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INDUSTRIAL AND INNOVATIVE DEVELOPMENT: CHALLENGES AND PROSPECTS FOR KAZAKHSTAN (analytical review)

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This paper explores the dynamics of industrial and innovative development with a focus on Kazakhstan. It begins by examining the principles guiding industrial and innovative strategies in foreign countries, setting a comparative backdrop. The analysis then shifts to Kazakhstan, detailing the major challenges confronting its manufacturing industry, including structural inefficiencies and market constraints. Further, the paper delves into the complexities and risks within Kazakhstan's oil and gas sector, highlighting both the obstacles and potential growth areas. Finally, it assesses the prospects and threats facing the country's mining and metallurgical complex, offering insights into future trends and strategic recommendations. This comprehensive review provides a nuanced understanding of Kazakhstan's industrial landscape and offers a framework for navigating its evolving economic environment.

Key words: industrial development, innovative strategies, manufacturing challenges, economy growth, risks, prospects.

РАЗВИТИЕ ПРОМЫШЛЕННОСТИ И ИННОВАЦИЙ: ВЫЗОВЫ И ПЕРСПЕКТИВЫ ДЛЯ КАЗАХСТАНА (аналитический обзор)

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В данной статье рассматриваются динамика промышленного и инновационного развития с акцентом на Казахстан. Сначала анализируются принципы, руководствующие промышленными и инновационными стратегиями в зарубежных странах, что создает сравнительный контекст. Затем внимание переключается на Казахстан, где подробно рассматриваются основные проблемы, с которыми сталкивается его производственный сектор, включая структурные неэффективности и рыночные ограничения. В дальнейшем статья исследует сложные вопросы и риски в нефтегазовом секторе Казахстана, подчеркивая как препятствия, так и потенциальные области для роста. Наконец, оцениваются перспективы и угрозы, с которыми сталкивается горнодобывающий и металлургический комплекс страны, предлагаются рекомендации по стратегии и прогнозирование будущих тенденций. Этот всесторонний обзор предоставляет глубокое понимание промышленного ландшафта Казахстана и предлагает основу для навигации в его развивающейся экономической среде.

Ключевые слова: промышленное развитие, инновационные стратегии, проблемы производства, экономический рост, риски, перспективы.

ӨНЕРКӘСІП ЖӘНЕ ИННОВАЦИЯНЫҢ ДАМУЫ: ҚАЗАҚСТАННЫҢ ҚАУІПТІЛЕРІ МЕН БОЛАШАҒЫ (аналитикалық шолу)

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Бұл мақалада Қазақстанға баса назар аудара отырып, өнеркәсіптік және инновациялық даму динамикасы қарастырылады. Алдымен шет елдердегі өнеркәсіптік және инновациялық стратегияларды басқаратын принциптер талданады, бұл салыстырмалы контекст жасайды. Содан кейін назар Қазақстанға ауысады, онда құрылымдық тиімсіздіктер мен нарықтық шектеулерді қоса алғанда, оның өндірістік секторының алдында тұрған негізгі проблемалар егжей-тегжейлі қарастырылады. Одан әрі мақала Қазақстанның мұнай-газ секторындағы күрделі мәселелер мен тәуекелдерді зерттеп, кедергілерді де, өсу үшін әлеуетті салаларды да атап көрсетеді. Ақырында, елдің тау-кен және металлургия кешенінің болашағы мен қауіптері бағаланады, стратегия бойынша ұсыныстар және болашақ тенденцияларды болжау ұсынылады. Бұл жан-жақты шолу Қазақстанның өнеркәсіптік ландшафтын терең түсінуге мүмкіндік береді және оның дамып келе жатқан экономикалық ортасында навигация үшін негіз ұсынады.

Түйін сөздер: Өнеркәсіптік даму, инновациялық стратегиялар, өндіріс проблемалары, экономикалық өсу, тәуекелдер, перспективалар**.**

Introduction. The global landscape of industrial and innovative development is continuously evolving, influenced by varying national strategies and economic conditions. As nations adapt to shifting technological advancements and market demands, understanding these dynamics becomes crucial for assessing their own industrial policies and growth trajectories. This paper provides an in-depth examination of industrial and innovative development principles, contrasting them with the unique challenges and opportunities faced by Kazakhstan.

Beginning with an overview of successful industrial strategies employed by foreign states, the study sets the stage for a comparative analysis. It then shifts focus to Kazakhstan, exploring the significant hurdles encountered by its manufacturing sector, which include structural inefficiencies and competitive pressures. The paper further investigates the complex landscape of Kazakhstan's oil and gas industry, identifying key risks and potential growth avenues. Additionally, it assesses the prospects and existing threats within the mining and metallurgical complex, offering a comprehensive view of the sector's evolving landscape.

