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THEORETICAL FOUNDATIONS OF THE DEVELOPMENT OF THE IRON ORE INDUSTRY IN UKRAINE

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INTRODUCTION

The mining industry take a significant role in the development of Ukraine's economy. Ukraine achieved the status of a leading global producer of iron ore raw materials by February 22, 2022. The country demonstrated a high level of iron ore production, despite challenges and technical complexities.

Ukraine possesses a significant raw iron ore base, including magnetite and oxidized quartzites, which play a crucial role in the mining and metallurgical industry. Technogenic deposits, such as tailing ponds, also contain various materials for further use and enrichment.

This raw material base provides Ukraine with substantial potential for the development of the mining industry and related sectors. However, it is essential to utilize it efficiently and address environmental and technological challenges. Among the key resources, natural-rich iron ores with high metal content, magnetite, and oxidized quartzites stand out, which are utilized in the mining and metallurgical industry.

Technogenic deposits, such as tailing ponds, are a vital part of the raw material base. They contain essential components for further utilization and enrichment. However, it is necessary to maintain a balance between the extraction of valuable minerals and the protection of ecosystems for the sustainable development of the mining industry.

Scientific research and technological advancements are constantly improving, opening up prospects for the further development of iron ore extraction and processing. Investments in the raw material sector and technological advancement will contribute to the successful future of Ukraine's mining and extraction complex.

According to the state geological and subsoil service of Ukraine's report for 2019, the total explored balance reserves of iron ores in the country amount to approximately 20.9 billion tons. this quantity indicates a robust potential in the iron ore base, which is crucial for the development of the mining and metallurgical industry[1].

[1] Офіційний сайт Державної служби геології та надр України: https://www.geo.gov.ua/?s=%D0%91%D0%B0%D0%BB%D0%B0%D0%BD%D1%81%D0%BE%D0%B2%D1%96+%D0%B7%D0%B0%D0%BF%D0%B0%D1%81%D0%B8+%D0%B7%D0%B0%D0%BB%D1%96%D0%B7%D0%BD%D0%BE%D1%97+%D1%80%D1%83%D0%B4%D0%B8, (Accessed 06 October 2023).

The mentioned 20.9 billion tons are categorized differently. Approximately 11 billion tons constitute reserves that are already in active enterprises. This availability of readily exploitable reserves is a valuable resource for meeting iron ore material needs and ensures the stability of the mining and extraction industry. Based on the average iron ore production rate of approximately 170 million tons per year, it is estimated that the available reserves will last for the next 65 years. Additionally, according to the state geological and subsoil service of Ukraine (DNVP "Geoinform Ukraine") data as of the beginning of 2021, the balance reserves of iron ores amounted to 18,065.04 million tons, which represents a significant quantity of iron ore resources with substantial potential for further exploration and extraction[2].

For the sustainable development of Ukraine's mining industry and the maximization of benefits from iron ore resources, it is necessary to actively explore new deposits and modernize extraction mechanisms.

This article analyzes the state of Ukraine's mining and extraction complex, focusing on the Kryvyi Rih iron ore basin. It examines factors influencing the industry's productivity and cost-effectiveness, including government support, legislation, technological modernization, and environmental requirements. The aim is to identify development priorities and propose measures to improve the industry's situation and enhance the competitiveness of Ukraine's mining and extraction complex, taking into account contemporary trends and sustainable development requirements.

1. Methods

This section outlines the primary methods and approaches used to optimize the production capacities of mining and extraction enterprises and ensure the sustainable development of the industry.

2.1. Utilization of Research and Analysis.

Thorough research and analysis of geological, mining, and technical parameters of deposits are essential for the efficient use of mineral resources. They help determine the structure and properties of resources and develop optimal approaches to their extraction and processing.

2.2. Innovation and Technology.

The use of modern technologies and innovative approaches is crucial for optimizing mining processes. New technologies[3], automated equipment, and

[2] Портал даних видобувної галузі України: https://www.eiti.gov.ua/resursi-rozvidka-ta-vidobuvannya/rudi-zaliza/, (Accessed 06 October 2023).

