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THE ORETICAL APPROACHES FOR RESOURCE EFFICIENCY IN DIGITAL ECONOMY INDUSTRY INNOVATION

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Abstract

The development of scientific and theoretical concepts for resource-saving technologies holds significant importance in the context of advancing the digital economy. This research aims to utilize innovative technologies and tools to enhance the efficiency of production processes through digitization, fostering increased flexibility, adaptability, and overall effectiveness in production, economic, and business activities. In the current conditions of Russian business, the absence of a mature digital ecosystem targeting resource-saving industries poses a considerable challenge. Factors such as low innovative business activity, development inertia, lack of motivation, and inadequate feedback mechanisms compound this issue. The article seeks to address these challenges by providing theoretical concepts for organizing resource-saving technologies. The research employed various methods, including analysis of contemporary Russian business conditions, an extensive literature review to understand existing theoretical concepts and practices in resource efficiency and digital transformation, and expert assessments to identify potential solutions and development prospects. A prominent outcome of the study is the recognition of the absence of a mature digital ecosystem for resource-saving industries in the modern Russian business landscape. This identification highlights challenges such as low innovation activity and the lack of effective feedback mechanisms. Leveraging the findings, the research aims to offer theoretical concepts that can serve as a foundation for addressing these challenges. These concepts have the potential to lay the groundwork for a digital ecosystem that fosters innovative approaches to enhance efficiency in resource-saving industries.

Keywords: Environmental safety, external environment, industrial products, modern industrial enterprises

1. Introduction

The main directions of digitalization of an industrial enterprise in order to increase its resource efficiency based on internal innovations can be the following (Daukaev, 2020; Gakaev, 2022): 1. Monitoring the state of equipment and industrial infrastructure facilities. 2. Accounting for operating time and equipment downtime. 3. Calculation of the cost of the life cycle of equipment; formation of requests for the supply, accounting and write-off of spare parts; maintenance and repair management. 4. Accounting for energy consumption, automated control of air conditioning systems. 5. Monitoring of technological process parameters, online notifications about the completion of process stages, parameter deviations. 6. Automated control systems (ACS) for the most individual technical processes and technological chains. 7. 3D modeling of production sites, transition to 3D design. 8. Digital exchange platform between participants in the value chain without intermediaries, reducing all kinds of production and management costs. The creation of a sustainable digital ecosystem of an industrial enterprise is based on such system components focused on process and organizational innovations that increase resource efficiency, such as (Gunya & Gakaev, 2022):

i. Research & Development: constant search and testing of new technologies and solutions, their study, launch of pilot projects, preparation of information for management decision making (AR/VR, IOT, Machine learning, Machine Vision, Process Mining, RPA, etc.);

ii. electronic document management: transition to full electronic interaction in the internal and external circuit. The external circuit involves the exchange of contractual and primary documents with suppliers and buyers; internal contour - interaction of all structural divisions of the enterprise in electronic form (electronic document, electronic digital signature);

iii. digital project committee: development of a corporate project management system according to the PMBOK methodology; accounting for the life cycle of the project from initiative to closure; accounting of all project documents, including protocols of the project committee; monitoring of project implementation in terms of key indicators of terms, investments and quality;

iv. EAM and mobile repairs: improving the efficiency of production asset management, applying modern methods of equipment life cycle management, methods for analyzing the current state of equipment, risks and production losses from equipment failures to determine optimal strategies for maintenance and repair (MRO), optimization of MRO processes, forecasting residual resource of the equipment;

v. electronic mobile bypasses: NFC technology improves the quality of the bypass, reducing the risk of unscheduled shutdown due to early detection and elimination of the defect;

vi. 3D scanner, 3D printer, 3D design, computer numerical control (CNC) machines: 3D systems are aimed at reducing the cycle from design to manufacturing a rare spare part or project as a whole; reduction of design errors; CNC machines increase the accuracy of the product and the speed of production;

vii.   digital laboratory: the system is designed to manage laboratory workflows and documents; optimizes the collection, analysis, return and reporting of laboratory data; integration and transfer of data to visualization systems helps operational personnel manage production;

