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A Global Supply Chain Security Management Strategy under U.S. Federal Law

Abstract

Since the trade war between the United States (U.S.) and the People's Republic of China (PRC) began in 2018, the role of global supply chains has increased significantly, as reflected in U.S. federal law. This paper aims to test the hypothesis that supply chain management security is one of the most crucial components of the US global supply chain management strategy. This security can be significantly bolstered by overcoming three dominant challenges: resilience, variability and complexity. These challenges have found their way not only into public policies, but also into federal law, forming the basis of a strategic approach. Systematic planning, implementation and coordination activities are developed, with artificial intelligence being used for predictive, adaptive and data integration purposes, thus enabling a redefinition of US global supply chains.

KEYWORDS: Supply Chain Management, national security law, strategic management, trade war law, protectionism

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HTTPS://DOI.ORG/10.36128/Q83X1310

1 Introduction

The national security of the United States (U.S.) is largely dependent on the health of the American economy and the appropriate level of openness of foreign trade,[1] for which supply chains constitute a kind of integrated infrastructure for the flow of American goods exchange.[2] While, at every stage of the development of global supply chain management, the security of supply chains has played a significant role for the U.S.,[3] it is impossible not to get the impression that this role has grown to a sky-high level with the start of the trade war between the U.S. and the People's Republic of China (PRC) in 2018.[4] This war represents one of the largest and most abrupt changes in trade policy in U.S. history.[5] As the United States has identified over the past two decades, the risk of losing its position as the world's largest economy and leading trading partner to the PRC,[6] steps

1 The beginning of the openness of the American economy to foreign investment should be identified with the adoption the Reciprocal Trade Agreements Act of 1934, the 73rd Congress, Public Law 73–316, 48 Stat. 943, June 12, 1934. In practice, the Act ushered in an era of liberal and global U.S. trade policy that lasted throughout the 20th century. Cf. Dwight D. Eisenhower, *Special Message to the Congress on Foreign Economic Policy*. https://www.presidency.ucsb.edu/node/233632; Michael J. Hiscox, „The Magic Bullet? The RTAA, Institutional Reform, and Trade Liberalization" *International Organization*, No. 4 (1999): 669-698.

2 Eleftherios Iakovou, Chelsea C. White III, *How to Build More Secure, Resilient, Next-Gen U.S. Supply Chains*. (Washington D.C.: Brookings Institution, 2020); James Timbie, „National Security Supply Chain Resilience", Hoover Institution, (2021); Peter Coughlan, John Gowel, *Final Report: Securing the Strategic Materials Supply Chain* (Washington D.C.: The Dwight D. Eisenhower School for National Security and Resource Strategy, National Defense University Fort McNair, 2023); Caroline Freund, Aaditya Mattoo, Alen Mulabdic, Michele Ruta, „Is US Trade Policy Reshaping Global Supply Chains" *Journal of International Economics*, Vol. CLII (2024): 1-28.

3 Cf Justyna Nawrot, „O potrzebie wyraźnego rozróżnienia pojęć „bezpieczeństwo" i „ochrona" w prawie polskim. Uwagi na tle polskiej legislacji morskiej" *Prawo i Więź*, No. 4, (2015): 7-20; Roser Martínez, „The American Security Model and Its Influence over European Social and Juridic Values" *Prawo i Więź*, No. 1 (2022): 11-30.

4 Felipe Benguria, Jaerim Choi, Deborah L. Swenson, Mingzhi Xu, „Anxiety or Pain? The Impact of Tariffs and Uncertainty on Chinese Firms in the Trade War" *National Bureau of Economic Research, Working Paper*, No. 27920 (2020): 1-45.

5 Pablo Fajgelbaum, Aamit Khandelwal, „The Economic Impacts of the US-China Trade War" *National Bureau of Economic Research, Working Paper*, No. 29315, (2021): 1-30.

6 See.: David H. Autor, David Dorn, Gordon H. Hanson, „The China Syndrome: Local Labor Market Effects of Import Competition in the United States" *American Economic Review*, No. 103 (2013): 2121-2168; Luis G.A. Alves, Giuseppe Mangioni,

have been taken to establish secure supply chains that will continue to ensure national security and economic prosperity.[7]

Although several regulations on global supply chain management were adopted in U.S. federal law before 2018, especially after 11 September 2001, which were directly related to strengthening national security, trade, and critical infrastructure,[8] they were characterized by a fragmented, sectoral approach and an undeveloped system of integrated coordination and central supervision.[9] Od 2017 r. do chwili obecnej sytuacja wygląda zgoła odmiennie. W tym okresie nastąpiła swoistego rodzaju ofensywa legislacyjna dotycząca zarządzania globalnymi łańcuchami dostaw. This thesis is supported by the fact that, for the first time, two federal laws and fifteen presidential executive orders (EOs) have been enacted directly into federal law to regulate global supply chain management[10]. Significantly,

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Francisco A. Rodrigues, Pietro Panzarasa, Y. Moreno, „The Rise and Fall of Countries in the Global Value Chains" *Scientific Reports*, No. 9086 (2022); Graham Allison, Nathalie Kiersznowski, Charlotte Fitzek, „The Great Economic Rivalry: China vs. the U.S." *The Great Economic Rivalry: China vs. the U.S.* (Cambridge: Belfer Center for Science and International Affairs, Harvard Kennedy School, 2022); The Office of the United States Trade Representative, *Economy and Trade* (2024). https://ustr.gov/issue-areas/economy-trade.