[3] Kateryna Babii, Mykhailo Chetveryk, Volodymyr Perehudov, Kostiantyn Kovalov, Ruslan Kiriia, Viacheslav Pshenychnyi (2022) Features of using equipment for in-pit crushing and conveying technology on the open pit walls with complex structure Mining of Mineral Deposits, Volume 16 (2022), Issue 4, 96-102 https://doi.org/10.33271/mining16.04.096, (Accessed 06 October 2023)

digital systems enhance productivity and efficiency in extraction, reduce environmental impact, and improve safety[4].

2.3. Environmental and Social Responsibility.

Preserving the environment and considering social aspects are key elements of optimizing mining processes. Developing and implementing environmentally friendly technologies, minimizing emissions and environmental impact, and ensuring the safety and well-being of employees are industry priorities.

2.4. Rational Resource Utilization and Strategic Planning.

Sustainable industry development involves the efficient use of available mineral resources and careful strategic planning for their extraction. Research into reserves and the development of growth strategies help ensure the industry's long-term viability and balance extraction with sectoral needs.

2.5. Investments and Partnerships.

Investments in the mining industry drive the adoption of new technologies and methods. Partnerships with scientific institutions, businesses, and international organizations facilitate the exchange of expertise and access to modern resources and knowledge.

2.6. Organizational and Technical Measures.

The implementation of a wide range of organizational and technical measures, supported by the government, is a key factor in successfully managing the mining industry. This approach has allowed for the effective increase in iron ore production and the realization of the country's export potential, even in the face of global financial crises and growing competition.

2.7. Sustainable Development and Exports.

The achieved results enable Ukraine to maintain a stable export potential despite global financial crises and competition. The mining industry in Ukraine remains resilient and capable of holding its positions in the global market.

2.8. Challenges of Modern Mining.

The past two decades have been challenging for the mining industry, driven by both objective and subjective factors. This period has not led to significant industry improvements due to natural limitations and management issues.

2.9. Challenges and Prospects.

The industry faces numerous challenges, such as limited technical development, high costs, and a lack of modernization. These aspects hinder industry growth and erode competitiveness in the international market.

[4] O. Kovrov, K. Babiy, M. Rakishev, A. Kuttybayev (2016) Influence of watering filled-up rock massif on geomechanical stability of the cyclic and progressive technology line Mining of Mineral Deposits Journal homepage Volume 10, Issue 2, pp. 55-63. https://doi.org/10.15407/mining10.02.055, (Accessed 06 October 2023)

These methods and approaches form a crucial foundation for achieving sustainable development in the mining industry and ensuring the efficient utilization of iron ore resources for the needs of the economy and society.

This section emphasizes the importance and challenges of optimizing mining processes, implementing effective technologies, and strategic management to ensure the stable and sustainable development of the iron ore extraction industry.

2. Theoretical part

3.1. Improvement of Strategic Development and Innovative Approaches.

Improving strategic planning and fostering innovation is a crucial task for the state and industry institutions. This will allow attracting investments and promoting the implementation of modern technologies in Ukraine's mining industry. Collaboration with international partners and scientific research can enhance the conditions for the development of the iron ore production sector.

The history of Ukraine's mining industry demonstrates that despite achieving records in iron ore production, it has been challenging to fully restore past performance levels. For example, in 1978, an impressive production volume of 126.4 million tons was reached, but subsequent years brought challenges and obstacles that limited the ability to replicate this success.

Even in 1990, when iron ore production amounted to 104.9 million tons, the industry could not fully restore previous figures. Various factors such as economic crises, changes in global market conditions, productivity losses at old deposits, and a lack of investment altered the prospects for the industry's development.

Active review of strategies and the identification of new development directions, coupled with initiatives for modernization and increased competitiveness, can contribute to the rapid growth of this vital sector of Ukraine's economy and secure its position in the international market.

3.2. Export and Import of Iron Ore: Challenges and Prospects.

In 2021, the industry supplied metallurgical enterprises with iron ore raw materials according to their production needs, and there was no import of iron ore raw materials, indicating the self-sufficiency of the industry[5].

However, it's important to note that iron ore exports decreased by 4.2% in 2021 compared to the previous year, amounting to 44.5 million tons. Still, the monetary value increased by 62.8% to $6.9 billion[6]. Despite exports

[5] Офіційний сайт Об'єднання підприємств «Металургпром»: https://www.ukrmetprom.org/pidsumki-roboti-gmk-ukraini-za-12-misyaci/, (Accessed 06 October 2023).

