of appropriate reporting. Objectives and research methodology. To achieve this goal, the following tasks were set. Based on the reports on the sustainable development of companies, the main approaches to the generation of reports were identified, differing both by industry and by the legal status of the companies. The relationship between the UN sustainable development goals and the ESG principles themselves is indicated. The main challenges facing companies at the stage of ESG business transformation have been identified and grouped into approaches. The main sources of problems with the spread of ESG commitment have been identified. A ESG matrix was compiled and an ESG analysis of 37 Kazakh companies was carried out for ESG commitment, on the basis of which the main directions for stimulating and developing this process were proposed.

Materials and Methods

Our study of sustainability reports from about 200 of the world's leading companies showed that sustainability reporting does not have strictly regulated structural requirements. Each company prepares a report based on its own interests, since the main approach remains that it is non-financial reporting. Thus, only 27% of Kazakh companies disclose the list of stakeholders in corporate reporting. 14% provide a fairly comprehensive report on interaction with stakeholders, 17% of companies disclose this process partially (the results of the report evaluation study are shown in Table 1). All this causes some difficulties in the study - it is impossible to conduct a comparable analysis for all indicators: we can state about the existence of a certain subjectivity.

Table 1. Results of sustainability reporting surveys

ESG criteria	Disclosure level		Disclosure level
Environmental			
Emergency and irregular discharges of pollutants	17	Energy consumption and energy efficiency	71
Biodiversity	29	Waste management	69
Materials used	33	Water consumption and environmental protection	67
Social responsibility			
Rights of minority shareholders	38	Health and safety at work	78
Impact on the population	43	Training and education	69
Impact on suppliers	48	Labor relations practice	69
Government			
About subsidiaries and dependent companies	45	Internal control and audit	69
About the organizational structure	71	Information policy	40
Structure of corporate management and board of directors of the organization	71	About corporate governance	69
Note: compiled by the authors following the QRA agency data			

In addition, it has been established that in certain industries all companies demonstrate minimal commitment to sustainable development goals (hotel business) - the lack of a standard in the industry, in turn, reduces interest for Kazakh business. It is noted that the service sector in general is characterized by fairly little experience of ESG commitment; even financial institutions, both Kazakh and global, have been preparing reports for literally 3-4 years, while the industrial sector has been involved in this process for about 10 years.

Results and Discussion

The significant gap in ESG awareness and commitment is due to various factors. First of all, the main question is how ESG is perceived and how these principles relate to sustainable development goals and corporate social responsibility. Studying about 300 publications on ESG issues, reports on sustainable development of about 200 global and Kazakh companies allowed us to conclude the following key approaches to ESG itself. If the SDGs are, first of all, global indicators for the development of states, then:

– ESG is a tool for achieving SDGs through the main participants of environmentally impacting companies;
– ESG, first of all, for business;
– ESG is non-financial and non-production reporting about responsible business conduct;
– ESG allows you to create a profile \ portrait \ reputation of the company;
– ESG environmental and social goodwill of the company;
– ESG Life metrics;
– ESG – proactivity, innovation, creativity.

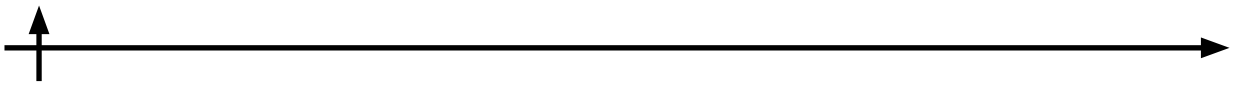
The dissemination and implementation of ESG in developing countries is sometimes compared to the experience of implementing IFRS - it was not easy; it took a long time and was accompanied by some resistance and rejection from local markets and businesses. Perhaps the main challenges that are currently faced on the stage of ESG business transformation are related to certain circumstances, which we have grouped into the following approaches.

Approach 1 – The requirement to report on SDG, CSR, ESG and follow GRI standards is not universal for the global community. Thus, the study showed that if for European countries this direction is already being implemented on the government regulation level, then in some states of America, the desire to call for ESG commitment is considered as a fact of infringement of the rights of entrepreneurs and an attempt to break the democratic foundations of American society (Joint Stock Company, 2023).

Approach 2 – For business, reporting and compliance with standards, first of all, is a result of international integration, requiring accession to the GRI, the Global Compact. In general, the global community still perceives ESG commitment as demonstration of company's corporate responsibility to the community, to the future generation. Considering that according to the World Bank, at the end of 2022, European countries account for about 20% of world GDP, China - 18.47%, the USA -15.51%, India - 7.23%, and Russia 3.25%, then, taking into account the logistics leverage, it can be assumed that the interests of Kazakh business towards European ones will also be a priority in the near future (Gross domestic product, 2022). This, as a result, requires Kazakh companies to be more integrated, which means the need to meet the expectations of foreign investors, for whom responsible investing and ESG are not just a fashionable trend.

Approach 3 – Non-financial reporting is becoming increasingly widespread among large businesses - transnational and global companies that concentrate a significant share of the world's assets. Thus, according to the KPMG report at the end of 2022, there are already about 240 companies from 250 of the 250G list (leaders in sales according to Fortune magazine) and 71% of the top 100N (a global sample of 5,800 companies included in the top 100 companies by revenue in each of the 58 countries) (Fortune 500 Ranking, 2023). These data indicate, first of all, that all large businesses today understand the importance of non-financial reporting and demonstrate their commitment to ESG.

Approach 4 – There are 5 main Frameworks on which companies and states rely when drawing up reports, analytical reviews regarding commitment to ESG, CSR. Thus, industry standards made by Sustainability Accounting Standards Board (SASB) focus on specific industries

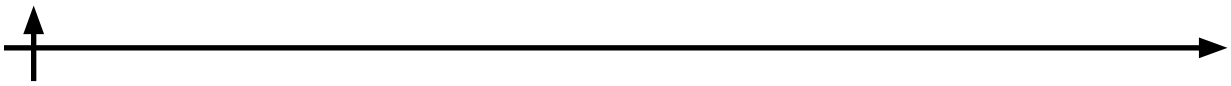


and risk factors associated with sustainability (SASB Standards, 2023). It should be noted that this standard is currently being updated and the ISSB (International Sustainability Standards Board) from the IFRS Foundation is expected to introduce a standard covering both financial and non-financial reporting principles. The Task Force on Climate-related Financial Disclosures (TCFD) standards govern reporting standards related to climate risk when a company evaluates and discloses financial, operational and strategic aspects related to climate change (Task Force on Climate-related Financial Disclosures, 2023). Carbon Disclosure Project (CDP) standards define a system for reporting greenhouse gas emissions and managing climate risks. Companies can voluntarily disclose their climate data through the CDP, allowing investors and stakeholders to evaluate their climate strategy and performance (Carbon Disclosure Project, 2023). All three standards already have significant experience in implementing the main provisions, are adapted for use, and, as a rule, do not have country specificities. The ISSB standard brings together various standards in the field of sustainability (International Sustainability Standards Board, 2023), such as GRI (Global Reporting Initiative) and regulations on ESG factors (Abdullina, 2023). Most of the GRI standards in one way or another overlap with the first three, but have their own more specific approaches, expressed in the example of such standards as indirect economic impact (SRS403) and social policy (SRS 615).

Approach 5 – The global community is moving towards introducing mandatory standards for non-financial reporting and updating IFRS – to make them "pro-sustainable", we are moving towards the full implementation of integrated reporting (IIR). This may be an important step in promoting ESG awareness, considering the experience gained in the Central Asian region during the implementation project of the IFRS. Considering that during the period of introducing IFRS and adapting Kazakhstan accounting to international requirements, the process began precisely with financial organizations and institutions, and then moved to the real sector and all this was accompanied by great resistance, perhaps that this process is worth of implementing through adapted IFRS.

At the same time, various industries and spheres have their own regulations, which in one way or another explain, recommend and define approaches to reflecting the results of business entities (for example, recommendations of National\Central Banks of countries on the disclosure of non-financial information; recommendations of the International Integrated Reporting Council (IIRC), TCFD; EU Environmental Management and Audit Scheme (GRI, 2023). All this indicates that in certain countries and regions, at different levels, the issue of promoting ESG awareness is gaining support and perception is gradually improving. On the other hand, this once again indicates that regulatory tools are necessary and that they contribute to improving the ESG culture (Tsertseil, 2023). At the same time, the application of the due diligence approach to ESG indicates that the application of this principle is associated with some difficulties in fulfilling obligations to disclose information along the entire value chain. This means that the issue of regulation is becoming increasingly relevant.

The meaning and role of ESG is also explained through the accumulation of experience in its promotion, the list of positive impacts of companies' commitment to these principles is expanded. There is no doubt that, first of all, through the disclosure of the essence comes the awareness of influence (Kuznetsov, 2023; Maydanova and Ilin, 2023). Thus, with the help of ESG reporting, the company completes its portrait for direct and indirect stakeholders, helping them understand the company's values with a certain strategic presentation, but without delving into the operational life of the business. As a result, gained benefit is an improvement in the reputation and image of the company. The widely discussed issue of greenwashing and imaginary CSR is supported by many cases, which, unfortunately, take place. In particular, various cases from Deutsche Bank reflect the application of both principles of social and corporate responsibility.



For example, in 2020, the New York State financial regulator fined Deutsche Bank for $150 million for failing to control the illegal/criminal connections of its client, who had been actively using the bank's accounts for many years for human trafficking operations. Or when the US Securities and Exchange Commission fined a bank $55 million for inaccurate descriptions of bank assets (overvalued assets and lack of sufficient collateral) (Corporate sustainability reporting, 2023). The Supervisory Board of the bank and the shareholder meeting recognized as the reasons for this situation (as well as of the other errors made in management) the appointment of two full-fledged executive directors of the bank – the use of the so-called tandem management model (2016). At the same time, sufficiently detailed information about ESG commitment and cases confirming Deutsche Bank's contribution to the development of green finance one way or another neutralizes negative cases and the issue of maintaining reputation depends on, as they say, "the number of good deeds" (Mingazov, 2023).

Undoubtedly, the main benefit of ESG commitment, recognized and working to stimulate companies' interest in the ESG agenda, is attracting investment. Investors are increasingly paying attention to ESG indicators when making investment decisions. Sustainability reporting provides an opportunity for companies to disclose their ESG practices and attract investors interested in responsible investing. Both parties involved in this process strive to highlight these cases, which typically relate to either two or all three ESG pillars. For example, a striking example is the case of Etihad Airways, which announced the signing of a loan agreement in October 2021 in the amount of $1.2 billion with financial institutions HSBC and First Abu Dhabi Bank. The terms of the loan require Etihad to meet key performance indicators in three ESG areas: CO2 emissions, increasing the number of women in Etihad's workforce and improving corporate governance integrity (Fedotovsky, 2015).

An additional opportunity that companies receive when preparing ESG reporting is the expansion of risk management tools. Sustainability reporting helps companies identify, assess and manage risks associated with ESG factors: climate change risks, environmental risks, supply chain risks and other aspects that can affect a company's financial performance and stability. Basing on them, the understanding of the need and methods of regulation through non-financial reporting is being transformed. Thus, the European Commission has made changes and made non-financial reporting mandatory for all companies covered by the Corporate Sustainability Reporting Directive (CSRD) (Etihad Airways, 2023). The desire of a business to comply with the requirements and regulatory environment becomes an important condition for the ability to be globally integrated.

The main sources of problems with the spread of ESG commitment, in our opinion, are several both objective and subjective reasons. Mentality is perhaps the most frequently cited reason when discussing the constraints to reform. And yet, it is enough to recall the Kazakhstani experience of transition from national to international IFRS. Basically, current practice shows all the same signs – quiet sabotage is observed within both middle management and top management (Zhizhikov, 2023). In addition, the specifics of international experience's implementation indicate that in this process, Kazakh companies face the same problem. Human capital, which determines the foundation of changes and transformations, is represented either by older workers who do not want changes, or by young people who, due to lack of experience, are not capable and not ready to implement these changes.

The complexity of the formation and non-financial reporting coverage is determined both by the need for a serious transformation of management reporting and by the expansion of approaches to generate financial and production data. In addition, non-financial information characterizing company's activities in the context of its environmental sustainability, social responsibility and corporate governance requires the generation and storage of a large amount

of data. The current picture of non-financial reporting on a global scale shows that information is not always clearly supported. Along with this, more than ten years of experience in the formation of non-financial reporting has shown a certain subjectivity in the reporting itself, eradicating which is only possible with the participation of professional personnel in this process - experts in the field of ESG. The lack of ESG specialists creates the problem of targeted impact on the results, when companies cannot timely and correctly assess the potential risks and benefits of ESG events.

It should be noted that, unlike financial reporting, ESG reporting has additional ways for transmitting information - social networks, information flows through which require special attention and costs. These are not only the costs of generating and posting relevant information in certain content of a particular media platform, but monitoring reactions and messages to certain posts, which can have both a positive and negative effect (Balashova, 2023).

An analysis of sustainability reports and websites of Kazakh companies showed that out of 37 surveyed companies, only 15 provide sustainability reports, and it should be taken into account that these are large business entities (minimum annual profit is 36.0 million tenge, maximum - 1344.0 billion tenge).

1. Of those companies that prepare a sustainability report, 23% of Kazakhstani companies disclose a list of stakeholders in corporate reporting. 12% provide a fairly comprehensive report on interaction with stakeholders, 15% of companies disclose this process partially. All this causes some difficulties in the study – it is impossible to conduct a comparable analysis for all indicators, there is a certain subjectivity.

2. The conclusions presented in Figure 1 show that despite the fact that these companies can be called systemically important in their industries, only 20 out of 37 have "Sustainable Development" tabs on the main page of the company's official website, which accordingly indicates the presence of certain information about company's commitment to sustainable development goals. However, the majority of these companies do not disclose information about investing in personnel development – 22 out of 37 companies do not disclose information in their reports on sustainable development. Despite the high popularity of gender equality topic, out of 37 companies: 5 do not provide information about the presence of women in the staff of their organizations. Only 10 out of 37 companies disclose information about reducing waste and 6 out of 37 share their results on reducing harmful emissions (the results of a survey of Kazakhstani companies are shown in Figure 1).

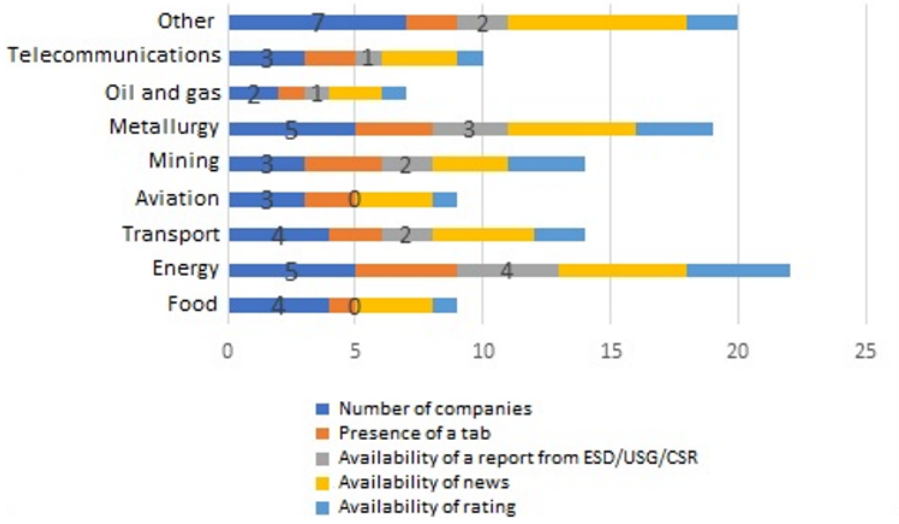


Fig. 1. Results of a survey of Kazakhstani companies (sample of 37 companies)
Note: according to official websites and reports on sustainable development of Kazakhstani companies

On the initial stage of this study's implementation showed a weak level of ESG culture, especially in the context of environmental responsibility among the population of Kazakhstan. In particular, the project team began a survey among employees of one of the largest mining enterprises in Kazakhstan. The first results of the survey show misunderstanding and ignorance of the basic principles and approaches to achieving sustainable development goals and corporate social responsibility on the part of both line managers (Meddle management) and ordinary employees. What is troubling is the lack of information among this category of respondents about what the company they work for is doing towards achieving sustainable development goals.

The implementation of research within the framework of this project faces certain difficulties. First of all, the disinterest of business entities in participating in these studies. The scientific community conducts research and offers assistance in popularizing ESG knowledge, but Kazakh companies demonstrate a lack of interest.

Conclusion

The implementation of the following measures is proposed as key recommendations at this stage of the study:

1. Submission of reports on sustainable development should become mandatory for companies operating in Kazakhstan. This process can be implemented in several stages, but at the initial stage this requirement should become mandatory for companies carrying out export-import activities.

2. The level of ESG literacy needs to be developed at the state level, both through science and the education system, and through media resources.

3. It is necessary to create a body at the state level, that is should be responsible for the implementation of sustainable development goals, and what is more important: at the regional level.

Achieving sustainable development goals, designated by the UN as a key vector of the world order, has become an important guideline in the development of public administration and big business in recent years. The implementation of ESG principles, despite their clear regulation, has its own specifics, and since it demonstrates a combination of approaches to management that are different in content, in practice it shows exposure to external and even internal factors that require detailed study.

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Статья поступила в редакцию 29.01.2024; одобрена после рецензирования 16.12.2024; принята к публикации 19.02.2024.

The article was submitted 29.01.2024; approved after reviewing 16.02.2024; accepted for publication 19.02.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 14–25.
Техноэкономика. 2024, Том 3, № 1 (8). С. 14–25.

Scientific article
UDC 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.2

SUSTAINABLE GROWTH IN KAZAKHSTAN: GREEN ECONOMY, DECARBONIZATION AND ENERGY TRANSITION

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Abstract. This research paper is highly relevant in the context of global efforts towards sustainable development and climate change mitigation. It provides a comprehensive analysis of Kazakhstan's transition from a fossil fuel-dependent economy to a green economy, highlighting the country's unique challenges and opportunities in this transformative journey. The paper emphasizes the importance of legislative, strategic, and economic instruments in facilitating this shift, showcasing Kazakhstan's commitment to balancing economic growth with environmental sustainability. By examining Kazakhstan's approach to decarbonization, including investments in renewable energy and energy efficiency, the paper offers valuable insights for other resource-rich countries facing similar challenges. Overall, this research is significant for its contribution to understanding the complexities of transitioning to a sustainable energy future in the context of a heavily fossil fuel-reliant nation. The aim of this research is to explore and analyze the pathways through which Kazakhstan can achieve sustainable economic growth by integrating green economy principles, decarbonization strategies, and energy transition processes. This involves understanding the interplay between environmental sustainability, economic development, and energy sector transformation in the context of Kazakhstan's unique geographical, economic, and socio-political landscape.

Keywords: sustainable development, decarbonization, energy transition, environmental sustainability, energy sector

Funding: This work was supported by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant "Exploring the impact of economic, social, and environmental factors on the relationship between urbanization and greenhouse gas emissions" No. AP19576071).

Citation: Imangali Zh., Bekturganova M. Sustainable growth in Kazakhstan: green economy, decarbonization and energy transition. Technoeconomics. 2024. 3. 1 (8). 14–25. DOI: https://doi.org/10.57809/2024.3.1.8.2

Научная статья
УДК 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.2

УСТОЙЧИВОЕ РАЗВИТИЕ КАЗАХСТАНА: ЗЕЛЕНАЯ ЭКОНОМИКА, ЭНЕРГЕТИЧЕСКИЙ ПЕРЕХОД, ДЕКАРБОНИЗАЦИЯ

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Аннотация. Данное исследование посвящено всестороннему анализу перехода Казахстана от экономики, зависящей от ископаемого топлива, к "зеленой" экономике, а также уникальным проблемам и возможностям страны на пути преобразований в контексте глобальных усилий по обеспечению устойчивого развития и смягчению последствий изменения климата. В исследовании подчеркивается важность законодательных, стратегических и экономических инструментов для содействия этому переходу, демонстрируется стремление Казахстана сбалансировать экономический рост с экологической устойчивостью. Рассматривая подход Казахстана к декарбонизации, включая инвестиции в возобновляемые источники энергии и энергоэффективность, предлагаются идеи для других богатых ресурсами стран, сталкивающихся с аналогичными проблемами. В целом, данное исследование является важным вкладом в понимание сложностей перехода к устойчивому энергетическому будущему в условиях страны, в значительной степени зависящей от ископаемого топлива. Данная статья направлена на определение перспектив устойчивого экономического роста путем интеграции принципов "зеленой" экономики, стратегий декарбонизации и процессов энергетического перехода. При этом, особое внимание уделяется взаимосвязи между экологической устойчивостью, экономическим развитием и трансформацией энергетического сектора в контексте уникального географического, экономического и социально-политического ландшафта Казахстана.

Ключевые слова: устойчивое развитие, декарбонизация, энергетический переход, экологическая устойчивость, энергетический сектор

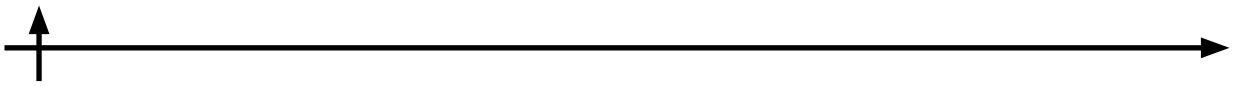
Финансирование: Работа выполнена при поддержке Комитета науки Министерства образования и науки Республики Казахстан (грант «Изучение влияния экономических, социальных и экологических факторов на взаимосвязь между урбанизацией и выбросами парниковых газов» № AP19576071).

Для цитирования: Имангали Дж., Бектурганова М. Устойчивое развитие Казахстана: зеленая экономика, энергетический переход, декарбонизация // Техноэкономика. 2024. Т. 3, № 1 (8). С. 14–25. DOI: https://doi.org/10.57809/2024.3.1.8.2

Introduction

The transformation of energy systems, particularly through decarbonization, is a critical and multifaceted endeavour essential for the sustainable development of the global economy. As the world grapples with the escalating challenges of climate change, the shift from fossil fuels to renewable and cleaner energy sources becomes not just an environmental imperative but a cornerstone for future economic stability and social well-being.

The concept of the fourth energy transition in Kazakhstan, as discussed in a 2020 study, revolves around the shift to renewable energy sources. This transition is seen as a critical step for the country to emerge from socio-economic challenges and address the pressing issue of climate change. In this transformative phase, renewable energy and energy efficiency have a



pivotal role (Assem, 2020). Decarbonization, the process of reducing carbon dioxide emissions, is central to this transformation. It involves a comprehensive shift in the energy sector, moving away from carbon-intensive sources like coal, oil, and natural gas to embrace renewable energies such as solar, wind, and hydropower. This transition is more than a technical shift; it encompasses socio-economic changes, policy innovation, and a reimagining of how energy is consumed and produced. The continuous worldwide shift towards a low-carbon economy has garnered significant attention in recent times (Zhakiyev, 2022).

