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MODERN TRENDS AND CHALLENGES IN THE MANAGEMENT OF INNOVATION PROCESSES AT ENTERPRISES

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СУЧАСНІ ТРЕНДИ І ВИКЛИКИ В УПРАВЛІННІ ІННОВАЦІЙНИМИ ПРОЦЕСАМИ НА ПІДПРИЄМСТВАХ

The article explores current trends in innovation processes at enterprises: from a linear process focused on internal research and development and intellectual property protection to more dynamic, open and collaborative models. In order to conduct this study, the author employed the general scientific methods of cognition. A critical analysis was conducted on scientific articles and analytical information pertaining to the current trends in the development of innovative models. The rise of digital technologies, such as big data, advanced analytics, and cloud computing, has been a pivotal factor in this shift. Data-driven innovation (DDI) employs data to gain insights, predict trends, and make informed decisions, thereby enhancing

efficiency and outcomes. Collaborative models such as “open innovation” and the “triple helix” emphasise the importance of cooperation among businesses, universities, and government institutions. These models encourage the sharing of knowledge and resources, accelerating the development and implementation of innovative solutions by combining diverse perspectives and expertise. The integration of artificial intelligence (AI) into innovation processes represents a further significant shift. AI facilitates research and development, trend prediction, product development, and business process automation. However, it also raises ethical and governance considerations. The management of innovation in the context of economic instability presents a number of challenges, including limited resources, infrastructure gaps, skill shortages, regulatory barriers, and market access issues. Effective strategies to address these challenges include enhancing access to finance, building infrastructure, developing human capital, creating supportive policies, fostering partnerships, and leveraging open innovation. This paper proposes a set of priority directions for innovation activity among Ukrainian enterprises in the context of economic instability. Future research should focus on integrating emerging technologies, promoting sustainable and social innovation, developing metrics to assess innovation impact, exploring global innovation networks, and ensuring inclusive innovation.

Метою статті є дослідження сучасних тенденцій, викликів в управлінні інноваціями та пріоритетних напрямків впровадження інновацій для українських підприємств в умовах економічної нестабільності. З метою проведення даного дослідження було використано загальнонаукові методи пізнання. Проведено критичний аналіз наукових статей та аналітичної інформації, що стосуються сучасних тенденцій у розвитку інноваційних моделей. Автор відзначає перехід від лінійних моделей інновацій, орієнтованих на внутрішні дослідження та розробки й захист інтелектуальної власності, до більш динамічних, відкритих та колаборативних моделей. Ключову роль у цьому відіграло поширення цифрових технологій, таких як великі дані, прогресивна аналітика та хмарні обчислення. Концепція "data-driven

innovation" (DDI) передбачає використання даних для отримання інсайтів, прогнозування тенденцій та прийняття обґрунтованих рішень, що підвищує ефективність та результативність інноваційного процесу. Колаборативні моделі, такі як "відкриті інновації" та "потрійна спіраль", підкреслюють важливість співпраці між бізнесом, науковими установами та урядами. Ці моделі заохочують обмін знаннями та ресурсами, прискорюючи розробку та впровадження інноваційних рішень шляхом поєднання різноманітних перспектив та експертизи. Інтеграція штучного інтелекту (ШІ) в інноваційні процеси сприяє дослідженням та розробкам, прогнозуванню тенденцій, розробці продуктів та автоматизації бізнес-процесів. ШІ продовжує розвиватися, тому його роль у формуванні майбутніх інноваційних моделей, безсумнівно, зростатиме, створюючи як можливості, так і виклики, які вимагатимуть ретельного дослідження. Управління інноваціями в умовах економічної нестабільності пов'язане з низкою викликів, включаючи обмеженість ресурсів, інфраструктурні прогалини, регуляторні бар'єри та проблеми доступу до ринків. Запропоновано пріоритетні напрямки інноваційної діяльності для українських підприємств в умовах економічної нестабільності. На основі даного дослідження було зроблено висновки, що застосування сучасних підходів до управління інноваціями сприятиме сталому розвитку підприємств.

Keywords: *innovation management, innovation processes, digital technologies, artificial intelligence, economic instability, collaborative models, global innovation networks.*

Ключові слова: *управління інноваціями, інноваційні процеси, цифрові технології, штучний інтелект, економічна нестабільність, колаборативні моделі, глобальні інноваційні мережі.* **General statement of the problem.** The nature of innovation management has undergone a significant transformation in recent years, moving away from traditional linear models towards more open, collaborative, and data-driven approaches. In agreement with the opinions of many scientists and Ukrainian entrepreneurs, the main challenges and difficulties faced by

enterprises in the management of innovation processes in the context of economic instability include:

1. The limited availability of resources. Enterprises, particularly startups and small-to-medium businesses, frequently encounter financial constraints and restricted access to capital, impeding their capacity to invest in research and development (R&D) and the implementation of innovative solutions.