[6] Офіційний сайт GMK Center: https://gmk.center/ua/news/ukrainskij-gmk-u-2022-roci-eksportuvav-24-mln-t-zaliznoi-(Accessed 06 October 2023).

accounting for half of the production, the ranking of the product remained low in the global market, making the industry vulnerable to market fluctuations.

This vulnerability is evident through the necessity of importing iron ore raw materials into Ukraine for several years, with imports exceeding 7 million tons. This indicates internal issues within the industry and a lack of domestic resources to produce products that meet global standards.

To enhance the competitiveness and resilience of the mining sector in Ukraine, it is essential to increase investments, improve technologies, enhance product quality, and develop the domestic market. This will help reduce dependence on external factors and increase the industry's resilience to changes in the global market, ultimately promoting the development of the Ukrainian mining sector in the future.

3.3. Resource Availability and Geological Conditions: Challenges and Importance.

The stability of the mining industry depends on the availability of sufficient iron ore reserves and the consideration of geological conditions during extraction. Resource availability allows the industry to plan production and ensures high product quality. Geological conditions affect the organization of mining but can create challenges, particularly in terms of safety and costs.

Preserving and replenishing ore reserves are crucial tasks for the industry's stability. Continuous mining leads to the depletion of deposits, so actively searching for new sources is necessary. Reclamation of mining sites, or the restoration of the natural environment after mining, helps preserve the ecological balance and provides opportunities for sustainable and environmentally friendly mining production.

3.4. New Deposits and Challenges of Underground Mining.

The mining industry in Ukraine continually seeks new deposits and implements advanced technologies. This is necessary to support production but presents challenges such as high costs and compliance with environmental standards. Lowering the level of mining operations at depth is a key aspect, as it affects extraction timelines and safety.

An important aspect is the annual decrease in the level of mining operations in open-pit mining, which is approximately 7-9 meters, while in underground operations, this figure increases to 12-16 meters.

Reducing the level of mining operations is essential for ensuring stable extraction and the restoration of natural resources. However, this requires specialized technologies and resources.

The depth of iron ore reserve exploitation through underground methods has indeed reached significant values, namely 1200-1400 meters, compared to the depth of open-pit mining, which is about 350-400 meters. These values

indicate the maximum depth to which iron ore deposits are developed depending on the extraction method.

3.5. Challenges of Deep Mining and Efficient Resource Management.

As mining operations go deeper, mining companies face the challenge of precise and efficient planning. Deep mining also leads to increased costs due to the need for powerful equipment and safety measures.

This situation poses a profitability challenge for companies. Planning and optimizing extraction processes at great depths are key tasks for sustainable development and the rational use of resources.

In some mining and beneficiation complexes, the ratio of iron ore overburden volume to production ranges from 0.3 to 1.5 m^3 per 1 ton of extracted ore. This affects environmental considerations and demands attention to ecology.

During financial crises, companies reduce the volume of overburden removal, which can limit their development and stability. The availability of ready-to-mine ore reserves for companies is a critical factor for sustainable production and efficient management. Balancing stability and financial performance is crucial for the industry's future development.

3.6. Challenges of Reduced Stripping Volumes and Water Resource Management.

From 2014 to 2021, mining companies witnessed a decrease in activity and increased competition, which required restraining the rise in production costs, particularly through reduced stripping volumes.

The overburden-to-ore ratio was 2.1% in 2014, but it increased to 20.8% in 2015, underscoring the challenges in providing the necessary stripping volumes for stable production.

Reduced stripping adversely affects the resource base and the industry's prospects, necessitating strategic measures to preserve stability and efficiency.

The reduction in mining depth is accompanied by water pumping from deep horizons. This increases geological risks, requiring significant expenditures to ensure safe working conditions and rock stability.

3.7. The Importance of Implementing Advanced Technologies and Reconstruction for the Mining Industry.

Ukrainian mining enterprises face significant challenges, such as increasing depths of ore deposit exploitation and dewatering of deep mines. This prompts them to adopt advanced technologies and undertake facility reconstruction.

Modernization and upgrading of enterprises enhance mining efficiency, reduce costs, and improve product quality. This provides enterprises with a competitive edge and supports their stability in the market.

Flexibility in utilizing cutting-edge technologies helps enterprises adapt to changing conditions and market demands. Increasing production capacity is

crucial for the development of the industry and the Ukrainian economy. Support for the reconstruction and modernization of production is essential for ensuring the sustainable development of mining in the country.