This transformation is also deeply intertwined with economic considerations. The global economy, long dependent on fossil fuels, faces the challenge of transitioning to a system that not only sustains economic growth but also adapts to the realities of a finite planet. This shift presents both challenges and opportunities. On one hand, it requires massive investments and the phasing out of industries that have been economic staples for centuries. On the other, it opens up new avenues for innovation, job creation, and economic diversification in the burgeoning green economy. Technological innovation plays a pivotal role in this transition. Advances in renewable energy technologies, energy storage solutions, smart grid developments, and improvements in energy efficiency are not only crucial for reducing greenhouse gas emissions but also present significant economic opportunities. The growth of green industries is poised to drive job creation, foster new markets, and stimulate economic growth, aligning environmental objectives with economic development.

Research conducted in 2020 on decarbonization strategies for developing Asia, including Kazakhstan, aligns with the objectives of the Paris Agreement. The study suggests a drastic overhaul of the energy portfolio, advocating for a decrease in fossil fuel use and an increase in low-carbon energy sources. This shift is deemed essential for substantial reductions in CO2 emissions and meeting global climate targets (Wenji, 2020).

Moreover, the global nature of climate change necessitates international cooperation. While agreements like the Paris represent a collective commitment to emission reduction, more robust and concerted global efforts are required. A study focusing on Kuwait, yet relevant to Kazakhstan, examines the role of energy transition and economic diversification in implementing climate agreements. It highlights the necessity for transitioning from fossil fuels to renewable energy sources. The research points out the critical need for policy reforms, energy pricing adjustments, and efficient energy consumption management for a successful transition (Hilmi, 2020). Effective policy frameworks are essential in facilitating this energy transition. Policies such as carbon pricing, renewable energy subsidies, energy efficiency regulations, and support for research and development are key components. The social implications of the energy transition are profound and wide-ranging. Ensuring equitable access to clean energy, addressing the needs of communities transitioning away from fossil fuels, and fostering public engagement are critical for a just transition. These social dimensions highlight the need for policies that are environmentally sound and socially equitable.

Kazakhstan, a country with a significant legacy in fossil fuel production, is now embarking on a transformative journey towards a greener and more sustainable future. This transition is not merely a response to the global call for environmental stewardship but also a strategic move towards ensuring long-term economic prosperity and stability. The nation's vast natural resources, including oil, coal, and gas, have historically been the backbone of its economy. However, the growing awareness of climate change impacts and the global shift towards renewable energy sources have prompted Kazakhstan to reevaluate and reshape its energy strategy. The concept of decarbonization, which involves reducing carbon dioxide emissions to minimize the effects of climate change, is central to this transformation. For Kazakhstan, this means diversifying its energy portfolio, investing in renewable energy sources like wind, solar, and hydroelectric

power, and enhancing energy efficiency across various sectors. This shift is not just environmentally significant but also economically strategic, opening up new avenues for growth and development in the green energy sector. Kazakhstan's energy transition is also closely tied to its broader economic ambitions. As the country seeks to position itself as a regional leader and a competitive player in the global market, transitioning to a more sustainable energy system is key. This involves not only harnessing renewable energy sources but also implementing policies and frameworks that encourage innovation, attract investments, and foster a conducive environment for the growth of new, sustainable industries.

Moreover, this transition has profound social implications. Ensuring equitable access to energy, creating new job opportunities in the green sector, and addressing the socio-economic impacts of moving away from fossil fuels are critical considerations. Kazakhstan's approach to this energy transition can serve as a model for balancing economic growth with environmental sustainability and social equity.

In summary, the shift towards decarbonized energy systems is a crucial and complex process, pivotal for achieving a sustainable and resilient global economy. This transformation transcends mere technological change, encompassing comprehensive socio-economic restructuring, innovative policy-making, and inclusive social strategies (Li, 2023). It represents not just a challenge but a significant opportunity to harmonize environmental sustainability with economic growth and social equity. As we navigate this path, the collective efforts in technology, policy, and societal engagement will shape a future that is not only environmentally sound but also prosperous and equitable for all. This process, while daunting, is a vital step towards a more sustainable and promising future for generations to come.

Materials and Methods

The research adopts a mixed-methods approach, blending qualitative and quantitative data to comprehensively analyze Kazakhstan's shift towards a green economy. Central to the study is an extensive literature review, encompassing academic papers, government reports, and industry analyses, to understand the historical and current dynamics of Kazakhstan's energy sector. Quantitative data collection focuses on key statistics related to energy production, consumption, carbon emissions, and the growth of renewable energy in Kazakhstan. Complementing this, qualitative data is derived from policy documents, strategic plans, and expert interviews, offering insights into the motivations and strategies behind the country's energy transition.

A descriptive analysis method is employed to present a clear picture of Kazakhstan's current energy landscape, highlighting its reliance on fossil fuels and the strides made in renewable energy adoption. This is paired with a comparative analysis, where Kazakhstan's energy policies and transition strategies are juxtaposed with those of countries in similar economic and geographical situations. Additionally, policy analysis is conducted to assess the effectiveness of Kazakhstan's legislative and economic measures in promoting sustainable energy practices (Muslimov, 2022).

The study also incorporates case studies of successful renewable energy projects and green economy initiatives within Kazakhstan, providing practical examples of theoretical strategies in action. Interviews with industry experts and policymakers are conducted to gain direct insights into the challenges and future directions of Kazakhstan's energy transition. The methodology, while comprehensive, acknowledges its limitations and maintains strict adherence to ethical research standards, ensuring a balanced and thorough exploration of Kazakhstan's journey to-

wards a sustainable energy future.

Results and Discussion

Kazakhstan's energy landscape is characterized by a heavy reliance on fossil fuels, a legacy of its vast natural resources and historical development patterns. As the world's 9th largest country in terms of land area and blessed with substantial reserves of oil, coal, and natural gas, Kazakhstan has long been a significant player in the global energy market. This section of the article would explore various aspects of Kazakhstan's current energy landscape (Brodach, 2021).

Kazakhstan ranks among the top countries in terms of oil and coal reserves. It is a major oil producer, with the petroleum sector playing a dominant role in its economy. The country also has substantial coal reserves, making it one of the top coal producers globally. Natural gas, although less prominent than oil and coal, is also a significant part of the energy mix.

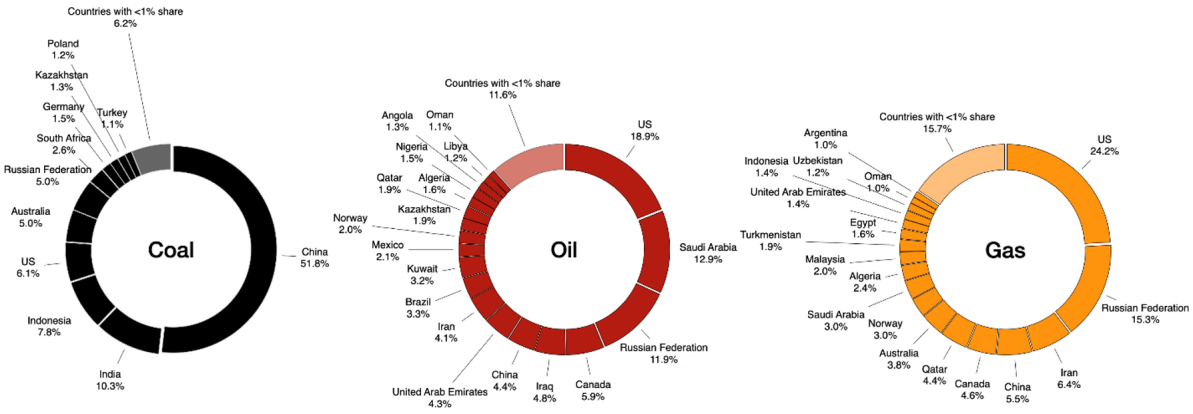
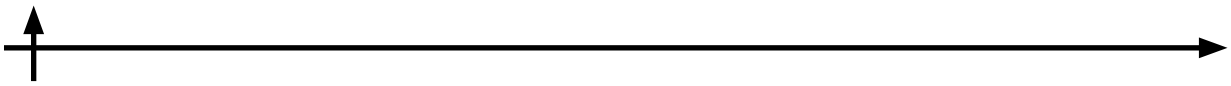


Fig. 1. Stages of RPA technology implementation at an industrial enterprise

Coal production reached a record high, oil production was 99% of the record level set in 2019, and gas production was 99.8% of the record level set in 2021 (Gulf Studies, 2023). Only nine countries produced a 5% or greater share of a fossil fuel in 2022: China, India, Indonesia, the US, Australia, Russia, Saudi Arabia, Canada, and Iran (Statistical Review, 2023). Kazakhstan is among the top 10 countries in terms of proven coal reserves of 1.3% of world reserves (chart 1), where 2/3 is brown coal, 1/3 is hard coal. The largest coal basins are located in the central and northern parts of the country: Ekibastuz (10 billion tons), Karaganda (6.9 billion tons) and Turgai (5.9 billion tons) (77.5% of proven coal reserves) (World Fossil Fuel Production & Primary Energy, 2023).

Humanity consumed oil at a rate equivalent to 622 million litres per hour continuously (157 million US gallons per hour). This is an increase of 27 million litres per hour over the rate in 2021 of 595 million litres per hour [5]. The oil and gas complex of Kazakhstan plays a significant role in the development of the country, provides a significant part of tax revenues to the country's budget and forms about a quarter of GDP. Since gaining independence, the volume of oil and gas condensate production in the republic has increased by more than three and a half times: from 25 million tons. up to 90.5 million tons per year in 2019. Kazakhstan ranks 17th among countries in the world in oil production. The main hydrocarbon production in Kazakhstan is concentrated in three largest fields: Tengiz, Karachaganak and Kashagan, the development of which is carried out by established consortia with the participation of transnational vertically integrated companies (Altukhova, 2023). To maintain and increase production at large fields, projects to expand and extend the achieved production level are being imple-



mented. The achievements of the oil and gas sector of Kazakhstan include the discovery of the Kashagan field, which is one of the 10 largest fields in the world. The achieved production level at Kashagan is 400,000 barrels per day.

Decarbonization in Kazakhstan is a significant process, given the country's status as a major energy producer and its reliance on fossil fuels. Kazakhstan, the largest landlocked country in the world, is rich in natural resources, including substantial fossil fuel reserves, minerals, and metals. It is also one of the largest emitters of greenhouse gases (GHGs) per capita in Central Asia. The decarbonization process in Kazakhstan involves transitioning from this heavy reliance on fossil fuels to more sustainable energy sources, in line with global efforts to combat climate change (Allahhah, 2023; Fadeev, 2023). Kazakhstan's energy sector is heavily reliant on coal, oil, and natural gas. Coal, particularly, has been a dominant source of energy, used extensively for electricity generation and heating. This reliance has contributed to high levels of carbon dioxide (CO2) emissions. In recent years, Kazakhstan has been among the top 30 CO2 emitters globally, with the energy sector accounting for a significant portion of these emissions. Focusing on marketing strategies for decarbonization within Kazakhstan's energy sector is crucial. Such strategies should aim to advance the concepts of decarbonization, a green economy, and ecological awareness in the energy market, highlighting the significance of servitization and motivational shifts to embrace green technologies (Economic Research Institute, 2023; Aizhana, 2022).

Kazakhstan has recognized the need for decarbonization and has taken steps towards this goal:

1. Renewable Energy Development: The country has been gradually increasing its investment in renewable energy sources, such as wind, solar, and hydroelectric power. As of recent data, renewable energy sources (excluding hydroelectric) account for a small but growing percentage of Kazakhstan's total energy mix.

2. Policy Initiatives: Kazakhstan has implemented various policies aimed at reducing GHG emissions. This includes the introduction of an emissions trading system (ETS) in 2013, which was one of the first of its kind in Asia.

3. International Commitments: Kazakhstan is a party to the Paris Agreement and has committed to reducing its GHG emissions. The country has set targets to decrease its GHG emissions to a certain percentage below 1990 levels by 2030.

The decarbonization process in Kazakhstan faces several challenges:

1. Economic Dependency: The economy is heavily reliant on the export of fossil fuels, making the transition to a low-carbon economy challenging.

2. Infrastructure and Investment: There is a need for significant investment in renewable energy infrastructure and technology.

3. Policy and Regulatory Framework: Effective implementation of policies and regulations supporting renewable energy and energy efficiency is crucial.

Some studies examined the economic and ecological challenges and advantages in the development of various energy sources in Kazakhstan. One study analysed the cost-effectiveness of conventional and unconventional hydrocarbon, non-hydrocarbon, and renewable energy sources, highlighting the environmental benefits of non-traditional energy sources like biomethane (Poljanskihh, 2018).

There was a study that examined the environmental impact of energy production, focusing on the potential and obstacles of wind energy in Kazakhstan. It evaluated wind power production possibilities in 42 different areas across the nation, pinpointing regions with significant potential for economic feasibility and reduction in emissions, underscoring the need for policy measures to promote wind energy adoption (Ivakhnenko, 2020; Jianzhong, 2018).

However, there are also opportunities:

1. Abundant Renewable Resources: Kazakhstan has significant potential for solar and wind energy development, given its vast territory and favourable climatic conditions.

2. Diversification of Economy: Transitioning to a green economy presents an opportunity for economic diversification and sustainable development (Makarov, 2021).

3. International Cooperation: Kazakhstan can leverage international partnerships and investments to accelerate its decarbonization process.

Decarbonization in Kazakhstan is a complex but essential process, requiring concerted efforts from the government, private sector, and international community. While challenges exist, the potential benefits of a transition to a low-carbon economy are significant, including improved environmental quality, sustainable economic development, and enhanced energy security. Continued monitoring and adaptation of strategies will be key to achieving Kazakhstan's decarbonization goals (Zharov, 2021).

Institutional instruments and economic mechanisms represent key elements in the green economy development strategy in Kazakhstan. These instruments and mechanisms, covering a wide range of policy and financial initiatives, form the basis for the transition to sustainable economic development (Dlimbetova, 2016). To review existing measures and their effectiveness, the tools and mechanisms of the green economy in Kazakhstan are systematized, including examples of their practical application (table 1).

The development of a green economy in Kazakhstan is supported by a number of institutional instruments:

1. Legislation: The basis of legislative support is the “Ecological Code of the Republic of Kazakhstan”, “Law on Supporting the Use of Renewable Energy Sources” and other regulations aimed at environmental protection and sustainable use of natural resources.

2. Strategic planning: An important step was the development and implementation of the national strategy "Kazakhstan 2050", which provides comprehensive measures for the transition to a green economy.

3. Government programs: Programs are being implemented to improve air quality, and energy efficiency, develop alternative energy sources and preserve biodiversity.

Economic mechanisms for a green economy in Kazakhstan include:

1. Tax policy: Introduction of tax incentives for enterprises using environmentally friendly technologies and taxation of environmental polluters.

2. Funding: Government funding for research and development in the field of green technologies, as well as support for private investment in sustainable projects.

3. Market instruments: Development of a system of “green” public procurement and stimulation of the production of environmentally friendly goods.

Examples of green economy implementation in Kazakhstan include:

1. Renewable energy: Projects for the construction of wind and solar power plants aimed at increasing the share of renewable sources in the country’s energy balance.

2. Energy efficiency: Programs to improve energy efficiency in industry and the residential sector, including modernization of infrastructure and the use of energy-saving technologies.

3. Environmental education: Implementation of educational programs and campaigns on sustainable development and ecology aimed at increasing the environmental awareness of the population.

Table 1. Tools and mechanisms of green economy in Kazakhstan: overview and examples

Tools and mechanisms	Description	Examples of implementation of tools and mechanisms for the development of a green economy in Kazakhstan
Legislation and regulation	Development and implementation of laws and regulations aimed at environmental protection, energy efficiency and sustainable use of resources.	Environmental Code of the Republic of Kazakhstan; Concept of the transition of the Republic of Kazakhstan to a green economy; Renewable Energy Support Act; Water Code of the Republic of Kazakhstan; Programs to improve urban air quality, including strict emissions standards for industrial plants; Kazakhstan 2050 Strategy; Action plan for environmental education and training in organizations of preschool, secondary, technical and vocational education for 2023-2029; Law on the protection of wildlife of the Republic of Kazakhstan; National project "Strong Regions – Driver of the Country's Development"; Regulation of the use of land resources to prevent their degradation and ensure sustainable land use, etc (Yesekina, 2021).
Economic incentives	Introduce carbon taxes, incentives and subsidies to support environmentally sustainable practices and technologies.	Tax incentives and subsidies to stimulate the use of renewable energy sources, including the development of solar and wind energy; Development of green finance through grants and loans for environmentally sustainable projects; Tax incentives for projects to improve the energy efficiency of buildings and structures; Development of a program to support energy-saving technologies in housing and communal services; Introduction of a "green" public procurement system that stimulates the production and consumption of environmentally friendly goods and services, etc.
Investments in green technologies	Funding research, development and deployment of clean technologies, including renewable energy.	Projects for the construction of wind and solar power plants, as well as initiatives to improve energy efficiency in urban infrastructure; Development and implementation of technologies for wastewater treatment and waste disposal; Projects to create "green" cities, including integrated waste and water management systems. Creation of the National Fund for Sustainable Development, the purpose of which is to finance projects in the field of renewable energy and ecology; Development of projects for the implementation of "smart cities", including technologies for smart management of energy resources and infrastructure; Development of projects for the disposal and processing of solid household waste, including the construction of waste treatment plants, etc.
Education and awareness	Development of educational programs and information campaigns to raise awareness of the importance of sustainable development.	Development of educational programs and courses on sustainable development and ecology in schools and universities, as well as information campaigns to increase environmental awareness among the population; Cooperation with international organizations to exchange knowledge and best practices in the field of environmental education; Organization and holding of national and regional environmental forums and conferences to discuss issues of sustainable development, etc.
International cooperation	Participation in international environmental programs and agreements, cooperation with other countries in the field of sustainable development.	Kazakhstan's participation in international environmental agreements, such as the Paris Climate Agreement, and cooperation with other countries and international organizations in the field of environmental sustainability, etc.

Corporate Social Responsibility	Encouraging companies to adopt sustainable development practices and minimize the environmental impact of their activities.	Introduction of sustainable development standards in the activities of large oil and gas companies; Programs to reduce the carbon footprint and transition to green energy in industry, etc.
Support for local initiatives	Involving local communities in the development and implementation of sustainable practices and projects.	Development of sustainable agriculture, including organic farming and the use of renewable energy sources in the agricultural sector; Projects to introduce environmentally friendly public transport in large cities, etc.
Note: compiled by the authors		

The development of a green economy in Kazakhstan is a complex process that includes legislative, strategic and economic instruments. These measures aim to achieve a balance between economic growth, environmental sustainability and social well-being, which is key to the country's sustainable development in the long term.

Conclusion

The process of Kazakhstan towards a green economy, as detailed in this paper, is a testament to the country's commitment to sustainable development amidst its heavy reliance on fossil fuels. The analysis of Kazakhstan's current energy landscape, institutional instruments, and economic mechanisms reveals a nation at a pivotal point of transformation, balancing its rich natural resource endowment with the global imperative for environmental stewardship and sustainable economic practices.

Kazakhstan's status as a significant global player in the fossil fuel market, with vast reserves of oil, coal, and natural gas, has historically shaped its economy. However, the global shift towards renewable energy and the urgent need to address climate change have prompted a strategic reorientation towards decarbonization. This transition, while challenging due to the country's economic dependency on fossil fuels, is seen as essential for future economic stability, environmental sustainability, and social well-being. The country's approach to decarbonization, which involves a comprehensive shift from carbon-intensive energy sources to renewables like solar, wind, and hydro power, is a bold step towards aligning with global climate goals. This transition is supported by a robust framework of institutional instruments and economic mechanisms. Legislative measures, strategic planning, and government programs form the backbone of this framework, guiding the nation towards its 2050 green economy goals.

Economic mechanisms, including tax incentives, government funding, and market instruments, play a crucial role in facilitating this transition. These measures not only encourage the adoption of environmentally friendly technologies but also aim to foster a conducive environment for sustainable economic growth. The practical applications of these policies, evident in renewable energy projects, energy efficiency programs, and environmental education initiatives, demonstrate Kazakhstan's proactive steps towards a sustainable future. Development of a green economy in Kazakhstan is a complex yet vital endeavor. It requires balancing economic growth with environmental sustainability and social equity. The nation's efforts to diversify its energy portfolio, invest in renewable energy, and enhance energy efficiency are commendable steps towards reducing its carbon footprint and contributing to global climate change mitigation efforts.

In conclusion, Kazakhstan's process towards a green economy and sustainable development

is a multifaceted process that encompasses legislative, strategic, and economic dimensions. It reflects a deep understanding of the need to harmonize economic development with environmental sustainability. As Kazakhstan continues to navigate this green transition, its experiences and strategies offer valuable insights for other resource-rich countries embarking on similar paths. The nation's commitment to a sustainable and resilient energy future not only positions it as a regional leader in green economy practices but also as a key player in the global effort to combat climate change.

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Статья поступила в редакцию 26.02.2024; одобрена после рецензирования 01.03.2024; принята к публикации 04.03.2024.

The article was submitted 26.02.2024; approved after reviewing 01.03.2024; accepted for publication 04.03.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 26–40.
Техноэкономика. 2024, Том 3, № 1 (8). С. 26–40.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2024.3.1.8.3

DIGITAL SUPPORT FOR SUSTAINABLE DEVELOPMENT OF THE ARCTIC ZONE

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Abstract. Development of the Arctic zone, known for its ecological significance and economic potential, faces a number of challenges: inaccessibility of territories, difficult climatic conditions, low population density, the growing threat of climate change, insufficient development of certain technologies, etc. In response to this, it becomes imperative to give priority attention sustainable development strategies that balance economic growth, social policy with environmental conservation. The article examines the views of various researchers on the transformative role of digital technologies in achieving these goals. The purpose of the study is to show the prospects for sustainable development of the Arctic zone and the potential for its digital support. The article discusses various aspects of digitalization of the Arctic. The article reviews the literature on the use of digital technologies to ensure sustainable development of the Arctic zone, identifies key aspects on which various researchers focus, and also provides a list of factors for the sustainable development of the Arctic zone, the effect of which can be "strengthened" by the use of digital technologies.

