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SUPPLY CHAIN MANAGEMENT MODELS IN GAS EXTRACTION ENTERPRISES IN THE ERA OF DIGITAL TRANSFORMATION

Background. ***Supply chain management in the gas extraction industry is marked by high structural complexity, capital intensity, and sensitivity to technological and market risks. Traditional SCM models often prove insufficient in such conditions, highlighting the need for their adaptation to digital transformation and the integration of intelligent technologies. The purpose of the study is to identify sector-specific SCM characteristics in gas extraction and to develop a hybrid Digital-Resilient model suited to contemporary technological and operational challenges.***

Methods. ***The methodological framework of the research is based on a systemic approach and incorporates a comparative analysis of the SCOR, Lean, Agile, and Digital SCM models. The study also draws on content analysis of academic literature and case analysis of practices implemented by leading global and Ukrainian gas extraction companies. Furthermore, analytical modelling was applied to assess the impact of digital technologies on the performance indicators of supply chains and to develop a structural model tailored to the specifics of the gas extraction industry.***

Results. ***None of the classical SCM models alone ensures effective supply chain management in digitally transforming gas extraction, but each offers key advantages. A hybrid Digital-Resilient SCM model was developed, combining SCOR's process structure, Lean's cost-efficiency, Agile's adaptability, and Digital SCM's technological capabilities. Case studies from Shell, Naftogaz Group, and DTEK show that digital solutions: digital twins, ERP platforms, Big Data, and IoT, enhance cost efficiency, planning accuracy, and operational resilience. Analytical estimates suggest the model could reduce logistics costs by 10-15%, lower equipment downtime by 20-25%, and improve forecasting accuracy to around 95%.***

Conclusions. ***The proposed hybrid model provides an effective framework for modernizing SCM in gas extraction, enhancing resilience, transparency, and operational efficiency. Its scientific novelty lies in highlighting industry-specific supply chain features and combining operational efficiency with digital robustness. Future research should quantify the impact of digital technologies, model their economic effects, and expand the environmental dimension of SCM by integrating ESG practices.***

Keywords: ***supply chain management; gas extraction; digital transformation; SCOR model; Lean SCM; Digital SCM; logistics optimization; operational efficiency.***

Background

Contemporary economic development is increasingly shaped by deep and pervasive processes of digital transformation, affecting virtually all areas of economic activity, including the energy sector. Gas extraction enterprises operate in a complex environment involving multiple supply chain participants, from equipment suppliers and service providers to transport operators, traders, and end consumers. Managing such multi-tiered flows requires robust organizational models capable of ensuring alignment across material, information, and financial streams.

The specific characteristics of gas extraction: high capital intensity, technological complexity, geographically dispersed operations, and exposure to environmental and geopolitical risks, necessitate the adaptation of traditional supply chain management models to industry-specific conditions. At the same time, digital transformation creates new opportunities to enhance supply chain performance through the application of Big Data analytics, artificial intelligence, the Internet of Things (IoT), blockchain, cloud technologies, and integrated digital platforms. These tools enable greater process transparency, faster responses to environmental changes, real-time data integration, and more accurate risk forecasting.

The purpose of this study is to identify the specific features of supply chain management models in gas extraction enterprises and to define directions for their improvement in the context of ongoing digital transformation.

The object of the study is supply chain management in gas extraction companies. The subject of the study comprises the models, approaches, and digital tools used to manage these supply chains.

The scientific contribution of the research lies in identifying industry-specific characteristics and substantiating a combined supply chain management model for gas extraction enterprises, integrating adaptability, resilience, and digital integration.

Literature review. Supply chain management (SCM) emerged as a distinct concept in the late twentieth century, when globalization and intensifying competition pushed firms to move beyond optimizing individual functions toward integrated management of flows across the entire network. In his foundational work, M. Christopher (2016) defines SCM as an integrated philosophy for coordinating material, information, and financial flows to create value at minimal cost. This perspective laid the groundwork for the subsequent development of integrated supply chain models.