2. Infrastructural deficiencies. Inadequate technological infrastructure, such as limited access to high-speed internet and digital tools, can impede the capacity for technological adoption and the development of innovative products and services.

3. Shortage of skilled personnel. A dearth of adequately skilled personnel in the fields of science, technology, engineering, and mathematics (STEM) can constrain the talent pool available to drive innovation within enterprises.

4. Regulatory barriers. Complex regulatory frameworks and the absence of supportive policies for innovation can impede entrepreneurial activities and the implementation of innovative practices.

5. Increasing level of competition. More and more modern enterprises recognize that competitiveness depends not only on the quality of products or services, but also on internal processes and business structure. The introduction of new technologies is becoming critical for creating innovative business models that provide a competitive advantage.

Analysis of recent studies and publications. The management of innovation processes has been a focal point in contemporary research, especially in the context of rapid technological advancements and shifting market dynamics.

Recent studies have underscored a pronounced shift from traditional, linear R&D models to more open and collaborative approaches. This trend is further supported by studies from Loet Leydesdorff (2016) [7] and Marcel Bogers (2018) [4], who examined the effectiveness of open innovation practices across various industries, demonstrating enhanced innovation outcomes through external collaborations.

The proliferation of digital technologies has significantly transformed innovation management. Studies by Jianxi Luo (2021) [8] focused on the role of big

data analytics in driving innovation. These studies showed that enterprises leveraging big data are better equipped to uncover market trends, optimize processes, and develop innovative products and services.

The integration of Artificial Intelligence (AI) into innovation processes has been extensively studied in recent years. Erik Brynjolfsson (2017) [5] highlighted AI's transformative potential in automating routine tasks, enhancing decision-making, and accelerating product development.

The period from 2019 to 2024 has seen significant economic disruptions, prompting research into innovation management under conditions of economic instability. Studies by Tejmur A. Kasumov (2023) [3], Boichenko, K. S., Mietiolkin, V. V. (2023) [1] examined how firms can sustain innovation during economic downturns.

Formulation of the objectives of the article. The objective of this article is to explore the current trends in innovation management that will help businesses to navigate the complexities of the modern innovation ecosystem and take advantage of its opportunities. To propose priority areas of innovation for Ukrainian enterprises in the context of economic instability.

Summary of the main research material. In the contemporary business landscape, innovation is not just a category, rather, it is a strategic imperative for enterprises aiming to thrive in an increasingly competitive and rapidly evolving market. Innovation, fundamentally, is the process of translating ideas into goods or services that create value or for which customers will pay. It is at the heart of economic growth, competitiveness, and the improvement of living standards. However, the nature of innovation management – how businesses and organizations shepherd new ideas to market success – has undergone significant transformations in recent years.

Historically, innovation was often viewed as a linear process, primarily driven by internal research and development (R&D) efforts within large firms. This traditional model emphasized secrecy and the protection of intellectual property to maintain competitive advantages. However, this approach has gradually given way to more dynamic, open, and collaborative models of innovation. These newer

models recognize that valuable ideas and expertise often lie outside organizational boundaries and that leveraging external sources of innovation can significantly enhance creativity, reduce costs, and speed up the innovation process.

A pivotal factor in this shift towards more open and collaborative innovation models is the advent and proliferation of digital technologies. The rise of big data, advanced analytics, cloud computing, and the internet of things (IoT) has enabled organizations to harness vast amounts of data.

The advent of big data, artificial intelligence (AI), and advanced analytics has transformed the landscape of innovation management. Data-driven innovation (DDI) leverages vast amounts of data to uncover insights, predict trends, and make informed decisions, thereby enhancing the innovation process's efficiency and outcomes [8 , 9]. This approach allows enterprises to harness the power of data in understanding customer needs, optimizing operations, and identifying new opportunities for innovation.

Collaborative models of innovation, such as “open Innovation” and the “triple helix” model, emphasize the importance of cooperation among different stakeholders, including businesses, universities, and government institutions [7]. These models advocate for leveraging external and internal ideas and paths to market, fostering an ecosystem where knowledge and resources are shared openly. This collaborative approach accelerates the development and implementation of innovative solutions by combining diverse perspectives, expertise, and capabilities.