Keywords: digital support, sustainable development, Arctic, innovations, digital platform

Funding: The research was supported by Russian Science Foundation grant No. 23-78-10190, https://rscf.ru/project/23-78-10190/

Citation: Gorbacheva A., Levina A. Digital support for sustainable development of the Arctic zone. Technoeconomics. 2024. 3. 1 (8). 26–40. DOI: https://doi.org/10.57809/2024.3.1.8.3

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2024.3.1.8.3

ЦИФРОВАЯ ПОДДЕРЖКА УСТОЙЧИВОГО РАЗВИТИЯ АРКТИЧЕСКОЙ ЗОНЫ

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Аннотация. Освоение Арктической зоны, известной своей экологической значимостью и экономическим потенциалом, сталкивается с рядом вызовов: труднодоступность территорий, сложность климатических условий, низкая плотность населения, растущая угроза изменения климата, недостаточный уровень развития отдельных технологий и др. В ответ на это становится обязательным уделять приоритетное внимание стратегиям устойчивого развития, которые уравновешивают экономический рост, социальную политику с сохранением окружающей среды. В статье рассматривается взгляд различных исследователей на преобразующую роль цифровых технологий в достижении этих целей. Цель исследования – показать перспективы устойчивого развития Арктической зоны и потенциал её цифрового обеспечения. В статье рассмотрены различные аспекты цифровизации Арктики. В статье проведён обзор литературы по проблематике применения цифровых технологий для обеспечения устойчивого развития Арктической зоны, выявлены ключевые аспекты, на которых фокусируются различные исследователи, а также приведён перечень факторов устойчивого развития Арктической зоны, действие которых может быть «усилено» использованием цифровых технологий.

Ключевые слова: цифровая поддержка, устойчивое развитие, Арктика, инновации, цифровая платформа

Финансирование: Исследование выполнено за счет гранта Российского научного фонда № 23-78-10190, https://rscf.ru/project/23-78-10190/

Для цитирования: Горбачева А., Лёвина А. Цифровая поддержка устойчивого развития Арктической зоны // Техноэкономика. 2024. Т. 3, № 1 (8). С. 26–40. DOI: https://doi.org/10.57809/2024.3.1.8.3

Introduction

The Arctic zone is a region of immense ecological importance and economic potential. As the effects of climate change continue to impact this vulnerable area, it is crucial to prioritize sustainable development strategies that minimize environmental harm while fostering economic growth. In the era of digital transformation, there lies a unique opportunity to leverage technology as a vital tool for achieving these goals. This article explores the concept of digital support for the sustainable development of the Arctic zone, highlighting the various ways in which digital solutions can contribute to preserving the fragile Arctic ecosystem, empowering local communities, and facilitating responsible economic activities. By understanding the power of digitalization in the context of Arctic development, we can unlock a new era of balanced progress in this vital corner of our planet. In this context, digital technologies emerge as powerful

tools offering innovative solutions for sustainable growth in the Arctic.

Materials and Methods

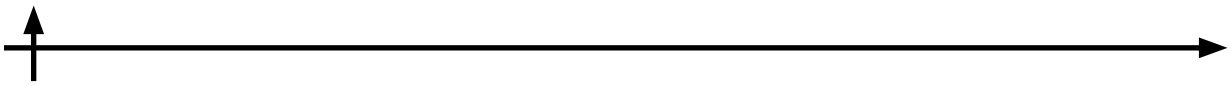
To comprehensively investigate the multifaceted relationship between digital transformation and sustainable development in the Arctic Zone of Russia, this study follows a methodological framework structured around literature review and synthesis. Literature review was conducted, spanning the years 2019 to 2023, to capture the evolving landscape of research in the field. The literature bases as Web of Science and Google Scholar were used during the research. The articles were mainly written by Russian scientists and research is also made by Swedish, some article mention the development of China and British robots which help to explore the Arctic. Based on the analysis of the literature, aspects of considering the digital transformation of the Arctic zone of the Russian Federation were highlighted. Based on a generalization of aspects, factors for sustainable development of the Arctic related to the capabilities of digital technologies were identified

"Technological Innovations for a Sustainable Arctic" by Jong Deog Kim, Sungwoo Lee, Minsu Kim, and Jeehye Kim (Kim, 2020) discusses the challenges and opportunities presented by the melting of Arctic ice due to climate change. The authors highlight the potential of the fourth industrial revolution to address these challenges, suggesting the use of innovative technologies to improve environmental monitoring, biodiversity management, and the development of sustainable ports and infrastructure. They also emphasize the need for international cooperation and scientific research to effectively address the risks and challenges posed by climate change in the Arctic. Overall, the article highlights the potential role of technology in promoting sustainable development in the Arctic zone and the importance of addressing the unique challenges faced by this region.

To reduce the gap in innovative technologies in the Arctic, policy initiatives and international co-operation are necessary. Investment in R&D relating to innovative technologies can have a socio-economic ripple effect through the industrial network, including the environment-resource-infrastructure-shipping-logistics network. Technological exchange and co-operation, including joint research with other technologically advanced countries, should also be considered. South Korea, as the most innovative country according to the World Economic Forum, has potential to contribute to sustainable and responsible development in the Arctic. However, a more comprehensive analysis is needed to arrive at a more accurate picture of the role and importance of technologies across applicable areas and types. The Covid-19 pandemic is further isolating the Arctic region, but also accelerating the development of "un-tact" technologies. Winterization of innovative technologies will be necessary in the Arctic. Differences in approach among Arctic states with regard to their policies, investments, and existing uses of innovative technologies exist, but co-operative initiatives are necessary to safeguard the Arctic region from the adverse impacts of global warming.

Some people are trying to understand climate change through a digital twin of some area. PolArctic, an Alaskan startup, is developing a digital twin of the Arctic Ocean to tackle challenges posed by climate change, with the aim of managing Arctic fish stocks more effectively (Stepanova, 2020). Climate change is affecting the Arctic significantly, leading to the disappearance of summer sea ice and affecting local species such as the snow crab. This digital twin will be the first virtual model to forecast the impact of climate change on Arctic fisheries, aiming to make the fishing industry more efficient and sustainable.

Leveraging AI and ML, PolArctic plans to integrate various types of data, including indigenous knowledge and scientific research, to create this comprehensive digital twin. This simulated ocean environment will help in understanding the complex dynamics of ocean ecosystems,



thus supporting the commercial fishing sector and potentially benefiting other sectors as argued by Mads Qvist Frederiksen of the Arctic Economic Council.

The initiative is expected to help the fishing industry by optimizing fishery output, setting accurate catch limits, and helping with the navigation of vessels through dynamic protected areas that take species biomass and climate change into account. PolArctic's unique approach combines multiscale data utilizing advanced algorithms and traditional insight from local indigenous populations, an integration that CEO Leslie Canavera points out as key to the project's success.

The digital model will simulate real-world oceanic conditions such as acidification and temperature changes, and it will also address issues like illegal fishing and intricate predator-prey relationships. This allows for precision-fishing practices that enhance profitability while promoting sustainable fishing practices.

The digital twin model extends its potential benefits beyond the fishing industry to shipping, climate research, and defense sectors. The increased model accuracy can aid the shipping industry by predicting navigational challenges like sea ice, potentially leading to safer routes and lower insurance costs. For defense purposes, the model can assist in identifying trends in illegal fishing, aiding Coast Guard missions. Furthermore, the model will support local Arctic communities by aiding subsistence activities and ensuring food security, while also providing valuable data for climate research, particularly for the High Seas Fisheries Agreement in the Central Arctic Ocean.

The article "The Potential of Digital Platforms for Sustainable Development Using the Example of the Arctic Digital Platform 2035" (Samylovskaya, 2022) unpacks the potential of digital platforms to revolutionize the economy, streamline public administration, and expedite societal transformations. Notable examples include business platforms like Uber and education platforms like Uchi.ru, promoting efficiency and accessibility. The paper underscores the state's pivotal role in fostering an environment conducive to digital platform success and regulating actions to safeguard user interests.

From a public administration perspective, digital platforms as depicted by Baranov and Glazkov, are systems of algorithmic relationships supported by a single digital technology application. Platforms like GovWeb illustrate the trend toward a unified digital government ecosystem, providing user-friendly, accessible online services.

Special attention is given to the "Arctic Digital Platform 2035," developed to garner ideas for the strategic sustainable development of the Arctic zone in Russia. This platform exemplifies how digital tools can gather public input, structure it meaningfully, and drive regional development policies by involving citizens, experts, and government in a participatory dialogue.

In conclusion, the paper posits that while digital platforms enable a comprehensive approach to sustainable development, they are not without risks, particularly concerning cybersecurity and data protection. A careful balance of innovation and regulation is deemed essential for safeguarding personal data and ensuring the overall success of digital platforms as tools for sustainable progress.

The paper (Fadeev, 2023) analyzes the integration of digital technologies into the oil and gas mining industry of the Russian Arctic, addressing the current state and foreseeable future trends in the sector. The authors examine global digitalization trends and the experiences of Russian companies, focusing on the implications for the Arctic region. Several trends and prospects are identified, underlining the significance of digital technologies in enhancing business process management and dealing with challenges like severe climatic conditions, cybersecurity threats, and the sensitivity to foreign technological reliance. The abstract suggests that digitalization in the Arctic oil and gas sector is primarily driven by the need to increase enterprise management efficiency. The introduction of digital measures is seen as a response to the necessity for

improved operational optimization, especially in the harsh and remote conditions of the Russian Arctic. The paper outlines that while companies like Gazprom Neft PJSC are leaders in digital innovation, the sector's overall digital transformation is hampered by a lack of qualified personnel, insufficient material and technical foundations, and growing cyber-security threats. Key concerns include the potential impact of sanctions, which could either spur on domestic software innovation or hinder Arctic project development through increased operational costs. Furthermore, the COVID-19 pandemic has emerged as a catalyst for adopting more automated digital methodologies in production and business processes. It also highlights specific "sensitivity parameters" affecting digitalization in the industry, particularly the reliance on foreign technology and cybersecurity issues. Power outages in the Arctic pose a fundamental technological risk, necessitating a reliable, adaptive power supply capable of supporting the digital infrastructure (Lyevkina, 2018).

Lastly, the paper postulates that while renewable energy sources (RES) are set to play a more significant role in the Arctic regions, the oil and gas sector—bolstered by digital technologies—will dominate the energy market for the foreseeable future. Despite the progress, digital transformation in the sector remains complex, with virtual and augmented reality, Internet of Things, and AI being integral yet underutilized technologies due to the challenges in operational integration.

Future research, as outlined in the paper, aims to delve deeper into understanding the digitalization nuances of Russian Arctic oil and gas projects, especially considering international sanctions and to conduct a wider survey among industry professionals. In summary, the paper underscores the importance and complexities of digital technology implementation in the development of oil and gas resources in the Russian Arctic, with particular emphasis on the socio-economic, technological, and security challenges inherent in this transformative process.

This article outlines the development and application of artificial intelligence (AI) and robotics in the Arctic region of the Russian Federation, emphasizing the strategic importance of this area for Russia's economy and geopolitical stance. The text reveals an ambitious approach aimed at leveraging AI and robotics to overcome the challenges associated with the harsh Arctic conditions, and it identifies multiple areas where these technologies could have a significant impact.

The document establishes the context based on two pivotal strategies—the State Policy of the Russian Federation in the Arctic until 2035 and the Strategy for the Development of Artificial Intelligence in the Russian Federation until 2030. These strategic frameworks underscore the intent of the Russian government to harness the potential of AI and robotics to further exploit the Arctic's rich mineral resources while mitigating environmental impacts and dealing with extreme local conditions.

AI's role in the Arctic is multifaceted, spanning mining, safety, medical care, transportation, construction, energy, historical preservation, environmental monitoring, and even tourism. Notable applications include intelligent automated process control systems to address gas production complexities and the development of robotic systems for search and rescue operations. The document also discusses medical care improvements through telemedicine, which is critical for remote Arctic communities.

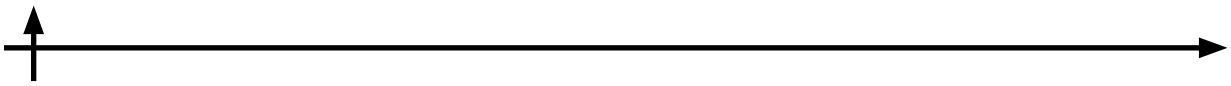
In detailing the progression of AI and robotics in the Arctic, several initiatives are highlighted:

– Oceanos marine robots for environmental monitoring.

– The "Iceberg" project, aiming to develop technologies for underwater exploration of minerals.

– Robotic underwater and surface vehicles with adjustable hull geometry for versatility in research and logistical applications.

– Chinese development of an autonomous deep-sea robot, Tan'so 4500, suitable for Arctic



research.

– IceNet, a new AI tool for sea ice prediction from the British Antarctic Survey and the Alan Turing Institute.

The document concludes by acknowledging Russia's significant potential and current progress in integrating AI and robotics into its Arctic strategy. Despite recognized advancements by Western and other international counterparts, Russia's initiatives show promise, although full-scale implementation may take longer due to socio-economic and policy-development hurdles across the nation. The piece underscores the competitiveness and environmental concerns within the Arctic region. As various Arctic nations intensify their efforts to harness the region's resources, international agreements such as the Reykjavik Declaration are crucial for enhanced biodiversity conservation and environmental management.

The development of offshore hydrocarbon fields in the Arctic is a crucial strategic objective for the Russian Federation (Andreychuk, 2022). Addressing this task requires a unified effort across all levels of government. The extraction of Arctic resources not only enhances the state's resource base, providing a competitive edge, but also fuels key industries, generates employment, expands the tax base, stimulates scientific advancements, and positively impacts the demographic situation by attracting skilled professionals to Arctic regions.

Current foreign economic and political challenges serve as a catalyst for reducing import dependence, enabling the Russian Federation to pursue an independent technology policy. This policy advocates collaborative efforts involving the state, energy companies, science, and industry. Furthermore, the authors underscore the significance of developing the Russian system of standardization in the energy sector. This initiative is viewed as a direct and effective means for import substitution, aiming to swiftly achieve technological sovereignty within the Russian oil and gas complex.

The article "Digital technologies and ILK in the Arctic: in search of epistemological pluralism" by Samuel Roturier and Rйmi Beau covers various aspects concerned with the intersection between digital technologies and Indigenous and Local Knowledge (ILK) within the context of the Arctic, specifically looking at the Sбmi reindeer husbandry in Sweden.

The article explores the implications of digital technology adoption in Indigenous contexts and how these technologies interact with traditional knowledge systems. The authors raise concerns about whether the integration of digital tools might undermine the value of ILK by promoting a Westernized worldview and oversimplifying complex Indigenous knowledge into quantitative data that can be understood and manipulated within Western scientific frameworks.

The text acknowledges the benefits of digital tools, such as saving time and providing new means for ecological management and advocacy. However, it critically examines the potential loss of in-depth, sensory, and experiential learning traditionally acquired through physical engagement with the environment (Kudryashov, 2020).

Roturier and Beau tackle the ethical considerations for researchers working with Indigenous communities and digital technologies, emphasizing that technology should be employed responsibly and with awareness of its potential to alter Indigenous ways of life. The authors propose two ethical frameworks: co-construction, which suggests collaborative development of technologies with Indigenous communities; and strong epistemological pluralism, defending the coexistence of diverse knowledge systems without necessarily merging them.

The article underscores the potential intellectual self-determination issues raised by digital technology adoption, arguing that true empowerment of Indigenous communities would involve the creation and use of digital tools that are defined, controlled, and understood from an Indigenous perspective rather than being imposed from outside.

Overall, the article appeals for greater sensitivity to cultural nuances, the risks of knowledge

monopolization by digital means, and the political dimensions of technology implementation in Indigenous settings. It prompts an inclusive dialogue that respects the integrity and validity of Indigenous knowledge systems alongside scientific inquiry, aiming for an ethical and pluralistic approach to environmental stewardship and technological advancement.

This article by Timur Ablyazov and Veronika Asaul focuses on improving the Arctic's transport infrastructure within the framework of the digital economy, specifically by incorporating smart city concepts in Arctic cities. Smart cities are defined as urban areas where infrastructure and services are interlinked through information and communication technologies to improve efficiency, optimize resources, and enhance the quality of life for residents.

The Arctic is emphasized as a strategic region for Russia due to the Northern Sea Route, which offers a shorter corridor between the Far East and Europe compared to southern maritime paths. Despite challenges including harsh climatic conditions, the digitalization of transport infrastructure in the Arctic region is presented as a necessity for enhancing accessibility, boosting international trade, and promoting development.

The authors propose the development of digital platforms to facilitate interaction among transport entities and accumulate data for analyzing and predicting the current and future states of the transport ecosystem. The goal is to harmonize sea, rail, road, and air transport, leading to optimized routes, improved transport safety, and coordination of infrastructure maintenance activities.

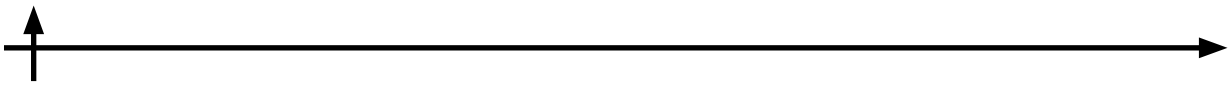
Examples from Anchorage (USA) and Bodш (Norway) demonstrate how Arctic cities are progressively incorporating smart technologies to improve their transport systems. In Russia, the authors point out the significance of maritime transport, particularly the Northern Sea Route, and the importance of port cities like Murmansk and Sabetta. Innovative projects such as the "Yamal LNG" and the "Integrated Development of the Murmansk Transport Hub" highlight the Russian government's commitment to developing the Arctic's infrastructure (Kikkas, 2023).

The authors suggest implementing smart city elements through digital platforms in the Arctic's largest cities as a starting point for improving logistics services, eventually aiming to extend these platforms for full-scale smart city development. These suggestions align with Russia's "Strategy for the Development of the Arctic Zone of the Russian Federation and Assurance of National Security for the period up to 2035," which prioritizes transport infrastructure improvement.

The article highlights the implementation of information and communication infrastructure as a crucial step in the Arctic's development, pointing towards ongoing projects like the Arctic Connect communication line and the digital platform "Arctic Labs" as vital initiatives towards this goal. The authors conclude that developing the Arctic transport infrastructure following smart city concepts is important to create a comfortable and safe living environment in the digital economy.

The article proposes leveraging digital economy concepts to transform Arctic cities into smart cities, improving efficiency and quality of life. Improvement of transport infrastructure in the Arctic is associated with enhancing regional accessibility and international trade capabilities. There is a particular focus on developing digital platforms enabling coordination across various forms of transport in the Arctic. Development of comprehensive communication infrastructure is integral to facilitating the spread of smart city principles in the Arctic region. Ongoing initiatives and projects reflect a significant effort towards incorporating smart technology in the Arctic's evolution, aligning with Russia's Arctic development strategy up to 2035.

The Arctic zone of Russia’s transport support data analysis suggests key proposals for infrastructure development (Abramov, 2019). These include prioritizing eco-friendly pipeline transport with advanced safety measures and constructing new trunk pipelines. The plan involves



calculating and adjusting for high-power icebreaker construction, determining optimal public-private partnership parameters, and formulating a program for modern vessels. Additional focus areas encompass the modernization of railways, creation of all-terrain vehicles, resolution of road departmental affiliation issues, building Arctic helicopters, and analyzing alternative transport modes. Finally, a comprehensive approach involves developing air traffic, calculating aircraft parameters, and reconstructing and constructing airports in the region.

The authors (Didenko, 2021) explore the adaptation of the "smart city" concept to the Arctic Zone of the Russian Federation (AZRF), acknowledging the unique challenges of the region, including extremely low population density, harsh climatic conditions, and a focus on industrial development. It suggests that "smart" technologies could provide innovative solutions tailored to Arctic settlements, and could help in sustainable development, improving living conditions, and managing the area's natural resources more effectively.

The paper emphasizes the growing interest in employing advanced Information and Communication Technologies, robotics, and intelligent solutions in developing "smart city" projects and addressing the peculiarities of the Arctic region through these technologies. It outlines how smart cities have evolved in response to challenges such as rapid population growth, limited resources, and environmental sustainability concerns. The successful implementation of "smart" features in European cities (e.g., Barcelona, Amsterdam) is also discussed. The paper proposes the application of smart city technologies—not just in metropolitan areas but across the diverse settlement network of the Arctic. This includes the potential use of technologies such as IoT, WSNs, cloud computing, fog computing, big data analytics, and unmanned transport vehicles (UTVs), including Unmanned Aerial Vehicle (UAVs).

The concept of a digital real-world virtual cyberspace is introduced, which is a self-organizing distributed computer network embedded with multifunctional UAVs. This system could assist in various logistical and computational tasks, helping in managing the Arctic zone's development more effectively. The paper delves into understanding the physical, informational, and social dimensions of cyberspace in the Arctic (Rodionov, 2023). This includes the technological infrastructure, nodes and hubs for communication, institutional organization, and electronic spaces for social interaction.

In conclusion, the authors argue for the application of smart settlement concepts as a path towards sustainable development. They envision a comprehensive and interconnected digital environment that leverages ICT and smart technologies to facilitate the management and development of the Arctic region. This approach could not only preserve the environment but also improve the quality of life and economic prospects of those living and working in one of the most challenging environments on Earth.

Results and Discussion

Based on the literature review the table below (Table 1) was made. It shows the review of different aspects and authors point of view and (or) advice regarding it.

