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ILCHENKO Natalia,
Doctor of Sciences (Economics), Professor,
Head of the Department of Trade Entrepreneurship and Logistics
State University of Trade and Economics
19, Kyoto St., Kyiv, 02156, Ukraine

n.ilchenko@knute.edu.ua
ORCID: 0000-0003-4052-571X

SUSHCHENKO Roman,
Full Higher Education,
Postgraduate Student of the Department of Trade Entrepreneurship and Logistics
State University of Trade and Economics
19, Kyoto St., Kyiv, 02156, Ukraine

r.sushchenko@knute.edu.ua
ORCID: 0000-0001-6642-4744

ADAPTIVE SUPPLY CHAIN MODELS

The change in the usual management models (Supply Chain Adaptability) in wartime has become a critical necessity to ensure the smooth functioning of the food supply. The adaptability of supply chains allows for a rapid response to changes in demand, market conditions, technological innovations, and in crisis situations. The aim of the research is to develop theoretical and methodological approaches to the formation of a business environment that promotes the creation of adaptive supply chain management models. It is hypothesized that the concepts of "SPOD-world", "VUCA-world", "BANI-world" and ANTIFRAGILE-world influence the formation and adaptation of supply chains, taking into account the complexity, instability and variability of the modern world. The main adaptive models of supply chain management are presented and characterized. It is proved that our proposed concept of ANTIFRAGILE-world, the development of which began in the context of the pandemic and continues under martial law in Ukraine, offers a new approach to supply chain management, where the main focus is on the ability of supply chains that form food retailers to become stronger and more efficient due to stress and change. It is proved that in 2024, Ukrainian retail continues to

ІЛЬЧЕНКО Наталія,
д. е. н., професор, завідувач кафедри торговельного підприємництва та логістики
Державного торговельно-економічного університету
вул. Кіото, 19, м. Київ, 02156, Україна

n.ilchenko@knute.edu.ua
ORCID: 0000-0003-4052-571X

СУЩЕНКО Роман,
магістр, аспірант кафедри торговельного підприємництва та логістики
Державного торговельно-економічного університету
вул. Кіото, 19, м. Київ, 02156, Україна

r.sushchenko@knute.edu.ua
ORCID: 0000-0001-6642-4744

АДАПТИВНІ МОДЕЛІ ЛАНЦЮГІВ ПОСТАЧАННЯ

Зміна звичних моделей управління (Supply Chain Adaptability) в умовах війни стала критичною необхідністю для забезпечення безперебійного функціонування постачання продовольчих товарів. Адаптивність ланцюгів постачання дозволяє оперативно реагувати на зміни у попиті, в умовах ринку, технологічних інноваціях, а також у кризових ситуаціях. Метою дослідження є розробка теоретико-методичних підходів до формування бізнес-середовища, що сприяє створенню адаптивних моделей управління ланцюгами постачання. Висунуто гіпотезу, що концепції "SPOD-світу", "VUCA-світу", "BANI-світу" та ANTIFRAGILE-світу впливають на формування та адаптацію ланцюгів поставок, враховуючи складність, нестабільність і мінливість сучасного світу. Наведено основні адаптивні моделі управління ланцюгами постачання, надано їх характеристику. Доведено, що запропонована нами концепція ANTIFRAGILE-світ, розвиток якої почався в умовах пандемії та продовжується за воєнного стану в Україні, пропонує новий підхід до управління ланцюгами постачання, де основний акцент зроблено на здатність ланцюгів постачання, що формують продовольчі роздрібні торговельні мережі ставати сильнішими та більш ефективними завдяки стресам і змінам. Доведено, що у 2024 р. український ритейл продовжує адаптуватися

adapt to the challenges of martial law, economic instability and the development of new technologies. The results of the research are aimed at identifying effective models that ensure the sustainability and efficiency of supply chains of national food retail chains under martial law. The article presents adaptive approaches and models of supply chain management used by retail food chains in Ukraine under martial law, such as: EVA (Emergency and Value-Added) Model, Distributed Supply Chain Model, Humanitarian Support Chain, Agile Supply Chain, Real-Time Visibility Model, Local Sourcing Model. Testing the hypothesis reveals the problems of adaptation and promotes the introduction of innovative management approaches.

Keywords: supply chain, adaptability, martial law, adaptive models, retail food retailers, VUCA-world, BANI-world, anti-fragility, SPOD-world, ANTIFRAGILE-world.

до викликів воєнного стану, економічної нестабільності та розвитку нових технологій. Результати дослідження спрямовані на визначення ефективних моделей, що забезпечують стійкість і ефективність ланцюгів постачання вітчизняних продовольчих торговельних мереж в умовах воєнного стану. Наведено адаптивні підходи та моделі управління ланцюгами постачання, які використовують роздрібні продовольчі мережі в Україні в умовах воєнного стану, такі як: EVA (Emergency and Value-Added) Model, Distributed Supply Chain Model, Humanitarian Support Chain, Agile Supply Chain, Real-Time Visibility Model, Local Sourcing Model. Перевірка висунутої гіпотези розкриває проблеми адаптації та сприяє впровадженню інноваційних підходів до управління.