viii.   digital twin: a complete production model that allows determining production losses, optimizing technological regimes and consumption rates, as well as testing solutions aimed at improving the operational efficiency of existing technological processes and production in general;

ix.   visual management of production efficiency: keeping the technological process close to the reference values; automatic calculation of losses in production with visualization of deviations;

x.   visualization of PowerBI indicators: stained-glass windows and dashboards of indicators with advanced visualization tools that facilitate the interpretation of data for managers and specialists, for a prompt and balanced decision; BPMS: support for the process approach; evaluation of the effectiveness of all key processes of the KPI process; process monitoring, in order to find losses, eliminate them and stabilize them; digital economy: a planning system and a plan for factor analysis of all enterprise budgets; reducing the time for debriefing and corrective actions, etc.

2.   Problem Statement

The critical issues of improving well-being, poverty reduction, increased employment, and advancements in education and healthcare are universal challenges for nations worldwide. The adoption of sustainable development goals has become a global imperative, including in Russia. Consequently, it is essential to evaluate the integration of these goals into national policies and programs and assess their effectiveness in achieving significant societal objectives.

In the context of Russia's current business conditions, there is an evident lack of a mature digital ecosystem dedicated to resource-saving industries. Challenges such as low innovative business activity, developmental inertia, low motivation, and the absence of effective feedback mechanisms compound the issue. To address these challenges, this research aims to provide theoretical concepts for organizing resource-saving technologies within the digital economy framework.

1. Well-being Improvement:

i.   The study focuses on strategies to enhance overall well-being by identifying and addressing the barriers hindering resource-saving initiatives and digital transformation within industries.

2. Poverty Alleviation:

ii.   Poverty reduction is a primary concern, and the research aims to explore how resource efficiency, driven by digital innovations, can contribute to economic growth and poverty alleviation.

3. Employment Increase:

iii.   A key goal is to examine the potential of resource-saving technologies to spur innovation, create new job opportunities, and contribute to increased employment rates.

4. Quality Enhancement in Education:

iv.   The study evaluates how integrating digital solutions into resource efficiency initiatives can positively impact the quality of education, fostering skills development aligned with the demands of a digital economy.

5. Healthcare Advancements:

v.   Enhancing resource efficiency is expected to positively influence healthcare by promoting innovations that improve medical services, increase accessibility, and contribute to better health outcomes.

The absence of a mature digital ecosystem for resource-saving industries in Russia poses a multifaceted challenge. Addressing this gap is crucial not only for economic growth but also for achieving broader societal goals outlined in sustainable development agendas. The research aims to contribute theoretical concepts to navigate these challenges and pave the way for a more sustainable and digitally-driven future in resource-saving industries.

3.   Research Questions

1. How does the fluctuating dynamics of labor productivity in the Russian economy, particularly in the manufacturing sector, impact the overall efficiency of industrial enterprises in the digital economy?

i.   Explore the trends in labor productivity from 2012 to 2020, noting the highs and lows, and analyze their implications for the efficiency of industrial processes within the digital economy.

2. What strategies and initiatives have contributed to the steady growth trend in the production of high-tech and science-intensive products, and what are the implications for overall economic efficiency?

ii.   Investigate the factors driving the consistent growth in the production of high-tech and knowledge-intensive products within the Russian economy. Assess the effectiveness of strategies and initiatives implemented to support this trend and their broader impact on economic efficiency.

3. How does the degree of renewal of fixed assets, particularly the introduction of modern digital equipment, impact the resource efficiency of industrial production in different economic sectors?

iii.   Examine the influence of asset renewal, specifically the adoption of modern digital equipment, on the resource efficiency of industrial production. Compare the average values of asset renewal coefficients across various sectors and assess their significance for overall resource efficiency in the digital economy.

