

THE IMPACT OF EMERGING TECHNOLOGIES ON SUPPLY CHAIN MANAGEMENT IN THE MILITARY ORGANIZATION

Robert-Cristian TRIF

"Lucian Blaga" University of Sibiu (robertcristian.trif@ulbsibiu.ro)

DOI: 10.19062/1842-9238.2023.21.2.12

Abstract: *This paper provides a general exploration of the transformative impact of emerging technologies on supply chain management in the military organization. It highlights the integration of advanced technologies such as artificial intelligence (AI), blockchain and autonomous systems, highlighting their profound effects on improving operational efficiency, security and real-time supply chain management. The study assesses the balance between improved logistics capabilities and the complexities introduced by these technologies, including concerns about dependency and cyber security.*

Through a technological innovation perspective, the paper proposes a conceptual framework of military supply chain management, proposing a future-oriented strategy for supply chain management in the military organization in an adaptive and resilient manner. This research is essential in understanding the synergy between cutting edge technology and military logistics in the modern era.

Keywords: *management, supply chain, artificial intelligence, emerging technologies, military organization*

1. INTRODUCTION

In the ever-evolving landscape of global military operations, the effectiveness and resilience of supply chain management are critical factors that determine the success of military efforts. The research analyzes the paradigm shift that military logistics has undergone following the emergence and implementation of emerging technologies within it. Traditional logistics frameworks, once constrained by manual processes and procedures, limited real-time data, are now being revolutionized by adopting advanced technological solutions. The introduction of artificial intelligence (AI), blockchain technology and autonomous vehicle systems, as well as automated decision-making processes, has not only improved the operational efficiency of military supply chains, but also redefined the paradigms of security, accuracy and speed in logistics management.

The significance of this development cannot be underestimated, as military logistics forms the backbone of any military operation, ensuring the timely delivery of essential resources, from weaponry to basic necessities for military personnel. Integrating these cutting-edge technologies into military logistics is not just a matter of modernizing systems, but a critical shift toward a more agile, secure, and cost-effective supply chain capable of meeting the dynamic demands of modern warfare. However, this technology integration also brings new challenges, including managing complex systems, the need for specialized training, and concerns about cybersecurity and technology dependency.

The paper aims to provide an analysis of the impact of these emerging technologies on military logistics management. The objective is not only to understand how technology is reshaping military logistics, but also to forecast future trends and challenges in this field through a bibliometric analysis.

In addition, it is intended to explore the strategic implications of these technological advances on military competitiveness and readiness. It investigates how the integration of these technologies can lead to a paradigm shift in the power dynamics of military conflicts, where logistical prowess increasingly dictates operational success. Furthermore, the study explores into the ethical and geopolitical considerations surrounding the adoption of such technologies, highlighting the need for a balanced approach that protects both efficiency and integrity in military operations.

2. CURRENT STATUS AND TRENDS IN THE FIELD OF RESEARCH

The field of military supply chain management has been the subject of extensive academic scrutiny and research, thus reflecting its critical role in ensuring the effectiveness and efficiency of military operations. This chapter presents a bibliometric analysis of the existing literature on military supply chains with the aim of systematically mapping the academic landscape and identifying key trends, thematic developments and research gaps in this field. As global military strategies increasingly depend on the robustness and agility of supply chain systems, understanding the amplitude and depth of academic research in this area becomes imperative.

Bibliometric analysis, a quantitative approach to literature review, provides a unique perspective to view the field of military logistics. By analyzing data from a multitude of research papers, this chapter uncovers patterns and relationships, such as the most influential authors, essential publications, and dominant research themes that have shaped the understanding of military supply chains over time. In addition, it aims to identify emerging topics and technologies that are gaining ground in the academic community, thereby providing insights into future research and development directions.

The focus on military supply chains is particularly relevant at a time when technological advances, geopolitical shifts, and evolving military doctrines are continually reshaping the logistics landscape. This bibliometric review not only serves as an essential tool for academics and researchers to navigate the vast literature, but also assists military strategists and policy makers in understanding the historical context and future trajectories of supply chain management in military.