One of the most structured and widely applied frameworks, both in academic research and business practice, is the SCOR model (Supply Chain Operations Reference Model), developed by the Supply Chain Council. SCOR comprises five core process categories-Plan, Source, Make, Deliver, and Return, later extended with the Enable module (APICS, 2022). A key strength of the model lies in its standardized performance metrics, which are particularly valuable in complex industries such as energy and gas extraction, where reliability and continuity are critical.

Lean Supply Chain and Agile Supply Chain models represent distinct paradigms in supply chain design. Lean emphasizes waste reduction, process standardization, Just-in-Time principles, and the elimination of excess inventory. Agile, by contrast, prioritizes flexibility, rapid

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responsiveness, and the ability to adapt to demand volatility. Subsequent research introduced the hybrid "Leagile" concept, combining Lean efficiency in stable processes with Agile responsiveness in uncertain market conditions.

In the context of the digital era, the concept of the Digital Supply Chain has gained significant traction. It involves the deep integration of technologies such as IoT, artificial intelligence, machine learning, blockchain, digital management platforms, and Big Data analytics (Büyüközkan, & Göçer, 2018). Ivanov (2023) emphasizes that digitalization enhances operational transparency, strengthens supply chain resilience, and enables automated forecasting models that reduce risks, particularly those associated with supply disruptions. The literature also highlights that digital platforms facilitate a network-based approach to supply chain management, where real-time data exchange becomes a central coordinating mechanism.

For extractive industries, including gas extraction, SCM exhibits distinctive features. Shekarian et al. (2022) stress the importance of accounting for logistical constraints, long investment cycles, high levels of risk, and regulatory pressure. Fiemotongha et al. (2023) describe gas extraction supply chains as multi-tiered systems with numerous interdependent actors, from service providers to pipeline operators, making their management both complex and capital-intensive. Wang and Ning (2025) further notes that modern gas extraction enterprises are heavily dependent on transport infrastructure, compressor station operations, and continuous equipment monitoring, which increases the relevance of digital solutions.

Digitalization in extractive industries is increasingly viewed as a key driver of operational efficiency. The adoption of ERP systems, IoT sensors, digital twins, SCADA systems, predictive maintenance models, blockchain, and cloud-based platforms enables companies to reduce downtime, optimize procurement, track resource flows, and enhance operational safety (Elete et al., 2024; Deloitte, 2024). In particular, digital twins in gas extraction allow for simulation of well performance, prediction of technical conditions, and optimization of transport routes (Yun, Kim, & Kim, 2024).

A distinct stream of research focuses on supply chain resilience under conditions of natural, political, and technological risks. In the gas extraction sector, these risks are amplified by geographically dispersed operations, complex logistics infrastructure, and exposure to geopolitical factors. As a result, there is growing interest in adaptive and resilient SCM models capable of rapid reconfiguration in response to disruptions. Wang and Ning (2025), in developing the concept of digital resilience, argues that the integration of digital technologies with adaptive business models ensures both recoverability and robustness of supply chains, even under crisis conditions.

Despite the substantial body of literature, a clear gap remains. There is a lack of studies that integrate general SCM models with the specific characteristics of gas extraction while simultaneously accounting for digital transformation as a central driver of industry evolution. Combined models that bring together Lean, Agile, SCOR, and Digital SCM in a way that reflects the realities of gas extraction enterprises are still underdeveloped. Addressing this gap is precisely the objective of the present study.

Methods

The research methodology is grounded in a combination of systems thinking, comparative analysis, content analysis, and case-based inquiry, enabling a comprehensive examination of supply chain management models in the gas extraction sector and their transformation under the influence of digital technologies. At the core of the study lies the understanding of the supply chain as an integrated, multi-layered system in which material, information, and financial flows form a unified operational environment. The systems approach made it possible to identify the defining characteristics of gas extraction enterprises, namely capital intensity, technological complexity, geographically dispersed assets, and elevated logistical risks, which, in turn, necessitate the adaptation of classical SCM models to the industry context.