Ключові слова: ланцюг постачання, адаптивність, воєнний стан, адаптивні моделі, роздрібні продовольчі торговельні мережі, *VUCA*-світ, *BANI*-світ, антикрихкість, *SPOD*-світ, *ANTIFRAGILE*-світ.

JEL Classification: F17, L21.

Introduction

In the context of the declaration of martial law in Ukraine, retailers are compelled to modify their customary supply chain management models (Supply Chain Adaptability) and adapt them to the prevailing circumstances in the country. The development of a supply chain adaptability system is imperative to ensure the smooth and efficient functioning of the food supply. Supply chain adaptability enables a response to changes in the environment, including fluctuations in demand, market conditions, technological innovations, crises or other factors with the potential to affect the supply chain. This process is not a one-time endeavor; rather, it is an ongoing effort necessitating the periodic review and refinement of strategies based on accumulated experience. The adaptability of food supply chains can be defined as the process of modifying and changing the supply system, in order to effectively adjust to market conditions, technological innovations, consumer trends, legislative regulations and other factors of the internal and external environment. This process may include revising company strategies, changing suppliers, and optimizing logistics processes. A prerequisite for adaptability is effective cooperation with suppliers, customers and other partners. The sharing of information and close collaboration with relevant stakeholders can facilitate the alignment of strategies and the coordination of changes in supply chains.

The issue of supply chain management is being addressed by researches and practitioners from both national and foreign institutions. For instance, Grigorak (2017) demonstrated that effective management of flows

within economic systems of enterprises, supply chains, regions and the national economy necessitates the development of new knowledge, technologies and specialists with the relevant professional competencies. Krykavskyi and Chornopyska (2012) determined that the expectation of "materialization" of the potential of external factors of a general business nature, which include the basic megatrends of our time, among which are globalization, individualization, informatization, environmentalization, etc., constitutes a significant contribution to the motivation for the formation of logistics supply chains. In a separate study, Ilchenko and Kochubey (2017) identified the main reference models of supply chain management, namely SCOR, GSCF and CPFR. They then went on to identify the directions and mechanisms for adapting these models to trade enterprises. In addition, they developed a scheme of the model of interaction of trade enterprises (TEs) with suppliers and consumers in the supply chain and a three-level CPFR model of supply chain design for wholesale and retail trade enterprises. In a separate study, Harsun and Patkovs'kyj (2020) examined the nature of cold supply chains and identified the main prerequisites for the development of cold logistics of food products in Ukraine.

According to Christopher (2011), the supply chain can be defined as a network of interconnected organizations involved in various processes and activities aimed at delivering a full range of products and services to the end user. Waters (2018) noted that the supply chain consists of a set of activities and organizations through which materials pass during their movement from the initial supplier to the end user. However, a comprehensive study of the problem of forming an adaptive supply chain that forms food retail chains is required.

The aim of this research is to establish a theoretical and methodological framework for examining the evolution of the business environment, with a view to inform the development of an adaptive supply chain management model. In addition, it will be analyzed which models can be applied to food retailers in Ukraine during the declaration of martial law.

The research puts forward the hypothesis that the concepts of "SPOD-world", "VUCA-world", "BANI-world" and ANTIFRAGILE-world influence the formation and adaptation of supply chains, given the complexity, instability and variability of the modern world. The empirical testing of this hypothesis will facilitate the identification of adaptation challenges and the development of models for supply chain management in the food retail sector.

The main part of the article consists of three sections: the first is devoted to the description of the genesis of supply chain adaptation in the global world, the second part of the article is a theoretical approach to determining the state of adaptive models of supply chain management, the third is devoted to the formation of an adaptive model of the supply chain of food retailers under martial law in Ukraine.

1. Genesis of supply chain adaptation in the global world

In order to ensure sustainable long-term development in the present environment, businesses possess a unique opportunity to reengineer and redesign their supply chains in a manner that reflects the future architecture of global material flows. In this context, logistics management must establish novel priorities in conjunction with established objectives, functions, and systems for the analysis and evaluation of logistics operations. The ongoing global pandemic has underscored the vulnerability of contemporary supply chains. Consequently, businesses have been compelled to restructure their logistics operations, thereby enhancing supply chain resilience. While businesses have developed strategies to cope with the challenges posed by natural disasters and global geopolitical events, they have not been adequately prepared for large-scale changes, particularly in terms of ensuring the resilience and adequate adaptation of supply chains. Such changes are necessary to respond quickly and effectively to challenges and threats. The operational dynamics of supply chains are intricately intertwined with the prevailing business environment, underscoring the necessity for a comprehensive examination of their evolutionary development.