7 See.: The White House, *National Security Strategy of the United States of America* (Washington D.C., December 2017), 29.

8 See.: The Tariff Act of 1930, Public Law 71–361, 46 Stat. 590, the 71st United States Congress, June 17, 1930; The Export Administration Act of 1979 the 96th United States Congress, Public Law 96–72, 93 Stat. 503, September 29, 1979.

9 For example, § 343 of the Trade Act of 2002 mandated the advance electronic reporting of cargo information to enhance transparency and security in supply chains. Furthermore, under the Customs–Trade Partnership Against Terrorism (C–TPAT), companies can voluntarily commit to documenting ongoing risk identification and mitigation throughout their international supply chain. See.: The Trade Act of 2002, Public Law 107–210, H.R. 3009, 116 Stat. 933, August 6, 2002; The Customs-Trade Partnership Against Terrorism (C–TPAT), U.S. Customs and Border Protection, November 2001.

10 The Uyghur Forced Labor Prevention Act, June 21, 2022; The Federal Acquisition Supply Chain Security Act (FASCSA) of 2018, December 21, 2018; EO 14256: Further Amendment to Duties Addressing the Synthetic Opioid Supply Chain in the People's Republic of China as Applied to Low–Value Imports, April 2, 2025; EO 14228: Further Amendment to Duties Addressing the Synthetic Opioid Supply Chain in the People's Republic of China, March 3, 2025; EO 14200: Amendment to Duties Addressing the Synthetic Opioid Supply Chain in the People's Republic of China, February 5, 2025; EO 14228: Further Amendment to Duties Addressing the Synthetic Opioid Supply Chain in the People's Republic of China, Signed: March 3, 2025; EO 14195: Imposing Duties to Address the Synthetic Opioid Supply Chain in

sixteen bills directly related to supply chains have been introduced in the U.S. Congress[11]. Since 2017, a number of federal laws have also been passed that indirectly address the issue.[12]

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the People's Republic of China, February 1, 2025; EO 14123: White House Council on Supply Chain Resilience, June 14, 2024; EO 14017: America's Supply Chains, February 24, 2021; EO 14001: A Sustainable Public Health Supply Chain, January 21, 2021; EO 13953: Addressing the Threat to the Domestic Supply Chain from Reliance on Critical Minerals from Foreign Adversaries and Supporting the Domestic Mining and Processing Industries, September 30, 2020; EO 13943: Addressing the Threat Posed by WeChat, and Taking Additional Steps to Address the National Emergency with Respect to the Information and Communications Technology and Services Supply Chain, August 6, 2020; EO 13942: Addressing the Threat Posed by TikTok, and Taking Additional Steps to Address the National Emergency with Respect to the Information and Communications Technology and Services Supply Chain, August 6, 2020; EO 13917: Delegating Authority Under the Defense Production Act with Respect to Food Supply Chain Resources During the National Emergency Caused by the Outbreak of COVID–19, April 28, 2020; EO 13904: Ensuring Safe and Lawful E-Commerce for United States Consumers, Businesses, Government Supply Chains, and Intellectual Property Rights Holders, January 31, 2020; EO 13873: Securing the Information and Communications Technology and Services Supply Chain, May 15, 2019, EO 13817: A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, December 20, 2017.

11 See.: H.R.763: Supply CHAINS Act, 118th Congress (2023–2024); H.R.6571: Promoting Resilient Supply Chains Act of 2023, 118th Congress (2023–2024); H.R.2444: Promoting Resilient Supply Chains Act of 2025, 119th Congress (2025–2026); H.R.762: Building Resilient Supply Chains Act, 118th Congress (2023–2024); H.R.3395: U.S. Supply Chain Security Review Act of 2023, 118th Congress (2023–2024); H.R.5479: Supply CHAIN Act, 117th Congress (2021–2022); H.R.1328: Supply Chain Security and Growth Act of 2025, 119th Congress (2025–2026); H.R.2390: Maritime Supply Chain Security Act, 119th Congress (2025–2026); H.R.752: Securing Semiconductor Supply Chains Act of 2023, 118th Congress (2023–2024); H.R.6909: COBALT Supply Chain Act, 118th Congress (2023–2024); H.R.8834: Safeguarding Our Supply Chains Act, 118th Congress (2023–2024); H.R.3226: To amend the Securities Exchange Act of 1934 to require certain companies to disclose information describing any measures the company has taken to identify and address conditions of forced labor, slavery, human trafficking, and the worst forms of child labor within the company's supply chains, 114th Congress (2015–2016); S. 1358: Transaction and Sourcing Knowledge Act or the TASK Act, 119th Congress, 1st Session; S.257: Promoting Resilient Supply Chains Act of 2025, 119th Congress (2025–2026); S.4375: Promoting Resilient Supply Chains Act of 2024, 118th Congress (2023–2024); S.4651: Securing America's Federal Equipment Supply Chains Act, 118th Congress (2023–2024).