3. Results

4.1. Reasons for the Decrease in Iron Ore Production and Product Deliveries.

The decrease in iron ore production and product deliveries in Ukraine can be attributed to the following key reasons:

1. Market oversaturation: iron ore production exceeds demand, leading to stockpiling. Enterprises limit production and deliveries to avoid oversaturating the market.

2. Low competitiveness: domestic products are not always competitive compared to global manufacturers. Enterprises must reduce costs and improve quality to attract customers.

3. Decreasing global prices: Excessive supply of iron ore products leads to falling prices on the world market, affecting profitability and the ability of enterprises to increase production.

4. Political instability and conflicts: political conflicts and military actions limit the supply and transportation of iron ore, negatively impacting the industry.

These factors collectively affect Ukraine’s mining industry, creating challenging conditions for its development and stable operation. Implementing effective strategies and measures can help overcome these challenges and ensure the industry's stable development.

4.2. Challenges and issues in Ukraine’s mining industry.

While possessing vast potential in iron ore resources and the capability for extraction and processing, Ukraine’s mining industry faces several critical problems requiring immediate resolution to ensure stable and efficient development:

1. Low ore quality: the ore exhibits low quality and necessitates additional expenses for enrichment before further use.

2. Increased depth of mining: continuous deepening of operations complicates extraction and raises costs.

3. High energy consumption: the industry demands significant energy resources, which can impact profitability.

4. Equipment renewal: constant replacement and upgrading of production equipment require investments.

5. Environmental concerns: mining operations can harm the environment.

6. Large volumes of waste: increased extraction leads to the accumulation of substantial waste volumes.

7. Rising transportation costs: deeper development increases transportation expenses for raw materials.

8. High costs of technological equipment and energy: rising equipment and energy resource prices create financial pressure.

9. Low innovation level: the absence of innovative solutions limits development opportunities and process optimization.

Addressing these issues is vital to support the effective growth of Ukraine's mining industry and sustain its competitiveness on the global market. Process optimization, innovative solutions, and a balanced approach to addressing these problems can contribute to the industry's sustainable development and minimize negative impacts.

4.3. Challenges of national significance and their impact on Ukraine's mining sector.

The constant negative pressure of national significance also significantly affects Ukraine's mining sector, putting its effective development at risk. Among the main problems arising from this are the following:

1. Lack of strategy and support: insufficient management and the absence of strategic plans complicate the industry's development.

2. Rising fees and tariffs: increased costs for resource use and product transportation can burden the sector.

3. Inadequate regulatory framework: the absence or obsolescence of laws and regulations complicates sector management.

4. Unfavorable investment climate: lack of investment slows down modernization and sector development.

5. Low scientific support: the absence of a proper scientific base hinders innovation and the development of new technologies.

6. Absence of domestic machinery production: dependence on imported machinery and equipment complicates sector development.

7. Global financial crises: changes in global markets can affect commodity prices and lead to economic difficulties in the sector.

Addressing these issues requires a comprehensive approach and active participation from the state, businesses, and the scientific community to create favorable conditions for the sustainable and efficient development of Ukraine's mining sector.

4.4. Adaptation and innovation: key aspects of the development of the mining sector.

Adaptation and innovation are key aspects of the development of Ukraine's mining sector, especially in the face of market uncertainty and competition. The main aspects of this process include:

1. Strategic review: companies must continually analyze their strategy, taking into account changes in the market and the economy. this may involve

shifting to new types of products, entering new markets, or expanding the geographic scope of sales.

2. Technological innovation: it is crucial to implement modern technologies to increase productivity and reduce costs. this may include automation, using data for decision-making, and adopting more efficient methods of ore extraction and processing.

3. Exploring new markets: decreased domestic demand may require exploring new markets for mining products, including export opportunities.

4. Balance and efficiency: companies should strive to balance their expenses and income, reduce losses and costs to maintain stability and profitability.

5. Promoting innovation: allocating financial resources to research and development of new technologies and approaches can support the innovative development of the industry.

6. Collaboration with research institutions: partnering with research institutions and universities can facilitate the development and implementation of new technologies and solutions.

Adaptation and innovation will help the sector maintain competitiveness and ensure sustainable growth, even in the face of challenges and uncertainty.