By integrating international perspectives with a detailed analysis of Kazakhstan's industrial environment, this paper aims to provide valuable insights for policymakers, industry leaders, and researchers interested in understanding and shaping Kazakhstan's economic future.

Methods. Principles of industrial-innovative development in foreign states. If we look at international experience, we can identify common

principles and approaches for organizing and implementing state policies in industrial-innovative development.

1. System of industrial-innovative development management.

Industrial countries generally have a similar organizational structure for state management of industrial development. The main elements of this structure are:

1) Clear legislative regulation of industrial policy, which allows for centralized and balanced industrial policy throughout the country, systematizes and focuses the process and conditions of state support for industry.

2) A central government body responsible for industrial development policy, related services, and their promotion in international markets (its tasks include formulating industrial-innovative development policy considering the state's strategic priorities, creating a comprehensive system of incentives and support measures for industrial-innovative projects and industrial clusters, conducting trade policy aimed at creating opportunities for expanding existing and new productions).

3) A coordinated system of institutions supporting industrial-innovative development, including industrial development funds or agencies.

4) Large state or national private companies, specifically designated by the state, with powers to attract investments and implement large industrial projects and establish production in new sectors.

5) A unified scientific, technological, and innovation policy, directed by plans, strategies, and programs of sectoral ministries and agencies.

2. Focus on high-value-added exports rather than commodities.

The experience of countries (Ireland, Canada, Vietnam, Botswana, Saudi Arabia, Morocco) that have successfully diversified their economies shows that state support is often complemented by a comprehensive export-oriented industrial policy, focused on high-value-added manufacturing sectors and products, through investments in productivity, human capital, transportation-logistics infrastructure, and technology transfer.

In Ireland, the export growth of manufacturing products between 2010 and 2016 was 174 [1]. This was supported by a state policy focused on business development. For instance, the country has established a favorable tax regime and provides financial assistance for the creation of companies and their entry into international markets.

Another example is Vietnam, where the government has introduced a new economic development model since 2010, involving restructuring of industry and services, with an emphasis on supporting the production of high-tech goods [1]. This led to the formation of a favorable investment regime, significantly increasing foreign direct investment and creating 135 industrial and export zones [1].

Canada has developed a state support system for exporters with key elements including [2]:

- Consulting services for Canadian companies on research and target market selection abroad (export preparation, market potential assessment, network identification, and problem-solving).

- The MY TCS online platform – access to market information and business opportunities.

- The Can Export program – financial support for a wide range of export operations to increase the competitiveness of Canadian companies, providing up to 50 million dollars over 5 years in direct financial support for small and medium-sized exporters, funding companies from any sector, covering 50% of expenses.

- Financial support for business associations to create or expand international cooperation.

- Business Women in International Trade – providing targeted products and services for women entrepreneurs aiming to enter global markets.

Canadian Technology Accelerators – supporting high-growth Canadian companies ready to enter global ICT and clean technology markets [2].

Thus, the key driver for export diversification is the private sector, and states support their enterprises to develop and expand their export

capabilities through increased access to external markets beyond their small domestic economies. In many countries, industrial growth is linked to creating favorable conditions for access to large developed markets (e.g., export subsidies, tax breaks, and easier financing). High-value-added exports stimulate the production of quality goods, work, and services, accelerates economic development, attracts foreign capital into the manufacturing sector, and helps diversify revenue sources in unstable global commodity markets.

3. International cooperation through integration into global value chains.

Global value chains (GVCs) refer to the sequence of operations in which products and services, undergoing various stages of development and processing in different countries due to the global nature of the economy, gain value (from the consumer's perspective).

Almost all countries aim to integrate into global value chains, which enables technology transfer and enhances the country's industrial potential. However, developing countries must adhere to free market rules – offering the best quality at minimal cost [3].

4. Development of value chains through attracting global players in manufacturing sectors.

Transnational companies play a crucial role in global value chains. The acceleration of globalization and the worldwide distribution of available raw materials, cheap labor, and potential markets have led transnational companies to benefit from maintaining geographically separated production facilities, research and development centers, and markets. The primary value is created not in the physical production of goods but in high-tech areas with a concentration of highly qualified labor.

Conversely, concentrating highly qualified specialists, scientific infrastructure, and engineering systems in manufacturing industries allows countries to increase competencies in advancing in the value chain, moving from lower to middle and upper-tier production. The main distinctions of these product categories are the complexity of the produced goods and their dependence on primary raw materials.