Data-driven innovation. The integration of data-driven innovation (DDI) within enterprises is revolutionizing the way organizations conceptualize, develop, and implement innovative solutions. By leveraging vast amounts of data, businesses can now uncover valuable insights, anticipate market trends, and foster a culture of informed decision-making. Enterprises harness the power of data-driven innovation by collecting, analyzing, and interpreting large datasets to inform their innovation strategies [8].

This process involves several key steps:

1. Data collection: enterprises gather data from a variety of sources, including customer interactions, operational processes, and external market trends.

2. Data analysis: advanced analytics and artificial intelligence (AI) tools are employed to sift through the collected data, identifying patterns, correlations, and insights that were not apparent before.

3. Insight application: the insights derived from data analysis are then applied to the innovation process, guiding the development of new products, services, and business models that are closely aligned with market needs and opportunities.

Data-driven innovation allows for a more agile, responsive approach to innovation, enabling enterprises to quickly adapt to changing market dynamics and maintain a competitive edge [9]. The predictive capabilities of DDI also play a crucial role in identifying emerging trends and technologies, ensuring that businesses stay ahead of the curve in their innovation efforts.

While the benefits of data-driven innovation are well documented, the field is still evolving, with many areas ripe for further research. Understanding the future research direction in DDI is crucial for several reasons:

1. Ethical considerations and data privacy: as enterprises increasingly rely on personal and sensitive data, research into ethical considerations and privacy-preserving methods becomes essential to maintaining consumer trust and compliance with regulations.

2. Enhancing analytical tools: the development of more sophisticated analytical tools and algorithms can improve the accuracy and efficiency of data analysis, leading to more impactful innovations.

3. Cross-industry applications: exploring the application of DDI across different industries can uncover unique challenges and opportunities, fostering cross-sectoral innovations and collaborations.

Data-driven innovation represents a paradigm shift in how enterprises approach the innovation process. By effectively harnessing the power of data, businesses can enhance their innovative capabilities.

Nonlinear processes in innovation. The concept of innovation as a nonlinear process fundamentally alters understanding and management of innovation within enterprises. This perspective diverges from traditional, linear models of innovation that often depict a straightforward progression from idea generation to product

development and market introduction. Instead, viewing innovation as a nonlinear process acknowledges the complex, dynamic, and often unpredictable paths that innovation activities can take [6].

1. Feedback loops: nonlinear innovation involves continuous feedback loops where insights gained at later stages of the innovation process can inform and modify earlier stages. This iterative approach facilitates adaptation and refinement of ideas, products, or services based on real-world feedback and learning.

2. Iterative cycles: rather than following a set sequence of stages, nonlinear innovation often involves iterative cycles of development, testing, learning, and adaptation. These cycles allow for rapid prototyping, experimentation, and the incorporation of innovative technologies or methodologies.

3. Shifts in direction: nonlinear processes are flexible and adaptable, allowing for shifts in direction in response to new opportunities, challenges, or insights. This agility is crucial in today's fast-paced and uncertain business environment, where staying ahead often requires the ability to pivot quickly and efficiently.

Understanding innovation as a nonlinear process offers a more realistic and dynamic framework for managing innovation in modern enterprises. It emphasizes the importance of adaptability, collaboration, and a supportive organizational culture in fostering successful innovation. As organizations embrace this complexity, they unlock the potential for more transformative, impactful innovations that can drive long-term success and growth.

Collaborative models of innovation. The landscape of innovation management has been significantly reshaped by the adoption of collaborative models, notably the "open innovation" and "triple helix" models. These frameworks emphasize the importance of collaboration among different stakeholders in the innovation process, expanding beyond the traditional boundaries of organizations. Furthermore, the visualization of collective idea generation and innovation processes within social networks offers insights into how ideas evolve and proliferate within and across communities [7].

Open innovation. The open innovation model challenges the conventional wisdom that companies must solely rely on their internal resources for innovation.

Instead, it proposes that firms can and should use external ideas as well as internal ideas, and reach out to markets externally as well as internally, as they look to advance their technology [7].

“Triple helix” model. The “triple helix” model of innovation introduces a triadic relationship between academia, industry, and government, highlighting their roles in fostering a more conducive environment for innovation [7]. This model suggests that the interaction between these three spheres can drive innovation through:

- creation of new knowledge and technologies through research initiatives;
- application of these advancements to develop marketable products and services;
- creation of policies and funding mechanisms to support research and development activities.