The "*SPOD-world*" (1945–1979) is a concept that describes a world in which systems and processes are under constant stress, pressure, overload, and are subject to disruption. Within the domain of supply chains, this concept mirrors the challenges and issues encountered by enterprises when their supply chains function in an environment characterized by elevated stress and complexity. *"SPOD-world"* is an acronym: *Sourcing* is the process of finding and selecting suppliers of raw materials or components needed to produce goods. It includes assessing the quality, cost and reliability of suppliers. *Production* is the process of transforming raw materials and components into finished products. It is important to consider the efficiency of production processes, quality management, and meeting deadlines. Order – This stage includes processing customer orders, managing inventory, and coordinating between production and warehouse operations. It includes planning and processing demand fulfillment orders. *Delivery* is the process of distributing finished products to the end user. *The conditions for implementation are*: supply chain optimization: helps in coordination between different supply chain participants, improving processes and reducing costs; efficiency improvement: focuses on process integration, which helps in reducing lead times and improving customer service; risk reduction: allows better management of risks associated with sourcing, production, orders and delivery through a more transparent and controlled approach. Accordingly, the *SPOD-world* mirrors the realities of contemporary supply chain management, characterized by incessant stress, pressure, overload, and disruption to routine operations. The implementation of

strategies to monitor and manage risks, adapt to changes, and utilize modern technologies to enhance the resilience and efficiency of supply chains is imperative for effective management in such an environment.

The term "*VUCA-world*" (1980–2000) was coined to describe an era of instability, uncertainty, complexity, and ambiguity. In the context of supply chains, this concept facilitates comprehension and management of the challenges and risks that emerge in a rapidly evolving environment. A thorough examination is warranted to ascertain the manner in which each facet of *VUCA* influences supply chain management and the strategies that can be employed to effectively navigate such a milieu. *Volatility,* defining and managing fluctuations: in the context of supply chains, volatility can manifest through frequent and unpredictable fluctuations in demand, pricing, or the availability of resources. To effectively manage such volatility, it is imperative to implement flexible and adaptive processes that can swiftly respond to these fluctuations. The utilization of flexible procurement strategies, the establishment of buffer stocks, and the implementation of systems to expeditiously respond to fluctuations in supply and demand serve as instrumental tools in the management of volatility. *Uncertainty* is defined as the absence of accurate information or predictability in the future. Effectively managing uncertainty entails the formulation of scenarios, forecasting, and strategic planning to mitigate risks and prepare for various potential outcomes. Management tools, in this case, are monitoring and analytical systems that facilitate the reception and processing of pertinent information, thereby enabling informed decision-making. *Complexity:* Managing complex systems: Supply chains frequently comprise numerous interdependent elements and actors, rendering them challenging to manage. Management tools: The implementation of supply chain management (SCM) technologies, tracking, and data analytics to optimize processes and increase transparency. *Ambiguity,* managing uncertain situations: Ambiguity is defined as the presence of incomplete or conflicting information, which consequently hinders effective decision-making processes. It is imperative to cultivate the capacity to swiftly adapt and respond flexibly to novel and unanticipated circumstances. Management tools include the implementation of mechanisms for the collection and analysis of data, which facilitate improved situational interpretation and the development of adaptable strategies to address changes. The integration of technology to enhance supply chain visibility and management is instrumental in mitigating the repercussions of volatility and complexity. Fostering collaboration with suppliers and partners is crucial to ensure enhanced flexibility and expeditious responses to changes. The preparation for unforeseen circumstances, including the formulation of crisis response plans, is paramount to ensure business continuity. Continuous improvement and learning are essential for developing the capacity to comprehend and manage

novel challenges. Consequently, supply chain management in a *VUCA* environment necessitates an integrated approach encompassing flexibility, transparency, adaptability to change, and the utilization of contemporary technologies. It is imperative to comprehend and execute strategies that acknowledge the inherent volatility, uncertainty, and complexity in order to establish sustainable and adaptive supply chains that are capable of operating effectively in a dynamic environment.

Chaliuk (2022) argues that in order to eliminate the negative consequences caused by uncontrollable external and internal factors, business entities in Ukraine should effectively combine SPOD and VUCA methods depending on the industry, the impact of information and technological changes.

But the "*BANI-world*" (2001–2019) is a concept that reflects the current challenges in supply chain management, in which systems and processes are becoming less resilient and predictable, making them difficult to manage effectively. The term "BANI" stands for "*brittle,*" indicating that systems and processes may appear reliable, but under certain conditions, they can easily fail, often due to excessive centralization or lack of flexibility. Fragile systems can be vulnerable, as evidenced by supply disruptions resulting from issues with a supplier or an inventory management system. *Anxiety* is defined by uncertainty and instability, leading to bottlenecks in the supply chain. These conditions can impede the efficiency of decision-making and management processes, resulting in delays and errors. The term "*nonlinear*" signifies that alterations may be disproportionate to their underlying causes. Minor alterations in a single segment of the supply chain can potentially generate substantial ramifications in other domains. *Incomprehensible* is defined by uncertainty and difficulty in predicting events and trends, which hinders effective decision-making. Unpredictability can complicate planning by making it difficult to assess potential consequences or changes in the environment. In light of these challenges, it is imperative to adopt a proactive approach to ensure resilience and adaptability in supply chains. This entails the development of strategies for unforeseen situations, the formulation of crisis plans, and the implementation of rapid response and recovery mechanisms. Moreover, investing in technology and innovation, leveraging modern technologies, and employing innovative solutions to enhance resilience and adaptability are crucial. Strengthening partnerships to ensure stability and flexibility within supply chains is also essential. Furthermore, continuous monitoring and adaptation to change are necessary to identify opportunities for improvement and to swiftly adapt to new conditions. In the context of the *BANI world*, the challenges posed to supply chain management are novel, characterized by aspects of fragility, nonlinearity, and unpredictability that impact the efficiency and sustainability of systems. To effectively navigate these circumstances, businesses must implement adaptive strategies, allocate