Lower-tier products typically use primary raw materials directly, whose prices are often set on commodity exchanges and are fluctuating, leading to variability in production volume and export depending on external conditions. On the other hand, middle and upper-tier products have more stable production and are less dependent on primary raw material prices, as high technology and scientific labor constitute a larger portion of their cost.

Therefore, developing countries focus on creating attractive offers for transnational companies, balanced by the "price/quality" criterion. Key aspects of integrating into global value chains include developing a strong scientific-technological base, building a qualified workforce, effectively using opportunities within international integration associations, developing trade agreements with promising partners, and implementing cluster policies to enhance value chains and competitiveness within the country.

In Kazakhstan, further integration into global value chains is necessary, with an expansion of cooperation with existing and new transnational companies. Developing relationships with transnational companies already operating in Kazakhstan should be based on mutually beneficial cooperation considering Kazakhstan's interests. This will be achieved through expanding the range of produced goods and deepening production to diversify and complicate the country's economy.

It should be noted that several global transnational companies (e.g., Arcelor Mittal, POSCO, LOTTE, Schneider Electric) are currently operating in the country [1]. However, these companies are either working with Kazakh enterprises in lower-tier production, outdated products, or have just begun fruitful cooperation. Therefore, a balanced and planned approach to cooperation with transnational companies is needed to develop and deepen existing cooperation. A notable example of integration into global value chains in Kazakhstan is the limited liability partnership "POSUK Titanium," which produces titanium slabs that are subsequently

supplied to Boeing through the value chain [1].

Attracting new transnational companies should also align with the state's interests in achieving set goals, specifically producing new high-value-added goods and exporting to global markets through the distribution channels of transnational partners.

5. Implementing tools for attracting global players to integrate into global value chains.

One of the primary tasks for attracting foreign investors should be focusing on global leaders in manufacturing industries that have their distribution channels in the global value chain.

Investment planning and integration into global value chains will include implementing a unified map of priority goods and services. This tool involves identifying a list of the most promising goods/product groups for localization within the country, considering workforce, technological, and raw material availability, as well as export markets.

This list of goods addresses both state and business interests. From the state's perspective, priority goods will focus on expanding product range, diversification, and complexity of production. For businesses, the list can serve as a guide for creating new productions with growth potential and entry into external markets.

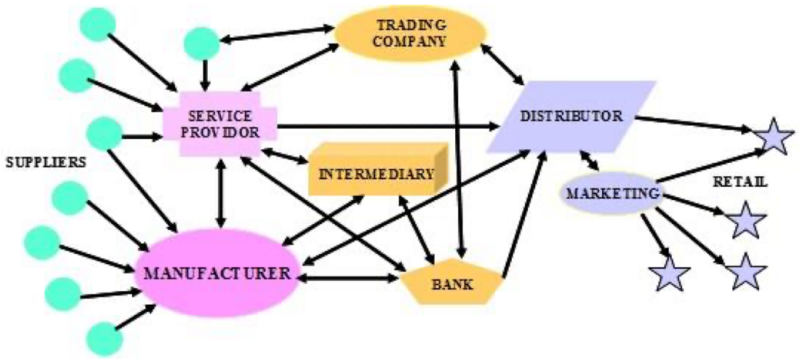

Figure 1 - Global value chains, commodity chains and production networks [3].

6. Development of new production types for value addition in the market and export.

The use of rare and rare-earth metals is crucial in complex industries such as electronics, medicine, and computer manufacturing. The development of finished products from these metals reflects the technological advancement of the industry.

Currently, global demand for rare-earth elements is around 120,000 tons per year [4]. However, the global market for rare-earth metals is almost monopolized by Chinese production. Supply restrictions are negatively impacting other countries' industries. Consequently, major economies actively using rare-earth metals (USA, Russia, Japan, Germany) are planning to reduce their dependency on Chinese supplies. An example of this shift is the agreement between the United States and Australia for joint mining and processing of minerals, including rare-earth metals [5].

Constant technological progress increases global demand for rare-earth metal products. Moreover, upper-tier products, which involve high value addition and technological complexity, are also significant.

Kazakhstan has substantial reserves and prospects for expanding its mineral resource base of rare and rare-earth metals. The republic's production of these metals is carried out at specialized enterprises.

Currently, the industry urgently needs investments, primarily for improving infrastructure in mining regions. With effective use of rare and rare-earth minerals, Kazakhstan can develop modern science and technology sectors and market these metals globally.