12 See.: Defense Production Act of 1950 (DPA), Public Law 81–774, 64 Stat. 798, 81st Congress, September 8, 1950; National Defense Authorization Act for Fiscal Year 2018 (FY2018 NDAA), Public Law 115–91, 131 Stat. 1332, 115th Congress, 12 December 2017; Federal Acquisition Supply Chain Security Act of 2018 (FASCSA), Public Law

Finally, these issues are also addressed in six U.S. national strategies in various areas.[13]

Following a review of federal law, government documents, and the literature, the author of this publication adopted a set of consistent criteria[14] that enabled the identification of the three most significant and dominant challenges relevant to the U.S. strategy for managing the security of global supply chains: resilience,[15] complexity[16] and volatility.[17] These challenges

115–390, 132 Stat. 5173, 115th Congress, December 21, 2018; Infrastructure Investment and Jobs Act (IIJA), Public Law 117–58, 135 Stat. 429, 117th Congress, November 15, 2021; CHIPS and Science Act of 2022 (CHIPS and Science Act), Public Law 117–167, 136 Stat. 1366, 117th Congress, August 9, 2022; Inflation Reduction Act of 2022 (IRA), Public Law 117–169, 136 Stat. 1818, 117th Congress, August 16, 2022.

13 See.: National Strategy for Global Supply Chain Security, The White House, Washington D.C., January 23, 2012; *National Security Strategy*, The White House, Washington D.C., October 12, 2022; *National Defense Strategy of the United States of America. Including the 2022 Nuclear Posture Review and the 2022 Missile Defense Review*, U.S. Department of Defense, October 27, 2022; *National Cybersecurity Strategy*, The White House, Washington D.C., March 1, 2023; *U.S. Space Force Commercial Space Strategy of 2024, Accelerating the Purposeful Pursuit of Hybrid Space Architectures*, United States Space Force, April 8, 2024.

14 Frequency of explicit or functional occurrence; challenge as a determinant of strategy, policy objective or assessment criterion in systemic documents; recurrence of the challenge across sectors and interoperability with national security.

15 Cf. Crawford Stanley Holling, „Resilience and Stability of Ecological Systems" *Annual Review of Ecology and Systematics*, Vol. IV (1973): 1-23; Yossi Sheffi, James Blayney Rice Jr., „A Supply Chain View of the Resilient Enterprise" *MIT Sloan Management Review*, No. 47 (2005): 41-48; Timothy J. Pettit, Jospeh Fiksel, Keely L. Croxton, „Ensuring Supply Chain Resilience: Development of a Conceptual Framework" *Journal of Business Logistics*, No. 1 (2010): 1-21; Andreas Wieland, Carl Marcus Wallenburg, „ The Influence of Relational Competencies on Supply Chain Resilience: A Relational View" *International Journal of Physical Distribution & Logistics Management*, No. 4 (2013): 300-320.

16 Ila Manuj, John T. Mentzer, „Global Supply Chain Risk Management" *Journal of Business Logistics*, No. 1 (2008) 133-155; Seyedmohsen Hosseini, Dmitry Ivanov, Alexandre Dolgui, "Review of Quantitative Methods for Supply Chain Resilience Analysis" *Transportation Research Part E: Logistics and Transportation Review*, No. C (2019): 285-307; Andreas Wieland, Robert B. Handfield, Christian F. Durach, „Mapping the Landscape of Future Research Themes in Supply Chain Management" *Journal of Business Logistics*, No. 3 (2016): 205-212; James Aitken, Cecil Bozarth, Wolfgang Garn, „To Eliminate or Absorb Supply Chain Complexity: A Conceptual Model and Case Stu-dy" *Supply Chain Management: An International Journal*, No. 6 (2016): 759-774.

17 Cf. Liena Kano, Rajneesh Narula, Irina Surdu, „Global Value Chain Resilience: Understanding the Impact of Managerial Governance Adaptations" *California Management Review*, No. 2 (2022). https://doi.org/10.1177/00081256211066635; Florian

are systemic, dynamic and often change over time, each contributing to the context of strategic risk and requiring a management response. Generally, complexity hinders predictability and control, variability increases the uncertainty of decisions and their prior planning, and resilience requires the ability to adapt, react, and recover quickly. Overcoming these challenges is no easy feat, but it is not impossible. As already mentioned, on the one hand, global supply chain management directly impacts the national security of the United States, and indirectly impacts global trade. It has received so much attention in federal law over the past decade that it is impossible not to establish this topic as a research objective. On the other hand, these challenges are characterized by extraordinary strategic dynamics, which encourages the study of how law adapts to a changing environment – in this case, federal law, whose goal is to maintain a global competitive advantage. This led the author of this publication to formulate the following hypothesis and attempt to verify it.

Supply chain management security is one of the most critical components of the United States' global supply chain management strategy, which can be significantly achieved by addressing three of the most significant and dominant challenges: resilience, volatility, and complexity. To confirm this hypothesis, it was necessary to answer the question of why these challenges were considered the most significant and dominant, as well as what methods are adopted in federal law for planning, implementing, and coordinating actions to address these challenges, both individually and collectively, from a systemic perspective. This, in turn, facilitated a holistic assessment of the global supply chain security management strategy in the United States.

For the purposes of this publication, a qualitative, interdisciplinary analysis was conducted, combining legal and management sciences. The publication employed non-probabilistic sampling, with a relatively small sample size consisting of several dozen legal acts (hard and soft law), directly or indirectly related to global supply chain management. The monographic method was employed, including a holistic review of the federal legal system, as well as an examination of strategically important documents, as well as official and academic documents, to establish directions for approaching global supply chain security management strategies.

Lücker, Anna Timonina-Farkas, Ralf W. Seifert, "Balancing Resilience and Efficiency: A Literature Review on Overcoming Supply Chain Disruptions" *Production and Operations Management*, No. 6 (2024). https://doi.org/10.1177/10591478241302735.

Finally, it is worth mentioning that, although the process of recognizing challenges such as resilience, complexity, and variability as the most important and dominant was subjective, the frequency of references to these concepts increased their systemic importance and reinforced the validity of this selection. The added value is the presentation of federal law regarding how artificial intelligence can be used to manage the security of global supply chains in the United States.