resources toward technological advancements, enhance communication networks, and ensure seamless supply chain operations.

We hereby propose a novel conceptualization of the *ANTIFRAGILE-world (*2020 *inclusive)* in the context of supply chain management adaptation stages. This conceptualization is predicated on the seminal work of Nassim (2013), entitled *Antifragile: Things That Gain from Disorder*. The aforementioned book expounds upon the notion of systems that exhibit a propensity to not only withstand stress and change, but to thrive and function more efficiently in such environments. In the context of supply chain adaptability, the *ANTIFRAGILE-world* exists in an environment where systems and processes are able not only to survive crises, but also to use them as opportunities for improvement and development.

The following discussion will explore the main principles of the *ANTIFRAGILE-world* and their impact on supply chains:

- Non-hereditary adaptation, or anti-fragile systems, is a concept that posits the ability of these systems to not only withstand stresses and crises, but also to utilize them for their own development and enhancement. Within the context of supply chains, businesses that adeptly manage change and risk emerge as stronger and more competitive entities;
- The implementation of redundancy in resilient systems frequently entails the incorporation of certain levels of redundancy or reserves, which facilitate the ability to manage the occurrence of unanticipated events. The incorporation of redundancies serves to mitigate the risk of disruption and ensure the continuity of supply;
- *Antifragile* systems are defined by their structural resilience and adaptability. In the face of change and stress, these systems possess the capacity to adapt and improve, thereby enhancing their ability to cope with challenges and maintain competitiveness.

The *ANTIFRAGILE-worldview* is instrumental in the formation of the LP, and it involves the following: The development of strategies for unforeseen situations, the creation of crisis action plans, and the formulation of rapid response and recovery strategies; the investment in technology and innovation, the utilization of modern technologies, and the implementation of innovative solutions to enhance resilience and adaptability; the strengthening and development of reliable and long-term partnerships to ensure stability and flexibility in supply chains; and the constant monitoring and adaptation, through constant monitoring.

The *ANTIFRAGILE-world* concept, which was developed in the context of the pandemic and martial law, offers a novel approach to supply chain management, emphasizing the capacity of systems to become more robust and efficient through stress and change. The integration of the principles of antifragility into supply chain management enables enterprises to not only withstand challenges but also leverage them for their own

development and enhancement. This approach ensures their competitiveness and sustainability in tumultuous economic conditions.

Thus, the scientific novelty is that these concepts *of* "*SPOD-world*", "*VUCA-world*", "*VUCA-world*" and "*ANTIFRAGILE-world*" have never been considered through the prism of forming a supply chain management model.

2. Adaptive supply chain management models

Adaptive supply chain management models are concepts and approaches to supply chain management that are able to respond quickly to changes in the internal and external environment while maintaining efficiency, sustainability, and compliance with market needs. These models are characterized by their ability to adapt to the volatility inherent in conditions such as economic instability, force majeure (e.g., wars, natural disasters), shifts in demand, technological advancements, and regulatory changes.

These models prioritize flexibility, rapid decision-making processes, the integration of modern technologies (e.g., digitalization, artificial intelligence), and active collaboration among all participants within the supply chain. These models are characterized by several key features, namely flexibility, which refers to the capacity for expeditious reconfiguration of operational processes and supply chains; predictability, the utilization of data for the forecasting of risks and fluctuations in demand; digitalization, the implementation of state-of-the-art technologies (e.g., Big Data, the Internet of Things, blockchain) for the purposes of monitoring, control, and automation; and resilience, the capacity to minimize losses and ensure the continuity of supply even in critical circumstances. The relevance of such models is particularly pronounced during periods of global crises, including pandemics, military conflicts, or economic downturns.

The objective of developing a supply chain adaptability model is to ensure resilience and reliability in an unstable environment. Such adaptation enables businesses to maintain efficiency, reduce costs and risks, and ensure uninterrupted supply of goods to end users even in volatile environments. Supply chain adaptability models (*Table 1*) encompass strategic solutions that enhance flexibility, mitigate vulnerability, and expedite responses to unanticipated changes, thereby safeguarding the stability and competitiveness of enterprises.