4.5. Technological upgrade and investments: key aspects of modernizing the mining sector.

Modernization and the adoption of new technologies will make this industry more efficient, competitive, and resilient to future challenges. Here are key points:

1. Investment in research and development: exploring new technologies and innovations can be a significant step toward modernization. This includes funding scientific research and development efforts aimed at improving mining and ore processing processes.

2. Support for initiatives: governmental and legislative support for initiatives aimed at modernizing the mining sector can incentivize investors and companies to implement new technologies.

3. Improved efficiency: the application of modern technologies can increase productivity and reduce production costs. Efficiency is a crucial factor in ensuring competitiveness.

4. Environmental sustainability: new technologies can help reduce the negative impact on the environment, which is an essential consideration in today's market and regulatory requirements.

5. Training and workforce development: developing and training personnel to work with new technologies is also a crucial component of successful modernization.

In general, it is in Ukraine’s best interest, both as a nation and for the mining industry as a whole, to actively pursue technological upgrades and

investments to ensure sustainable development and competitiveness in the global market.

4.6. Prospects and priorities for the development of Ukraine's mining industry.

To ensure sustainable and effective development of Ukraine's mining industry, it is essential to actively address the challenges that put it at a crossroads. This can be achieved through investments in new technologies, scientific research, equipment modernization, and enhancing competitiveness in the global market. Such measures can secure steady and efficient industry growth, preserve its significance for the country's economy, and improve the quality of life for miners.

The priority directions for sustainable and effective long-term development of Ukraine's mining complex, including addressing issues in the Kryvyi Rih iron ore basin, include:

1. Product diversification: in addition to ore enrichment, consider expanding the range of products to include other valuable minerals or higher-value metal production. This can reduce the industry's dependence on fluctuations in the iron ore market.

2. International cooperation: explore opportunities for collaboration with international companies that have experience in modern mining technologies. This can accelerate the adoption of new practices and technologies.

3. Human capital: invest in the training and development of miners and engineers to equip them with the skills required to operate modern equipment and technologies.

4. Safety standards: ensure the highest safety standards for miners and mining processes to prevent accidents and incidents.

5. Green mining initiative: consider launching a green mining initiative that promotes environmentally friendly mining and ore processing practices.

The successful development of the mining industry will have significant implications for Ukraine's economy and social stability. Implementing these measures will help overcome challenges and create conditions for the sustainable and efficient growth of the mining industry in Ukraine, enhancing its competitiveness in the global market.

CONCLUSIONS

The implementation of state support for Ukraine's mining industry to comprehensively address its challenges can be a key factor in ensuring its sustainable and effective development. Introducing the following measures will contribute to resolving pressing issues:

1. State support - a crucial stimulus for the sustainable development of Ukraine's mining sector.

2. The research program for the Kryvyi Rih iron ore basin - a guarantee of safety and stability in extraction.

3. A prospective development strategy - necessary for effective reforms and the industry's sustained growth.

4. Strengthening state regulation - contributes to the fair distribution of resources and income.

5. Joint projects and technical adaptation - enhance resource utilization efficiency.

6. Innovation support - the key to the industry's competitiveness in the global market.

7. Creating a favorable investment climate - ensures the stability and growth of the country's export potential.

These steps share a common goal - the comprehensive resolution of issues in the mining industry, improvement of the resource base, and increased efficiency of resource utilization. It is crucial for government bodies, businesses, and research institutions to collectively direct their efforts towards implementing these measures to achieve the sustainable development of the industry and contribute to the prosperity of the country as a whole.

SUMMARY

The article examines the theoretical foundations of the development of the iron ore complex in Ukraine, with a focus on the Kryvyi Rih iron ore basin. Key issues are identified, such as outdated equipment, insufficient investment, and environmental and social aspects. The author proposes solutions to these problems, including technological improvement, optimization of deposit development, the advancement of scientific research, and attracting investments. The importance of government support for the sustainable development of the industry is discussed, and specific measures are suggested, such as the development of development strategies and programs, ensuring transparent resource allocation, and providing incentives for innovative enterprises. The critical importance of the development of the mining industry for the country's economy and ecology is emphasized. As a result of the research, specific steps are proposed to ensure the sustainable and efficient development of the industry and enhance competitiveness in the international market.

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