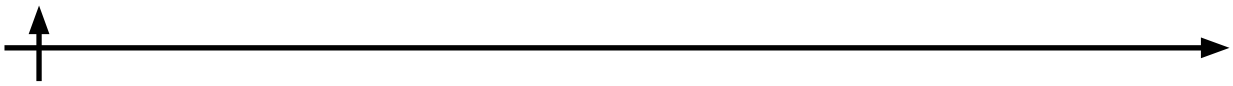
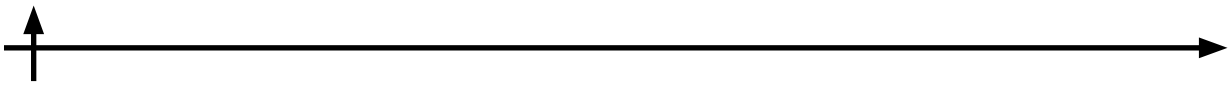


Table 1. Key sources review

Aspect	Authors' Point or Advice and Source (Article)
Melting of Arctic ice due to climate change	Discusses challenges and opportunities presented by melting Arctic ice (Kim, 2020).
Fourth industrial revolution in the Arctic	Suggests using innovative technologies for environmental monitoring, biodiversity management, and sustainable infrastructure (Kim, 2020).
Role of international cooperation in addressing climate change in the Arctic	Emphasizes the need for international cooperation and scientific research to address risks and challenges in the Arctic (Kim, 2020).
Digital twin of the Arctic Ocean by PolArctic	Developing a digital twin of the Arctic Ocean to address climate change challenges, focusing on managing Arctic fish stocks efficiently (Stepanova, 2020).
Integration of AI and ML in PolArctic's digital twin	Plans to integrate various types of data, including indigenous knowledge and scientific research, to create a comprehensive digital twin (Stepanova, 2020).
Benefits of PolArctic's digital twin for fishing industry	Optimizing fishery output, setting accurate catch limits, and navigating vessels through dynamic protected areas for sustainable practices (Stepanova, 2020).
PolArctic's approach to combining data and insights	Combines multiscale data using advanced algorithms and traditional insight from local indigenous populations for project success (Stepanova, 2020).
Other/Extended benefits of PolArctic's digital twin	Extends benefits beyond the fishing industry to shipping, climate research, and defense sectors, aiding in navigation, defense missions, community support, and climate research (Stepanova, 2020).
Potential of digital platforms for sustainable development	Unpacks the potential of digital platforms to revolutionize the economy, streamline public administration, and expedite societal transformations (Samylovskaya, 2022).
Digital platforms as systems of algorithmic relationships	Describes digital platforms as systems of algorithmic relationships supported by a single digital technology application (Samylovskaya, 2022).
"Arctic Digital Platform 2035"	Highlights the Arctic Digital Platform 2035 as an example of how digital tools can gather public input, structure it meaningfully, and drive regional development policies through participatory dialogue (Samylovskaya, 2022).
Risks associated with digital platforms	Points out risks, especially concerning cybersecurity and data protection, and emphasizes the need for a balance of innovation and regulation (Samylovskaya, 2022).
Addresses current state and future trends	Analyzes the integration of digital technologies into the oil and gas mining industry of the Russian Arctic (Fadeev, 2023).
Highlights challenges	Challenges: severe climatic conditions, cybersecurity threats, and reliance on foreign technology (Fadeev, 2023).
Emphasizes digitalization's importance for business process management.	Discusses the role of digital measures in operational optimization, especially in harsh Arctic conditions (Fadeev, 2023).
Sensitivity parameters	Identifies "sensitivity parameters" affecting digitalization, including reliance on foreign technology and cybersecurity (Fadeev, 2023).
Reliable power supply	Acknowledges the significance of a reliable power supply in the Arctic (Fadeev, 2023).
Support of digital technologies	Postulates that the oil and gas sector, supported by digital technologies, will dominate the energy market in the Arctic despite the rise of renewable energy sources (Fadeev, 2023).
Challenges in the operational integration	Discusses challenges in the operational integration of virtual and augmented reality, Internet of Things, and AI (Fadeev, 2023).
Outlines the development and application of AI and robotics in the Arctic region of the Russian Federation	Emphasizes the strategic importance of the Arctic for Russia's economy and geopolitical stance. Discusses the ambitious approach to leverage AI and robotics to overcome challenges in the harsh Arctic conditions (Andreychuk, 2022).
Highlights multiple areas where AI and robotics could have a significant impact	Describes AI's multifaceted role in mining, safety, medical care, transportation, construction, energy, historical preservation, environmental monitoring, and tourism (Andreychuk, 2022).



The idea to use blockchain and big data technologies	To analyze Arctic and find ways to explore its full potential (George, 2021).
Digital technologies in the Arctic	The article explores the implications of digital technology adoption in Indigenous contexts, particularly in Sбmi reindeer husbandry in Sweden (Roturier, 2021).
Interaction with Indigenous and Local Knowledge	Raises concerns about potential negative impacts on ILK, such as the promotion of a Westernized worldview and oversimplification of complex Indigenous knowledge into quantitative data (Roturier, 2021).
Benefits of digital tools	Acknowledges benefits like time-saving and providing new means for ecological management and advocacy (Roturier, 2021).
Critique of digital tools	Critically examines the potential loss of in-depth, sensory, and experiential learning traditionally acquired through physical engagement with the environment (Roturier, 2021).
Indigenous Knowledge	The authors highlight the risk of digital tools undermining the value of ILK by reducing it to quantitative data that fits within Western scientific frameworks. They emphasize the importance of preserving in-depth, experiential learning gained through physical engagement with the environment (Roturier, 2021).
Ethical Considerations	Roturier and Beau stress the ethical responsibility of researchers when working with Indigenous communities and digital technologies. They propose ethical frameworks like co-construction and strong epistemological pluralism to ensure collaborative development and respect for diverse knowledge systems (Roturier, 2021).
Intellectual Empowerment	The article discusses the importance of intellectual self-determination for Indigenous communities in adopting digital technologies. It advocates for tools that are defined and controlled from an Indigenous perspective to empower communities rather than impose external influences (Roturier, 2021).
Cultural Sensitivity	The authors call for greater sensitivity to cultural nuances, risks of knowledge monopolization through digital means, and political dimensions of technology implementation in Indigenous settings. They advocate for inclusive dialogue that respects Indigenous knowledge systems alongside scientific inquiry for ethical environmental stewardship and technological progress (Roturier, 2021).
Pipeline Transport Development	Prioritize the development of eco-friendly pipeline transport with advanced safety technologies. Construct new trunk pipelines to sea terminals, incorporating means to detect, localize, and eliminate pipeline accidents efficiently (Ablyazov, 2021).
High-Power Icebreakers	Calculate and adjust plans for the construction of a new generation of high-power icebreakers to meet the region's specific needs and challenges (Ablyazov, 2021).
Public-Private Partnership Parameters	Determine optimal parameters for public-private partnerships in the construction of transport infrastructure and vehicles, emphasizing effective collaboration for sustainable development (Ablyazov, 2021).
Modern Vessels and Icebreakers	Formulate a comprehensive program for the construction of modern supply vessels, Arctic container ships, and multifunctional nuclear and diesel-electric icebreakers. Aim to equip vessels with dynamic positioning systems (Ablyazov, 2021).
Railway Modernization	Prioritize the modernization and new construction of railway sections, focusing on transport corridors, meridian railways, and connections between resource regions and oil production zones with industrial areas in the Urals (Ablyazov, 2021).
Creation of All-Terrain Vehicles	Emphasize the creation of all-terrain vehicles to enhance transportation capabilities in challenging Arctic terrains (Ablyazov, 2021).
Transport Infrastructure	The authors highlight the necessity of digitalizing transport infrastructure in the Arctic to overcome challenges posed by harsh climatic conditions and enhance accessibility. They advocate for the development of digital platforms to facilitate coordination among different transport modes, optimize routes, improve safety, and streamline infrastructure maintenance activities (Abramov, 2019).
Case Studies	Examples from cities like Anchorage, Воднш, Murmansk, and Sabetta illustrate the gradual integration of smart technologies in Arctic transport systems. Projects such as "Yamal LNG" and the "Integrated Development of the Murmansk Transport Hub" showcase Russia's commitment to enhancing Arctic infrastructure (Abramov, 2019).

Digital Economy	The article underscores the role of information and communication infrastructure in driving the Arctic's development, citing initiatives like the Arctic Connect communication line and "Arctic Labs" digital platform as key steps towards implementing smart city principles. It aligns with Russia's strategic vision for Arctic development up to 2035 (Abramov, 2019).
Future Prospects	The authors propose expanding smart city elements in Arctic cities to enhance logistics services and ultimately achieve full-scale smart city development. They argue that leveraging digital economy concepts is essential for creating a comfortable and safe living environment in the Arctic region (Abramov, 2019).
Smart City Concepts	The authors define smart cities as urban areas where information and communication technologies interconnect infrastructure and services to optimize resources, enhance efficiency, and improve residents' quality of life. They propose applying these concepts to Arctic cities to modernize transport systems and promote development (Abramov, 2019).
Smart City Concepts	The paper defines smart cities as urban areas that utilize advanced ICT, robotics, and intelligent solutions to address challenges and improve living conditions. It emphasizes the relevance of smart technologies in Arctic settlements due to their specific needs and conditions (Didenko, 2021).
Technology Integration	The authors discuss the evolution of smart cities in response to population growth, resource limitations, and environmental concerns, citing successful examples from European cities like Barcelona and Amsterdam. They propose integrating technologies such as IoT, WSNs, cloud computing, big data analytics, and unmanned transport vehicles (UTVs) in Arctic settlements to enhance efficiency and connectivity (Didenko, 2021).
Digital Real-World Virtual Cyberspace	The concept of a self-organizing distributed computer network embedded with multifunctional UAVs is introduced as a tool for managing logistical and computational tasks in the Arctic zone. The paper explores the physical, informational, and social dimensions of cyberspace in the Arctic, emphasizing its role in facilitating development and communication (Didenko, 2021).

Before talking about digital support for sustainable development of the Arctic, it is important to understand what factors of sustainable development in the Arctic exist in general. Figure 1 shows the factors of sustainable development in Arctic.

Fig. 1. Features of sustainable development of the Arctic region

Digital technologies are helping to solve grand challenges to slow down climate change and promote sustainable development (Berezikov, 2019). Diverse phenomenological lenses co-exist and offer unique perspectives on addressing climate change, sustainable development, and socioecological value creation. The road to a sustainable economy is hard, yet some scientists remain optimistic that some entrepreneurial ventures hold the potential to create impactful solutions.

The catalyzing role of digital transformation in localizing SDGs is highlighted in another paper that also examines how digital transformation can impact the localization and achievement of the Sustainable Development Goals (SDGs) (Arctic Economic Council; ElMassah, 2020). The integration of Big Data and e-government proves instrumental in effective SDG implementation, especially in regions with higher levels of decentralization which may be used in some areas of the Arctic. Digital solutions enable progress in technological advancements, offering a promising avenue for improving living standards globally.

Conclusion

In summary, the message is clear: Arctic is of immense importance to global ecology and the economy. While faced with challenges, there's a drive towards collaborative efforts to balance resource development with sustainability and safety, in which AI and robotics may play a pivotal role.

In conclusion, innovative technologies, particularly AI and digital twins, are pivotal in adapting to changing Arctic conditions. The case of PolArctic's digital twin model demonstrates a promising approach to optimizing fishery outputs and managing resources while simultaneously extending benefits to shipping, defense, and climate research. The digital platforms highlighted in the papers offer a blueprint for revolutionizing public administration and public engagement, fostering a more inclusive and efficient socioeconomic ecosystem in the Arctic.

As the digital landscape evolves, the importance of incorporating smart city concepts is evident to improve the logistics and quality of life for Arctic residents. The integration of digital technologies in the Arctic's oil and gas industry is being explored to enhance operational efficiency, despite challenges related to extreme weather and the heavy reliance on external technologies.

While there are concerns about cybersecurity, data protection, and the potential overreliance on foreign technologies, the articles advocate for international cooperation and robust policy initiatives that could catalyze the socio-economic development of the Arctic.

From AI and robotics in resource extraction to the push for smart infrastructure, there is a clear indication that technology could be a game-changer for the Arctic. However, its success hinges on striking a careful balance between innovation and the preservation of the Arctic's delicate ecosystems. Embracing smart settlement concepts may be the key to transforming the Arctic into an area of strategic significance while also securing a sustainable future for one of the planet's most pristine frontiers.

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Статья поступила в редакцию 10.02.2024; одобрена после рецензирования 27.02.2024; принята к публикации 28.02.2024.
The article was submitted 10.02.2024; approved after reviewing 27.02.2024; accepted for publication 28.02.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 41–50.
Техноэкономика. 2024, Том 3, № 1 (8). С. 41–50.

Scientific article
UDC 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.4

REDUCING EMISSIONS OF HARMFUL SUBSTANCES AT COAL-HEATED THERMAL POWER PLANTS

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Abstract. In this research, using the three-dimensional modeling method, computational experiments were carried out to introduce two-stage combustion technology inviting the example of the combustion chamber of the BKZ-75 boiler at the Shakhtinskaya TPP, burning high-ash Karaganda coal. Computational experiments were carried out on the implementation of two-stage fuel combustion technology under various modes of supplying additional air through OFA injectors: 0% (basic version, traditional combustion), 5%, 10%, 15%, 18%, 20%, 25% and 30% from the required total air volume. It has been shown that the technology of two-stage fuel combustion allows optimizing the process, improving ignition and combustion conditions and minimizing emissions of harmful substances.

Keywords: thermal power plant, two-stage combustion, computational experiment, high-ash coal, temperature, nitrogen oxides

Funding: This work was supported by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP19679741, AP14870834, BR18574080).

Citation: Askarova A., Bolegenova S., Nugymanova A. Reducing emissions of harmful substances at coal-heated thermal power plants. Technoeconomics. 2024. 3. 1 (8). 41–50. DOI: https://doi.org/10.57809/2024.3.1.8.4

Научная статья
УДК 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.4

СОКРАЩЕНИЕ ВЫБРОСОВ ВРЕДНЫХ ВЕЩЕСТВ НА УГОЛЬНЫХ ТЕПЛОВЫХ ЭЛЕКТРИЧЕСКИХ СТАНЦИЯХ

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Аннотация. С использованием метода трехмерного моделирования в данном исследовании были выполнены вычислительные эксперименты по внедрению технологии двухступенчатого сжигания на примере топочной камеры котла БКЗ-75 Шахтинской ТЭЦ, сжигающей высокозольный карагандинский уголь. Проведены вычислительные эксперименты по внедрению технологии двухступенчатого сжигания топлива при различных режимах подачи дополнительного воздуха через OFA-инжекторы: 0% (базовый вариант, традиционное сжигание), 5%, 10%, 15%, 18%, 20%, 25% и 30% от необходимого общего объема воздуха. Согласно результатам исследования, технология двухступенчатого сжигания топлива позволяет оптимизировать процессы, улучшить условия воспламенения и горения, а также минимизировать выбросы вредных веществ.

Ключевые слова: ТЭЦ, двухступенчатое сжигание, вычислительный эксперимент, высокозольный уголь, температура, оксиды азота

Финансирование: Работа выполнена при поддержке Комитета науки МОН РК (гранты № AP19679741, AP14870834, BR18574080).

Для цитирования: Аскарова А., Болегенова С., Нугыманова А. Сокращение выбросов вредных веществ на угольных тепловых электрических станциях // Техноэкономика. 2024. Т. 3, № 1 (8). С. 41–50. DOI: https://doi.org/10.57809/2024.3.1.8.4

Introduction

The environmental situation in the world is getting worse every year. According to the World Health Organization, more than 92% of the world's population breathes polluted air. Air pollution is significantly influenced by: industrial production, road congestion with urban transport and low ventilation of populated areas. It is these three factors that contribute to the high level of air pollution in populated areas with pollutants such as nitrogen dioxide, carbon monoxide, sulfur dioxide, formaldehyde, hydrogen sulfide, suspended particles, phenol, ammonia (Georgiev, 2022; Xiang, 2003; Yang, 2017; Zaychenko et al., 2018).

The world's leading countries are seeking to increase the use of renewable energy sources, but the industrial economy remains largely dependent on fossil fuels – coal, oil and gas. Recent events in the world have shown that energy sources such as wind and sun, which are characterized by inconsistency (calm and cold weather), may not be enough to provide the world with electricity and heat. Some countries have begun switching to coal, reviving coal-fired power plants, which could slow the global transition to green energy.

Despite the fact that the leading countries of the world announce their plan for 2020-2060. achieving carbon neutrality, the rate of coal production is not expected to slow down. Mainly due to high prices for natural gas, huge demand for electricity, increased development of energy and industry in China, India and the countries of Southeast Asia. Demand for coal remains flat

and is likely to reach record highs this year, driving up global emissions. Production records will be broken by the TOP 3 largest coal producers in the world - China, India and the USA (Figure 1).

Attempts to ensure domestic energy consumption by increasing the volume of coal use in almost all Central Asian countries have led to an aggravation of the environmental situation. In countries rich in natural resources, renewable energy sources are still losing competition to traditional types of generation. In the future, the share of coal-fired stations will decrease, but coal in these countries will remain the main type of fuel for now. In this regard, to increase the efficiency of using traditional fuel, various methods of environmentally friendly and efficient combustion are being developed.

The creation of energy-efficient technologies that make it possible to control the main processes of the formation of harmful dust and gas emissions, and the development of recommendations for their reduction is an urgent task in the thermal power industry. Research in the field of progressive technological processes to improve power plants for burning pulverized coal fuels and the use of alternative methods for burning various types of fuel are currently the most relevant for the entire energy complex of the Republic of Kazakhstan.

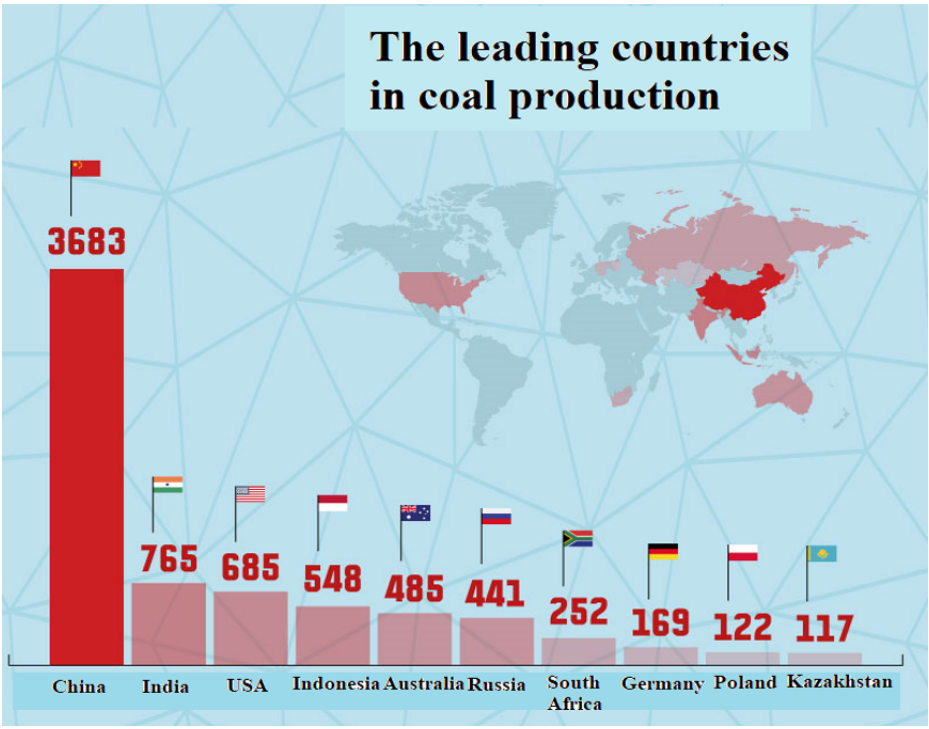

Fig. 1. The leading countries in coal production

There are various methods for reducing nitrogen oxide emissions, the most appropriate of which is the introduction of nitrogen oxide suppression technology at the stage of fuel combustion in the combustion chamber. Staged fuel combustion – Overfire Air (OFA) technology is one of the effective methods for reducing the concentration of nitrogen oxides NOx. Stepped air supply into the combustion space with OFA technology consists of supplying the required volume of air for coal combustion as follows: 70-90% of the air is supplied to the burners and 10-30% through OFA injectors, which are located above the burner devices. In this case, a low-temperature combustion zone depleted in oxygen and enriched in fuel is created in the lower part of the combustion device, which makes it possible to reduce the formation of NOx

from fuel nitrogen (fuel NOx). At the same time, the low temperature in the oxygen-enriched zone of OFA injectors leads to minimization of the formation of NOx from the air (thermal NOx) (Bartlomiej, 2019; Messerle, 2004; Muller, 1994).

This article suggests the introduction of modern technology of OFA ignition and stabilization of pulverized coal fuel at Kazakhstan thermal power plants, using the latest information technologies and methods of 3D computer modeling methods. This will allow to optimize the processes occurring when burning high-ash energy fuel, to reduce harmful dust and gas emissions into the atmosphere (carbon oxides, nitrogen oxides, ash, etc.), to create and introduce in the future a method of obtaining "clean" energy.

All of the above stated the main goal of the work – the study of heat and mass transfer processes in high-temperature and two staged fuel combustion of pulverized coal fuel in a real physical and chemical system (combustion chambers of TPPs) in order to introduce the newest technologies of "clean energy" production in Kazakhstan.

Materials and Methods

In this paper, we study the heat and mass transfer in a high-temperature media through using a physical-mathematical model and a chemical model. These models include the following: 3D Navier-Stokes equations, heat and mass transfer equations with the source terms – they related to the chemical kinetics, nonlinear effects of thermal emission, interphase interaction, and multistage chemical reactions (Baizhuma, 2018).

The general view for heat and mass transfer equations in the boiler furnace is the following:

$$\frac{\partial \rho\varphi}{\partial t} = -\frac{\partial \rho u_i \varphi}{\partial x_i} + \frac{\partial}{\partial x_i}\left(\Gamma_\varphi \frac{\partial \varphi}{\partial x_i}\right) + S_\varphi \qquad (1)$$

where φ is a generalized transport variable, Γ_φ is a generalized coefficient of transfer, S_φ is the source of term (defined by the chemical kinetics of the process), nonlinear effects of thermal radiation and interphase interaction, and the multistage nature of chemical reactions. The system of equations (1) is solved numerically using the control volume method.

Modelling of heat and mass transfer processes in combustion chambers of operating power boilers allows solving complex problems of heat and power engineering and ecology related to reduction of emission of pollutants such as hydrocarbons CnHm, soot, CO, CO2 and NOx carbon oxides by controlling the regularities of temperature and fuel concentrations and oxidizer, which are fed in the area of their combustion.

In this paper, a computer software package FLOREAN was used as the basis for computational experiments to study heat and mass transfer processes using 3D modeling in the combustion chamber of a TPP boiler. This software package is widely used for calculations and research in the field of processes of highly reactive streams in the combustion chambers of many heat power plants. The FLOREAN application software package has been developed and developed for more than a decade due to the painstaking work of the team of German scientists, such as Von Muller (1992), Vockrodt (1995), Schiller (1999), Pauker (2001), Hoppe (2005) and Noack (2010) at the University of IWBT Germany.

This software package was adapted by us for carrying out computational experiments on numerical modelling of the combustion of high-ash solid fuel, which was plasma-trained, at Kazakhstan thermal power plants.

Computational experiments on the implementation of two-stage fuel combustion technology using the example of the combustion chamber of the BKZ-75 boiler at the Shakhtinskaya TPP. The BKZ-75 boiler is equipped with four pulverized coal burners, two burners installed at the front and at the rear in one tier. The boiler burns dust from Karaganda ordinary (KR-200) coal

with an ash content of 35.1%, a volatile yield of 22%, a humidity of 10.6% and a calorific value of 18.55 MJ/kg. The general view of the combustion chamber of the BKZ-75 boiler (Figure 2a) and the arrangement of burners and injectors for the implementation of the technology of two-stage fuel combustion (Figure 2b) is shown (Messerle, 2019; Aliyarov, 2012; Ustimenko, 1982; Chibyshev, 2018).