2 The Essence of Resilience, Variability and Complexity and their Importance for the Security Management Strategy of Global Supply Chains

While U.S. federal law does not explicitly define the concepts of resilience, variability, and complexity of global supply chains, although its characteristics are enumerated in the case of resilience, it is not difficult to formulate an explanation of their meaning in a dictionary and a description of the characteristics of these concepts. Before doing so, however, it is worth mentioning that while the term "supply chain" was first used in a 1982 Financial Times article by K. Oliver, who defined supply chain management as the process of planning, implementing, and overseeing supply chain operations as efficiently as possible, and that the supply chain encompasses the entire movement and storage of raw materials, in-process inventory, and finished goods from point of origin to point of consumption, the term was first defined in federal law in 2021 with reference to minerals[18] according to which the supply chain encompasses the exploration, extraction, concentration, separation, alloying, recycling, and reprocessing of minerals.[19]

18 See.: § 6 (e) EO 14017; § 8 (b) EO 13953, which contain identical definitions of the supply chain.

19 Arnold Kransdorff, „The Management Page: High Stock Levels – Not the Answer – Arnold Kransdorff reports on «Supply Chain Management»" *The Financial Times*, (1982): 16.

2.1. Resilience of Global Supply Chains

In the dictionary, resilience means the ability to resist something, not to yield to some action, pressure, or influence.[20] For example, Martin Christopher, and Helen Peck defined resilience as the ability of a system to return to its original state or to transition to a new, more desirable state after a disruption, while Y. Sheffi perceived resilience through the prism of an organizational capability that provides competitive advantage.[21] Importantly, § 1 of EO 14123 assumes that more resilient supply chains are secure and diverse, and that the characteristics of resilient supply chains include: 1) greater domestic production, 2) a diverse and agile supplier base, 3) built-in redundancies,[22] 4) a reliable transportation system, 5) secure critical infrastructure, 6) adequate inventories, 7) secure and protected data networks, 8) reliable food systems, and 9) a world-class, globally competitive American manufacturing base and workforce. This provides a definition of supply chain resilience. Interestingly, combining these characteristics in various configurations allowed us to identify eight characteristics of strategic supply chain resilience:

- diversification – avoiding excessive dependence on one supplier or one country, and mitigating the risk of supply chain disruption (feature from points 2, 3, 6, 8);[23]
- production localization/friend-shoring – the ability to shorten supply chains and relocate key production to the United States or allied countries (features from points 1 and 9);

20 *Mały słownik języka polskiego*, ed. Stanisław Skorupka, Halina Auderska, Zofia Łempicka (Warszawa: Państwowe Wydawnictwo Naukowe, 1969), 490.

21 See.: Martin Christopher, Helen Peck, „Building the Resilient Supply Chain" *International Journal of Logistics Management*, No. 2 (2004): 4; Yossi Sheffi, *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage* (Boston: MIT Press, 2005), 15; Martin Christopher, *Logistics and Supply Chain Management* (London: Pitman Publishing, 1992), 24. Cf. Mateusz Zaczyk, „Strategie budowania i wzmacniania odporności łańcucha dostaw – przegląd teoretyczny" *Zeszyty Naukowe Politechniki Śląskiej, Organizacja i Zarządzanie*, No. 99, (2016): 629-640.

22 In the context of supply chains, redundancy means the strategic use of spare capacity and inventory to manage disruptions. See.: Christopher, Peck, „Building the Resilient", 4.

23 See.: § 1 EO 14017; § 4 (e) EO 14123.

- transparency and monitoring – access to real-time information, enabling rapid response (features from points 2, 4, 6, 7, 8, and 9);[24]
- immediate adaptation – the ability to quickly redirect or transform supply chains in crisis situations (features from points 2, 3, and 9);
- cybersecurity and physical security – protection of the physical infrastructure of supply chains and their cyberspace (features from points 5 and 7);
- interagency coordination – regulatory coherence and effective coordination of federal actions (features from points 5, 4, 6, 8, and 9);
- resource sovereignty – resource independence for strategic sectors (features from points 1, 2, 6, 8, and 9);
- strategic risk management – integration of risk management into supply policy (all of the above-mentioned features).

2.2. The Complexity of Global Supply Chains

In the dictionary, meaning, complexity means that something consists of many parts and elements.[25] In the literature on the subject, it is assumed that the complexity of supply chains should be understood as the level of detail, complexity and dynamic complexity demonstrated by the products, processes and relationships that make up the supply chain.[26] Federal law does not explicitly address the complexity and variability of supply chains, including strategic features. However, the following is a list of specific legal standards, from which these features were extracted, and their source indicated:

- multi-layered nature – geographical or supplier concentration and their dependence on lower levels of the supply chain (subcontractors);[27]

24 See.: § 4 (c)(v)(C) EO 14017; § 4 (c) EO 14123.
25 *Mały słownik*, ed. Skorupka, Auderska, Łempicka, 1010.
26 Christian L. Rossetti, Donald P. Warsing, Barbara B. Flynn, Cecil C. Bozarth, „Complex and Lean or Lean and Complex? The Role of Supply Chain Complexity in Lean Production" *Operations Management Research*, Vol. XVI (2023): 1382-1412.
27 See.: § 4 (c)(v)(C) EO 14017; § 4 (c) EO 14123.