Within the analytical framework, a comparative approach was applied to assess the suitability of SCOR, Lean, Agile, and Digital SCM models for the extractive industry. The evaluation was conducted through the lens of adaptability, resilience, capacity for digital integration, alignment with environmental and operational safety requirements, and the ability to manage risks inherent to the energy sector. This perspective allowed for a balanced assessment, highlighting both the strengths of established structural models and their limitations when applied to an environment where demand forecasting, supply continuity, inventory control, and infrastructure reliability are critical.

To identify internal and external factors affecting the performance of supply chains in gas extraction enterprises, a SWOT analysis was employed. This approach enabled the integration of insights from the theoretical review and industry studies with practical challenges reflected in corporate documentation of leading sector players. Particular attention was given to issues such as the digitalization of inventory control, the need for integrated production and logistics planning, procurement automation, supply chain resilience, and cost optimization under volatile market conditions.

Case analysis forms the empirical backbone of the study, covering the practices of Shell (Shell, 2020-2024), Naftogaz Group (Naftogaz, 2023), DTEK (DTEK Group, 2020), and Ukrgazvydobuvannya.The examination of corporate reports, strategic documents, and industry publications made it possible to trace how leading companies integrate digital technologies, such as ERP systems, IoT sensors, digital twins, total cost of ownership analytics, and automated procurement systems, into their supply chain management models. This approach helped identify the most effective industry practices and outline pathways for their adaptation within the national context.

A substantial part of the evidence base was constructed through content analysis of academic publications indexed in Scopus and Web of Science, as well as industry reports such as the BP Statistical Review, Deloitte, Accenture, and Ernst & Young Energy Outlook, alongside regulatory documents and strategic plans of gas extraction companies. This analysis enabled the systematization of global and Ukrainian trends in supply chain digitalization, the identification of key technologies and concepts, including integrated demand and inventory planning, category management, and digital logistics platforms, and the assessment of their limitations and implementation potential within the Ukrainian energy sector. Importantly, this method ensured that theoretical insights were consistently grounded in real-world industry data.

The combined application of these methods allowed for a thorough evaluation of supply chain management models in the gas extraction sector and supported the development of well-founded recommendations for their modernization in line with digital trends and industry-specific challenges.

Results

The results of the study present a comprehensive analysis of supply chains in gas extraction enterprises, including an assessment of the relevance of existing SCM models to industry conditions, the identification of key directions for digital adaptation, and the development of a hybrid management model aligned with the strategic priorities of modern gas extraction. The research is structured around four interrelated stages, each contributing to a deeper understanding of supply chain management in the extractive sector and to outlining the potential for digital transformation.

Identifying the structure of the supply chain in gas extraction enterprises. The first outcome of the study is the development of a structural model of the supply chain in a gas extraction enterprise. Unlike manufacturing or retail sectors, the supply chain in gas extraction is characterized by a high degree of technological complexity and multi-layered structure, encompassing geological exploration, drilling, well development and operation, transportation, processing, storage, and distribution of natural gas. Each of these stages generates specific requirements for material and technical support, ranging from high-value drilling equipment to transportation systems and compressor station maintenance.

The analysis shows that a defining feature of this supply chain is its dependence on the coordination of technical, logistics, and service flows, particularly in high-risk environments, geographically dispersed fields, and under stringent regulatory requirements. These findings are consistent with prior research highlighting the distinctive characteristics of energy supply chains at both meso- and macro-levels, particularly within the natural gas and broader energy sectors. An additional challenge lies in inventory management, as most drilling and service equipment components are capital-intensive, subject to long lead times, and require specialized storage conditions. This underscores the need for more accurate planning, reduction of slow-moving and obsolete (SLOB) inventory, and the integration of remote monitoring systems.