According to the findings of our research, supply chain adaptation models are capable of encompassing a variety of aspects, including, but not limited to, the following: flexibility and the capacity to respond expeditiously to fluctuations in demand or supply; integration of state-of-the-art technologies to optimize processes; diversification of supply sources to mitigate dependence on a solitary supplier or region; inventory optimization to minimize the risk of shortages or excess stock; forecasting and risk management to proactively identify potential threats to the supply chain; and continuous improvement, consideration of novel technologies, strategic initiatives, and the capacity for agile adaptation to changes, with due consideration for the aforementioned concepts.

Table 1

Adaptive supply chain management models

Models	Focus	Main features
Agile supply chain model	An agile supply chain can quickly adapt to changes based on customer demands, market conditions, or supply disruptions. It is advisable to use for industries with high variability in demand or those that require frequent product customization (e.g., fashion, electronics)	Flexibility: the ability to quickly reconfigure processes and resources. Responsiveness: quick response to customer orders or changes in the market. Partnership in cooperation: close relationships with suppliers, distributors and customers. Fast decision-making: reducing decision-making cycle time to increase responsiveness
Lean supply chain model	It involves optimizing all stages of the supply chain to reduce losses and increase efficiency. The main focus is on minimizing time, costs and resources, which increases customer value and improves overall system performance. Lean Supply Chain is appropriate for a wide range of industries, as Lean principles are aimed at reducing costs and increasing efficiency, which can bring significant benefits in any sector. However, the greatest effect of Lean Supply Chain is achieved in the following industries: Trade and distribution: In retail chains and distribution companies, Lean approaches help reduce excess inventory, optimize supply, and reduce order processing time. This is especially important in retail, where delays in deliveries should be avoided and logistics efficiency maximized. Food and beverages: In the food industry, it is important to respond quickly to changes in demand and reduce the risk of product spoilage due to long-term storage. Lean Supply Chain helps to reduce delivery times and increase the efficiency of the production and distribution process. Automotive industry: Lean principles are widely used in the automotive industry to achieve high efficiency of production processes. A striking example is the just-in-time (JIT) system, which is used to minimize inventory and maximize adaptation to changing demand. Lean Supply Chain is useful for any industry where cost reduction, process speed, inventory optimization, and product quality are important factors. However, the system achieves the greatest effect in sectors where there is a high level of competition, rapid changes in demand and the need to minimize costs at all stages of the supply chain	Reducing waste: minimizing the loss of time, materials and labor. Continuous improvement: using methods such as Kaizen to continuously optimize processes. Just-in-time (JIT): Inventory is kept at the lowest possible level to reduce costs and space utilization. Standardization of processes to improve efficiency and quality. Quality assurance at every stage (Built-in Quality) Inventory Reduction, which reduces storage costs and reduces the risk of accumulating outdated goods or raw materials. Flow Optimization: minimizes delays and inefficient processes, which helps to respond more quickly to changes in demand and reduces order processing costs. Pull Systems: orders are placed only when there is real demand. Lead Time Reduction: It is important to reduce the time spent moving goods between supply chain participants; it is also important to reduce the time spent moving goods between different stages of the supply chain. This is achieved through efficient operations and logistics, process automation, optimization of transport and communications
A model for a sustainable supply chain	This model has the ability to withstand and recover from disruptions caused by natural disasters, geopolitical events, or unexpected changes in demand. It is typical for industries that face frequent supply chain disruptions (including food retailers)	Diversification: multiple sources for critical components or materials. Risk management, proactive strategies to identify, assess and mitigate risks. Buffering inventory, maintaining safety stock or flexible production capacity to adapt to shocks. Emergency planning

Continuation of Table 1

Models	Focus	Main features
Digital supply chain model or artificial intelligence for supply chain optimization	This model uses digital technologies (Internet of Things, artificial intelligence, big data, blockchain) to increase transparency, automation, and real-time data analysis of supply chain management. It is best suited for the technology industry or companies that require a high level of transparency and real-time data (e.g., electronics, retail, pharmaceuticals)	Automation, the use of robotics, artificial intelligence, and machine learning for forecasting, inventory management, and logistics optimization. Real-time data, continuous monitoring and analysis of supply chain activities for decision-making. Blockchain, transparency and tracking of goods from suppliers to consumers. Predictive analytics for demand forecasting and resource optimization
Global supply chain model	This model focuses on creating a supply chain that can operate globally, with international suppliers, manufacturers, and distribution networks. It is typical for multinational companies or enterprises operating in international markets and in different regulatory environments	Global supply, purchasing products from different regions of the world. Cross-border logistics: efficient international delivery, customs clearance and regulatory compliance. Local adaptation, the adjustment of products, goods and services to local demand and regulatory requirements. Global management of risks related to global trade, tariffs and political uncertainty
Circular supply chain model	This model is based on the principles of the circular economy, where products and materials are reused, recycled and repurposed rather than disposed of after use. It is best suited for businesses focused on sustainability, environmental impact, and waste reduction (e.g., consumer electronics, fashion, automotive)	Resource optimization: maximizing the product life cycle and minimizing waste. Recycling and reuse, recycling. Sustainable development, focus on environmental impact, carbon footprint reduction and ethical sourcing. Reverse logistics, managing the return of goods for processing or reproduction
Hybrid supply chain model	This model combines elements of different supply chain strategies (flexibility, lean, resilience) to adapt to different challenges and market demands. It is best suited for businesses that need to operate in a dynamic environment, such as fast-growing companies or companies with diverse product lines	Flexibility, the ability to switch between different strategies depending on changing needs. Cost-effectiveness, a balance between cost reduction and rapid response. Risk diversification, reducing risks by adopting elements of both flexible and resilient approaches. Scalable operations, allows companies to scale operations as needed depending on market conditions
Model of a collaborative supply chain	In this model, supply chain partners (suppliers, manufacturers, distributors, and customers) work closely together, sharing information, resources, and responsibilities. It is best suited for industries where close cooperation with suppliers or distributors is essential (e.g. automotive, consumer electronics, pharmaceuticals)	Shared resources, partners collaborate on joint projects, resources and networks distribution. Transparency, exchange of information between all stakeholders to improve decision-making. Joint planning, coordination of production, forecasting and logistics to optimize the entire supply chain. Trust: establishing long-term partnerships based on mutual benefit

