

ADAPTABILITY AND REDUNDANCY: CORE PRINCIPLES DIFFERENTIATING MILITARY LOGISTICS FROM CIVILIAN MODELS

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Abstract: This paper explores the fundamental differences between military and civilian logistics systems, focusing on adaptability and redundancy as the core principles that set military supply chains apart. While civilian logistics prioritize efficiency and cost-effectiveness through lean practices and global optimization, military logistics are designed to function under extreme conditions where resilience, flexibility, and operational security are paramount. By examining structural models, key concepts, and real-world examples, the paper presents a comparative SWOT analysis highlighting the strengths, weaknesses, opportunities, and threats facing both sectors. The findings suggest that civilian supply chains could enhance their resilience by integrating lessons from military logistics, while military systems could benefit from adopting advanced civilian technologies.

Keywords: military logistics, civilian logistics, adaptability, redundancy, chain of supply

1. Introduction

The military supply chain represents a complex and multidimensional system, whose theoretical examination demands the integration of interdisciplinary paradigms. At its core lies the resource-based view (RBV), which underscores the significance of strategic assets — such as dual-use infrastructure and tracking technologies — in securing a competitive advantage [1]. Within military logistics, scarce and hard-to-replicate resources (e.g., cutting-edge weaponry and advanced military equipment) are critical for sustaining operational effectiveness, particularly in asymmetrical conflict environments[2]. Complementarily, the theory of adaptive systems offers a valuable framework for understanding the dynamics of supply

chains operating in hostile environments[3]. These systems, marked by emergence and self-organization, require decentralized structures and redundancy mechanisms (e.g., alternative routes, buffer stocks) to mitigate the risk of collapse triggered by external disruptions, such as cyberattacks or geographic blockades. Consequently, adaptability emerges as a critical variable, increasingly supported by predictive models powered by artificial intelligence. From an economic perspective, transaction cost theory elucidates the tendency of military organizations to internalize certain logistical functions. The coordination costs associated with external suppliers in conflict zones, alongside the heightened risk of delivery delays, justify investments in in-house production and maintenance

capabilities. This model becomes even more pronounced in multinational operations, where divergences in technical standards can escalate transaction[4]. costs. The resilience of military supply chains is addressed through the principle of triple immunity: resilience (post-shock recovery), robustness (functionality under stress), and redundancy (reserve resources) [5]. These principles are operationalized through policies such as forward stocking in critical areas and the use of digital twins for crisis scenario simulations. For instance, in the context of hybrid warfare, the redundancy of communication networks ensures supply chain continuity even under conditions of electronic jamming. Logistics officers' decisions in violent environments are governed by decision theory under Knightian uncertainty [6], where incomplete data necessitate the adoption of adaptive strategies, such as multi-horizon planning and stochastic optimization algorithms. These approaches are reinforced by advances in cyber-physical systems, which integrate IoT and blockchain technologies to enable real-time monitoring of logistical flows.

At the macro-strategic level, interdependence theory highlights the vulnerabilities arising from the globalization of supply chains. Dependence on critical resources (e.g., microprocessors) sourced from neutral or adversarial states necessitates the adoption of strategic autonomy policies, as reflected in initiatives such as the European Union's *Strategic Compass*, which advocates for supplier diversification and the reshoring of production capabilities [7].

2. Definitions and key concepts

Logistics is a multidimensional and complex domain, representing one of the most critical and essential components of military operations. However, much like other intangible and intricate concepts such as economics, strategy, politics, or defense intelligence, the term *logistics* is difficult to

define or encapsulate in a few simple words. In general terms, logistics can be described as a sophisticated fusion of physical entities, processes, and regulations — a system governed by largely abstract concepts and principles, aimed at providing the material support necessary for military operations.

An early formal and functional definition of military logistics, though not entirely aligned with the contemporary understanding of the term, was offered by Antoine Henri Jomini. According to his definition, "logistics is the art of moving armies," encompassing the organization and details of marches and encampments, as well as the supply of troops. In essence, it involves the execution of strategic and tactical undertakings.

Later, in his treatise *The Art of War* [8], Jomini's broader interpretation of logistics becomes evident, extending beyond the initial concise definition.

A similar perspective is reflected in the U.S. Army's *Field Manual 100-16: Operational Support*, which defines logistics as "the process of planning and executing the movement and sustainment of operating forces in the execution of strategy and military operations. It is the foundation of combat power, the bridge connecting a nation's industrial base to its operational forces."

The British Army employs the term *Administration* to denote the function responsible for the movement, maintenance, and supply of armed forces.