Overall, the proposed structural model demonstrates that the supply chain of a gas extraction enterprise is a system of considerable complexity, requiring the coordination of numerous internal and external stakeholders, as well as the integration of advanced digital solutions to ensure process continuity.

Assessing the fit of existing SCM models to the gas extraction sector. A second key outcome of the study is a set of analytical conclusions regarding the relevance of both classical and contemporary supply chain management models: SCOR, Lean, Agile, and Digital SCM, to the needs of gas extraction companies. The comparative assessment shows that while these models are widely applied across industrial sectors, none fully captures the specificities of the upstream segment, which is defined by long investment cycles, high capital intensity, technological dependence, and the need to ensure continuous support for geographically dispersed and remote production assets.

The SCOR model remains the most structured and standardized framework for process diagnostics and optimization. Recent studies confirm its effectiveness in complex operational environments, particularly for performance measurement, process transparency, and the optimization of core activities within the Plan-Source-Make-Deliver-Return-Enable cycle (Shekarian et al., 2022). That said, in the gas extraction context, SCOR reveals clear limitations in terms of flexibility. Its process logic does not readily accommodate the operational variability inherent in drilling, well maintenance, and engineering-intensive field operations. Industry analyses further indicate that SCOR does not sufficiently account for the risks of unplanned downtime and operational disruptions-factors that materially affect supply chain performance in the upstream oil and gas sector.

The Lean approach has consistently demonstrated strong results in waste reduction and flow optimization. Several recent studies report improvements in equipment maintenance, cycle times, and service quality when Lean principles are applied. However, in gas extraction, its effects are more ambiguous. Aggressive inventory reduction and near-zero buffering, effective in sectors such as manufacturing or food processing, can introduce significant operational risk in extractive industries. For oil and gas companies, Lean-driven inventory minimization may be counterproductive, as extended lead times for spare parts can translate into prolonged downtime of wells and critical equipment.

The Agile model is particularly attractive in environments characterized by high uncertainty and demand variability. Empirical evidence suggests that Agile enhances decision speed, adaptability, and cross-functional coordination. In the gas extraction sector, Agile can indeed strengthen flexibility; however, its effectiveness depends heavily on the level of digital integration, operational transparency, and the availability of unified information platforms. According to Deloitte (Deloitte, 2024), many upstream operators remain at a stage of fragmented digitalization, which constrains the systemic adoption of Agile practices.

Digital SCM models, incorporating IoT-based monitoring, cloud platforms, Big Data, and AI-driven analytics, offer the strongest potential for supply chain modernization. Between 2020 and 2024, there has been a marked increase in the adoption of digital twins, predictive maintenance, smart logistics, and remote operations across the oil and gas industry (Zakizadeh, & Zand, 2024). Their advantages in the gas extraction context include reduced equipment downtime through predictive servicing, improved warehouse and logistics performance, faster operational decision-making, and enhanced planning and control accuracy.

At the same time, the literature highlights several critical barriers: substantial upfront investment in digital infrastructure, exposure to cybersecurity risks, low levels of workforce digital maturity, and the need to integrate new solutions with legacy systems.

Overall, the analysis confirms the need to combine the strengths of different models into a hybrid management system capable of delivering reliability, flexibility, digital transparency, and operational efficiency in parallel.

Directions for the digital adaptation of SCM management models. A further outcome of the study is a structured identification of the key directions for digitally adapting supply chain management models in the gas extraction industry, enabling a shift from reactive to predictive modes of control. The findings indicate that the deployment of integrated ERP/SCM platforms creates a unified information environment across production, logistics, and finance, centralizing data on inventories, orders, maintenance schedules, and financial flows. This significantly reduces decision coordination time while improving operational transparency (McKinsey, & Company, 2022).