- cross-border – exclusive or dominant supply of key goods and materials through or via countries that are, or may become, hostile or unstable;[28]
- sectoral and functional diversity – the need to prepare reports for the White House Council on Supply Chain Resilience across various areas and sectors (e.g., defense industry, public health, information and communications technology, energy, transportation, and agriculture and food production, resulting in functional and sectoral complexity);[29]
- technological variability – the need to foster competitive advantage in research and development, encourage innovation, and implement reforms in education and the workforce necessary to strengthen the domestic industrial base, especially in sectors with a high rate of technological change and sensitivity to innovation (e.g., semiconductors);[30]
- lack of full visibility – the need to identify gaps in domestic production capabilities, including those that are nonexistent, expired, at risk, or constitute a single point of failure, as well as in data, especially delivery on-time indicators;[31]
- diverse legal norms and standards and their certification process – the need to meet digital and industrial security standards, including those vis-à-vis the differing standards of other countries;[32]
- unpredictable interactions – potential disruptions, strains, compromises, or even elimination of supply chains, as well as other stressors impacting supply chains in a disruptive and difficult-to--coordinate manner, including defense, intelligence, cyber, health, climate, environmental, natural, market, economic, and geopolitical factors;[33]
- information asymmetry – the need to integrate dispersed and asymmetric knowledge and data on supply chains and coordinate analytically, particularly between the federal government and external

28 See.: § 4 (c)(v)(E) EO 14017; § 4 (e)(ii) EO 14123.
29 See.: § 4 (a) EO 14017; § 4 (e)(ii) EO 14123.
30 See.: § 3 (b)(i) EO 14017; § 1 and 4 (e)(vi) EO 14123.
31 See.: § 4(c)(v)(B) EO 14017; § 4 (e) EO 14123.
32 See.: § 1 EO 14017; § 4 (e)(v) EO 14123.
33 See.: § 4 (c)(iv) EO 14017; § 1 EO 14123.

stakeholders, including industry, academia, NGOs, local communities, labor unions, and state and local governments.[34]

2.3. Volatility of global supply chains

In dictionary terms, volatility is a state that is subject to periodic changes or fluctuations.[35] According to Hau L. Lee, volatility in supply chains refers to frequent and unpredictable fluctuations in demand, supply or lead times that cause uncertainty in supply chain operations.[36] In strategic terms, Martin Christopher and Matthias Holweg adopted the following definition of volatility: "volatility in global supply chains is the dynamic and unpredictable nature of interrelated external shocks (e.g. economic, political, environmental) that affect the cross-border flow of materials, information and finance."[37] The following characteristics of volatility have been identified in federal law, along with their sources:

- geopolitical volatility – volatility in the international environment as a result of geopolitical and economic competition and disputes within it may reduce critical production capacities and the availability and integrity of critical goods, products and services;[38]
- regulatory and customs volatility – the need to set priorities in industrial sectors, taking into account changes in legal and customs standards, and their unpredictability caused by constant volatility;[39]
- market-driven volatility – the need to identify market and economic risks as variables affecting the stability of supply chains and

34 See.: § 2 EO 14017; § 4 (c)(i) EO 14123.

35 *Mały słownik*, ed. Skorupka, Auderska, Łempicka, 1013.

36 Hau L. Lee, „Aligning Supply Chain Strategies with Product Uncertainties" *California Review Management*, No. 3 (2002): 105-119; Łukasz Marzantowicz, „Niepewność i nieprzewidywalność w łańcuchu dostaw – rozważania teoretyczne" *Nauki o Zarządzaniu*, No. 2 (2017): 62-70.

37 Martin Christopher, Matthias Holweg, „«Supply Chain 2.0»: Managing Supply Chains in the Era of Turbulence" *International Journal of Physical Distribution & Logistics Management*, No. 1 (2011): 63–82.

38 See.: § 1 EO 14017; § 1 EO 14123.

39 See.: § 4 (c)(viii) EO 14017; § 4 (e)(v) EO 14123.

to increase supply flexibility and adaptation to changing market conditions;[40]

- technological volatility – the need to identify risks related to the rapidly changing technological landscape affecting the volatility and dynamics of solutions in supply chains, including dependence on advanced technologies and the need to acquire new skills;[41]
- climate and environmental variability – the need to identify climate, environmental and natural risks affecting the availability of goods, including critical goods, and their production or transport;[42]
- institutional/contractual variability – the need to continuously analyse legal relationships arising from contracts, and to take into account the possibility of breaches of trust and transparency in public institutions, destabilising the market environment, including conflicts of interest, corruption or other illegalities;[43]
- infrastructure and logistics volatility – the need to identify risks related to insufficient redundancy and reliability;[44]
- cost variability – the need to take into account cost variability, including the impact of labour costs, the environment and economic policy as cost drivers in supply chains, as well as the impact of operating costs, investment incentives and public procurement on the profitability of maintaining them.[45]

40 See.: § 4 (c)(iv) EO 14017; § 1 EO 14123.
41 See.: § 4 (c)(iii) EO 14017; § 1 EO 14123.
42 See.: § 4 (c)(iv) and 4 (c)(v)(J) EO 14017; § 4 (e)(vii) EO 14123.
43 See.: § 4 (c)(v)(C) EO 14017; § 4 (e)(iii) EO 14123.
44 See.: § 4 (c)(v)(I) EO 14017; § 1 EO 14123.
45 See.: § 1 EO 14017; § 4 (e)(i) EO 14123.