Collaborative models of innovation like “open innovation” and the “triple helix”, complemented by the visualization of idea generation in social networks, provide a multi-dimensional approach to understanding and managing innovation. These models emphasize the importance of external collaboration and the interconnectedness of various actors within the innovation ecosystem.

Network dynamics and innovation. The way innovations spread through networks is a fascinating study of interactions, influences, and the underlying structures that facilitate or hinder the proliferation of new ideas and technologies. Understanding network dynamics is crucial for grasping how innovation diffuses across different communities and sectors.

Innovations spread through networks via complex patterns influenced by the network's structure, the nodes' connectivity, and the quality of the innovations themselves [12]. Key elements include:

1. Nodes and links: individuals or organizations (nodes) are interconnected through relationships or communication channels (links). The more interconnected a node, the higher its potential to influence the spread of innovation [12].

2. Small-world networks: these networks feature clusters of well-connected nodes, with a few links between clusters. Innovations can spread rapidly within clusters and then leap across the network via the inter-cluster links [12].

3. Influence and threshold models: the decision of nodes to adopt an innovation can depend on the influence of neighboring nodes and certain thresholds of acceptance [12].

Once a critical mass of adopters is reached, innovation can spread more rapidly through the network.

Understanding the dynamics of how innovations spread and the factors that influence these processes provides valuable insights for strategists and marketers. By leveraging network structures and influential nodes, organizations can optimize the dissemination of innovations, overcoming potential damping effects to achieve wider adoption and impact.

The role of artificial intelligence in innovation. The advent of Artificial Intelligence (AI) has ushered in a new era of business innovation, fundamentally altering how research is conducted, products are developed, and markets are approached. The impact of AI spans across various facets of business operations, driving efficiencies, uncovering new opportunities, and reshaping industries [10].

AI technologies have significantly accelerated the pace of research and development (R&D) across sectors. By leveraging machine learning algorithms and big data analytics, businesses can:

- predict trends: AI helps in identifying emerging trends and consumer behaviors by analyzing vast amounts of data, enabling companies to stay ahead of market demands;
- enhance product development: through rapid prototyping and simulation, AI reduces the time and cost associated with developing new products, increasing the speed to market and the potential for innovation.

The most profound impact of AI on innovation lies in its potential to redefine business models:

- business process automation: by automating routine tasks, AI allows companies to focus on core innovation activities, enhancing productivity and operational efficiency;

- new value propositions: AI enables the creation of new value propositions, such as AI-powered services and products, opening up novel revenue streams and competitive advantages;

- ethical and governance considerations: as AI becomes integral to innovation, addressing ethical concerns and establishing robust governance frameworks become imperative to ensure responsible use and trust among stakeholders.

As AI continues to evolve, its role in shaping the future of business innovation will undoubtedly expand, presenting both opportunities and challenges that will require careful navigation.

Managing innovation at enterprises in the context of economic instability.

Managing innovation and technology in the context of economic instability presents unique challenges that stem from a variety of socio-economic, infrastructural, and institutional factors. However, addressing these challenges with effective strategies can significantly enhance the potential for sustainable development and economic growth in these regions [3].

Challenges in managing innovation at enterprises in the context of economic instability:

1. Limited resources: financial constraints and limited access to capital can hinder the ability of startups and enterprises to invest in innovation and research and development (R&D).

2. Infrastructure gaps: inadequate technological infrastructure, including internet access and digital tools, limits the capacity for technological adoption and innovation.

3. Skill shortages: a lack of skilled workforce in areas of science, technology, engineering, and mathematics (STEM) restricts the development and implementation of innovative solutions.

4. Regulatory and policy barriers: complex regulations and the absence of supportive policies for innovation can stifle entrepreneurial activities and innovation.

5. Market access challenges: limited market access and the dominance of established players can create barriers for new entrants and innovators.

To overcome these challenges can adopt several strategies to foster innovation and leverage technology for development:

1. Enhancing access to finance: developing financial instruments and support mechanisms such as innovation funds, grants, and microfinancing can provide the necessary capital for startups and innovators.

2. Building and upgrading infrastructure: investing in digital and technological infrastructure, including broadband internet and mobile networks, is crucial to enable access to information and digital services.

3. Developing human capital: strengthening education and training programs in STEM fields, along with continuous professional development and vocational training, can address skill shortages and build a workforce capable of driving innovation.

4. Creating supportive policy environments: simplifying regulatory frameworks and creating policies that encourage innovation, protect intellectual property rights, and support entrepreneurship are essential steps to create a conducive environment for innovation.