Using the search term: subject: ("military") AND ("chain of supply ") in the Scopus database resulted in a total of 985 scientific papers, including literature from the beginning of the 21st century.

Bibliometric analysis applies mathematical, statistical, and visual methods to summarize research patterns and trends in scientific publications. Using the metadata from the Scopus database and the visualization software VOSviewer, a map was created that illustrates the structure of the knowledge domain. Co-occurrence, a method frequently used in scientometric analyzes for various purposes such as co-authorship and co-citation, was applied. From the sample of examined articles, which includes 6982 keywords, 677 keywords with more than 3 co-occurrences were selected, resulting in 23031 connections in 6 clusters. These connections are represented on the map by circles, the size of which varies according to the frequency of occurrence, and they are connected by lines that highlight the strength of the connections between them.

It also presents a clear visual perspective on how different topics are interconnected, giving researchers and practitioners a foundation to build on the fertile intersections between diverse fields of interest.

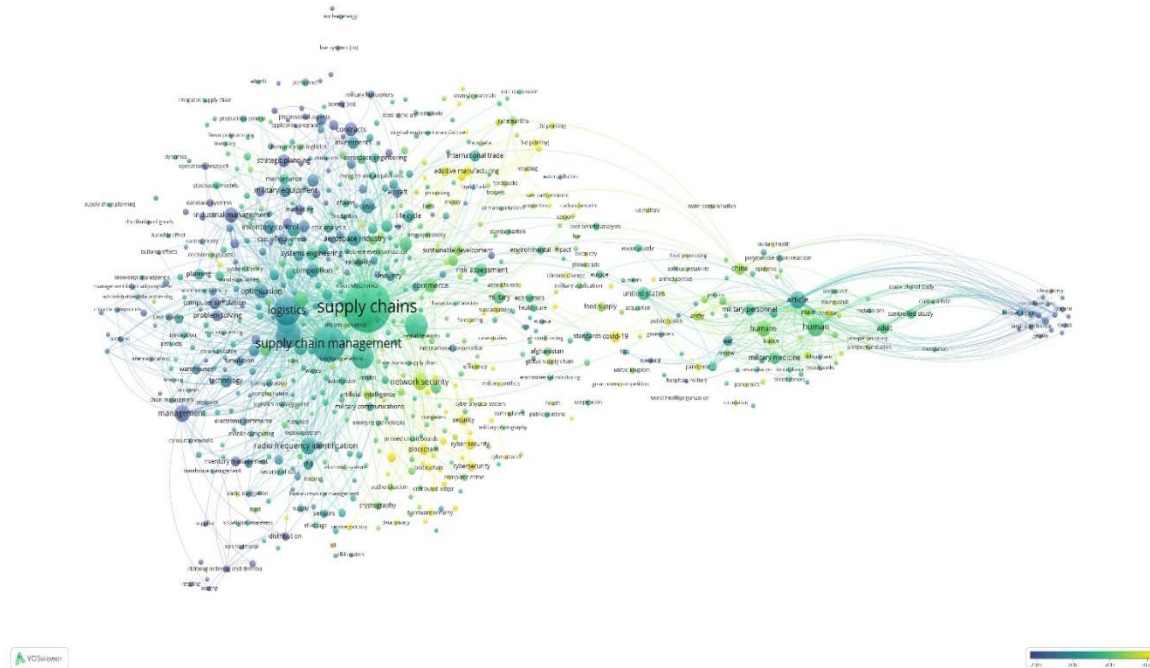


FIG. 2. Map of co-occurrence networks - temporal perspective

The timelines at the bottom of the map suggest the evolution and growth of interest in certain topics over time. For example, we can infer that interests have shifted from traditional supply chain management topics to topics dealing with the impact of emerging technologies and global issues such as pandemics, renewable energy issues or sustainability, signaling changes in the real world and how they influence academic research.

At the same time, performing an analysis of the co-occurrence of key words, we arrived at the following graph, see Fig. 3. From the results obtained from the number of occurrences of the keywords, we will present the first 20 words with the highest number of occurrences in the analyzed sample.