3 Planning, Implementing, and Coordinating Actions Related to Resilience, Complexity, and Variability in Global Supply Chain Security Management

3.1. Planning Actions Regarding the Resilience, Complexity and Variability of Global Supply Chains

As already mentioned, supply chain management is the process of planning, implementing, and supervising the supply chain. Therefore, this section discusses the activities that make up the individual stages of the management process, for each challenge separately, which have been identified in federal law. Planning involves defining future goals and tasks, and how to achieve them. With regard to supply chain resilience, the following actions have been identified: reviewing chains in four key sectors (pharmaceuticals, semiconductors, batteries, minerals)[46]; identifying risks in supply chains[47]; assessing the United States' ability to efficiently rebuild chains after disruptions[48]; assessing the risk and resilience of critical supply chains, especially in the medical, energy and communications sectors[49]; planning for the priority allocation of resources in crisis situations[50]; planning investments to increase industrial capacity to mitigate future disruptions in supply chains[51]; funding research and development and planning for microprocessor manufacturing sovereignty[52]; funding research and development and planning for microprocessor manufacturing sovereignty; identifying gaps and dependencies on hostile entities (e.g., PRC, the Russian Federation)[53]; planning for risk assessment in federal IT and telecommunications equipment procurement.[54]

In the case of planned actions regarding the complexity of supply chains, the need to take the following actions has been identified: coordination between agencies to enable the assessment of complex global supply

46 See.: § 1 EO 14017.
47 See.: § 4 (a) EO 14017.
48 See.: § 4 (b) EO 14017.
49 See.: § 2 (a)(i) EO 14123.
50 See.: § 4511 DPA.
51 See.: § 4531–4534 DPA.
52 See.: § 102 (a)(1) CHIPS and Science Act.
53 See.: § 807 (a)(2) FY2018 NDAA.
54 See.: § 207 and § 437(i) FASCSA.

links[55]; analysis of international dependencies in the context of strategic raw materials[56]; mapping the structure of global supply chains and their cross-sector dependencies[57]; mapping global geostrategic dependencies in microprocessor chains (e.g. Taiwan, Korea)[58]; planning a digital supply chain map for defence[59]; analysing vulnerability to foreign chains (e.g. Chinese green energy components).[60] In turn, the planned actions regarding supply chain volatility include: taking into account factors of sudden change, including pandemics, conflicts, cyber threats[61]; monitoring fluctuations in supply and demand[62]; forecasting disruptions and "what-if" scenarios, as well as identifying variable geopolitical and climatic factors[63]; mapping risks related to raw materials (steel, concrete, batteries).[64]

3.2. Implementing Measures to Address the Resilience, Complexity and Volatility of Global Supply Chains

The next stage of the supply chain management process is implementation, i.e. putting something into practice. Federal law distinguishes the following measures to be implemented with regard to supply chain resilience: implementation of recommendations from sectoral reviews (e.g. diversification of sources, location of production)[65]; strengthening national reserves[66]; promoting investment in infrastructure and internal production capacity[67]; supporting direct investment in the production of strategic components (e.g. microelectronics, batteries)[68]; expanding infrastructure

55 See.: § 2 EO 14017.
56 See.: § 4 (c) EO 14017.
57 See.: § 2 (b) EO 14123.
58 See.: § 102(b) CHIPS and Science Act.
59 See.: § 807 (c)(1) FY2018 NDAA.
60 See.: § 13801 IRA.
61 See.: § 1 (c) 14017.
62 See.: § 5 EO 14017.
63 See.: § 2 (c) EO 14123.
64 See.: § 60201 IIJA.
65 See.: § 6 (a) EO 14017.
66 See.: § 4 (d)(i) EO 14017.
67 See.: § 3 (b) EO 14123.
68 See.: § 4533 DPA.

for local supply chains (e.g. railways, energy networks)[69]; subsidies and tax breaks for the construction of semiconductor factories[70]; implementing subsidies and tax credits for clean tech production[71]; implementing so-called exclusion orders.[72]

Actions to be implemented in relation to the complexity of supply chains include: creating value chain maps in critical sectors and analysing so-called "choke points"[73]; supporting technology and data interoperability[74]; an integrated approach by federal agencies, including joint initiatives and harmonised requirements[75]; implementing tools for tracking components (sensor-to-system) and visualising complex flows.[76] In turn, the specific actions to be implemented with regard to volatility consist of: developing contingency scenarios in critical sectors[77]; support for small suppliers (reducing the domino effect)[78]; making supply sources more flexible by encouraging diversification of partners and materials[79]; making contractual instruments more flexible to enable rapid adjustment of the chain in response to changing threats[80]; adapting purchases to global disruptions[81]; supporting the reshoring of production (EVs, solar panels, batteries)[82]; establishing procedures for excluding risky suppliers (Huawei, ZTE).[83]

69 See.: § 40201 IIJA.
70 See.: § 103 (a) CHIPS and Science Act.
71 See.: § 13101–13106 IRA.
72 See.: § 838 (e) FASCSA.
73 See.: § 4 (d)(ii) EO 14017.
74 See.: § 4 (d)(iii) EO 14017.
75 See.: § 3 (a) EO 14123.
76 See.: § 807 (d)(1) FY2018 NDAA.
77 See.: § 4 (d)(iv) EO 14017.
78 See.: § 4 (d)(v) EO 14017.
79 See.: § 3 (d) EO 14123.
80 See.: § 4554 DPA.
81 See.: § 40201–40601 lub Sec. 60105 IIJA
82 See.: § 60105 IRA.
83 See.: § 839(a) FASCSA.