5. Fostering partnerships and collaborations: encouraging collaborations between the public sector, private enterprises, academia, and international organizations can leverage collective expertise and resources for innovation. Establishing innovation hubs and incubators can also support startups and entrepreneurs.

6. Leveraging open innovation: adopting open innovation models can help tap into a global pool of knowledge and ideas, allowing to leapfrog technological advancements and innovation practices.

7. Emphasizing inclusive innovation: developing inclusive innovation policies that address the needs of marginalized and underserved populations can ensure that the benefits of innovation and technology are widely distributed.

By addressing these challenges with targeted strategies, enterprises in the context of economic instability can unlock their innovation potential, driving sustainable development and economic growth.

Priority areas of innovation in Ukraine. The war and its aftermath have significantly changed the economic landscape of Ukraine. In this environment, many businesses were forced to rethink their business models and adapt to the new realities. Some of them focused on the domestic market and developed import substitution strategies. Others started looking for new export markets and changed their business vectors. Some businesses have turned to innovation and technological upgrading to increase its competitiveness and reduce dependence on imports. In general, the development of business models during the war has become a requirement of the times and now requires a creative and flexible approach to solving complex problems [1].

In our opinion, the priority areas of innovation activity for enterprises in Ukraine are:

1. National security and defence. Ukraine's geopolitical situation has placed a strong emphasis on strengthening its national security and defence capabilities. Enterprises in this sector must focused on developing innovative technologies, such as advanced weaponry, surveillance systems, and cybersecurity solutions, to enhance the country's defence posture and protect its sovereignty.

2. Energy and energy efficiency. Enterprises must have investing in renewable energy technologies, including solar, wind, and biofuels, to diversify the energy mix and reduce greenhouse gas emissions. Additionally, there is a strong focus on developing energy-efficient technologies and smart grid solutions to optimize energy consumption and distribution.

3. Agricultural sector. Agricultural enterprises must leveraging innovation to improve crop yields, enhance food security, and increase the competitiveness of Ukrainian agricultural products in global markets. Areas of innovation include

precision farming techniques, advanced seed varieties, and the development of value-added agricultural products.

4. Recycling of waste. Developing innovative technologies to process and repurpose various types of waste, including municipal solid waste, industrial waste, and electronic waste are the goal is to reduce landfill volumes, conserve natural resources, and create new economic opportunities through the circular economy.

5. Information technology. Ukraine has a strong tradition of excellence in science, technology, engineering, and mathematics (STEM) education, which has fostered a thriving IT sector. However, realizing the full potential of innovation in these sectors requires a supportive policy environment, access to financing, and a skilled workforce.

Future directions for research and practice.

1. Integration of emerging technologies. Further research into how emerging technologies like blockchain, IoT, and quantum computing can be integrated into innovation management practices.

2. Sustainable and social innovation. Exploring how innovation processes can address global challenges such as climate change, inequality, and health crises.

3. Measuring innovation impact. Developing more nuanced metrics and evaluation frameworks to assess the socio-economic impacts of innovation beyond traditional financial metrics.

4. Global innovation networks. Investigating the dynamics of global innovation networks and how they can be optimized to foster cross-border collaboration and knowledge exchange.

5. Inclusive innovation. Focusing on strategies to ensure that innovation benefits all segments of society, particularly in underserved and marginalized communities.

Conclusion. The strategies and approaches explored – from data-driven analytics to collaborative models – highlight the complexity and dynamism inherent in fostering innovation, namely:

1. Data-driven innovation. The shift towards leveraging big data and analytics has transformed innovation management, enabling more predictive, efficient, and customer-centric approaches.

2. Collaborative models. Open Innovation and the Triple Helix model emphasize the importance of collaboration across sectors, enhancing the innovation ecosystem's richness and diversity.

3. Network dynamics. Understanding how innovations spread through networks reveals the importance of connections, influencers, and the structural properties of networks in facilitating or hindering innovation.

4. AI's transformative role. Artificial Intelligence has emerged as a key driver of innovation, offering tools that reshape research, development, and market deployment strategies.

5. Challenges for enterprises in the context of economic instability. Managing innovation in the context of economic instability presents unique challenges, but strategic interventions and policies can unlock significant innovation potential.

In conclusion, the landscape of innovation management is continually evolving, driven by technological advances, changing market demands, and the global socio-economic environment. Staying at the forefront of innovation requires an ongoing commitment to research, learning, and adaptive strategies that embrace the complexities and opportunities of the modern world. By fostering an environment that values creativity, collaboration, and inclusivity, enterprises can not only drive their own growth but also contribute to the broader goals of sustainable development and societal well-being.

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