Among the first words in terms of number of occurrences we have " supply chains " with 355 occurrences and " supply chain management " with 177 occurrences. The "logistics" domain proves its importance, being the basic domain of the supply chain. In the same way, the word "military operations" implies the vision of an interconnected whole that is to be represented using models and the application of artificial intelligence techniques. The words "artificial intelligence" (83 occurrences), "decision-making" (51 occurrences), and "network security" (34 occurrences) are core terms in current research on the implementation of emerging technologies in the military environment.

At the end of this chapter dedicated to the bibliometric study, we can affirm that the in-depth analysis of the specialized literature, carried out through the prism of the bibliometric and scientometric methodologies, offered a comprehensive perspective on the current contours and the evolution of the dynamics in the studied field. Visualization tools, such as VOSviewer, allowed not only to map the relationships between different concepts and key terms, but also to observe how these interconnections developed over time, reflecting paradigm shifts and the advance of knowledge.

By identifying thematic clusters and evaluating the co-occurrence of keywords, we were able to detect both well-established domains and emerging niches, thus opening new horizons for future research. This analysis has been particularly valuable in highlighting areas where scholarly dialogue is most intense, as well as pinpointing areas that, to date, have been less explored.

The bibliometric study contributes significantly to the understanding of the structure and trajectory of research in our area of interest, enriching the theoretical foundation and indicating future directions of investigation.

| No. | Key word | Co-occurrence | Number of links |
|-----|---------------------------------------|---------------|-----------------|
| 1 | Supply chains | 355 | 2549 |
| 2 | Supply chain management | 177 | 1397 |
| 3 | Logistics | 107 | 902 |
| 4 | Military operations | 94 | 809 |
| 5 | Artificial intelligence | 83 | 502 |
| 6 | Military applications | 76 | 562 |
| 7 | Decision making | 51 | 515 |
| 8 | Human | 46 | 513 |
| 9 | Article | 40 | 477 |
| 10 | Radio frequency identification (rfid) | 38 | 327 |
| 11 | Management | 37 | 423 |
| 12 | Military logistics | 34 | 211 |
| 13 | Military supply chains | 34 | 232 |
| 14 | Network security | 34 | 298 |
| 15 | People | 32 | 358 |
| 16 | Industrial Management | 31 | 303 |
| 17 | Aerospace industry | 30 | 240 |
| 18 | Optimization | 30 | 261 |
| 19 | Costs | 29 | 218 |
| 20 | Inventory control | 26 | 235 |

FIG.3. Co-occurrence of keywords

3. THE USE OF EMERGING TECHNOLOGIES WITHIN THE MILITARY ORGANIZATION

One of the main areas of activity and interest in the new era is the use and implementation of blockchain technology in logistics processes. Blockchain is a distributed ledger technology, best known for its role in underpinning digital currencies such as Bitcoin. It provides a secure and decentralized way to record transactions and information in a digital blockchain, where each block contains a number of transactions. Key features of blockchain include:

- Decentralization: unlike traditional systems where data is stored centrally, blockchain distributes data across a network of computers, thus eliminating the need for a central authority and reducing the risk of data manipulation or corruption.
- Security: Each block in the chain is encrypted and linked to the previous block by a cryptographic process, making it nearly impossible to retroactively change records without affecting all subsequent blocks.
- Transparency: Although the data is secure, the blockchain allows visibility of transactions for all users of the network, ensuring a high degree of transparency.

- **Immutability:** Once a transaction is recorded in the blockchain, it cannot be deleted or altered, thus providing a permanent and verifiable record of transactions.

- **Consensus:** transactions must be validated by network nodes through processes such as "proof of work" or "proof of stake", ensuring majority agreement on the validity of transactions.

Blockchain has various applications beyond cryptocurrencies, including supply chain management, electronic voting, digital identity, smart contracts and more, providing solutions for recording and sharing data in a secure and transparent manner.