End of Table 1

Models	Focus	Main features
Sustainability-oriented supply chain	It is a supply chain management model that focuses not only on economic aspects, such as cost reduction and efficiency, but also on long-term environmental and social sustainability. The goal is to create a balance between economic, environmental and social requirements to achieve sustainable development and minimize negative impacts on the environment and society. It is best suited for retailers seeking to develop a green reputation and ensure sustainable development	The supply chain is focused on reducing environmental impact, using environmentally friendly raw materials and reducing emissions. This includes the use of renewable resources, energy-saving technologies, waste reduction and integration with socially responsible suppliers. The requirements for ethical standards in the production and transportation of goods are taken into account

Source: compiled by the authors on the basis of (IBM, n. d.). and own research.

3. The adaptive model formation of the supply chain by food retailers under martial law

In 2024, the Ukrainian retail sector is undergoing a period of adjustment to the challenges posed by martial law, economic instability, and the development of new technologies. In response to these challenges, Ukrainian food retail chains have been compelled to recalibrate their supply chain strategies, shifting their focus toward domestic markets and local suppliers with the aim of mitigating potential shortages. In their efforts to mitigate risk and ensure a reliable supply of goods, food chains are exploring alternative sourcing options, including the identification of new suppliers in Ukraine and other countries not previously considered due to security concerns. Concurrently, efforts are being made to bolster local farmers and food producers, ensuring uninterrupted supply even in challenging circumstances. The economic operations of retailers are intricate, entailing cost management, process optimization, and comprehensive adaptation to consumer demands. As illustrated in *Table 2*, leading food retail chains in Ukraine have experienced fluctuations in revenue from sales of products (goods and services) from 2019 to 2023. The profitability of retail chains is influenced by various factors, including the prices for the purchase of goods, logistics, inventory management, pricing, and consumer behavior management.

Revenue from sales of products (goods and services) of ATB Market LLC in the first six months of 2024 increased by 14.3% to UAH 97.5 billion, with a profit of UAH 1.6 billion and 1226 supermarkets. Revenue from sales of products (goods and services) of Fozzy Group (Silpo-Food LLC, Fora LLC, Trash LLC, Expansion LLC) increased by 3.3% to UAH 64.6 billion in the first half of 2024. In 2023, Fozzy Group's revenue from sales of products (goods and services) amounted to UAH 123.7 billion. In January–June 2024, Silpo-Food LLC reduced its loss by 16.6% to UAH 863.5 million, Fora LLC's profit amounted to UAH 7.6 million, Trash LLC's profit decreased by 87.1% to UAH 14.2 million, and Expansion LLC's loss increased by 60.1% to UAH 192.6 million. Fozzy Group has 600 stores across the country (Slovoidilo, 2024, September 11; Retailers, 2024, August 19).

Table 2

Revenue from sales of products (goods and services) of the leading food retail chains in Ukraine in 2019–2023, UAH billion

Name of the network	Years				
	2019	2020	2021	2022	2023
ATB	104.9	123.9	148.7	148.3	181.1
Silpo	62.4	64.4	72.8	70	84.7
Fora	14.3	16.4	18.9	19.6	29.6
Metro Cash & Carry Ukraine	17.8	21.5	25.9	20.2	25.6
NOVUS	11	12.7	17.3	16	23.6
VARUS	11	12.2	13.7	14.6	17.5
AUCHAN	14.2	14	14.5	10.7	11
Velmart	11.1	11.3	12.7	13.5	17.2

Source: compiled by the authors according to (Slovoidilo, 2024, September 11).