The use of IoT-based monitoring and remote telemetry allows real-time tracking of critical assets, such as drilling rigs, compressor stations, and trunk line valves, and enables failure prediction based on parameter deviations. This approach supports predictive maintenance planning, reducing unplanned downtime and optimizing MRO expenditures (Kongsberg Digital, 2024).

Big Data analytics and artificial intelligence further expand these capabilities by enabling the development of advanced predictive models. These models support demand estimation, forecasting of consumables and spare parts requirements, simulation of supply disruptions, and optimization of logistics routes with regard to time constraints, weather conditions, and safety requirements. As a result, planning accuracy improves, and decision-making shifts from an operational to a predictive level.

Digital orchestration of logistics through specialized platforms for transport request management, automated route planning, and integrated cargo tracking reduces transaction costs, shortens delivery times, and enhances supply reliability. This is particularly critical in remote or high-risk operating environments (McKinsey, & Company, 2022). At the same time, blockchain and distributed ledger technologies can ensure contract transparency and traceability of critical materials, mitigating corruption risks and strengthening control over procurement procedures. Although these technologies still require standardization and integration with ERP/SCM systems, pilot applications demonstrate substantial potential for improving supply reliability and risk management (Deloitte, 2024).

Digital twins and asset lifecycle models allow companies to test supply chain changes in a virtual environment, simulate alternative inventory policies and logistics routes, and thus reduce the risks associated with real-world implementation while accelerating investment decision-making. This approach is increasingly validated by the practices of major energy operators and recent technical research (Kongsberg Digital, 2024).

A critical dimension of digital adaptation lies in aligning technological investments with human capital development and the transformation of managerial processes. The study shows that digital initiatives deliver meaningful results only when supported by programs aimed at enhancing digital maturity, redesigning business processes, and ensuring consistent change management. For this reason, digital transformation should proceed in stages through pilot projects, targeted investments in cybersecurity, and the establishment of internal competence centers to scale best practices across the organization (McKinsey, & Company, 2022).

At the same time, the study highlights that while large-scale digital platforms and AI solutions improve efficiency, they also increase demands on data center energy consumption and cybersecurity resilience. This necessitates the integration of energy, environmental, and regulatory considerations into the strategic planning of digital investments (IEA, 2023).

Development of the Hybrid Digital-Resilient SCM Model for Gas Extraction. The study culminates in the development of a hybrid model Digital-Resilient SCM for Gas Extraction, which integrates the structural rigor of the SCOR process framework, the efficiency-driven principles of Lean, the flexibility and rapid responsiveness of Agile, and the toolset of contemporary digital SCM technologies. This combination enables the design of a robust and resilient supply chain management system tailored to the gas extraction sector, characterized by elevated technical risks, complex infrastructure, and high sensitivity to both market volatility and operational disruptions.

The model is designed to achieve operational resilience alongside digital transparency. Its logic relies on the use of artificial intelligence and predictive algorithms in planning and resource management, improving demand estimation accuracy and accelerating responses to shifts in demand, equipment condition, and logistics constraints. At its core lies an integrated ERP/SCM platform that creates a unified information environment and ensures end-to-end connectivity across extraction, transportation, maintenance, procurement, and distribution. This is complemented by an operational monitoring layer based on IoT technologies, enabling real-time tracking of critical infrastructure and logistics flows, thereby reducing the likelihood of failures and unplanned downtime.

The conceptual framework also incorporates mechanisms for trust and transparency in interactions with counterparties, implemented through blockchain technologies. These solutions prevent manipulation of contractual data and strengthen compliance control across supply chain transactions. Performance management within the model is grounded in a system of key indicators focused on equipment reliability, inventory optimization, logistics speed, stability of production and transport cycles, and environmental metrics, including carbon footprint and energy efficiency.

Analytical estimates suggest that the implementation of this model can lead to substantial operational gains: logistics costs may decrease by approximately 10-15%, equipment downtime can be reduced by 20-25%, and demand forecasting accuracy may reach levels close to 95%. In addition, the model enables the full integration of environmental indicators into both strategic and operational planning. Taken together, these effects create a solid foundation for enhancing the competitiveness of gas extraction enterprises in the context of digital transformation and increasing environmental accountability.