At the same time, the blockchain is studied and implemented in various ways, considering its qualities and capacities for data processing and processing, but, most importantly, the capacity of its immutability and the security of each individual block.

| Field | Specific uses |
|--|--|
| Communications (C4ISR) | Encryption of communications Credential management |
| Command and Control (C2) | Management of orders of battle Digital verification of battle orders |
| Military intelligence | Confidential payments Management of information and sources, their encryption and storage |
| Military logistics | Supply chain management Inventory management 3D printing Fleet management (land, sea, air, rail, space) Management of critical infrastructures |
| Instruction | Management of career/personal files |
| Terrorism and counter-terrorism | Tracking, locating and alerting |

FIG. 4. Domains and modes of use [5]

In today's context, where the security and efficiency of military logistics are essential, blockchain technology offers innovative solutions to meet these challenges. Through its decentralized and immutable nature, blockchain can transform the way information and resources are managed in the military. The use of blockchain in military logistics brings an increased level of security, reducing the risks associated with cyber-attacks and data manipulation. Every transaction or movement of resources recorded on a blockchain is verifiable and transparent, thus facilitating better control over supply chains.

Furthermore, blockchain technology can improve efficiency by automating processes through smart contracts. These self-executing contracts can trigger automated resource deliveries or payments based on meeting pre-defined conditions, reducing administrative time and effort. Additionally, blockchain's immutability feature ensures data integrity, a crucial aspect in situations where the accuracy of information can have major strategic implications.

Another important advantage is the improved traceability of resources. In a military environment, where every component, from equipment to supplies, must be precisely tracked, blockchain provides an efficient method of maintaining a detailed record of movements and inventories. This not only increases accountability, but also optimizes inventory management.

At the same time, we can use this technology in:

- **Supply Chain Management for Sensitive Equipment:** Blockchain can be used to ensure the integrity of the supply chain of sensitive and critical equipment, such as weaponry or communications technology. By using blockchain, every stage of the supply process - from production to delivery - can be recorded in a way that does not allow data to be tampered with.

This not only ensures full traceability of the equipment, but also reduces the risk of interception or counterfeiting [3].

- **Securing Operational Communications and Data:** Operational communications and data are vital to the success of military missions. Blockchain can be used to create encrypted communication networks where messages are securely recorded and can only be accessed by authorized entities. This system prevents unauthorized interception and ensures that information remains confidential and protected from unauthorized access.

- **Improving Humanitarian Logistics in Conflict Zones:** Blockchain can be used to coordinate and track humanitarian aid in conflict zones, ensuring that resources reach their destination and are distributed equitably. By using a decentralized and transparent system, the risk of corruption or embezzlement of aid can be reduced. Blockchain can also facilitate collaboration between various governmental and non-governmental organizations in streamlining humanitarian efforts.

- **Improving decision-making processes based on blockchain, AI and deep learning:** The implementation of blockchain, artificial intelligence (AI) and deep learning in decision-making processes is a significant step towards improving efficiency and accuracy within organizations. Blockchain provides a transparent and immutable environment for recording and verifying data, thereby increasing the reliability of information used in decision-making. Artificial intelligence and deep learning enable fast and complex analysis of large volumes of data, making it easier to identify trends and patterns that might otherwise go unnoticed. These technologies also provide the ability to anticipate outcomes and optimize decisions in real time, thus contributing to better adaptability and reactivity in dynamic and ever-changing situations specific to military actions. Using these advanced technologies in decision-making can lead to greater accuracy, efficiency, and ultimately improved performance [6].

- **Use of AI in decision support and piloting of unmanned aircraft (UAV):** The implementation of artificial intelligence (AI) in decision support and piloting of unmanned aircraft is a revolutionary innovation in aerospace technology. AI helps to improve the accuracy and speed of the decision-making process by analyzing a large volume of data and simulating various scenarios in real time. In the piloting of unmanned aerial vehicles, AI provides advanced navigation capabilities and autonomous response to variable environmental conditions, thereby enhancing the effectiveness and safety of missions. These technological advances open new horizons for military and civilian applications, redefining paradigms in aviation and aerospace operations [2].

These examples highlight the versatility and added value of blockchain technology in various aspects of military logistics, from data security to operational efficiency and humanitarian coordination. The innovative use of blockchain in these areas represents an important step towards modernizing and securing military operations.