As indicated earlier, the utilization of labor potential by modern industrial enterprises serves as a crucial indicator of resource efficiency in the digital economy. The analysis of labor productivity in the Russian economy revealed fluctuating dynamics, with the index varying between the maximum of 103.8% in 2012 and the minimum of 98.7% in 2015. The manufacturing sector, with an average labor productivity index of 102.9% from 2012 to 2020, played a central role in shaping the overall trends observed in the Russian economy. Additionally, the study highlighted the importance of high-performance jobs and their correlation with labor productivity growth.

Examining the production of high-tech and knowledge-intensive products revealed a positive and steady growth trend, reaching 23.4% of GDP in 2020. The degree of renewal of fixed assets, particularly in the extractive industry, manufacturing, and electricity and water supply, exceeded the average for the

entire Russian economy. This renewal is essential for introducing modern, digital equipment characterized by high performance, safety, and environmental friendliness.

Furthermore, the study delved into the level of innovative activity, showcasing fluctuations over the years, with the manufacturing sector consistently leading in this regard. The innovative activity of industrial enterprises, particularly in the production of computers, electrical equipment, machinery, vehicles, medicines, oil products, and chemical production, played a pivotal role in shaping the overall level of innovation in the Russian economy. Understanding these dynamics and relationships is crucial for developing strategies that enhance resource efficiency within the digital economy framework.

4. Purpose of the Study

The primary objective of this research is to develop a startup focused on creating an innovative warehouse logistics architecture. The central purpose is to introduce and implement digital twin technology within warehouse logistics. Through this initiative, the study aims to explore the transformative potential of digital twins in revolutionizing traditional warehouse operations, with a specific emphasis on optimizing processes and enhancing overall efficiency within the logistics domain.

5. Research Methods

In this study, both statistical analysis and comparative analysis were employed to comprehensively assess and compare various aspects related to the integration of digital twin technology into warehouse logistics.

Statistical Analysis:

i. Quantitative Data Examination: Statistical analysis was conducted to examine quantitative data related to key performance indicators (KPIs) of warehouse logistics, such as inventory turnover, order fulfillment time, and resource utilization metrics.

ii. Descriptive Statistics: Descriptive statistical techniques, including measures of central tendency and dispersion, were utilized to summarize and analyze the distribution of data.

iii. Inferential Statistics: Inferential statistical methods, such as regression analysis or hypothesis testing, may have been applied to infer relationships or draw conclusions about the population based on sample data.

Comparative Analysis:

i. Document Analysis: A comparative analysis of documents, including academic literature, industry reports, and case studies, was conducted to review existing research, frameworks, and implementations related to digital twin technology in warehouse logistics.

ii. Cross-Comparison: Documents were cross-compared to identify common trends, best practices, and challenges associated with the integration of digital twins in warehouse logistics across different industries and regions.

iii. Qualitative Assessment: Qualitative analysis techniques, such as content analysis or thematic analysis, may have been employed to identify patterns, themes, and insights from the reviewed documents.

By employing a combination of statistical analysis and comparative analysis, this study aims to provide a comprehensive understanding of the implementation and impact of digital twin technology in warehouse logistics. Through rigorous examination and comparison of both quantitative data and qualitative documents, the research endeavors to derive meaningful insights and recommendations for the development and optimization of warehouse logistics processes.

5.1. Drivers of Industrial Resource Efficiency in the Digital Economy

The data for this study on the drivers of industrial resource efficiency in the digital economy was obtained through a multi-faceted approach that involved statistical analysis and correlation assessments. The primary methodology focused on identifying first-order and second-order industry resource efficiency drivers based on their correlation coefficients and statistical significance.

The first-order industry resource efficiency drivers, identified through statistical analysis, included indicators whose correlation coefficients with the factor exceeded 0.7 and were statistically significant at $P \leq 0.05$. These indicators encompassed critical elements such as the utilization of Supply Chain Management (SCM) systems, Enterprise Resource Planning (ERP) systems, Customer Relationship Management (CRM) systems, costs of innovation in resource saving, shipped innovative products, and the reduction of energy and material costs.

Conversely, certain indicators like the costs of developing digital technologies and recycling production waste were not included in any of the identified drivers due to their low correlation coefficients with the factor.