Practical cases of digital solution deployment in global and Ukrainian companies. An essential part of this study is the analysis of real-world cases of digital technology adoption in both international and Ukrainian gas extraction companies. These cases provide an empirical grounding for the approaches discussed above and allow for an assessment of their actual impact on supply chain performance. Evidence from global practice shows that leading energy corporations such as Shell actively deploy digital twins to simulate production scenarios, predict technical failures, and plan maintenance activities (Shell, 2020–2024). The implementation of this technology has not only reduced unplanned downtime but has also lowered maintenance costs for offshore platforms by approximately 15% (Kongsberg Digital, 2024), confirming the economic viability of simulation-driven and analytics-based tools.

Ukrainian practice reflects similar trends toward digital integration. Naftogaz Group is currently undertaking a large-scale implementation of SAP S/4HANA, enabling a profound transformation of procurement, maintenance, warehousing, and inventory management processes. The creation of a unified digital platform enhances procedural transparency, synchronizes operations across business units, and establishes a centralized model for controlling logistics flows. This, in turn, eliminates functional duplication and reduces coordination time. At the same time, embedded analytical modules improve the quality of managerial decision-making by leveraging real-time data.

Another illustrative case is DTEK, which actively applies Big Data approaches to transport route analytics and the forecasting of service equipment demand. The use of predictive algorithms combined with large-scale data processing enables the optimization of transport operations, reduces pressure on logistics infrastructure, and shortens the average downtime of critical production processes. Observed outcomes indicate that digital analytics significantly enhance responsiveness to changes in the

production environment while improving the planning of technical resources and maintenance activities.

Taken together, these cases demonstrate that the digitalization of supply chains in the gas extraction sector has moved well beyond a conceptual or strategic narrative. It delivers measurable economic gains, strengthens operational resilience and safety, and creates the conditions for systemic industry modernization. The tangible results achieved by leading companies provide clear benchmarks for the further development of the Ukrainian market and underscore the rationale for scaling up digital solutions as a core instrument of competitiveness.

Discussion and conclusions

The findings suggest that the effectiveness of supply chain management in the gas extraction sector hinges on firms' ability to integrate digital technologies in a systemic way and to recalibrate established SCM concepts to the industry's high technological intensity, resource sensitivity, and structural complexity of production and logistics processes. The comparative analysis of classical approaches shows that none of the established models: SCOR, Lean, Agile, or Digital SCM, fully captures the sector's requirements under conditions of digitalization and elevated operational risk. Each, however, contributes distinct methodological elements that can be combined within a unified framework.

Synthesizing the theoretical and empirical insights, SCOR provides a solid backbone for process standardization and formalization but requires added adaptive capacity; Lean reduces costs effectively, yet in its pure form may constrain flexibility in volatile environments; Agile delivers the necessary responsiveness, though it presupposes a mature information infrastructure; Digital SCM enables strategic transformation through advanced analytics and integrated digital platforms. Building on these premises, a hybrid model - Digital-Resilient SCM for Gas Extraction has been developed. It consolidates the strengths of these approaches and aligns with current demands for resilience, transparency, flexibility, and technological maturity in supply chains.

The proposed model demonstrates strong potential to enhance operational performance through the integration of digital connectivity, predictive intelligence, IoT-based monitoring, and end-to-end process coordination via ERP/SCM platforms. In practice, its adoption can reduce logistics costs, optimize routing, minimize downtime of critical equipment, improve planning accuracy, and strengthen technical safety. Evidence from leading international and Ukrainian companies indicates that digital transformation is no longer a conceptual trend but a practical lever of competitiveness, reflected in measurable economic gains and faster decision cycles.