4. VULNERABILITIES VS OPPORTUNITIES

In the context of the implementation of emerging technologies in military logistics, it is essential to carefully analyze the risks and vulnerabilities inherent in this process. Although the adoption of advanced technologies such as artificial intelligence, blockchain and autonomous systems promise significant improvements in efficiency and security, they also bring new challenges and potential risks.

One of the major risks is vulnerability to cyber-attacks. As technology becomes more complex, so does the risk of exposure to security breaches, malware and other forms of cyber-attacks.

These attacks can compromise the integrity of the military supply chain and have serious consequences, from the loss of sensitive information to the disruption of critical logistics activities [7].

Another vulnerability is over-reliance on automated systems and technology. While automation can increase efficiency, it can also reduce adaptability and the human ability to respond quickly to unexpected situations or system errors. This reliance can lead to a loss of critical knowledge and skills among military personnel, making the organization vulnerable to a technological failure.

Also, the implementation of emerging technologies requires significant investments, both financial and in terms of time and human resources for training and development. There is a risk that technologies will quickly become obsolete due to rapid technological progress, which could lead to inefficient spending or the need for frequent updates, putting additional pressure on state budgets.

Ethical and legal issues are also a major concern, particularly with regard to the use of artificial intelligence and autonomous systems. There are ethical dilemmas related to the delegation of critical decisions to automated systems, as well as the implications of these decisions for international law and the rules of conflict.

In conclusion, while emerging technologies offer significant opportunities for improving military logistics, they also bring with them a complex set of risks and vulnerabilities. It is crucial that these risks are properly assessed and managed to ensure that the advantages of the technology are not overshadowed by its potential negative consequences. This requires a balanced and prudent approach that includes robust cyber security strategies, business continuity plans and clear ethics policies.

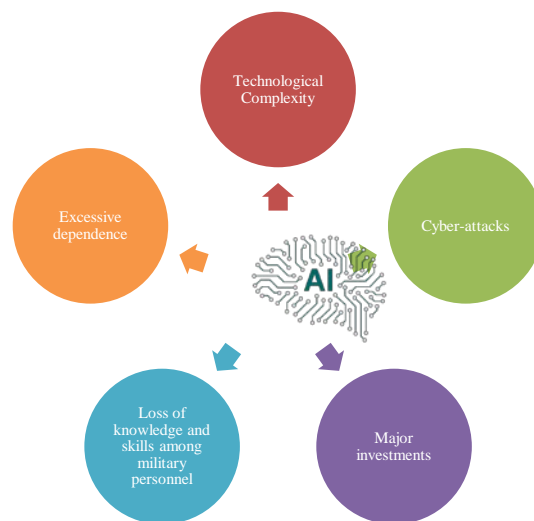


FIG. 5. Major risks in the implementation of emerging technologies

CONCLUSIONS

The research explored the impact of emerging technologies on supply chain management within the military organization, highlighting how technological innovations are redefining the efficiency, security and agility of logistics operations. The bibliometric analysis revealed that the integration of technologies such as blockchain and artificial intelligence leads not only to the optimization of processes, but also to an increased security of data and resources, but also to an effervescence in research in these fields, not far from Sci-Fi.

These emerging technologies offer innovative solutions to traditional challenges such as the risk of human error, cyber vulnerabilities and operational inefficiencies.

By implementing these technologies, military organizations are able to achieve better coordination and monitoring of supply chains, thus ensuring a quick and efficient response in critical situations. At the same time, this technological progress promotes increased transparency and greater accountability, essential elements in the context of military operations. However, the paper also identified challenges associated with the adoption of these technologies, such as the need to develop technical skills and robust security mechanisms to prevent risks associated with complex digital systems.

Emerging technologies have a significant impact on supply chain management in the military organization, offering extensive possibilities for improving efficiency and security. This evolution requires a strategic and adaptive approach, as well as a continuous assessment of risks and opportunities. It is imperative that military organizations stay abreast of technological innovations and proactively integrate them to improve their ability to effectively respond to the dynamic challenges of the modern military environment.

In conclusion, the implementation of blockchain technology in military logistics has the potential to revolutionize this field, bringing more security, efficiency and transparency. As this technology continues to evolve, it is expected that its applications in the military context will become increasingly sophisticated and widespread.

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