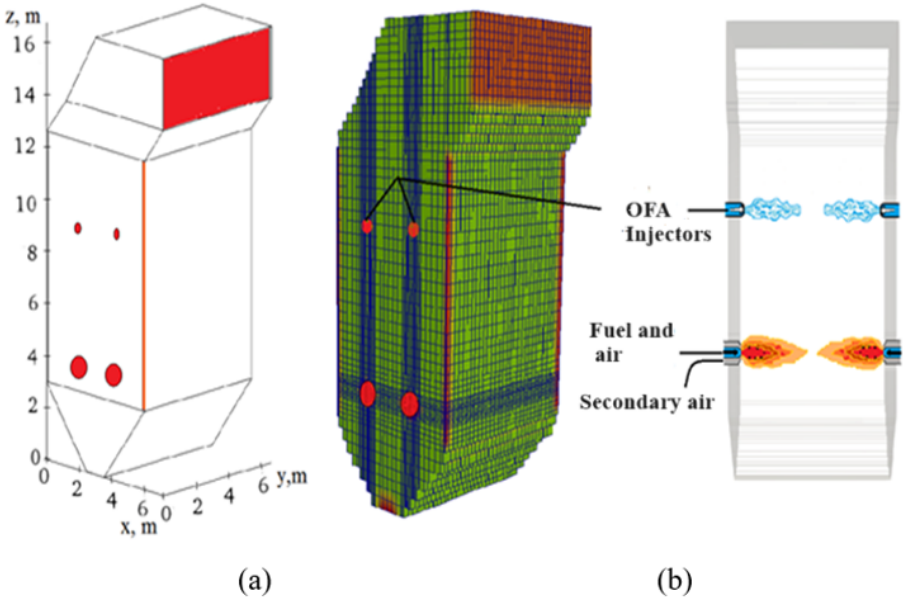

Fig. 2. General view of the combustion chamber of the BKZ-75 boiler at the Shakhtinskaya TPP (a), its breakdown into control volumes (b), the layout of burner devices and OFA injectors, and the three-dimensional distribution of the concentration of nitrogen dioxide NO2 along the height h of the combustion chamber of the BKZ-75 boiler at different volumes of air supplied through the injectors

Results and Discussion

Using computer modeling methods, various modes of supplying additional air to the combustion chamber of the BKZ-75 boiler through OFA injectors were studied: OFA=0% (basic version), OFA=10%, OFA=18%. As a result of the computational experiments, the distributions of concentrations of carbon oxides CO and nitrogen dioxide NO2 throughout the entire volume of the combustion chamber were obtained.

Figure 3 shows two-dimensional graphs of the distribution of the cross-section average temperature T along the height h of the furnace for the studied regimes of additional air supply. Its distribution over the height of the combustion chamber of the BKZ-75 boiler at different volumes of air supplied through OFA-injectors. At the outlet from the combustion chamber, we have a further decrease in temperature. Therefore, the average value of the temperature at the outlet from the combustion chamber is for OFA=0%, T=885.790C; OFA=10%, T=865.900C and OFA=18% T= 856.270C. The temperature distribution over the height of the combustion chamber is confirmed by experimental data (Figure 3) obtained directly at the operating Shakhtinskaya TPP (Zenkov, 2021; Korovyakovskiy, 2023; Ermolin, 2017, and at the outlet from the furnace space, its theoretical value, calculated by the CBTI method (Sheverdyaev, 2014; 2017) for the basic version (OFA=0%). Comparing the results obtained, it can be noted that with an increase in the volume of air supplied through the OFA injectors, a shift in the location of the flame core and an increase in the length of the zone of maximum temperatures are observed (Figure 3, curves 2, 3).

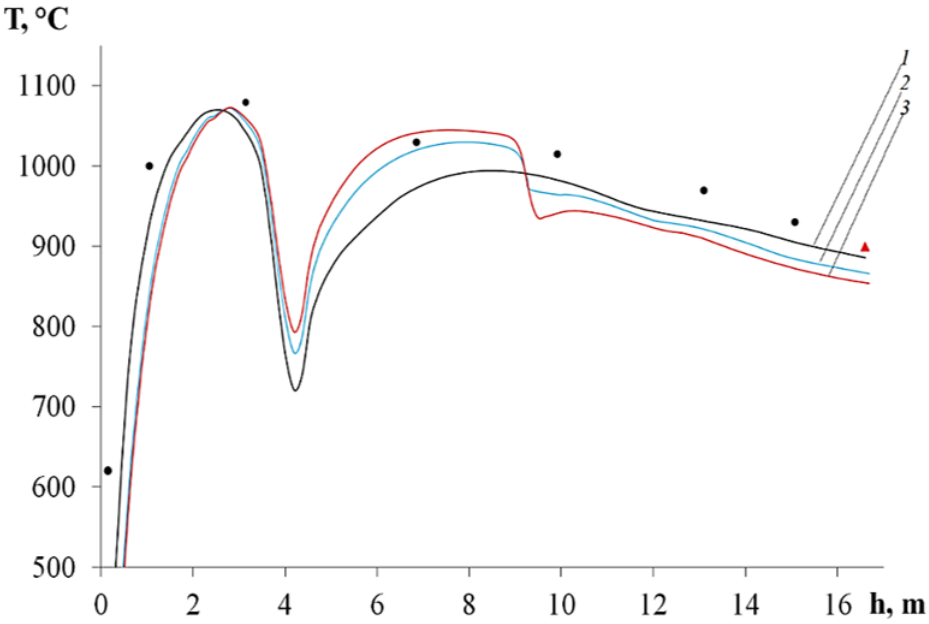

Fig. 3. Two-dimensional temperature distribution T along the height h of the furnace of the BKZ-75 boiler at various volumes of air supplied through the injectors: 1 – OFA=0%, 2 – OFA=10%, 3 – OFA=18%, – thermal power experiment (Zenkov, 2017; Globina 2021), red triangle – theoretical value obtained by the CBTI method (Sheverdyaev, 2014; 2017)

Figure 4 shows a graphical interpretation of the distribution of the concentration of nitrogen dioxide NO2 in the central (y = 3.3 m) section of the furnace of the BKZ-75 boiler for three options for supplying additional air through the injectors: a) OFA=0% (basic version), b) OFA=10%, c) OFA=18%. Analysis of Figures 4a, 4b and 4c shows that most of the nitrogen dioxide NO2 is formed in the active combustion zone located in the zone of the burners. It is this region that is characterized by high values of the temperature of the two-phase flow and the concentration of nitrogen dioxide NO2, which decreases along the height of the furnace.

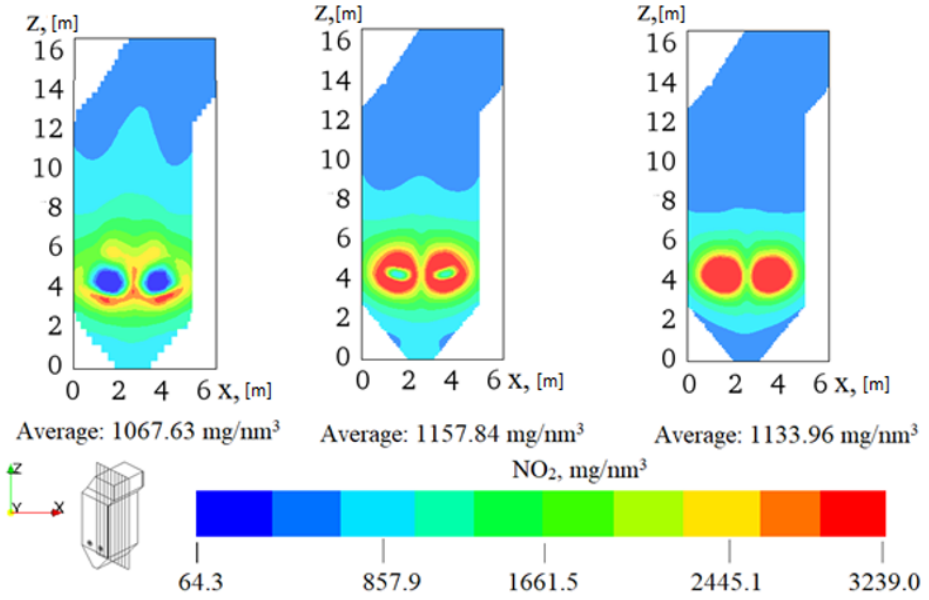

Fig. 4. Distribution of nitrogen dioxide NO2 concentration in the central section (y = 3.3 m) of the furnace of the BKZ-75 boiler with different volumes of air supplied through the injectors: (a) OFA = 0%, (b) OFA = 10%, (c) OFA = 18%

Conclusion

Based on the results of studies of the effect of introducing a two-stage combustion technology in the furnace of the BKZ-75 boiler, the following conclusions can be drawn:

1. As the volume of air supplied through the OFA injectors increases, the temperature in the zone where the burners are located increases. The use of two-stage combustion technology causes a decrease in the oxygen concentration in the zone of the most intense combustion (in the zone burner), which leads to a decrease in the total excess air ratio in this zone and to an increase in the flame temperature in this zone.

2. The temperature distribution over the height of the furnace is confirmed by experimental data obtained directly at the operating Shakhtinskaya TPP, and at the outlet from the combustion space with its theoretical value calculated using the CBTI method for the basic (OFA=0%). This confirms the adequacy of the models used in the numerical formulation of the problem.

3. The use of the technology of two-stage combustion in the furnace of the BKZ-75 boiler at Shakhtinskaya TPP leads to a significant decrease in the concentration of carbon monoxide CO and nitrogen dioxide NO2. One of the optimal options for reducing them at the outlet from the furnace is the use of injectors at OFA=18%.

The modern methods of physical, mathematical and 3D computer modeling presented in the work make it possible to study the processes of turbulent heat and mass transfer and the formation of harmful substances during the combustion of solid fuel in the combustion chambers of real energy facilities. The obtained results of the influence of the design parameters of the combustion chamber, various layouts of burner devices and the method of supplying the fuel air mixture on the main characteristics of the heat and mass transfer process (flow aerodynamics, temperature distribution and concentration of combustion products) will allow optimizing the process of burning low-grade fuel not only in the combustion chamber of the BKZ-75 boiler at the Shakhtinskaya TPP , but at other coal-burning thermal power plants of the Republic of Kazakhstan.

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Статья поступила в редакцию 24.01.2024; одобрена после рецензирования 08.02.2024; принята к публикации 12.02.2024.

The article was submitted 24.01.2024; approved after reviewing 08.02.2024; accepted for publication 12.02.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 51–60.
Техноэкономика. 2024, Том 3, № 1 (8). С. 51–60.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2024.3.1.8.5

APPROACH TO ORGANIZING CORPORATE TRAINING IN AN ENERGY SECTOR COMPANY

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Abstract. This article considers potential challenges that may arise in developing and implementing a business glossary, offering best practices and strategies to overcome them effectively. Ultimately, it underscores the transformative impact a well-organized business glossary can have on corporate training projects and organizational success. Moreover, the article delves into the significance of regularly updating and maintaining the business glossary to ensure its relevance and accuracy over time. It discusses how a comprehensive glossary can serve as a valuable reference tool for all team members, aiding in onboarding new employees and facilitating knowledge transfer. By establishing a shared understanding of key terms and concepts, businesses can foster a culture of consistency and clarity in communication.

Keywords: business glossary, project management, corporate training, digitalization, business processes

Citation: Salnikova S. Approach to organizing corporate training in an energy sector company. Technoeconomics. 2024. 3. 1 (8). 51–60. DOI: https://doi.org/10.57809/2024.3.1.8.5

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2024.3.1.8.5

ПОДХОД К ОРГАНИЗАЦИИ КОРПОРАТИВНОГО ОБУЧЕНИЯ В КОМПАНИИ ЭНЕРГЕТИЧЕСКОГО СЕКТОРА

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Аннотация. В данном исследовании рассматриваются потенциальные проблемы, которые могут возникнуть при разработке и внедрении бизнес-глоссария, а также предлагаются наиболее эффективные практики и стратегии для их эффективного преодоления. В статье приводятся ключевые факторы, которые оказывают преобразующее влияние, с точки зрения хорошо организованного бизнес-глоссария, на проекты корпоративного обучения и успех организации. Кроме того, в статье рассматривается важность регулярного обновления и ведения глоссария для обеспечения его актуальности и точности с течением времени. В результате, установлено, каким образом адекватный глоссарий может служить ценным справочным инструментом для всех членов команды, способствуя адаптации новых сотрудников и эффективной передаче знаний. Устанавливая общее понимание ключевых терминов и понятий, компании могут способствовать формированию культуры последовательности и ясности в работе предприятия.

Ключевые слова: бизнес-глоссарий, управление проектами, корпоративное обучение, цифровизация, бизнес-процессы

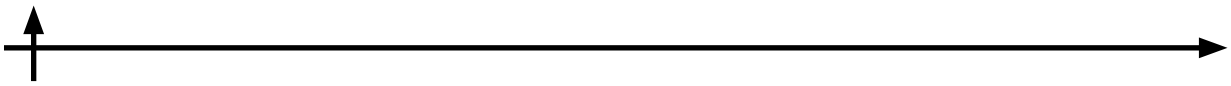
Для цитирования: Сальникова С. Подход к организации корпоративного обучения в компании энергетического сектора // Техноэкономика. 2024. Т. 3, № 1 (8). С. 51–60. DOI: https://doi.org/10.57809/2024.3.1.8.5

Introduction

In the contemporary business landscape, the significance of corporate training cannot be overstated, particularly in industries characterized by the necessity for specialized knowledge and skills, such as the energy sector. However, an inherent challenge faced by organizations in these industries is the absence of a unified terminological foundation for articulating work processes. This deficiency can lead to communication gaps, misunderstandings, and inefficiencies within project teams. This paper seeks to address this issue by proposing a solution: the creation of a comprehensive business glossary. By systematically organizing and standardizing the terminology and concepts employed in the energy sector, this business glossary aims to enhance the quality of training initiatives and, consequently, elevate the productivity and efficiency of project teams.

One of the primary impediments to achieving this goal is the lack of a unified and standardized language to describe and communicate work processes. Divergent interpretations of terminologies and concepts among team members can lead to confusion, errors, and a suboptimal learning experience. Recognizing the importance of overcoming this challenge, this paper proposes the development of a business glossary.

The business glossary will serve as a centralized repository of terms and their standardized definitions, offering a common understanding of terminology across the organization. This ini-



tiative aims to bring about several positive outcomes, including improved clarity in communication, enhanced collaboration among team members, and a more effective transfer of knowledge during training sessions (Karimi, 2015; Martinez, 2019; Santos, 2019).

The relevance of this paper stems from the urgent need to create a common terminology base for the successful execution of corporate training projects in a company in the energy sector. With energy sector companies facing an ever-changing landscape of technological advances, a rigid regulatory environment, and complex operational processes, the lack of a standardized language to articulate workflows becomes a significant obstacle.

The purpose of this article is to conduct a comprehensive study and propose a strategic approach to corporate learning organization through the creation of a business glossary (Budovsky, 2019). By addressing the problems associated with the lack of a common terminology framework, this article aims to contribute to the improvement of corporate learning practices in the energy sector. The main objective is to identify the problems arising from the variation of terms and concepts and to propose a solution in the form of systematization and standardization of these terminologies (Agarwal, 2010; Aibinu, 2020; Al-Busaidi, 2021; Andriole, 2017; Baber, 2019).

The implementation of a business glossary in the context of corporate training in the energy sector is anticipated to have a profound and positive effect on various aspects of organizational functioning. The key outcomes of utilizing a business glossary include:

Establishment of a Common Understanding of Terms:

By providing clear and standardized definitions for key terms, a business glossary fosters a shared understanding of terminology across the organization. This common understanding is pivotal in mitigating the risk of misinterpretations and misunderstandings that may arise due to varied interpretations of terms. In the energy sector, where precision and accuracy are paramount, a shared vocabulary ensures that all team members are on the same page when discussing critical concepts and processes.

Standardization of Terminology:

The business glossary plays a crucial role in standardizing the use of terminology within the organization. This standardization is vital for creating consistency in communication, documentation, and training materials. In an industry as complex as the energy sector, where precision is crucial, having a standardized set of terms ensures that communication is not only clear but also conforms to industry best practices. This, in turn, facilitates effective collaboration and knowledge transfer among team members.

Enhanced Clarity and Accuracy of Communication:

Clarity and accuracy are foundational to effective communication, particularly in industries where technical nuances can have significant implications. The business glossary, by providing precise and unambiguous definitions, contributes to the clarity of communication. Team members can articulate ideas, processes, and concepts with confidence, knowing that everyone shares a common understanding of the terminologies involved. This clarity is essential for seamless project execution, troubleshooting, and the overall success of corporate training initiatives in the energy sector.

Facilitation of Training Programs:

In the context of corporate training, the business glossary becomes an invaluable tool. Trainers can rely on a standardized set of terms and definitions, ensuring that participants receive consistent and accurate information. This not only enhances the quality of training but also streamlines the learning process, making it more efficient and impactful. Training materials, modules, and assessments can be developed with greater precision, aligning closely with the

standardized terminology outlined in the business glossary.

Reduction of Ambiguity and Errors:

Ambiguity in terminology can lead to errors, confusion, and inefficiencies. The business glossary acts as a preventive measure by reducing ambiguity through clear and standardized definitions. This reduction in ambiguity contributes to a more error-free working environment, minimizing the potential for costly mistakes or misunderstandings, particularly in safety-critical environments common in the energy sector.

Materials and Methods

When addressing the challenges posed by diverse terminologies in a corporate training project within the energy sector, the chosen solution involves the systematic development and implementation of a business glossary (Bassano, 2017). This methodology is designed to establish a unified understanding of terms and concepts, thereby improving communication, minimizing errors, and enhancing overall project efficiency.

1. Analyzing Existing Terms and Concepts:

Conduct an in-depth analysis of the terms and concepts used by various units and departments involved in the corporate training project. Identify discrepancies and variations in the use of terminology that may lead to misunderstandings or inefficiencies.

2. Drawing up a List for Standardization:

Compile a comprehensive list of terms and concepts that exhibit inconsistencies or variations across different units. Prioritize terms based on their frequency of use, criticality to project success, and potential for misinterpretation.

3. Consultations with Subdivisions:

Engage in consultations with representatives from different subdivisions to gather insights and perspectives on the identified terms. Seek clarification and harmonization of terms through collaborative discussions with stakeholders to ensure accuracy and inclusivity.

4. Creation of the Business Glossary:

Develop a centralized business glossary that includes the approved and standardized terms and concepts. Clearly define each term, providing precise explanations and contextual information where necessary. Establish a user-friendly structure, potentially categorizing terms based on relevant criteria to enhance accessibility.

5. Dissemination and Implementation:

Distribute the finalized business glossary to employees within the business units involved in the corporate training project. Conduct training sessions or workshops to familiarize team members with the business glossary, emphasizing its importance in promoting uniformity and clarity. Integrate the business glossary into relevant training materials and documentation.

6. Updating Terms as Needed:

Establish a feedback mechanism for continuous improvement, encouraging employees to provide insights on the effectiveness and relevance of the business glossary. Regularly review and update the business glossary to accommodate changes in project requirements, industry standards, or evolving terminology.

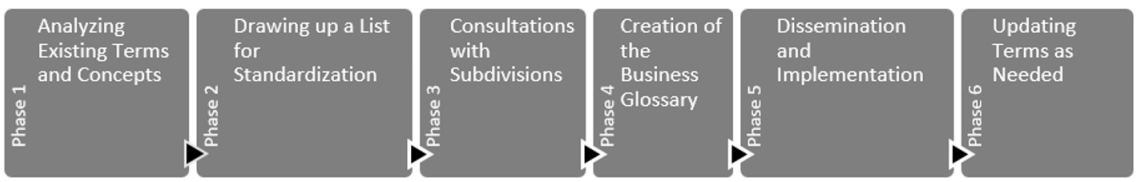
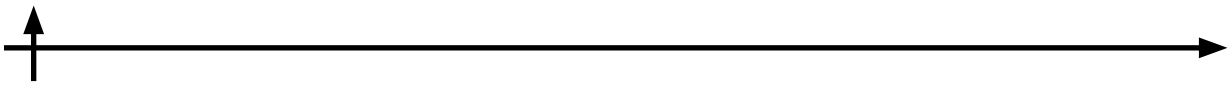


Fig. 1. Phases of developing a business glossary



The proposed methodology outlines a systematic approach to address the challenges arising from divergent terminologies in a corporate training project within the energy sector. By conducting a thorough analysis, standardizing terms through collaborative consultations, and implementing a dynamic business glossary, this methodology aims to create a cohesive and standardized communication framework (Bolchek, 2023; Efimova, 2018). The ongoing process of updating the glossary ensures its adaptability to changing project dynamics and industry standards, contributing to the long-term success of corporate training initiatives (Bjorkdahl, 2020; Ceipek, 2021).

A business glossary offers valuable benefits and can be advantageous to various stakeholders involved in corporate training projects, especially in industries like the energy sector. Here's how different roles can benefit from a business glossary:

Project Leaders, Managers, and Administrators:

Clear Communication: Project leaders and managers can ensure consistent and clear communication among team members by relying on a standardized set of terms outlined in the business glossary.

Efficient Coordination: The glossary helps streamline coordination efforts by providing a common understanding of terminologies, minimizing the risk of misunderstandings and errors.

Resource Optimization: Managers can optimize resources and time by avoiding delays caused by confusion or the need for clarification due to inconsistent use of terms.

Corporate and Academic Program Managers: Alignment with Objectives: Program managers can ensure that corporate training programs align with organizational objectives by incorporating standardized terminologies from the business glossary into the curriculum.

Consistent Training Materials: The glossary contributes to the creation of consistent and standardized training materials, ensuring that employees receive coherent information across different training sessions.

Performance Assessment: Managers can use the glossary to develop assessments that accurately measure employees' understanding of key terms, facilitating effective performance evaluations (Belyanina, 2019).

Mentors:

Enhanced Teaching Effectiveness: Mentors and teachers can enhance the effectiveness of their training sessions by using the business glossary to convey concepts with precision and clarity.

Reduced Ambiguity: The glossary helps eliminate ambiguity in educational materials, making it easier for mentors to convey complex ideas and ensuring that learners have a clear and accurate understanding of key terms.

Consistent Mentoring Approaches: Mentors can maintain consistency in their mentoring approaches by adhering to the standardized terms and definitions provided in the glossary (Nochevnov, 2013; Kalseth, 2001; Thomas, 2003).