Results. Trends and challenges in Kazakhstan's manufacturing industry.

In 2022, the manufacturing sector's output totaled

21.2 trillion tenge. The main contributors to the manufacturing industry are metallurgy (44% of the total sector), food production (19%), machine engineering (15%), construction materials production (6%), and chemical industry (4%) [6].

Manufacturing accounts for 13.4% of the country's GDP. In this regard, Kazakhstan remains a net importer for all categories of goods except metallurgy. The highest net imports are observed in machine engineering (7.6 trillion tenge), the chemical industry (1.4 trillion tenge), and food production (0.9 trillion tenge) [6].

The observed underutilization of production capacities indicates a low level of competitiveness among domestic manufacturers: 70% of manufacturing enterprises have an average annual capacity utilization rate of no more than 70%, and the average annual capacity utilization rate in the machine engineering sector has fluctuated between 25% and 48% in recent years. [6].

Key challenges facing Kazakhstan's manufacturing industry.

1. Low complexity of produced goods.

- Despite overall sector development, the share of raw materials in exports remains at 66%, while the proportion of local manufacturing enterprises engaged in innovative activities is only 14.8%. Consequently, Kazakhstan has a negative economic complexity index (-0.47) and ranks 88th out of 133 countries in this indicator, trailing behind neighboring countries with similar economies (Russia - 53rd place (0.19), Turkey - 40th place (0.61), and Belarus - 29th place (0.91)) [7].

- In Kazakhstan, the depth of processing in raw material sectors is low, with most products being exported as intermediate raw materials. For example, 77% of lead, 87% of aluminum, and 99% of copper are exported in an unprocessed or minimally processed state [8].

- Despite having a raw material base, Kazakhstan has not developed a significant gas or petrochemical sector, and only in 2022 was the first large-scale gas chemical project launched. Raw materials from Tengiz, Kashagan, and Karachaganak contain high levels of fatty gas fractions (ethane, propane, butane) necessary for gas chemical production. Currently, fatty fractions are only extracted from raw materials from the Tengiz field, which supplies polypropylene production (KPI) [8].

Additionally, existing enterprises face raw material unavailability and shortages: the volume of imported raw materials and components for the manufacturing sector exceeds 50%, which increases production costs and creates barriers to establishing high-tech manufacturing. For instance, imports constitute a significant portion of raw materials and components for industrial equipment, vehicles, and agricultural machinery, while the main output in machine engineering comprises simple assembly operations with minimal localization.

- The insufficient level of international technology and standard implementation in production is another factor reducing the economic complexity index. This process requires technological upgrades and substantial investments, which, in turn, affects the competitiveness of domestic products.

2. Wear and low energy efficiency of production.

- The average level of wear is 41%, with higher levels in the production of metal products, beverages, weapons, military equipment, and other machine engineering products exceeding 45% [8].

- Energy costs in Kazakhstan's mining and metallurgical complex are among the highest in the world. With energy intensity at 1.6 tons of oil equivalent per thousand USD, Kazakhstan's products lag significantly behind developing and developed markets, where this figure ranges from 0.2 to 0.9 tons of oil equivalent per thousand USD [8].

Discussion. Problems, risks, and opportunities in Kazakhstan's oil and gas sector. Oil and gas production continues to have a significant impact on Kazakhstan's economy: in 2022, the sector's gross added value (GAV) amounted to 11% of GDP, with the sector's share in total goods exports exceeding 50%, and in net investment inflow – almost 40% [8].

Annually, oil production prospects in Kazakhstan fall short of expectations. According to the

current forecast, considering the modernization of production at major fields, peak production is expected to reach 104 million tons by 2030. Among the existing major fields, the most significant decline in production is anticipated at Kashagan: in 2021, its expected peak production volume was reduced by 40% compared to the 2017 forecast [8].

Additionally, one of the challenges is the depletion of deposits. For instance, according to international experts' forecasts, several major companies within KazMunayGas are expected to see a 15-30% decline in production by 2030. In this context, sustainable reduction in production and the closure of depleting fields are critical both from environmental and social perspectives. Moreover, in the medium term, there is a risk of a shortage of oil raw materials in addition to the expected gas deficit in 2024-2025, as local demand is met by the KazMunayGas fields [8].

International experts note that from 2017 to 2022, the forecast for production at fields in the development and exploration stages also dropped from 65 to 6 million tons [8]. The attractiveness of exploring and developing new fields is limited by the pricing of raw material supplies to the domestic market.