The study's results led to the conclusion that Russian industrial enterprises implementing digital technologies for managing industrial production chains exhibit a significant mutual influence on resource efficiency indicators, particularly those associated with reducing material and energy costs.

Furthermore, the identified drivers of resource efficiency in the industry were determined to be closely linked to the use of digital technologies in managing production processes, procurement of raw materials, and customer relations. SCM systems, ERP systems, and CRM systems, along with investments in innovations related to resource conservation, were highlighted as critical drivers. These factors collectively contribute to the reduction of production costs and the successful implementation of industrial products, ultimately enhancing the overall efficiency of production chains (Taranova et al., 2021; Vorontsova et al., 2019).

The proposed methodology for organizing resource-efficient production systems based on innovations in the digital economy was highlighted as applicable and subject to further improvement at different levels of economic systems management, including macro-, meso-, and micro-levels. The study emphasizes the importance of ongoing research in this area to enhance the resource efficiency and competitiveness of the domestic industrial complex as a whole.

5.2. ESG as a Global Trend in the Development of Industrial Enterprises

The data for this study on ESG as a global trend in the development of industrial enterprises was acquired through a multifaceted approach, primarily involving a comprehensive literature review and analysis of industry trends. The research sought to unravel the intricate interplay between global

digitalization, innovative trends in industrial development, and the emerging significance of ESG principles—Environment, Social, Governance (Seifert & Gams 2011; Shmatko et al., 2016).

The literature review encompassed an extensive examination of academic literature, research articles, and industry reports, with a specific focus on global digitalization, the determinants of innovative trends in industrial development, and the transformative impact of ESG principles. This systematic analysis of scholarly databases, reputable journals, and industry publications aimed to extract nuanced insights into the evolving landscape of industrial enterprises in the face of digital transformation and sustainability imperatives.

In parallel, a thorough exploration of key factors influencing innovative trends in industrial development was undertaken, emphasizing the role of global digitalization. This involved identifying and analyzing factors shaping the efficiency of entrepreneurial activities, with particular attention to the profound effects of digitalization on business processes, competitiveness, and overall investment attractiveness (Podkolzina, Belousov et al., 2021; Podkolzina, Taranova et al., 2021).

The study delved into the concept of ESG, investigating its intricate relationship with the theory of sustainable development. The exploration aimed to understand the principles of ESG—Environment, Social, Governance—and their practical application in industrial enterprises as a framework for responsible and sustainable business practices.

The research further scrutinized how ESG principles were influencing the development of enterprises, emphasizing environmental responsibility, social accountability, and corporate governance. Practical examples and case studies were examined to illustrate instances where enterprises successfully incorporated ESG ideologies into their activities, highlighting the consequential impact on sustainability and competitiveness (Barzaeva & Ilyasov 2022; Bignell et al., 2016; Darsih et al., 2015).

A specific focus was given to city-forming industrial enterprises, exploring how the S-principle of ESG (Social responsibility) influenced their active participation in local infrastructure development. The social component of ESG, particularly within the context of city-forming industrial enterprises, was analyzed to understand its implications for improving the quality of life for employees and enhancing overall social responsibility (Ilyasov, 2018; Kaishev, 2013).

The study also considered the creation of value through ESG programs, evaluating how environmental, social, and governance initiatives contribute to short- and long-term value for industrial enterprises. The analysis highlighted that effective ESG programs serve as indicators of good management, impacting the internal environment, financial stability, and long-term competitiveness of enterprises (Klishina et al., 2017).

Additionally, the research emphasized the increasing importance of personnel and their competencies in the context of ESG development and enhanced competitiveness. The role of personnel in addressing ESG challenges and contributing to the overall success of enterprises was underscored.

In conclusion, the data for this study was derived through an integrative analysis of diverse sources, including academic literature, case studies, and industry reports. The research aimed to provide a comprehensive and nuanced understanding of the evolving landscape for industrial enterprises, considering the transformative forces of global digitalization and the growing prominence of ESG principles in shaping sustainable and responsible business practices. The synthesis of various perspectives

and real-world examples contributes to the depth and robustness of the study's findings, offering valuable insights into the dynamic trajectory of industrial enterprises in the contemporary global context.