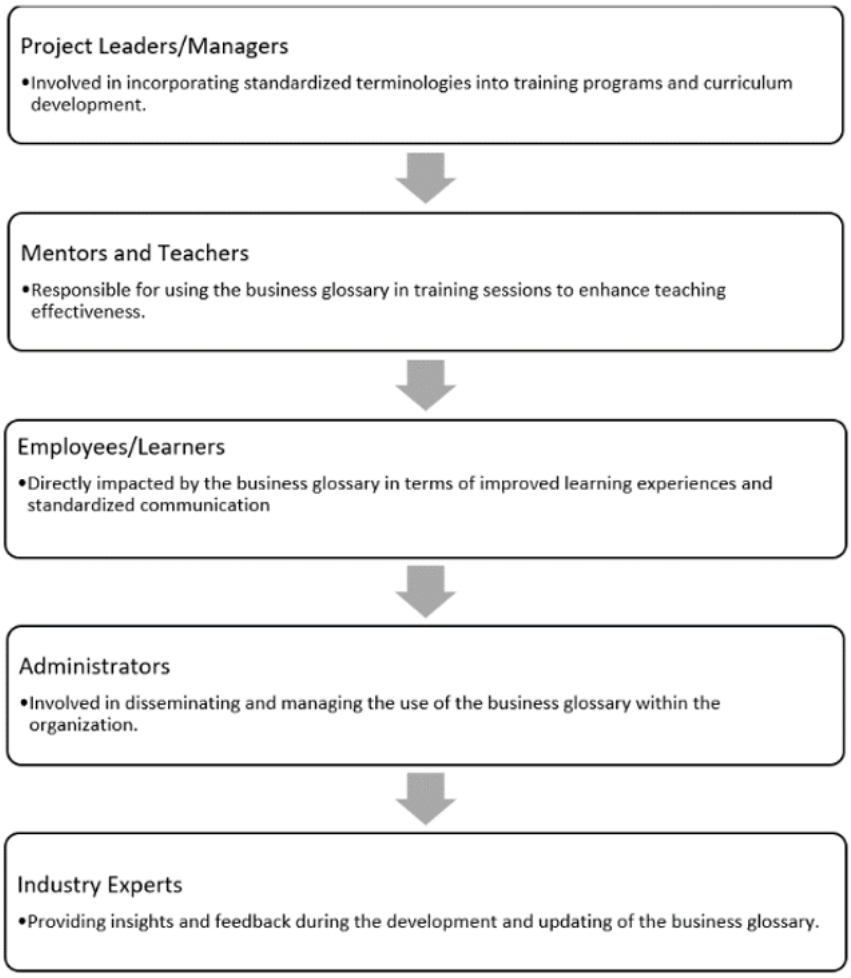


Fig. 2. Stakeholder map of the business glossary project

In essence, a business glossary serves as a unifying tool that enhances communication, promotes consistency, and contributes to the overall success of corporate training initiatives. The benefits extend across various roles, ensuring that stakeholders at different levels can effectively contribute to and benefit from the standardized language and concepts established by the glossary (Chen, 2016; Bashina, 2023).

Results and Discussion

Following a thorough analysis of current terms and collaborative interviews with project team members, the structure of the business glossary for the corporate training project in the energy sector has been successfully formulated. The resultant structure is designed to enhance clarity, accessibility, and effectiveness in conveying essential information. The key components of the business glossary are outlined below:

1. General Terms (Entities) Section:

This section serves as the initial point of reference for users, directing them to fundamental concepts that are universally applicable to all project team members and other participants. Common terms, foundational principles, and overarching concepts are presented in a user-friendly manner, laying the groundwork for a shared understanding among stakeholders.

2. Training Program Section:

Users are provided with a dedicated section offering a selection of training programs tailored

to the energy sector's unique requirements. Within this section, users have the option to explore various training programs, each designed to address specific aspects of the energy sector, including technical skills, regulatory compliance, safety protocols, and more.

3. Program Passport:

A crucial feature of the business glossary is the inclusion of a detailed "Program Passport" for each training program. The Program Passport serves as a comprehensive document, offering in-depth information about a specific training program. This includes details on the program's direction, specialization, training format, cost, duration, profile modules, key features, and the experts and instructors involved. Users have the opportunity to delve into specific aspects of a training program, gaining insights into the intricacies of each program's focus, methodology, and structure.

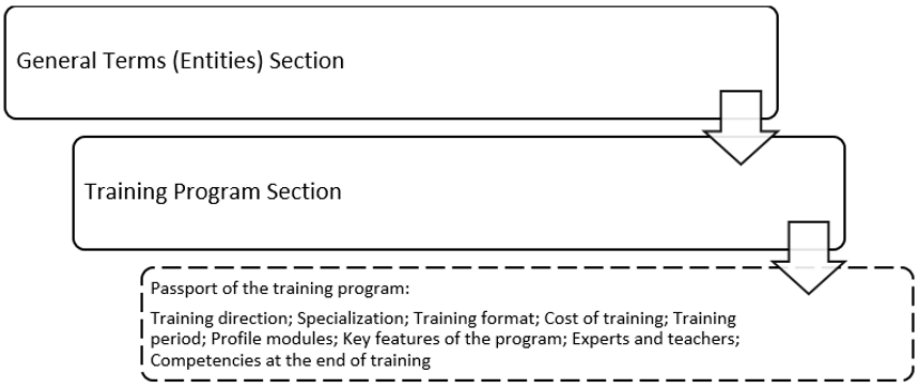


Fig. 3. Structure of a business glossary for a corporate training project

By structuring the business glossary in this manner, the project team aims to provide a cohesive and user-friendly resource that not only defines terms but also guides users through the intricacies of the corporate training project. This structure facilitates efficient navigation, ensuring that stakeholders can easily access the information most relevant to their roles and responsibilities within the energy sector (Galindo-Martin 2019). Additionally, the inclusion of the Program Passport ensures transparency and detailed insights into the specificities of each training program, fostering informed decision-making and a deeper understanding of the training initiatives.

Conclusion

The development and implementation of a business glossary emerge as a pivotal and multifaceted tool, not solely confined to the dynamics of a corporate training project but extending its influence to the broader spectrum of communication within the company.

The sustained use of a business glossary contributes to the long-term benefit of the organization. As a living document, it can evolve to accommodate changes in terminology, industry standards, and project requirements, ensuring its continued relevance and effectiveness in facilitating communication and training initiatives.

In conclusion, the business glossary emerges as a versatile and essential tool that extends its impact far beyond the confines of specific projects. It becomes an integral part of the organizational culture, fostering a shared language, promoting consistency, and ultimately contributing to the efficiency and success of corporate endeavors within the dynamic landscape of the energy sector. As organizations embrace the value of a standardized vocabulary, the business glossary stands as a testament to the proactive approach in ensuring effective communication and streamlined processes.

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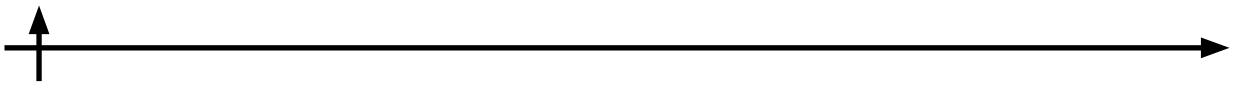

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Статья поступила в редакцию 13.02.2024; одобрена после рецензирования 25.02.2024; принята к публикации 27.02.2024.
The article was submitted 13.02.2024; approved after reviewing 25.02.2024; accepted for publication 27.02.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 61–70.
Техноэкономика. 2024, Том 3, № 1 (8). С. 61–70.

Scientific article
UDC 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.6

ECONOMIC ASSESSMENT OF FRESHWATER ECOSYSTEM SERVICES IN THE REPUBLIC OF KAZAKHSTAN AS A BASIS FOR ENSURING SUSTAINABILITY

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Abstract. The natural environment plays an integral role in achieving the Sustainable Development Goals (SDGs). Currently, freshwater ecosystems are experiencing significant impacts caused by human activities, including pollution, over-consumption, watering, alteration and reduction of runoff. These pressures are exacerbated by climate change. The aim of this research is to analyze the structure, functions and values of freshwater ecosystems of the Republic of Kazakhstan as a basis for ensuring their sustainability. This research studies the structure, features, types and main functions of aquatic ecosystems of the Republic of Kazakhstan; analyzes the current state and factors of impact on freshwater ecosystems; classifies modern methods of economic assessment of freshwater ecosystem services; considers examples of ecosystem services assessments of freshwater ecosystems in the world at different scales, as well as examines the main types of freshwater ecosystem services on the example of the Ile River.

Keywords: SDGs, freshwater ecosystems, sustainability, over-consumption, efficiency improvement

Citation: Duskaev K., Zhanabaeva Zh. Economic assessment of freshwater ecosystem services in the Republic of Kazakhstan as a basis for ensuring sustainability. Technoeconomics. 2024. 3. 1 (8). 61–70. DOI: https://doi.org/10.57809/2024.3.1.8.6

Научная статья
УДК 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.6

ЭКОНОМИЧЕСКАЯ ОЦЕНКА УСЛУГ ПРЕСНОВОДНЫХ ЭКОСИСТЕМ РЕСПУБЛИКИ КАЗАХСТАН КАК ОСНОВА ОБЕСПЕЧЕНИЯ УСТОЙЧИВОСТИ

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Аннотация. Природная среда играет неотъемлемую роль в достижении целей устойчивого развития (ЦУР). В настоящее время пресноводные экосистемы испытывают значительные негативные последствия, вызванные деятельностью человека, включая загрязнение, чрезмерное потребление, обводнение, изменение и сокращение стока. Эти нагрузки усугубляются изменением климата. Целью данного исследования является анализ структуры и функций пресноводных экосистем Республики Казахстан как основы для обеспечения их устойчивости. В данном исследовании изучены структура, особенности, типы и основные функции водных экосистем Республики Казахстан; проанализировано современное состояние и факторы воздействия на пресноводные экосистемы; классифицированы современные методы экономической оценки пресноводных экосистемных услуг; рассмотрены примеры оценки услуг пресноводных экосистем в мире в различных масштабах, а также рассмотрены основные виды пресноводных экосистемных услуг на примере реки Иле.

Ключевые слова: ЦУР, пресноводные экосистемы, устойчивость, чрезмерное потребление, повышение эффективности

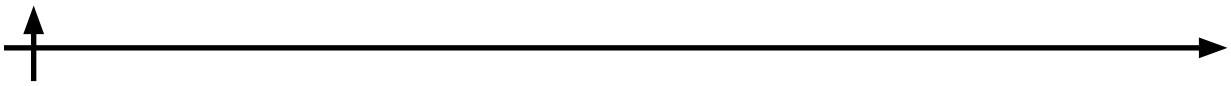
Для цитирования: Дускаев К., Жанабаева Ж. Экономическая оценка услуг пресноводных экосистем республики Казахстан как основа обеспечения устойчивости // Техноэкономика. 2024. Т. 3, № 1 (8). С. 61–70. DOI: https://doi.org/10.57809/2024.3.1.8.6

Introduction

Freshwater ecosystems, including lakes, rivers, wetlands and groundwater, are of great biological, social, educational and economic importance. They underpin economy-wide activities. They also provide important ecosystem services such as: naturally purifying freshwater, regulating runoff, mitigating extreme conditions, acting as a carbon sink, supporting adaptation to climate change, and providing a cultural connection between humans and nature. Recognizing the importance of freshwater ecosystems to the 2030 Agenda, SDG Target 6.6 specifically aims to "protect and restore water-related ecosystems."

According to data collected worldwide through the UN-Water 2020 program, one-fifth of the world's water basins are experiencing rapid changes in surface water area. Therefore, policymakers together with stakeholders need to understand the importance and significance of water-related ecosystems, the threats they face, and take timely and appropriate measures to protect and restore them (Synthesis report on SDG 6, 2018).

As freshwater ecosystems are complex, dynamic and diverse, it is important to know and consider their main characteristics, dynamics and drivers of change in practicing the sustainability of such natural sites. A freshwater ecosystem can be defined as an ecosystem characterized by low salt content in water, usually less than 1 %. In general, freshwater ecosystems fall into



three main groups: lentic ecosystems, lotic ecosystems, and wetlands. Lotic systems are mainly characterized by moving freshwater streams (rivers). For large rivers, three main zones can also be distinguished with respect to morphometric characteristics, hydrological regime and ecosystem features: the zone of flow formation, transit and dispersion.

Lentic ecosystems are standing water systems characterized by a longer residence time of water in the system and, as a consequence, they have the following characteristics: sedimentation of suspended particles on the underwater surface; development of phytoplankton and zooplankton populations; presence of complex currents instead of unidirectional flow as in flowing waters; mixing of upper and lower water layers may be limited due to vertical stratification (separation of water into layers due to differences in temperature and density).

In lentic ecosystems, depending on the depth and degree of sunlight penetration, there are three main zones: littoral, limnic and profundal.

The Ramsar Convention defines wetlands as "areas of marsh, wetland, peat and water, natural or artificial, permanent or temporary, static or flowing, fresh, brackish or salt water, including areas of sea water, the depth of which at low tide does not exceed six meters".

Wetlands are among the most important and scarce freshwater ecosystems. Although they cover only about 6% of the Earth's land surface and are most common in temperate and boreal regions, wetlands perform a wide range of ecosystem functions, many of which are of global importance. Freshwater ecosystems, as noted above, are subject to increased anthropogenic pressures and many of them are severely degraded.

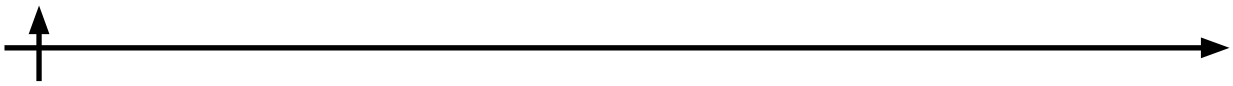
The UN Synthesis Report on Water Resources for SDG 6 (Synthesis report on SDG 6, 2018) emphasizes that over the last 40 years, populations of freshwater species have declined by 80%, more than twice the rate observed for species on land and in the oceans. At the same time, the world has lost 70% of its natural wetlands in the last 100 years, including a significant loss of freshwater species, while artificial water bodies such as reservoirs, dams and rice paddies are increasing in most regions of the world. Compounding the decline in wetlands is the fact that an estimated 80% of wastewater worldwide is discharged directly into water bodies without treatment, with serious consequences for freshwater ecosystems and human health.

SDG Target 6.6 directly addresses the protection and restoration of water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes. One global indicator, Indicator 6.6.1, change in extent of water-related ecosystems over time, is used to monitor progress towards SDG 6.6 to provide countries with the data they need to take action. This indicator aims to monitor four main categories of ecosystems: vegetated wetlands (including marshes, swamp forests, wetlands, rice paddies, peatlands and mangroves), open water bodies (such as lakes and reservoirs), rivers and estuaries, and groundwater, while four sub-indicators (spatial extent, water quantity, water quality and ecosystem health) describe different aspects of these ecosystems (UNEP, 2017). As freshwater ecosystems are complex, dynamic and diverse, it is important to know and consider their main characteristics, dynamics and drivers of change in practicing the sustainability of such natural sites.

Materials and Methods

To analyze pressures on freshwater ecosystems, the widely used Driving Forces-Pressures-State-Impacts-Responses (DPSIR) scheme was used, a similar description of which is given in the main body of the paper.

The authors review current methods for quantifying ecosystem services of freshwater ecosystems. A description is given of traditionally price-based approaches that use market data to determine the monetary value of such services. Examples of ecosystem service valuation using the total economic value (TEV) method are discussed in detail and presented.



Results and Discussion

Freshwater ecosystems of the Republic of Kazakhstan

There are three main groups of freshwater ecosystems on the territory of the Republic of Kazakhstan: lotic, lentic and wetlands.

Lotic ecosystems: in total, there are over 178 thousand temporary watercourses and lairs on the territory of the Republic, through which surface runoff passes. About 7 thousand rivers and temporary watercourses are more than 10 km long, 155 rivers are more than 100 km long, 7 rivers are more than 1000 km long.

At present, there is not a single large river in Kazakhstan, the flow of which has not been disturbed to a greater or lesser extent by human economic activity, i.e. all of them belong to disturbed ecosytems.

Lentic ecosystems: Kazakhstan's lakes are very numerous, they number 48262 with a total water surface area of 45002 km2. Small lakes (less than 1 km2) account for 94% in terms of number and 10% in terms of area. The total volume of water in these natural water bodies is 190 km3.

To naturally disturbed ecosytems can be attributed most of the high-mountainous mountain lakes, which, in addition to the pure ultrapreserved water, are the most valuable recreational resource due to the picturesque landscapes.

Wetlands (WBU): Kazakhstan joined the Ramsar Convention on May 2, 2007 and currently has 10 sites declared as wetlands of international importance. In addition, 5 potential WBU's have been identified for inclusion in the Ramsar List within the territory of the Republic of Kazakhstan. All Ramsar wetlands in Kazakhstan, in accordance with current national legislation, are fully or partially covered by specially protected natural areas (SPAs).

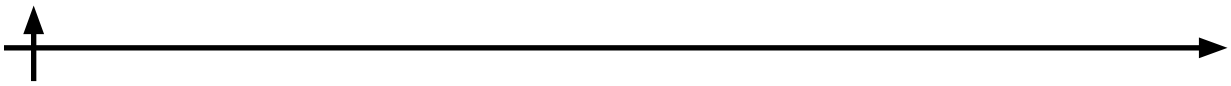
Pressure on freshwater ecosystems and its factors

Pressure factors affecting freshwater ecosystems include (Ari, 2018): Aquatic infrastructure (dams and weirs), flow alteration (water abstraction and withdrawal, reservoir operation); aquatic habitat alteration and land use change (urbanization or conversion of land to agricultural production); overexploitation (overfishing or hunting, excessive water abstraction or sand mining); biological water pollution (by invasive biological species); chemical water pollution (agricultural or urban runoff or untreated sewage); thermal water pollution.

The above pressures and their drivers are themselves dynamic and change over time, primarily due to socio-economic evolution and climate change. As already noted, interactions between freshwater ecosystems and human society result in changes in freshwater ecosystems. Such changes can have unfavorable or positive impacts on ecosystems, and thus on the services they provide. Understanding these linkages and the potential direction of change is key to the sustainable management of freshwater ecosystems, including by identifying threats that need to be addressed and potential ways to change their state.

A benchmark framework for such analysis is the Drivers-Pressures-State-Impacts-Responses (DPSIR) framework. This framework is a causal structure to describe the interaction between society and the environment and is used to assess and manage environmental problems (Global Water Partnership for Central Asia and Caucasus, 2006).

Driving factors are the main causes of environmental change that are external to the system or region under consideration, such as climatic and socio-economic changes; regional, country and international policies. They reflect past, present or future conditions that cause changes in ecosystems. Pressure is a variable that quantifies the influence of driving factors in a system or region, such as temperature, precipitation, land cover, regional population, per capita water demand, crop prices or gross margins, and is typically estimated through the development of



regional quantitative change scenarios.

State variables represent the sensitivity of the system (industry) to pressure variables. This includes identifying and quantifying all elements relevant to the provision of ecosystem functions by biological organisms and human demand for ecosystem services. States are made up of variables that describe the entire social-ecological system, including indicators of ecosystem service recipients and indicators of ecosystem service providers. Impact is a measure of whether changes in state variables have negative or positive effects on individuals, society and/or environmental resources. In the flowchart presented, negative or positive impacts are measured in terms of the ability to provide a given service.

Responses through planned policy and management aim to minimize negative impacts (or maximize positive impacts - benefits) by influencing socio-economic pressure variables or directly on state variables. Identifying and understanding the different types of services provided by freshwater ecosystems helps to understand their contribution to sustainable development and to engage stakeholders in their protection and restoration.

Pressures, drivers and patterns of change in freshwater ecosystems in the Republic of Kazakhstan

The general features of the current state of freshwater ecosystems in the estuary zone of rivers in Kazakhstan can be characterized by the example of the Ile River (Mudd, 2009). The total area of the estuary reaches 20 thousand km2, of which the modern estuary occupies about 8 thousand km2, the rest is the ancient estuary with a fan of dry channels – bakanas. At the present stage of development of the Ile River estuary, three main estuary systems are distinguished: Topar, Ili and Zhidelin estuary systems.

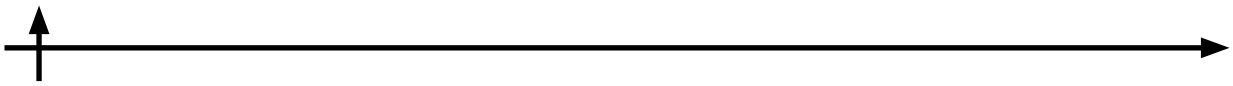
According to the scheme (DPSIR) for the modern Ile River estuary, the following pressures can be identified: climate change, pollution from point and diffuse sources, water intakes and wastewater discharges, hydraulic structures, population of the Balkhash-Alakol water basin, urbanization of the region and others. The main sectoral driving factors include: agriculture (primarily irrigated agriculture), industry, energy, infrastructure development, households, fisheries and tourism.

As a result of this impact, the process of drying up of the Ile River estuary and degradation of its ecosystem is observed: the area of water lands has significantly reduced, the quality of surface and groundwater has deteriorated, the secondary estuary network is dying out and the conditions of habitat and breeding of commercial species, primarily fish and muskrat, have significantly deteriorated (Mikhaylov, 2023). Negative changes are characteristic in general for flora and fauna of the whole territory of the Ile River estuary. Drying of the river estuary leads to soil disturbance, loss of its fertility and deflation, and reduction of biodiversity.

The modern estuary of the Ile River is also characterized by a vigorous process of desertification of its territory. The condition of the estuary ecosystem depends primarily on the flow of the Ile River, which in recent years tends to decrease and is spent mainly on watering the estuary itself, maintaining the level and water-salt balance of Lake Balkhash (Gupta, 2020).

Ecosystem services of freshwater ecosystems

Ecosystem services provided by freshwater systems based on the Millennium Ecosystem Assessment (MA) are defined as the conditions and processes by which natural ecosystems and their constituent species support and sustain human life. The ability of freshwater habitats to produce these services is declining over time and action is needed to improve their condition. All ecosystem services are categorized according to their functions. The following structure has been proposed to describe ecosystem services: provisioning, regulating, cultural and supporting (UN World Water Development Report, 2021). Provisioning ecosystem services are the products that people obtain from ecosystems; regulating ecosystem services are the benefits derived from regulating ecosystem processes; cultural ecosystem services are the cultural, educational and spiritual



benefits that people derive from ecosystems; and supporting ecosystem services are the natural processes required to maintain other ecosystem services. For the Ile River estuary, according to the Millennium Ecosystem Assessment, the following categories of ecosystem services can be identified.

Providing: food (fish, game, rice); fresh water (provision of domestic and agricultural water supply); provision of water to Lake Balkhash; production of fodder for livestock, fuel for the local population; construction materials (reeds); reproduction and conservation of biodiversity. Regulatory: climate regulation (greenhouse gases, temperature, precipitation; atmospheric chemistry); hydrological flow regulation (flow of estuary watercourses, level and volume of estuary lakes, groundwater recharge and discharge); self-purification of estuary water bodies (significant reduction of pollutant concentrations); protection from soil erosion; protection of estuary territory from flooding and others. Cultural: spiritual and inspirational (personal feelings and well-being); cultural and recreational (tourism, amateur fishing, rafting); aesthetic ("Tamgaly Tas", "Singing Dunes", etc.); educational (educational and industrial practices of students, field seminars and conferences). Supporting: water cycle; photosynthesis; soil formation; nutrient cycle.