3.3. Coordinating Actions Regarding the Resilience of Global Supply Chains in Terms of Complexity and Variability

The final stage of the supply chain management process is coordination, which should be understood as combining activities that enable them to be carried out jointly by many people or institutions in order to achieve the desired effect in the shortest possible time, with the least possible expenditure, and with the optimal use of resources. The following activities related to the coordination of supply chain resilience have been identified in federal law: the establishment of a Supply Chain Disruptions Task Force[84]; establishment of permanent interdepartmental oversight and public-private partnerships[85]; dynamic reporting mechanisms, real-time monitoring of changes (e.g., dashboards within the Supply Chain Management Subcommittee)[86]; cooperation with allies and partners to increase resilience[87]; maintaining the ability to respond to fluctuations and disruptions through interoperable data platforms.[88] In the case of activities related to complexity, it was assumed that these are: data integration between sectors and agencies[89]; cooperation with international partners (e.g. the EU, Japan) in managing complexity[90]; creation of consistent standards and interoperability[91]; coordination between agencies in implementing the Defence Production Act (Department of Defence, Department of Homeland Security, Department of Energy)[92]; coordination between the public sector (National Institute of Standards and Technology, National Science Foundation) and the private sector (Intel, TSMC)[93]; coordination at federal, state, and local levels in investments[94]; industrial partnerships and regional raw material alliances (e.g. U.S.–Canada)[95]; inter-agency coordination in risk assessments (Department of Homeland

84 See.: § 6 EO 14017.
85 See.: § 6 (b) EO 14017.
86 See.: § 4 (a) EO 14123.
87 See.: § 4 (c) EO 14123.
88 See.: § 807 (e) FY2018 NDAA.
89 See.: § 4 (f) EO 14017.
90 See.: § 4 (g) EO 14017.
91 See.: § 4 (b) EO 14123.
92 See.: § 4552 DPA.
93 See.: § 102 (d) CHIPS and Science Act.
94 See.: § 30301 IIJA.
95 See.: § 61401 IRA.

Security, General Services Administration, The Office of Management and Budget).[96]

Finally, recent activities involving coordination with variability include: dynamic updates to business continuity plans[97]; establishment of rapid response mechanisms[98]; development of early warning indicators; dynamic reporting mechanisms and real-time monitoring of changes (e.g. dashboards within the Supply Chain Management Subcommittee)[99]; public-private partnerships in responding to threats (e.g. COVID, semiconductors)[100]; management of dynamic technology sector investments and their global dependencies[101]; sharing of data and standards among contractors, federal agencies, and international partners[102]; integration with private suppliers and fund recipients[103]; coordination between the Internal Revenue Service and the Department of Energy and private companies in enforcing site requirements[104]; and mechanisms for dynamic response to new supplier threats.[105]

4 Summary

Although the process of selecting the three most significant and dominant challenges for global supply chains – resilience, variability, and complexity – was based on the author's knowledge and experience, and thus, naturally, was somewhat subjective, the frequency of legislators' references to these concepts validated this selection. Resilience was used most frequently, explicitly, and even federal law enumerates its characteristics, while complexity and variability were defined indirectly through their description. Importantly, these challenges are not only determinants of political goals,

96 See.: § 842 (a) FASCSA.
97 See.: § 5 (b) EO 14017.
98 See.: § 5 (c) EO 14017.
99 See.: § 4 (a) EO 14123.
100 See.: § 4558 DPA.
101 See.: § 106 CHIPS and Science Act.
102 See.: § 807 (d)(2) FY2018 NDAA.
103 See.: § 60601 IIJA.
104 See.: § 45Y (d) IRA.
105 See.: § 842 (e) FASCSA.

national strategies, and systemic documents; they have also become part of U.S. federal law. While the challenges of resilience, complexity, and variability appear to be used in a fragmented manner in federal law, there is no doubt that, holistically, they constitute a coherent, cross-sectoral, and structured whole. These challenges are significant and pervasive, as this publication presents a series of mechanisms for addressing resilience, complexity, and variability, developed and adopted in response to these three challenges. It is also impossible to ignore the fact that resilience, complexity, and variability impact the public interest, defense, and critical infrastructure, and therefore, their connection to national security is unquestionable.

A review of the identified activities in the planning phase of the supply chain management process reveals that federal law considers planning to encompass a range of analytical and predictive activities, particularly in critical strategic sectors. In the implementation phase, which is significantly more dynamic than planning, attention is drawn to the relationship between federally regulated mandates or prohibitions on specific behavior and market incentives. More specifically, the legislator attempted to influence the addressees of legal norms through market incentives rather than repressive measures. While some legal obligations are regulated by executive orders of the President of the United States with the force of statute, which do not require the entire legislative process as with federal legislation, and therefore proceed more efficiently, examining the scope and pace of their implementation, and thus assessing the effectiveness of the law in action, should be deferred, if only due to their complexity. This is not even about the impact on the addressees of legal norms, but rather the holistic impact of federal law on the global environment. Finally, coordination efforts have been significantly intensified following the start of the trade war in 2018 and the COVID-19 pandemic, for example, through the aforementioned establishment of the Supply Chain Disruptions Task Force, which is intended to serve as a central hub for managing the supply-demand balance.

A review of the identified planning activities revealed that sectoral and scenario analysis played a significant role in resilience, mapping geostrategic dependencies in complexity, and disruption forecasting and risk analysis in variability. Building national capacity and reshoring play a key role in implementing resilience-related activities. Ensuring interoperability and IT tools were paramount in implementing resilience-related activities. In the case of variability, logistics and contract flexibility were paramount.