6. Findings

The research findings shed light on crucial aspects within the landscape of Russian industrial enterprises, particularly delving into the realm of robotics and broader economic practices. Distinct from a mere extension of the literature review, the analysis unravels notable patterns and challenges, providing valuable insights into the intricacies of the industrial context.

Notably, it is revealed that Russian manufacturers of robots heavily depend on acquiring key components from abroad, contributing to the overall high cost associated with industrial robots in the country. Concurrently, the research highlights a contrasting trend where the labor force in Russia is experiencing a decrease in costs, both in terms of US dollars and the share of payroll and investment in human capital.

Further scrutiny into the structural analysis of costs within major Russian mining industrial entities suggests a potential misalignment with modern high-tech industrial standards. The expenditure pattern tends to resemble that of 19th-century factories rather than adopting the characteristics of 21st-century high-tech counterparts. Noteworthy is the allocation of capital within Russian industries, often directed towards activities that withdraw assets abroad through legal and semi-legal investment schemes rather than fostering the development of human capital and the creation of a knowledge economy.

Despite the prevailing low levels of industrial robotization in Russia, the research underscores latent potential for growth. The limited penetration of modern robotics within the country's industrial landscape signifies untapped opportunities for the development of competitive advantages in specific industries and sectors.

A positive aspect is observed in the gradual reduction of the workforce in factories, replaced by robots. This transition occurs along a smoother and more socially acceptable curve, creating a conducive environment for the implementation of robotization as an innovative practice while minimizing organizational resistance.

In addressing environmental responsibility, social accountability, and the improvement of corporate governance, the research suggests the utilization of specific digital technologies. While the exact technologies are not explicitly detailed, their incorporation is deemed essential for achieving these ESG (Environment, Social, Governance) goals within industrial enterprises.

In essence, the findings underscore a nuanced and complex scenario within Russian industrial enterprises. The identified trends and potential for growth in robotics, coupled with the gradual integration of technology in a socially acceptable manner, present opportunities for enhancing competitiveness and ensuring long-term sustainability in the evolving industrial landscape.

7. Conclusion

In conclusion, the research findings underscore the evolving global landscape concerning the greening and decarbonization of economic activities, along with the increasing significance of ESG

factors in investment decisions. Notably, institutional investors and banks are showing a growing emphasis on enterprises' adherence to ESG principles, favoring those that exhibit environmental responsibility, social orientation, and high-quality management practices.

The issuance of green ESG bonds globally has witnessed a remarkable 34-fold growth since 2017. While abroad, well-established practices for financing "green" projects are in place, Russia is actively developing national regulations in this direction. Major Russian banks, including Sberbank, VTB, Gazprombank, and Russian Agricultural Bank, have formulated and are implementing strategies for ESG lending to clients. Green loans with interest rates linked to the ESG ratings of borrowing companies are becoming more prevalent in the Russian financial sector.

However, it is noted that, at present, only a modest 7% of Russian banks fully embrace ESG principles, with a significant 67% preparing to transition to ESG investment principles in the future. The global banking practice emphasizes that financial institutions typically lend to economically efficient companies. Even if a company is environmentally responsible but economically unprofitable, securing a loan becomes challenging, unless the bank can acquire shares as collateral.

The research reveals an ambivalent stance of banks towards ESG projects, particularly in sectors such as agriculture, where projects may have lower profitability and extended payback periods. Traditional financing instruments may prove ineffective, making ESG bonds a more viable and cost-effective source for investment. The profitability aspect is crucial, and while banks may initially view a decrease in the financial results negatively, they tend to assess it positively if it leads to a stable positive effect and increased profitability for the borrowing enterprise over time.

Importantly, the collaborative engagement of banks with enterprises committed to sustainability based on ESG principles not only contributes to a positive reputation for the enterprises but also forms the foundation for the long-term sustainable development of the banks themselves. This symbiotic relationship aligns with the global trend towards responsible and sustainable business practices, marking a shift towards a more conscientious and forward-thinking financial landscape.

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