Assessment (values) of ecosystem services

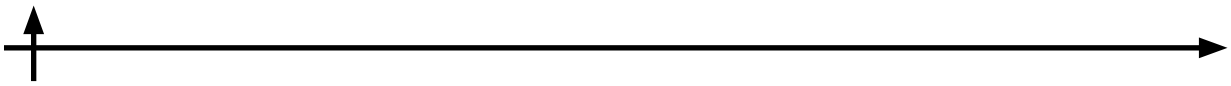
The economic valuation of freshwater ecosystems is a key tool for decision-making, although it is important to keep in mind that their value has many dimensions, including economic, cultural, spiritual and ecological aspects, among others. As emphasized in the UN World Water Development Report 2021 "The Value of Water", recognizing, measuring and expressing the value of water, and incorporating it into decision-making are fundamental to achieving sustainable and equitable water resources management and SDGs (Kent, 2000).

"Value" means different concepts to different user groups and stakeholders, and it is important that in the decision-making process, the different values of water are harmonized and trade-offs between them are resolved and considered in a systematic and comprehensive manner.

Methods for economic assessment of freshwater ecosystem services

Freshwater ecosystems provide many different goods and services to human society. Many of these goods and services, which may be provided by freshwater ecosystems around the world today, are not bought and sold, and therefore do not have readily observable prices. Ecosystem valuation is the process of determining the value (worth) of ecosystem services to one or more stakeholders. Stakeholders often value ecosystem services in different ways. This diversity of valuations is due to different worldviews or different levels of knowledge about nature (Makate, 2018; Ilin et al., 2016).

Depending on the purpose, biological, holistic, cultural and social, health or economic valuation may be required. Economic evaluation always requires some level of social and biological assessments to set the context for decision-making, and in most cases it requires the results of such assessments. Depending on the purpose and research questions, valuations can be purely descriptive, qualitative, quantitative, or reduced to a determination of monetary value, where price is not the same as value. Price is only a part of value and many measures of value are not considered in setting the market price (Mukhamedzhanov, 2020). Available methods for quantifying the value of surface freshwater ecosystems require knowledge of both social and natural sciences. Traditionally, pricing approaches have utilized "real world" market data to determine monetary value. This approach is relatively straightforward for goods and services that are traded in commercial markets (e.g. drinking water or energy supply), but more complex for services



that are not: e.g. landscape quality.

Total Economic Value (TEV) method

This approach includes a use value framework as well as a non-use value framework. Use value includes direct use, indirect use, and the ability to use the resource. Non-use value includes the existence value of the resource and the benefit of the resource to others (Regional Ecological Center of Central Asia, 2011).

$$TEV = UV + NV, \quad (1)$$

where UV is the value of use; NV is the value of non-use.

Direct use value may refer to extracted resources such as fish and aquatic resources, while indirect value may be the provision of services for rearing fish fry, and the ability to use these ecosystem resources for recreational fishing also has a monetary value without actual extraction. The non-use value system addresses the willingness to pay to use an ecosystem as well as to ensure its existence for future generations. Non-use value is usually centered on intangible resources.

In addition to the total economic value method, the following methods are used for the economic valuation of water body services: a comprehensive system of hydrologic-hydraulic and economic models for valuing ecosystem services for flood protection; the market price method; replacement value methods; avoided damage value methods; opportunity cost methods; general analysis methods, and others (Petrov, 2015; Yang, 2015; Huijbregts, 2003)

Examples of ecosystem service assessment

At the global level (Dudgeon, 2006), quantified the global loss of ecosystem services due to land use change and found it to be between US$4.3-20.2 trillion/year. The same study found that environmental services contribute more than twice as much to human well-being as global GDP. Thus, the dynamics of land use change result in enormous losses of environmental services coupled with subsequent increases in the value of existing services.

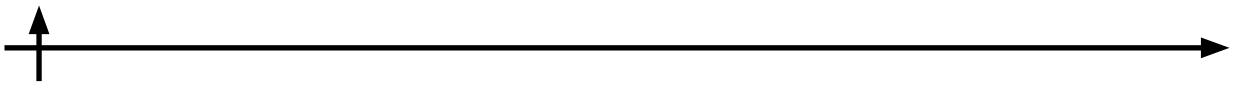
As part of the development of a plan to regulate the flow and catchment of Lake Ohrid, located between Albania and Northern Macedonia, an ecosystem services assessment was conducted in 2017. The value of ecosystem services provided by the lake was estimated at more than 60 million USD for water supply services alone, in addition the value of services of the entire catchment of the lake was estimated. This valuation was a key input to the development of the basin-wide management plan.

Value substitution methods were applied to assess the wastewater treatment services provided by the Nakivubo Swamp wetland, Uganda (Taylor, 2013). Covering an area of 5.5 km2 and a catchment area of over 40 km2, the wetland extends from the central industrial area of Kampala, the capital city of Uganda, passing through densely populated areas before reaching Lake Victoria at Murchison Bay.

The study considered the replacement cost of replacing the wastewater treatment wetland services with artificial technologies. The replacement cost included two components: connecting the Nakivubo Canal with upgraded wastewater treatment facilities that could handle the additional wastewater load, and constructing an above-ground septic tank to treat wastewater from nearby slum areas. According to studies, building the infrastructure necessary to achieve the same level of wastewater treatment that is provided by the wetland requires about $2 million annually to expand the treatment plant.

Conclusion

It should be noted that the assessment of freshwater ecosystem services is an extremely



complex and time-consuming task that involves many uncertainties in its implementation. At present, it is complicated by the fact, as noted above, that the increase in anthropogenic load and climate change significantly changes the nature of ecosystem functioning and their ability to provide those services on which society depends. In the Republic of Kazakhstan, active work is being carried out to study methods and their implementation for assessing freshwater ecosystem services of individual water bodies, but so far at the level of projects and publications on this problem.

Based on the identification of services provided by freshwater ecosystems in Kazakhstan, the assessment of these services can make a significant contribution, first of all, to the protection and restoration of the ecosystems themselves. An assessment of freshwater ecosystem services can help evaluate the potential they contribute to the well-being of our country, facilitate the exchange of stakeholder views on the benefits of ecosystem protection and approaches to ecosystem protection. Such an assessment will contribute to understanding the incentives decision makers face in managing ecosystems and analyzing the consequences of alternative actions.

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Статья поступила в редакцию 21.02.2024; одобрена после рецензирования 01.03.2024; принята к публикации 04.03.2024.

The article was submitted 21.02.2024; approved after reviewing 01.03.2024; accepted for publication 04.03.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 71–80.
Техноэкономика. 2024, Том 3, № 1 (8). С. 71–80.

Scientific article
UDC 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.7

MANAGEMENT OF ATMOSPHERIC AIR QUALITY AT MINING FIELDS BASED ON ESG PRINCIPLES

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Abstract. Mining plays one of the most significant roles in modern economy, which, on the one hand, provides an opportunity for a region to provide additional jobs, develop infrastructure and, as a result, improve the quality of life. However, on the other hand, it poses a threat to the environment. Research in this area is relevant for the development and implementation of effective air quality management strategies. With their help, it becomes possible to create and implement innovative and environmentally sustainable technologies, reduce environmental impact and take measures to improve air quality in mining fields. This article is devoted to the analysis of pollution sources and climatic conditions of the lead-zinc mine area, assessment of the air quality management system in the study area, as well as the role of ESG principles in the air quality management system of "Shalkiya ZincLtd".

Keywords: air quality management, mining, ESG principles, lead-zinc mines, sustainable technologies

Citation: Salnikov V., Kozhagulov S., Rysmagambetova A. Management of atmospheric air quality at mining fields based on ESG principles. Technoeconomics. 2024. 3. 1 (8). 71−80. DOI: https://doi.org/10.57809/2024.3.1.8.7

Научная статья
УДК 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.7

УПРАВЛЕНИЕ КАЧЕСТВОМ АТМОСФЕРНОГО ВОЗДУХА ГОРНОРУДНЫХ МЕСТОРОЖДЕНИЙ НА ОСНОВЕ ПРИНЦИПОВ ESG

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Аннотация. В современном мире невозможно обойтись без добычи полезных ископаемых, с одной стороны дающей возможность какому-либо региону получить дополнительные рабочие места, развить инфраструктуру и в итоге повысить качество жизни, а с другой, представляющей значительную опасность для окружающей среды (ОС). Исследования в этой области являются актуальными для разработки и реализации эффективных стратегий управления качеством атмосферного воздуха. С их помощью становится возможным создать и внедрить инновационные и экологически устойчивые технологии, снизить воздействие на окружающую среду и принять меры к улучшению качества воздуха в горнорудных месторождениях. Данная статья посвящена анализу источников загрязнения и климатических условий района свинцово-цинкового рудника, оценке системы управления качеством атмосферного воздуха в районе исследования, а также роли принципов ESG в системе управления качеством атмосферного воздуха АО «Шалкия ЦинкЛТД».

Ключевые слова: управление качеством воздуха, горнорудные месторождения, ESG принцыпы, свинцово-цинковые рудники, устойчивые технологии

Для цитирования: Сальников В., Кожугалов С., Рысмагамбетова А. Управление качеством атмосферного воздуха горнорудных месторождений на основе принципов ESG // Техноэкономика. 2023. Т. 3, № 1 (8). С. 71–80. DOI: https://doi.org/10.57809/2024.3.1.8.7

Introduction

Ore deposits, including mines and quarries, are a significant source of emissions and air pollution. Ore extraction and processing, including the use of heavy machinery and chemicals, often results in the release of hazardous substances and dust into the atmosphere. This can have a negative impact on the environment, the health of local residents and ecosystems. Therefore, the integration of mining air quality management is required.

Thus, Pb-Zn is widely used in the construction and automotive industries of the world. However, the global assessment of Pb-Zn mineral resources, which has been conducted, clearly reflects the environmental challenges, especially those related to air pollution, facing the lead-zinc (Pb-Zn) ore mining sector. According to operational data from the mining industry, the volume of tailings generated is estimated to be approximately 0.26-2.5 tons for every ton of Pb-Zn ore processed. It is estimated that more than 8100 tailings ponds with a discharge volume of 10 billion m3 are generated worldwide (Chen, 2023).

ESG principles are oriented to a balanced consideration of the environment, social aspects and management. The implementation of these principles in the air quality management of mining deposits can lead to the reduction of harmful emissions, improvement of technologies

used in ore mining, and reduction of negative impact on health and the environment.

Materials and Methods

The problem of air pollution in general is now unprecedentedly urgent due to natural causes, as well as the increasing impact of anthropogenic factors, in particular, the continuing increase in the concentration of carbon dioxide and other greenhouse gases (GHG) in the Earth's atmosphere, which has a direct and indirect impact on humans, the food chain and the environment. Compared to other components of the geosphere, the atmosphere has a number of inherent features: unlimited capacity, high mobility, variability of its constituent components, peculiarity of physical and chemical processes and transformations. Specific features of these transformations are associated with both natural (activity of the Sun, geographical location, climate, seasons and day) and anthropogenic factors (Morozov, 2020).

Atmospheric concentrations of GHGs reflect the balance between emissions from human activities, sources and sinks. The increase in atmospheric GHG levels due to human activities is a major driver of climate change. The ongoing climate change caused by the accumulation of GHGs in the atmosphere lasts from decades to centuries and causes changes in the OS around the world. According to all data collected by WMO, the last eight years could be the warmest on record, fueled by ever-increasing GHG concentrations and accumulated heat. The global average temperature in 2022 was about 1.15 [1.02-1.27] °C above pre-industrial (1850-1900) levels. 2022 was the eighth consecutive year (2015-2022) when annual global temperatures were at least 1 °C above pre-industrial levels (WMO Bulletin on Air Quality and Climate No. 1).

In today's world, global environmental policy has a clear goal to ensure the realization of the Sustainable Development Goals (SDGs), one of the main objectives of which is to preserve, restore and effectively use the components of the natural environment. The study of these problems and the search for ways to solve them within the framework of achieving carbon neutrality, commitments in the Paris Climate Agreement is an urgent task to ensure sustainable development for each country, including Kazakhstan ("adilet").

According to the World Bank experts, air pollution in Kazakhstan is the cause of 10 thousand premature deaths and economic damage of more than 10.5 billion dollars per year. In the rating of countries on combating climate change in 2022, Kazakhstan ranked last among 64 countries as the country with the worst air pollution index (API) (Liter.kz network).

The scientific concept of sustainable development has now been realized in the form of more specific ESG standards (ESG The Report) based on the principles of Environmental Impact Assessment (EIA) (WECOOP). The ESG agenda for the mining sector includes the following issues:

– Environment (Environment): biodiversity, ecosystem services, water management, mine waste/tailings, air, noise, energy, climate change (carbon footprint, greenhouse gases), hazardous substances, mine closure;

– Social: human rights, land use, resettlement, vulnerable people, labor practices, worker/community health and safety, security, miners, mine closure/after-use;

– Governance: legal compliance, ethics, transparency.

In doing so, mining companies need to consider whether there are environmental, social or governance risks that may affect their ability to: raise capital; obtain permits; work with communities, regulators and NGOs; and/or protect their assets from impairment. And then there may be opportunities to: reduce energy and water bills or carbon emissions; improve operational performance; and improve community and regulatory relations (Ruan, 2019).

An important part of implementing an ESG strategy is green mining, which involves using environmentally friendly mining technologies, building environmentally friendly mines, and

shifting from extensive mining to a green, zero-waste mining regime. One of the first countries to put forward the concept of "green mining" is China. At present, China defines a green mine (Shuai, 2022) as a mine that carries out scientific and planned mining in the whole mining process, controls the disturbance of the ecological environment in the mining area and adjacent areas within a controlled range, and realizes an ecological environment, scientific mining methods, efficient resource utilization, digitized management information and a harmonious mining community (Chaulya, 2003; Zaitsev, 2022).

Globally recognized ESG principles presuppose consideration of technical, environmental, social and economic indicators of the designed economic object in interrelation; proposal of several variants of economic activity implementation ensuring fulfillment of environmental requirements; consideration of regional peculiarities of the natural environment condition; consideration of prospects of socio-ecological development of the region and social interests of its population. ESG standards management recommendations are organized in accordance with five key principles:

ESGP 1 – Environmental and Social Governance: create effective leadership and governance on ESG issues.

ESGP 2 – Impact and Risk Management: assess and manage impacts and risks.

ESGP 3 – Permits: obtain and maintain compliance with approvals and permits.

ESGP 4 – Environmental planning: minimizing environmental impacts and long-term liabilities.

ESGP 5 – Social Planning: protecting people and benefiting communities.

In order to improve ESG rating and attract sustainable finance, mining companies create and publish non-financial reporting on sustainable development, corporate social responsibility and GHG regulation.

ShalkiyaZinc LTD JSC plans to implement the project for construction of the processing plant at the Shalkiya lead-zinc mine in compliance with ESG standards based on reduction of environmental impact and implementation of the principles of closed-loop economy. One of the main types of environmental impacts associated with the Shalkiya mine expansion project is the impact of mining operations on air quality.

JSC "ShalkiyaZinc LTD" is an enterprise for mining and processing of lead-zinc ore at the Shalkiya deposit, which is located in the south-east of Kyzylorda, in the north-east 17 km from the town of Zhanakorgan, at 67°25'00 "E east longitude and 44°01'20 "N north latitude (Figure1). According to research company BrookHunt (2006) total zinc reserves of Shalkiya deposit make more than 30% of all reserves of Kazakhstan and is the 5th largest deposit in the world with proven and probable reserves of 6.5 million tons of zinc.

On the territory of JSC "ShalkiyaZinc LTD" there are no pollution monitoring stations of RGP "KKG".

of the natural environment of RGP "Kazgidromet". The nearest settlement, which also bears the name Shalkiya, is located 4 km south of the mine and was built in Soviet times to provide housing for miners' families. Currently, the population of the settlement is approximately 5 thousand people, since the population of the settlement is less than 10 thousand people, according to RD 52.04.186-89, when the population is less than 10 thousand people, background concentrations are assumed to be equal to zero for all pollutants.

Results and Discussion

In industrialized countries, the optimal combination of the amount of atmospheric pollution and the degree of protection from it is the system of atmospheric air quality management in accordance with the EIA principles. The system of atmospheric air quality management is based

on consideration of environmental and economic priorities (Stehlнk, 2018; Represa, 2020). The purpose of atmospheric air quality management is to ensure the fulfillment of norms and requirements limiting the harmful impact of production processes on the environment, ensuring the rational use of natural resources, their recovery and reproduction (Tsyplakova, 2012). The state of atmospheric air in the area of mining operations, affecting the components of the OS, is determined by two factors:

– climatic features of the territory, determining the conditions of dispersion of polluting components;

– ingredient composition, volumes of pollutant emissions and characteristics of sources of harmful emissions.

At the first stage of the study we analyzed the sources of pollution and climatic conditions of the area of the lead-zinc mine, characterized the object as a source of atmospheric air pollution (Kozhagulov, 2023).

The geographical location of the mine determines the magnitude and character of zonal climatic processes. The deposit is located in the southwestern part of the Karatau Range. The relief is weakly hilly with a slope to the southwest with a difference in altitude from 260 to 230 meters.

The Shalkiya mine is located 18 km north of the Zhanakorgan station, Kzylorda region, Republic of Kazakhstan.

region, Republic of Kazakhstan. The mine site is flat with a slight gradient to the west towards the Syrdarya River.

towards the Syr Darya River. The vegetation is mainly steppe grass and low shrubs. Economic use of lands - pastures. Climate of the district is sharply continental. It is characterized by aridity and significant fluctuations of daily and annual temperatures.

– Climatic sub-area IV - G.

– Road-climatic zone - V.

– Region by weight of snow cover - I

– Area by ice wall thickness - II

– District by wind pressure - III.

– The average monthly temperature of the warmest month (July) is 27.8 degrees, the coldest month (February) - 6.1 degrees.

– The prevailing wind direction is NE. Average wind speed in winter is -2.7m/s in July -1.8m/s.

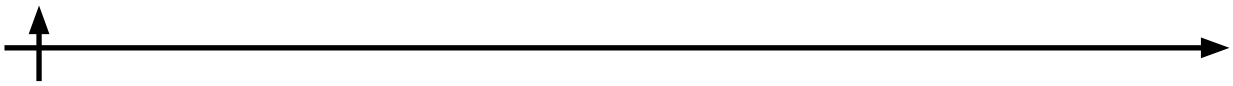
– Average precipitation (total) for April-October - 71mm.

– Average precipitation (total) for November-March-86 mm.

– The thickness of snow cover is 20cm.

The climate of the district is sharply continental with hot, dry, long summer and cold, snowy winter. Continentality of the climate is manifested in large fluctuations of meteorological elements, in their daily and annual course, aridity. Natural-climatic conditions of the territory under consideration, characterized by a significant predominance of evaporation over precipitation, have formed naturally saline lands (Geldyeva, 2004).

The abundance of heat, sunny days, low precipitation, and large amplitudes of air temperature are characteristic. Increased temperatures together with significant reduction and mineralization of precipitation, aeolian processes contribute to aridization, which leads to the process of salinization and desertification of the territory. Due to prevalence of easily dispersed soil, which on desert, semi-desert lands poor in vegetation cover, in the presence of dry and hot weather in most part of the year, favorable conditions are created for formation of increased background of natural atmospheric pollution by dust. The abundance of sunny days and high intensity of



solar radiation create favorable conditions for the formation (in the presence of pollutants) of secondary harmful substances, even more toxic than the initial products, as a result of photochemical reactions - the formation of so-called photochemical smog (Salnikov, 2006).

It is established that in the presence of dry and hot weather in most part of the year, favorable conditions for the formation of an increased background of natural atmospheric pollution by dust are created.

It is established that in the process of the enterprise activity 15 pollutants are emitted into the atmosphere at the present position. Emissions of harmful substances are emitted during mining operations, movement of vehicles and from fuel combustion products. The results of air emissions monitoring for 2021 and 2022 showed the following: air pollutant emissions from stationary sources at the main industrial site of the mine do not exceed the established limits, concentrations of pollutants in the air at the boundary of the sanitary protection zone and in settlements comply with applicable standards. The content of Pb, Zn, Cd in air samples also did not exceed the permissible limits. In the future, during the construction of the enrichment plant their amount will increase to 64 pollutants, the priority ones being suspended solids, sulfur dioxide, carbon monoxide and nitrogen oxides (Unified environmental portal).

It is shown that the totality of climate-forming factors of the mine area, located in the zone with high potential of atmospheric pollution, can create unfavorable conditions for the dispersion of harmful substances. In this regard, it is necessary to conduct system measurements of background atmospheric air concentrations in different seasons of the year for operational forecasting of impurity concentrations.

At the second stage we analyzed the system of atmospheric air quality management, which is an integral part of the environmental policy of the company.

The position of the company JSC "Shalkiya ZincLtd" in relation to its role and obligations in preservation of favorable environment in the territories of facilities location and adjacent territories is formed as its own vision of environmental policy of development and transition of the company to ESG standards, contains necessary elements such as principles, intentions and obligations of the organization in relation to the protection of the environment (Yadav, 2020).

The company sees its mission in the creation of production that intelligently combines primary and secondary material resources, based on advanced technological solutions, adaptive, fair, safe and inclusive model of interaction of all participants of the value chain.

First of all, the enterprise is focused on meeting the requirements set by the legislation of the Republic of Kazakhstan in the field of atmospheric air protection (Ecological Code of the Republic of Kazakhstan).

The requirements imposed by modern environmental legislation of the Republic of Kazakhstan include the organization and maintenance of primary accounting, which is based on the inventory of sources of harmful emissions, development and approval of such important for the enterprise regulatory documents in terms of air protection, such as "Draft standards of maximum permissible emissions (MPE) of pollutants into the atmospheric air". The permit for emission of harmful (polluting) substances into the atmospheric air establishes maximum permissible emissions and other conditions that ensure atmospheric air protection (Chaulya, 2006; Pezzella and Pliushch, 2022). The most important element of the atmospheric air quality management system is regular industrial environmental control. The atmospheric air quality management system at the Shalkiya lead-zinc mine affects a number of important technological and organizational aspects of production activities, including the energy resources and energy efficiency management system and emission treatment methods.

The Environmental Policy of JSC "ShalkiyaZinc LTD" contains necessary elements such as principles, intentions and obligations of the organization in relation to the environment. This

policy declares ensuring compliance of the company's activities with the legislation of the Republic of Kazakhstan, allocation of necessary resources, openness and dialogue with the public, minimization of risks and impacts on the environment, monitoring, etc. The framework for revision of the policy is set. It should be noted the unconditional importance of adopting an environmental policy as the first key step towards the creation of an Environmental Management System.

Conclusion

In accordance with the basic principles of ESG JSC "Shalkiya ZincLtd" has undertaken the following obligations:

– implementation of measures to ensure environmental safety and protection of the environment;

– carrying out preventive measures to prevent pollution and environmental damage;

– elaboration of management decisions based on multi-variant development scenarios and taking into account environmental priorities;

– ensuring minimization of risks of negative environmental impacts at all stages of production activities;

– conducting industrial environmental monitoring;

– ensuring the availability of the Company's environmental information in the field of environmental protection and decisions taken;

– periodic updating of the environmental policy taking into account changing environmental requirements and scientific and technical development.