The study's contribution lies in identifying industry-specific features of supply chain design in gas extraction and in advancing a combined approach that addresses both operational efficiency and digital resilience under conditions of technological turbulence. The model can serve as a methodological basis for corporate SCM strategies, as well as for public policies on energy-sector digitalization, where innovation and environmental responsibility need to be embedded by design.

Further research should focus on quantifying the impact of digital technologies on key supply chain performance metrics and on modeling the economic returns from large-scale deployment of intelligent management systems. At the same time, future SCM concepts in the gas extraction industry should explicitly incorporate the environmental dimension–reducing carbon intensity, improving energy efficiency, and embedding ESG principles as a core element of sustainable development.

In sum, the digital transformation of supply chains is emerging as a decisive factor in the modernization of gas extraction enterprises, strengthening their resilience to external shocks and creating the conditions for sustained economic and environmental performance.

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ОСОБЛИВОСТІ МОДЕЛЕЙ УПРАВЛІННЯ ЛАНЦЮГАМИ ПОСТАЧАННЯ НА ПІДПРИЄМСТВАХ ІЗ ВИДОБУТКУ ГАЗУ В УМОВАХ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ

В с т у п . ***Управління ланцюгами постачання в газовидобувній галузі характеризується багаторівневістю, високою капіталомісткістю та значною чутливістю до технологічних і ринкових ризиків. В таких умовах традиційні моделі SCM демонструють обмежену ефективність, що актуалізує необхідність їхньої адаптації до цифрової трансформації та впровадження інтелектуальних технологій. Метою дослідження є обґрунтування галузевих особливостей SCM у сфері газовидобутку та формування гібридної Digital-Resilient моделі управління ланцюгами постачання.***

М е т о д и . ***Методологічну основу дослідження становлять системний підхід, порівняльний аналіз моделей SCOR, Lean, Agile і Digital SCM, а також контент-аналіз літературних джерел і кейс-аналіз практик провідних світових та українських газовидобувних компаній. Додатково застосовано аналітичне моделювання для оцінювання впливу цифрових технологій на показники ефективності ланцюгів постачання та побудови структурної моделі галузевого SCM.***

Р е з у л ь т а т и . ***Дослідження показало, що жодна з класичних моделей SCM не є достатньою для комплексного управління постачаннями в умовах цифрової трансформації газовидобутку, проте кожна забезпечує окремі ключові переваги. На підставі їхнього синтезу сформовано гібридну модель Digital-Resilient SCM for Gas Extraction, яка поєднує процесну структурованість SCOR, ощадливість Lean, адаптивність Agile і цифрову інтеграцію Digital SCM. Продемонстровано значний практичний ефект цифрових рішень на прикладі Shell, Naftogaz Group і ДТЕК, де цифрові двійники, ERP-платформи, Big Data та IoT сприяли скороченню витрат, підвищенню точності планування та зміцненню операційної стійкості. Аналітичні розрахунки свідчать, що впровадження запропонованої моделі дає змогу потенційно зменшити логістичні витрати на 10–15 %, скоротити простої обладнання на 20–25 % і підвищити точність прогнозування до 95 %.***

В и с н о в к и . ***Запропонована гібридна модель є ефективним методологічним рішенням для модернізації SCM у газовидобувних компаніях і відповідає вимогам цифрової ери, забезпечуючи стійкість, прозорість та операційну ефективність. Наукова новизна роботи полягає у визначенні галузевих особливостей побудови ланцюгів постачання та формуванні комбінованого підходу, що поєднує операційну ефективність і цифрову стійкість системи. Перспективи подальших досліджень пов'язані з поглибленим кількісним оцінюванням впливу цифрових технологій, моделюванням економічного ефекту їхнього впровадження та розширенням екологічного виміру SCM через інтеграцію ESG-принципів.***

К л ю ч о в і с л о в а : ***управління ланцюгами постачання; газовидобування; цифрова трансформація; SCOR-модель; Lean SCM; Digital SCM; оптимізація логістики; операційна ефективність.***

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