Revenue from sales of products (goods and services) of NOVUS Ukraine LLC increased by 25.9% to UAH 13.4 billion in the first six months of 2024. The company overcame a loss of UAH 128.5 million to make a profit of UAH 409 million. Revenue from sales of products (goods and services) in 2023 amounted to UAH 24.5 billion. Revenue from sales of products (goods and services) of the VARUS retail chain increased by 20.6% to UAH 17.5 billion in 2023. At the same time, the company's profit amounted to UAH 140.7 million. The chain has 109 supermarkets in the largest cities of Ukraine: Dnipro, Kyiv, Kryvyi Rih, Zaporizhzhia and Odesa. More than 260 000 customers shop at VARUS every day (Forbes Ukraine, 2024, March 8; Slovoidilo, 2024, September 11; Retailers, 2024, August 19).

In order to ensure the stability of the supply chain under martial law, retailers have been known to create strategic food stocks. These stocks include the storage of critical goods, such as cereals, canned food, meat, and dairy products, which may become scarce under martial law. In the event of a power outage or blackout, food chains prioritize products that are in demand during wartime, such as long-life food, canned goods, water, and cooking products. The range of food products is modified depending on the needs of consumers, such as the provision of ready-to-eat food.

In the context of martial law in Ukraine, food retailers are compelled to recalibrate their supply chains by implementing specialized models to ensure uninterrupted operations and address the demands of the populace. The *Table 3* will present a compendium of the most salient adaptive approaches and management models employed by food retailers in Ukraine.

Therefore, the establishment of an adaptive supply chain model for food retailers under martial law is imperative to ensure food security, maintain social stability, and ensure the efficient functioning of the economy. The efficacy of this model hinges upon the integration of contemporary technologies, collaboration with relevant stakeholders, and the capacity to promptly adapt to evolving crisis scenarios. However, implementing such a model carries inherent risks, including:

Table 3

Adaptive approaches and models of supply chain management used by retail food chains in Ukraine under martial law

Adaptive models	Description	Example of implementation
EVA (Emergency and Value-Added)	It is a model that is used to manage crisis situations while aiming to create added value for organizations or communities. The model combines emergency response with initiatives that promote sustainability, efficiency and long-term benefits. Focus on rapid adaptation to changes in product availability and logistics routes. Priority is given to essential goods.	During martial law, ATB's retail network actively cooperated with suppliers to ensure a minimum set of food products even in combat zones. Reorganization of warehouses for greater mobility and the ability to quickly replenish goods.
Distributed supply chain model	It is a model of supply chain management in which production, warehousing, and logistics processes are located in different geographical regions or segments to achieve greater efficiency, flexibility, and sustainability. This model aims to optimize processes, reduce costs and respond quickly to changes in demand or market conditions. The ability to quickly change routes depending on the situation.	The Silpo retail chain has shifted its focus to creating warehouses closer to safe regions and ensuring delivery to the nearest stores. Engaging local suppliers to reduce transportation time
Humanitarian supply chain model	This is a specialized approach to organizing the supply chain aimed at providing the population with vital goods and services in the context of armed conflict. The model is based on effective logistics management, coordination between different stakeholders, and emergency adaptation. Joining forces with international humanitarian organizations and government agencies to supply products to critical areas. Use of special logistics corridors to ensure safe transportation.	Metro Cash & Carry Ukraine and Fozzy Group actively contributed to humanitarian aid programs by creating additional stocks for the crisis regions. The total amount of charitable assistance provided by ATB during the war to Ukrainian defenders, medical institutions, affected civilians, etc. has already reached almost UAH 2 billion.
Agile supply chain Flexible delivery model	It is an adaptive approach to supply chain management aimed at ensuring rapid response, adapting to changing conditions and meeting the needs of the population in the context of instability caused by war. This model focuses on minimizing risks, maximizing the use of available resources and ensuring continuity of supply, even in situations with high levels of uncertainty.	ATB and NOVUS have introduced flexible delivery models, optimizing routes to avoid dangerous areas. Use of alternative modes of transportation (e.g. rail).
Real-time visibility model	It is an approach to supply chain management that ensures transparency and real-time monitoring of all stages of the delivery of goods. Thanks to the use of modern technologies, this model allows you to quickly respond to changes, eliminate disruptions and maintain continuity of supply in the context of military operations. Real-time monitoring of supplies using digital technologies. Use of GPS, IoT, and mobile platforms to track the movement of goods.	Silpo and ATB have integrated monitoring systems to track the movement of goods and redirect them in case of threats. Implementation of mobile applications for communication with drivers and suppliers.
Local suppliers model	Transition to purchasing goods from local farmers and producers to shorten supply chains. Minimize dependence on imports.	Varus and other local chains actively supported Ukrainian producers by offering products made in safe regions of the country. Expanding the assortment with local brands.

Source: compiled by the author based on (ProConnect Integrated Logistics, n. d.; Li, 2020; Steffes, 2024, September 5).

Logistics risks:

destruction of the logistics infrastructure: Risk: high. *Possible actions*: use of alternative routes, creation of local warehouses;

Danger to transportation: the threat of shelling, checkpoints, or roadblocks makes it difficult to move around. *Risk*: high.*Possible actions*: cargo insurance, cooperation with the military to secure routes.