The main mechanisms of air quality management at the Shalkiya mine include: application of air quality norms and standards; control and regulation of pollutant emissions, through licensing and permitting procedures for the company; application of the best available technologies and production processes; development and implementation of programs to limit the use of fossil fuel-based transportation, in the future it is envisaged to transition to a "digital mine - concentrator", application of the "digital mine - concentrator".

The analysis has shown that the totality of climate-forming factors of the mine area, located in the zone with a high potential of atmospheric pollution, can create unfavorable conditions for the dispersion of harmful substances. In this regard, it is necessary to conduct systematic measurements of background atmospheric air concentrations in different seasons of the year for operational forecasting of impurity concentrations.

The atmospheric air quality management system at the Shalkiya lead-zinc mine affects a number of important technological and organizational aspects of production activities, including the energy resources and energy efficiency management system and emission treatment methods.

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Статья поступила в редакцию 01.03.2024; одобрена после рецензирования 07.03.2024; принята к публикации 07.03.2024.
The article was submitted 01.03.2024; approved after reviewing 05.03.2024; accepted for publication 07.03.2024.

Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 81–90.
Техноэкономика. 2024, Том 3, № 1 (8). С. 81–90.

Scientific article
UDC 330.47
DOI: https://doi.org/10.57809/2024.3.1.8.8

THE INFLUENCE OF THE INSTITUTIONAL FACTOR ON BUSINESS PROCESSES IN THE FIELD OF CONSTRUCTION PRODUCTION

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Abstract. At present, justification and detailed description of business processes of construction production is one of the fundamental steps in the direction of enterprise development. Special attention should be paid to the fact that the main thing in any business process is a person, who is the main actor in the institutional factor. In this regard, this paper aims to identify the key manifestations of human factor in construction business. Regression analysis method, cluster analysis and theoretical research methods were used in the study. As a result of the analysis of economic indicators, it is concluded that construction is characterized by significant flexibility and adaptability to internal and external factors, and the reason for this is a human being, which proves the importance of both formal and informal institutional factors in the construction of business processes.

Keywords: business model, construction, institutional factor, economy, corruption

Citation: Rusanova E. The influence of the institutional factor on business processes in the field of construction production. Technoeconomics. 2024. 3. 1 (8). 81−90. DOI: https://doi.org/10.57809/2024.3.1.8.8

Научная статья
УДК 330.47
DOI: https://doi.org/10.57809/2024.3.1.8.8

ВЛИЯНИЕ ИНСТИТУЦИОНАЛЬНОГО ФАКТОРА НА БИЗНЕС-ПРОЦЕССЫ В СФЕРЕ СТРОИТЕЛЬНОГО ПРОИЗВОДСТВА

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Аннотация. В настоящее время обоснование и подробное описание бизнес-процессов строительного производства является одним из основополагающих шагов в направлении развития предприятий. Особое внимание следует уделить тому, что главное в любом бизнес-процессе – это человек, который является основным действующим лицом в институциональном факторе. В этой связи, данная статья направлена на выявление ключевых проявлений человеческого фактора при ведении строительного бизнеса. В ходе исследования использовались метод регрессионного анализа, кластерного анализа и теоретические методы исследования. В результате анализа экономических показателей, сделан вывод, что строительная сфера отличается особой гибкостью и адаптивностью к внутренним и внешним факторам, и причиной тому – человек, что доказывает важность как формальных, так и неформальных институциональных факторов при построении бизнес-процессов.

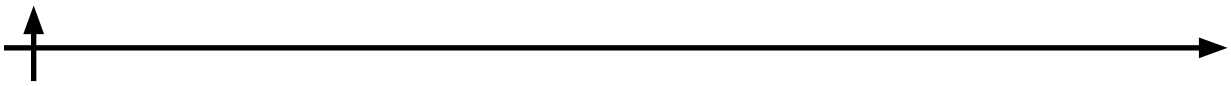
Ключевые слова: бизнес-модель, строительство, институциональный фактор

Для цитирования: Русанова Е. Влияние институционального фактора на бизнес-процессы в сфере строительного производства // Техноэкономика. 2024. Т. 3, № 1 (8). С. 81–90. DOI: https://doi.org/10.57809/2024.3.1.8.8

Introduction

For the economic life of any state, the construction industry is important, setting the pace of development. It is one of the most important sectors of wealth production, and its determining role is to create conditions for the dynamic development of the country and regions. The construction industry is one of the most stable and rapidly developing industries in the Russian economy. In recent years, the number of erected residential buildings in the country has been growing rapidly, each time breaking the previous record, which gives grounds to judge about the high rate of development of the construction sector in Russia. It should be noted that in Russia, the share of construction in GDP in 2022 is 5.2% and is one of the key sectors of the national economy, so this industry, despite its stability, cannot but react to even minor changes in both domestic and foreign markets.

Such an important industry has not been neglected by many researchers. Some authors, such as Vandina O.G. delve into the theory of business processes of construction organizations: classifications, stages, different interpretations of the definition of a business process. The textbook by Kovaleva L.V. describes in detail the preparatory work and its stages, the necessary technical documentation, scheduling of work, which helps to reflect the business model "as is". Practical methods of business process management are described in detail in the scientific work of Mikhin D.Y. "Theoretical bases of business process management at construction enterprises". But in



the age of digitalization it is necessary to understand that theory alone is not enough. For optimization and formation of business processes that correspond to global trends, it is necessary to introduce advanced means and methods of remote and automated control of equipment, which is described by Barinova N.B. in the scientific article "Optimization of construction and business processes through modern hardware and software complexes".

Certainly, business processes of construction production do not exist separately from political and economic factors. Both external and internal. But the so-called "institutional factors" should not be overlooked. According to D. North's definition, institutions are "rules of the game" in society or "man-made" restrictive frameworks that organize relations between people, as well as a system of measures to ensure their implementation. They create a structure of incentives for human interaction, reduce uncertainty, and organize everyday life.

Materials and Methods

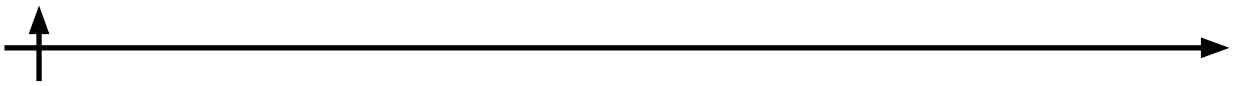
Many scientific articles are devoted to the institutional factor in business processes. For example, V.A. Makushkin writes in his article "Analysis of modern conditions for the development of construction business in Russia" that integration forms of organizations can be counted as an institutional factor, since people unite guided by certain interests and common goals. The importance of institutional approach in crisis conditions is analyzed by D.R. Zainullina in the article "Institutional development of investment and construction complex in crisis conditions". The conclusions obtained in the article can be taken into account when describing the business model "as it should be". About integration processes and reduction of transaction costs due to it (which are considered further in the framework of institutional approach) and increase of profitability and efficiency are considered in the work of Saksina E.V. "System and mechanisms of integration processes management". "System and mechanisms of management of integration processes in the investment and construction complex". Bribes are also transactional costs. Stiva E.B. and Pavlova A.A. write in detail about the negative impact of corruption risks and about mechanisms to counteract corruption in the work "The use of special construction and technical knowledge in the fight against corruption". Also among formal state sources, laws and bylaws are devoted to this topic.

Despite the sufficient number of scientific works that speak about the importance of the institutional approach, it should not be overlooked that a person exists in a system. Including a person is an important component of the socio-economic sphere of any state. In this regard, let us first consider what economic indicators can affect the business processes of the construction sphere. It is on the basis of the conclusions that will be presented based on the results of the analysis of economic factors that the importance of the institutional approach will be justified.

Results and Discussion

To substantiate the influence of certain factors on the modeling of business processes in the construction industry, we will consider statistical data for 2000 - 2022 from the official website of the Federal State Statistics Service. To substantiate the influence of external economic factors on the construction industry of the Russian Federation, we conducted a regression analysis between the following indicators:

1. Investment in fixed capital of construction organizations and the price per barrel of oil. Having conducted regression analysis, we can note that there is a direct linear interdependence between these two indicators. However, if we consider the dynamics of oil prices and the dynamics of changes in the world demand for "black gold", we can conclude that since 2003-2007 the price of oil ceases to reflect the real progressive development of demand and becomes speculative. Since 2000, there have been two sharp drops in oil prices in 2009 and in 2015,



which is most likely related to the global crisis and the situation with the annexation of Crimea, respectively. Due to such market behavior, the construction industry in Russia felt the negative impact. Thus, we can conclude that the construction industry really depends on external economic factors, and, moreover, is directly dependent on the political games of external actors (Komarova, 2020).

2. Price per square meter of housing in the primary market and price per barrel of oil. When conducting regression analysis, we see that the indicator of interdependence "multiple R" is equal to 0.5, which indicates that only in 50% of cases one factor depends on the other. Thus, the price per square meter of housing in the primary market does not always increase with the growth of the cost of a barrel of oil. Nor are the inflation rate and the cost of a barrel of oil (multiple R is 0.23, and the significance of F is 0.5). Thus, we can conclude that these specific indicators always depend on each other, but we should not deny the influence of external factors on the domestic economy of the country.

When considering macroeconomic indicators, we can safely state that the internal situation of the construction industry of the Russian Federation was favorable throughout the XXI century. We can see that the average per capita income and the total number of commissioned dwellings are growing from year to year, at the same time the level of unemployment, dilapidated housing and unfinished construction is decreasing. However, special attention should be paid to the fact that year after year the price per square meter and the population's creditworthiness are growing, while the Central Bank's key rate and inflation are extremely unstable (Shiryaev, 2017).

In the regression analysis we see that there is a pronounced direct correlation between the price per square meter and the number of loans, just as the key rate and the inflation rate are interdependent. In both cases, the multiple R tends to one, and the points on the normal distribution graph lie next to the straight line, which shows the strong interdependence of factors. But it should be noted that dependent at first glance indicators of the inflation rate and the actual cost of a square meter in the regression analysis shows the absence of direct linear interdependence. Consequently, the cost of housing grows not from the inflation rate, the key rate of the Central Bank and not even from such an important foreign economic factor as the price per barrel. Moreover, due to the small sample of data, we can notice through observation, as an empirical way of analyzing data, that in certain years there was a general simultaneous growth or decline of all the indicators under consideration. In order to determine what could be the cause and how business processes of companies from the construction industry reacted to it, we will conduct a cluster analysis (Gumenna-Derij, 2020).

For more accurate values of cluster analysis we will take a number of interdependent intra-economic factors: the cost of a square meter, the population's borrowing, the key rate of the Central Bank, the inflation rate. No less important indicators of economic stability are the unemployment rate and average per capita income, and indicators of the construction sector are unfinished houses and the number of dilapidated housing, so they are also included in the cluster analysis variables.

As a result of the analysis, 4 clusters were identified.

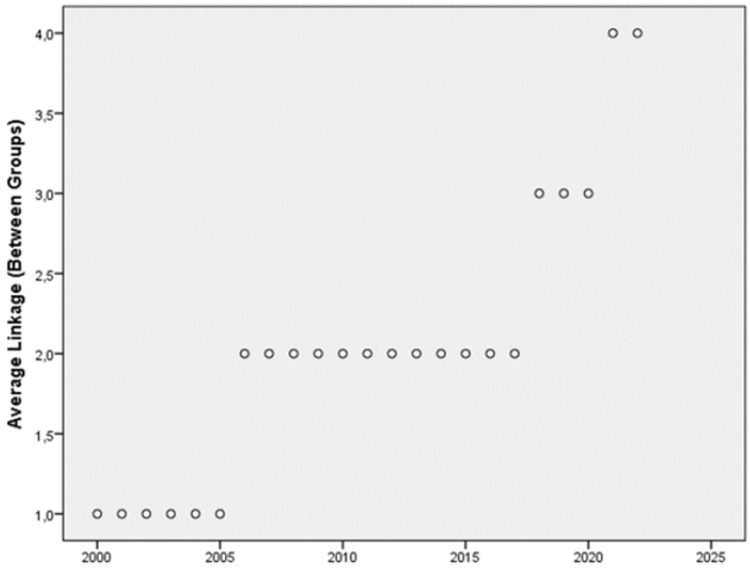


Fig. 1. Scatterplot of the cluster analysis

Overall, we see that the clusters are explained by the following years:

1) 2000 – 2005;
2) 2006 – 2017;
3) 2018 – 2020;
4) 2021 – 2022.

But in general, if we look at the table with the data, due to the small sample, and if we go back to the graphs at the beginning of the study, we can see that these indicators were steadily growing with small fluctuations, so the clustering was based on the average number. But, on the other hand, clustering clearly shows that the second cluster, in fact, took place during the global crisis that began in 2009. Unemployment rose sharply in 2009, but price per square meter, unemployment rate and number of construction in progress fell. Also in 2011, as the crisis continued, the value of price per square meter fell sharply (with the price per meter being almost the lowest during the period of the second cluster. While the cost of a barrel of oil was the highest for all the statistics we tracked). In the following years there was positive dynamics of all indicators without sharp jumps (Pleshkov, 2015).

In general, the correlation analysis only confirmed our conclusions based on the results of the regression analysis. We can see that the clusters are combined in a row by years, because positive dynamics was observed for all indicators for 2000- 2022 (except for 2009-2011, as we wrote above). Having conducted regression analysis, we found that a number of indicators of macroeconomics of the Russian Federation are closely correlated with each other: the inflation rate and the interest rate of the Central Bank, the cost of a square meter and the population's creditworthiness (Lodeishchikov, 2021). However, we should not overlook the fact that the domestic economy is dependent on external political factors: the economy was undermined by the global crisis of 2009 - 2011, unemployment increased sharply due to COVID-19 in 2020, and we also found a direct dependence of investment in construction production on the price per barrel of oil. At the same time, according to the results of the cluster analysis, we noticed that the economy as a whole was stable, which tells us that there are internal regulators that stabilize the business processes of the construction industry and help to quickly and effectively engage in crisis situations. And one of these "regulators" is the human factor and past experience, which

refer to institutional factors (Grushina, 2022; Raevsky, 2022).

The concept of institutionalism appeared in 1918. Institution was defined as "a common way of thinking or acting, imprinted in the habits of groups and customs of the people". Institutions nurture and strengthen private customs and transmit them to new elements of a given group. Customs as institutions in the sense of old institutionalism are stable and inert, they tend to preserve their characteristics and thus "pass them on", from the present to the future and from institution to institution. Institutions fix established procedures, reflect a general agreement, an arrangement that has developed in society. In 1934, institutional economic theory introduced the concept of transaction, which is based on negotiation, acceptance of obligations and their fulfillment. The transactional process was defined in its essence as a process of determining "reasonable value", which ends with a contract that realizes "guarantees of expectations" (Treptow; Topazly, 2020).

In the new institutional economics, which emerged in the 60-70s. In the new institutional economics, which was formed in the 60-70s of the twentieth century, the key concept of institutional economics becomes transaction costs, which consist of the costs of searching and acquiring information, negotiations and decision-making, checking and ensuring their fulfillment. The use of this category allows us to turn to the analysis of contractual relations (North, 1997).

Ultimately, in the newest institutional approach, which emerged in the 90s of the twentieth century, it was determined that institutions are the key to understanding the relationship between society and the economy and the impact of these relationships economic growth (or stagnation and decline). The newer institutional approach incorporates the historical past into its research. This approach separates the analysis of the rules of the game from the strategy of the players. According to D. North's definition, institutions are the "rules of the game" in society or "man-made" restrictive frameworks that organize relations between people, as well as the system of measures that ensure their implementation (Bakalo, 2018). They create a structure of incentives for human interaction, reduce uncertainty, and organize everyday life.

As we have already said, in business processes it is impossible to exist without the human factor, so it is impossible to take institutions, and in particular transaction costs, out of business. Transaction turns out to be an action put by interaction between people. Institutions ensure the extension of the will of an individual person beyond the area within which he can influence the environment directly by his actions, i.e. beyond physical control (Dmitriev, 2022). This extension turns out to be transactional, as opposed to individual action per se (stock) or the exchange of goods. When a transaction is considered, the constraints (e.g. limited resources) or the social background or context in which they (actions) are considered (e.g. pursuit of self-interest) must be explicitly defined.

There are 3 types of transactions: trade transactions, management transactions, and rationing transactions. We are interested in the last type. In a rationing transaction, one party (board of directors, court) determines the rights of the other (heads of departments, plaintiff and defendant). At the same time, there are possible appeals of one party to the other, which outwardly may resemble negotiations: to prove the possibility of appropriation or the need to alienate a good, it is necessary to present sufficient grounds. However, only one party has the exclusive (formally) right to make the final decision. The rationing subject does not necessarily have the ability to determine the actions of the rationed (as it happens in the transaction of management). In contrast to the management transaction the active role in the realization of the rights of freedoms is performed by the claimants for the corresponding share of wealth. In contrast to the trade transaction negotiations are realized in the form of putting forward arguments, petitions, eloquence (Yaskova, 2014).

Transaction costs arise from transactions. Transaction costs are the value of resources spent

on the implementation of transactions (general definition, which is based on the definition of transaction). Transaction costs, reflect the change or reproduction of "legal", and more generally - institutional characteristics. If we imagine the economy as a life support system, then transaction costs can be considered as the costs of exploitation of the economic system. To explain the phenomenon of transaction costs, two points are the most significant: the mismatch of economic interests of interacting agents and the phenomenon of uncertainty (Azarenko, 2010). Thus, the institution of bribes has been historically formed by experience and years to smooth out the corners in case of mismatch of economic views, as well as to incline the decision-making party to its side (Alexeenko, 2018).

Before discussing specific institutions, let us consider what are formal and informal institutions. Formal institutions are embodied in the form of constitutions, laws and institutions in formal and formalized form, the existence and application of informal institutions takes place outside the officially sanctioned channels (Azylkanova, 2022; Biryukova, 2023). Informal institutions, depending on a variety of factors, can play different roles in relation to formal ones - supporting, replacing, competing or even "undermining". Informal institutions can act as an extension of culture and history, but can also proliferate as rules and practices for the benefit of particular groups and actors.

Bribes are an informal institution of transaction costs. Construction is traditionally considered to be one of the most corrupt spheres of activity. The level of its corruption is manifested in the high degree of heterogeneity of costs and results of construction. The arbitrariness of officials, on whose decisions a construction site depends, is legendary, and construction companies that dare to build are considered to be "hotheads" with an off-scale degree of risk (Urmancheeva, 2016). A survey of industry veterans showed that even in the planned-directive economy, the pressure of the state apparatus was very tangible, although the procedures of coordination, norms and rules were stable, seemingly eternal. Traditions of bribery, especially in construction, were so firmly embedded in the practice of investment and construction activities that they became almost a norm. It is no coincidence that Russia ranks 154th out of 200 countries in terms of perception of corruption, sharing it with Tajikistan, Laos, Papua, Kenya and Congo (an index of 2.1 points out of a possible 10) (Construction industry in Russia: development prospects, 2023). According to global surveys of corruption capacity in business, in Russia representatives of more than 30% of companies indicated the presence of corruption. At the same time, construction organizations set aside 15% to 50% of the cost of an investment and construction project for bribes to officials. It is obvious that the breeding ground for corruption, to the same extent as economic crime, is the contradictions between the economic interests of the state, the business environment and the individual (Ablyazov, 2020).

The preconditions for corruption offenses in construction appear at the stage of planning and design. For example, during the registration of title to land plots. At the stages of pre-project works, project implementation and construction works, operation of the capital construction facility, corrupt practices consist in securing victory in tenders of "their" suppliers and contractors, delaying the approval of urban planning documentation and issuance of expert opinions for the purpose of extortion. Corruption risks appear when concluding agreements on connecting capital construction projects to engineering and technical supply networks, and subsequently during construction of the project (Abdullaev, 2021). The practice of refusing to grant a construction permit in the presence of already agreed design documentation is used. Often the period of issuing permits for work in protection zones is intentionally extended due to interdepartmental coordination of such projects. During commissioning, corruption manifests itself in the non-issuance of a permit despite the absence of specific comments. Thus, we can see that bribes run through the entire business process of construction production. Consequently, the

urgent task today is to develop and improve methods of direct and indirect state regulation in construction to reduce the corruption capacity of legislation and all processes and procedures for obtaining construction permits in Russia. And here the formal factors of the institutional approach, which include laws, by-laws, regulations, resolutions, orders, etc., come to the rescue.

Currently in Russia there are 5 federal laws, 20 Decrees of the President of the Russian Federation, 9 Resolutions of the Government of the Russian Federation, as well as 33 orders of the Ministry of Construction of Russia, aimed at combating corruption. According to the Ministry of Construction, every year a plan of measures to counteract corruption in the Russian Federation is developed. But nevertheless, some normative acts on the contrary "played into the hands" of corrupt officials (On the production and use of gross domestic product (GDP), 2022). For example, the fact that 223-FZ does not contain norms, such as the deadline for payment for goods, works and services and an exhaustive list of cases of procurement from a single supplier, which contribute to the growth of procurement efficiency and minimize corruption, contributes to the growth of corruption. Another factor in the growth of corruption capacity in the sphere of public procurement resulted from the amendments to 223-FZ that restrict access to corporate procurement. Since the end of 2017, information on purchases of financial services and services for the use of state and municipal property can no longer be added by customers to the unified information system (UIS) (Federal State Statistics Service, 2023). As a result, in 2018, contracts for RUR 7.5 trillion are missing from the UIS (in 2017 for RUR 3.4 trillion), as according to customers' reports, contracts for RUR 24.2 trillion were concluded, while information for only RUR 16.7 trillion was added to the UIS.

Conclusion

Thus, we see that the construction industry is dependent on both the situation in the external market and internal economic factors, but nevertheless, all indicators are stably dependent on each other, without sharp jumps. The economy is quite plastic and adaptive, but the tools for this were invented by people and it is people who manage the processes that help the economy to adapt to what is happening. It should be understood that you can write any number of business processes of construction production, describing the full cycle, starting from the purchase of materials and ending with the transfer of the finished conditional house, thinking through the movement of documentation and information, but all this can stop working if you introduce a key figure - a person. People can violate the business process, guided by personal interests and business "rules", jump from stage to stage with violations, but knowing about the possibility to pay off. Institutional factors are an integral part of the Russian economy. And the right political course will allow to obtain a developed institutional system of the Russian Federation, forming favorable conditions, on the basis of which sustainable economic development and the construction industry in particular will be ensured.

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Статья поступила в редакцию 14.02.2024; одобрена после рецензирования 26.02.2024; принята к публикации 28.02.2024.

The article was submitted 14.02.2024; approved after reviewing 26.02.2024; accepted for publication 28.02.2024.

Научное издание

Technoeconomics

Том 3, № 1, 2024

Учредитель, издатель – Федеральное государственное автономное образовательное учреждение высшего образования
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