In addition to resource base constraints, the risk of raw material shortages is exacerbated by the rapid growth in fuel consumption in Kazakhstan. Per capita diesel fuel consumption (about 30% of the demand for petroleum products) significantly exceeds that of neighboring countries. Moreover, fuel prices in Kazakhstan are among the lowest in the region and the world, and the creation of common oil, gas, and petroleum product markets within the EAEU in 2025 could lead to a flow of lubricants to neighboring countries, further reducing domestic fuel availability. According to the analytical company IHS Markit, if the current consumption trajectory remains, by 2025, the demand for petroleum products will reach 19 million tons of refined oil and exceed the capacities of oil refineries [8].

There are several opportunities for developing additional supply corridors through the Trans-Caspian and Chinese routes. Current oil transshipment through the Aktau port is 2.2 million tons per year with the port's technical capacity at 7 million tons per year (available volume - 4.8 million tons). The Atasu - Alashankou pipeline handles about 11 million tons per year, including 10 million tons of transit. The technical capacity of this pipeline is approximately 17.5 million tons per year (available volume - 6.5 million tons) [8].

In the gas transportation system, existing constraints mainly concern transportation for domestic consumption. There is significant wear and load on several key infrastructure facilities, such as the Beineu - Bozoy - Shymkent pipeline and underground gas storage facilities.

Prospects and threats for Kazakhstan's mining and metallurgical complex.

Kazakhstan's mining and metallurgical complex (MMC) is one of the key drivers of the country's economic growth: in 2022, the total gross added value (GAV) from metal mining, coal, lignite, and other solid minerals (SMs), as well as the metallurgical industry, reached nearly 10% of the economy, and over 25% in exports.

However, the MMC faces key challenges and opportunities that will determine its future development.

Kazakhstan is experiencing low levels of reserves prepared for development, insufficient replenishment of reserves, a decline in average ore content and increased complexity in processing ore bodies. The availability of prepared copper reserves is 10-12 years; chromite reserves suitable for open-pit mining have been depleted; the availability of proven iron ore reserves suitable for open-pit mining is 20-25 years.

A critical factor affecting the situation is the low activity in geological exploration. The legal reform in the mineral resource sector has drastically changed its regulatory framework, providing more competitive access to subsoil resources.

Currently, only 16% of the country's territory available for exploration has been licensed. In 2022, the unit costs for geological exploration in Kazakhstan were only \$63 per km^2, which is significantly lower than the global average (\$88 per

km^2 for metals) and the figures for leading mining countries such as the USA, Canada, and Australia ($170 - $300 per km^2) [8].

In addition to the insufficient replenishment of existing reserves, the country has significant unrealized potential in the most rapidly growing and promising metals used in modern batteries and electronics: nickel, cobalt, and lithium. Another rapidly growing and unrealized category in Kazakhstan is rare earth metals.

Another challenge for the sector is the rising cost of labor. Since 2000, the average cost per employee in the MMC has increased sevenfold, reaching $1,190 per month. However, wage increases have not been accompanied by a comparable rise in labor productivity in the sector, which remains at a relatively low level: in 2020, labor productivity in Kazakhstan was $62,000 per employee per year, compared to $114,000 in Peru and $160,000 - $200,000 in developed countries (Norway, Australia, Canada, Ireland, Sweden) [8].

Transportation and logistics constraints, such as the distance from key markets, resulting in complex and costly logistics, as well as risks related to the limited export transportation corridors, negatively impact the competitiveness of Kazakhstan's MMC products.

Conclusion. In conclusion, the interplay between industrial and innovative development strategies is pivotal in shaping the economic future of nations. This paper has provided a comparative overview of global industrial practices and analyzed the specific challenges and opportunities faced by Kazakhstan. The examination of Kazakhstan's manufacturing sector reveals critical inefficiencies and competitive constraints that require targeted reforms and strategic investments. Similarly, the analysis of the oil and gas sector highlights both significant risks and promising growth opportunities that must be carefully managed to ensure sustainable development.

The insights into Kazakhstan's mining and metallurgical complex underscore the need for a balanced approach to harness its potential while mitigating associated threats. By integrating international best practices with a thorough understanding of local contexts, Kazakhstan can better navigate its industrial and economic challenges.

Ultimately, the path forward for Kazakhstan involves leveraging its existing strengths, addressing critical vulnerabilities, and adopting innovative strategies to foster long-term growth and stability. This comprehensive analysis serves as a foundational guide for policymakers, industry stakeholders, and researchers dedicated to advancing Kazakhstan's industrial capabilities and economic resilience.

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