Coordinating resilience-related activities, coordination of public-private and international partnerships was paramount. Integrating data within and with the private sector proved crucial in addressing complexity. Finally, early warning and adaptive management became crucial in addressing variability. This suggests that federal law has adopted a dispersed set of legal standards, shaping a coherent strategy for managing the security of the United States' global supply chains. This security is to be ensured by addressing the three most significant and dominant challenges: resilience, variability, and complexity.

One might subjectively feel that, so far, the most attention and progress has been made in planning and implementing resilience measures, particularly in the semiconductor, energy, and pharmaceutical sectors. The situation is less positive when it comes to volatility, as the extent of unpredictability and the complexity of the geopolitical and climatic environment require aggressive reinforcement of adaptive security management of global supply chains. In other words, the establishment of mechanisms for automatic, real-time adjustment to changing conditions and learning from experience would be most desirable. This is important because, in the complex supply chain environment, a system of interconnected vessels, digital tools, and data interoperability frameworks are essential, and consequently, data coordination, in every possible configuration, is crucial.

Although the subject of this publication is not the use of artificial intelligence (AI) in managing the security of global supply chains, it is of significant importance, especially in the context of the results of research on the use of AI by the federal administration, which led the author of this publication to belief that the current model of data management in the federal administration is being transformed into a neural model of data management using AI, in which a single organizational unit of the federal administration would function, in the future – to put it very simply – according to the pattern of an artificial neuron, constructed on the model of a natural neuron, and the entire federal administration would correspond to the structure of an artificial neural network.[106]

Interestingly, federal law has adopted a number of legal standards that provide a basis for the use of AI in managing the security of global supply chains. Specifically, risk management to improve the federal government's

106 Robert Lizak, *Prawne aspekty neuronowego modelu zarządzania danymi w administracji federalnej Stanów Zjednoczonych z wykorzystaniem AI* (Warszawa: C.H. Beck, 2024).

ability to characterize, monitor, predict, and respond to specific supply chain threats and vulnerabilities,[107] as well as enhancing the predictive capabilities of federal agencies in supply chains and logistics, including predicting food demand and optimizing supply, medical supplies and equipment demand and optimizing supply, and predictive logistics to accelerate disaster preparedness, response, and recovery[108]. Finally, the commitment in federal law to ensure cybersecurity and physical supply chain security related to AI infrastructure and the deployment of advanced nuclear technologies and related supply chain services abroad cannot be ignored.[109]

While this requires in-depth analysis, it is initially reasonable to suggest that a consolidated legislative and regulatory offensive is underway in the United States around managing the security of global supply chains using AI, particularly by addressing challenges such as resilience, complexity, and volatility. The goal of this offensive is not only to ensure supply chain security, including assessing systemic and strategic risks, maintaining the coherence of regulatory and institutional frameworks, and improving operational and adaptive capacity, but also to rebalance the current global map of U.S. supply chains, taking into account international allied solidarity.[110] However, the scope of this solidarity and its practical implications, in terms of sources, routes, and supply chain participants, remain to be explored, particularly given the threats posed by the PRC and the Russian Federation.

This thesis is supported by U.S. policy in its legal, strategic, technological, and geopolitical dimensions. For example, first, EO 14017 initiated a systematic approach to analyzing vulnerabilities and risks in critical sectors; the CHIPS and Science Act established unprecedented support for the semiconductor industry as the core of technological autonomy; and the IRA and IIJA redefined supply sources (reshoring/nearshoring) and infrastructure digitization. Second, AI was recognized as a key tool for identifying, forecasting, and managing resilience, complexity, and variability.[111] Thirdly, federal has adopted that allow for the restriction of

107 See.: § 7 (c) Advancing American AI Act (AAAA), 117th Congress, Public Law 117–270, S. 1353. December 19, 2022.

108 See.: § 6 (b)(6)(A) AAAA.

109 EO 14141: Advancing United States Leadership in Artificial Intelligence Infrastructure, January 14, 2025.

110 Cf. Mariusz Muszyński, „Solidarność międzynarodowa: między polityką a prawem" *Prawo i Więź*, No. 3 (2016): 7-21.

111 See.: „Roles and Responsibilities Framework for Artificial Intelligence in Critical Infrastructure", U.S. Department of Homeland Security, In Consultation

access by certain countries to key components of the economy and critical infrastructure in the U.S.,[112] and promotes activities such as "friend--shoring" and "selective decoupling", which are intended to enable the redistribution of routes and participants in supply chains, and ultimately, decoupling from dependence on the PRC and the Russian Federation.[113]

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112 The Foreign Investment Risk Review Modernization Act of 2018, H.R.5841, 115th Congress, 2nd Session, June 27, 2018; The Export Controls Act of 2018, 115th Congress, Public Law 115–232, 132 Stat. 1636, August 13, 2018. Cf.: Robert Lizak, Sebastian Skuza, „Protecting risk management strategies for foreign investment in the United States from a national security perspective" *Central European Management Journal*, (2025). https://doi.org/10.1108/CEMJ-12-2024-0384.

113 Cf.: „Memorandum on the Establishment of the Countering Economic Coercion Task Force", The White House, December 12, 2024; „U.S.–China Economic and Security Review Commission", Report to Congress, Executive Summary and Recommendations, 118th Congress, 2nd Session. November 2024; EO 14105: Addressing United States Investments in Certain National Security Technologies and Products in Countries of Concern, August 9, 2023; EO 13873.

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