Economic risks:

Financial constraints: rising costs for fuel, transportation, and security may make the adaptive model economically unprofitable. *Risk*: medium. *Possible actions*: cost optimization through coordination with other networks and partners;

Currency fluctuations: dependence on imported goods increases costs due to currency volatility. *Risk*: medium. *Possible actions*: increasing the share of local suppliers.

Social risks:

Staff outflow: military operations lead to the loss of personnel through mobilization or migration. *Risk*: medium. *Possible actions*: automation of processes, involvement of local communities;

Increased social tension: shortages of goods may cause discontent among the population. *Risk*: high. *Possible actions*: transparent communication with consumers, setting fair prices.

Technological risks:

Limited access to technology: lack of stable internet or electricity makes it difficult to use monitoring systems. *Risk*: medium. *Possible actions*: backup power supplies, decentralized metering systems;

Cyber threats: Hacker attacks can disrupt supply chain management systems. *Risk*: high. *Possible actions*: investing in cybersecurity and backup systems.

Political risks:

Regulatory instability: frequent changes in legislation or regulations can create obstacles for business. *Risk*: medium. *Possible actions*: Adaptation to changes through rapid legal response;

Dependence on humanitarian aid: unpredictable volumes of international aid may affect the availability of goods. *Risk*: medium. *Possible actions*: development of own stocks and local production.

Environmental risks:

Damage to goods: war conditions can cause delays in transportation, which leads to damage to products. *Risk*: high. *Possible actions*: use of cold chains and shorter routes;

Environmental pollution: military operations may affect product quality due to pollution. *Risk*: low. *Possible actions*: control of product quality and sources of supply.

Reputational risks:

Loss of consumer confidence: late delivery or lack of goods may reduce trust in retail chains. *Risk*: medium. *Possible actions*: regular communication with consumers, expanding the range of products.

In the context of martial law in Ukraine, it is imperative for retail analysts to implement tools and methodologies that will enhance supply chain adaptability. We offer risk monitoring systems, such as RiskWatch, a platform for assessing and monitoring risks in supply chains. To facilitate

data analysis and forecasts, we recommend Tableau or Microsoft Power BI, which offer capabilities for the visualization of inventory, demand, and supply data, thereby enabling the identification of trends in real time. Supply chain management platforms, such as Oracle Supply Chain Management Cloud, offer capabilities for data integration, order management, and forecasting. For the inventory management system, SAP Integrated Business Planning can be utilized to optimize inventory management and demand forecasting. Collaboration platforms, such as Slack or Microsoft Teams, facilitate real-time communication between teams and partners. For the monitoring of road transport carriers, Project44 or FourKites can be utilized to track cargo and provide visibility at all stages of supply.

Conclusions

A rigorous examination of the hypothesis positing the significance of the concepts of SPOD-world, VUCA-world, BANI-world, and ANTIFRAGILE-world in the formation and adaptation of supply chains has substantiated their pivotal function in elucidating the predicaments of the contemporary era. These concepts enable us to encapsulate various dimensions of complexity, instability, and variability inherent in the contemporary environment. Consequently, they contribute to the development of effective approaches to supply chain management.

Therefore, the significance of concepts in the context of adaptation is paramount. SPOD-world serves as a foundational model, illustrating the limitations of the conventional approach when confronted with escalating uncertainty. VUCA-world underscores the imperative for agility, prompt responsiveness, and adaptability in the face of volatilities and uncertainties. BANI-world accentuates the significance of resilience, decentralization, and effective anxiety management in crisis-stricken environments. ANTIFRAGILE-world demonstrates that effective supply chains should not only exhibit resilience in the face of stress, but also leverage such challenges to enhance performance.

The supply chains of food retailers are encountering a series of challenges, including logistics disruptions, increased demand uncertainty, and associated risks. A lack of readiness for rapid change and insufficient integration of digital technologies impede adaptation. The application of concepts such as VUCA, BANI, and ANTIFRAGILE has been identified as a potential catalyst for the development of adaptive, flexible, and sustainable management models. The integration of digital technologies (Big Data, the Internet of Things, and artificial intelligence), multi-level forecasting, and the establishment of alternative routes are crucial for ensuring efficiency in crisis conditions.

In the contemporary environment, national retail chains and the Ukrainian system are classified as "ANTIFRAGILE" entities, indicating their resilience in crisis conditions and their capacity to leverage challenges as catalysts for enhancement. In the context of martial law, food retail chains exemplify these characteristics. Chains that have adapted to martial law gain

an advantage over less resilient competitors. The ANTIFRAGILE concept provides a multidimensional framework for analyzing current challenges and developing adaptive supply chain management models. The implementation of these models enables the identification of deficiencies inherent in conventional methodologies, the identification of novel adaptation instruments, and the establishment of supply systems that maintain efficacy under the most arduous circumstances, as evidenced by the context of martial law in Ukraine. The insights gleaned from this analysis facilitate a more profound comprehension of contemporary supply chain challenges and enable the formulation of novel management strategies. These strategies are expected to contribute to ensuring the country's food security, enhancing the resilience of retail food retailers, and mitigating risks in volatile environments.

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