Similarly, NATO defines military logistics in its *NATO Logistics Handbook* [4] as "the science of planning and carrying out the movement and maintenance of forces. In its broadest sense, those aspects of military operations which deal with:

- the design and development, acquisition, storage, movement, distribution, maintenance, evacuation, and disposal of materiel;
- the transport of personnel;
- the acquisition or construction,

maintenance, operation, and disposition of facilities;

- the acquisition or furnishing of services;
- medical and health service support."

When analysing the two distinct approaches to logistics — civilian and military — it becomes clear that while they may appear similar at first glance, their objectives and, often, their means differ significantly. As Martin Christopher notes [9], civilian logistics is defined as "the strategic planning, implementation, and control of the efficient flow of goods, services, information, and financial resources from the point of origin to the point of consumption, with the aim of meeting customer needs while minimizing costs." This definition highlights logistics' critical role in supply chain management by integrating the movement of goods, storage, inventory control, and information technology.

Lambert [10] further emphasizes that in civilian logistics, systems engineering focuses on synthesizing physical and informational flows to achieve minimal response time and maximum system efficiency. By contrast, military logistics prioritizes operational continuity, where emphasis is placed on operational effectiveness, safety, and resilience rather than economic efficiency or sustainability. Moreover, Rogers and Tibben-Lembke [11] argue that in the context of the circular economy, civilian logistics incorporates reverse flows (reverse logistics) to recover materials through recycling, reuse, or disassembly of products — a practice mandated by the EU Waste Framework Directive 2008/98/EC [12]. While both approaches share certain fundamental dimensions, civilian logistics is primarily oriented towards profit maximization and market performance, whereas military logistics is centred on operational readiness, security, and resilience — aspects that will be further explored in the following subsections.

3. Distinctions between defense and civil Supply Chain Systems

Analogous to the three levels of warfare — strategic, operational, and tactical — military logistics is likewise structured into three corresponding tiers: strategic logistics, operational logistics, and tactical logistics. These categories are not strictly distinct; rather, they represent the domains or levels at which logistical functions are executed.

3.1. Defense supply chain systems

A large-scale industrial corporation is typically organized around three fundamental layers: the board of directors, the executive management level, and the operational infrastructure, which encompasses production lines, storage facilities, distribution hubs, and research and development units. The board of directors formulates the organization's long-term strategic direction, setting strategic objectives, financial targets, selected market segments, and decisions regarding strategic alliances with other entities. The executive management translates these overarching directives into medium- and short-term plans, including marketing strategies, inventory management policies, infrastructure configuration, seasonal production schedules, and quality assurance procedures. Moreover, this executive tier is responsible for overseeing the implementation of these plans and for developing managerial solutions in response to unforeseen circumstances that cause significant deviations from the projected course.

The actual operational activities are conducted at the third, or operational, level of the entity. This layer, which integrates production lines, R&D activities, procurement processes, inventory administration, marketing strategies, and related fields, is tasked with executing the plans, policies, directives, and standards set forth by the executive leadership. Operations at this level are characterized by their physical, routine nature and

materialize in concrete forms, such as the development of innovative products, the setting of production quotas, the definition of quality standards, inventory level management, and the establishment of transportation programs. The production units rely on an array of input resources, the magnitude and composition of which are determined by the executive management. These three organizational tiers are not entirely autonomous. Interactions between adjacent levels — between the board of directors and executive leadership, and between the latter and the operational-management tier — are essential for ensuring the organization's cohesive and efficient performance. These interfaces serve to facilitate necessary coordination and communication.

The segmentation of the organization into three distinct strata arises from both structural considerations, relating to formal organization, and perceptual perspectives, based on functional roles and interdependencies. Executive management, positioned at the intermediary level, plays an integrative role, mediating between the organization's economic, strategic, financial, and technological resources, primarily governed by the board, and the "tactical units" responsible for managing

the company's daily operations, such as production lines, laboratories, IT services, storage facilities, and distribution infrastructure — reflecting a specific structural model. This organizational logic finds a parallel within military logistics, where the operational level serves as the bridge linking the macro-level, strategic and economic bases of military capability with the tactical units tasked with the actual implementation of military operations.

Similar to the corporate context, the tripartite logistical structure within the military domain is deeply embedded in its organizational architecture and is likely to persist, even though, theoretically, advancements in command, control, communications, and information technologies could suggest potential pathways for restructuring.

In many respects, the strategic level of military logistics mirrors the decision-making authority of a multinational corporation's governing board, with strategic military logistics operating at an aggregate, macro-level either national or multinational, depending on its origin and purpose and concerned with the resources and capabilities provided by the nation or alliance that sustains it.

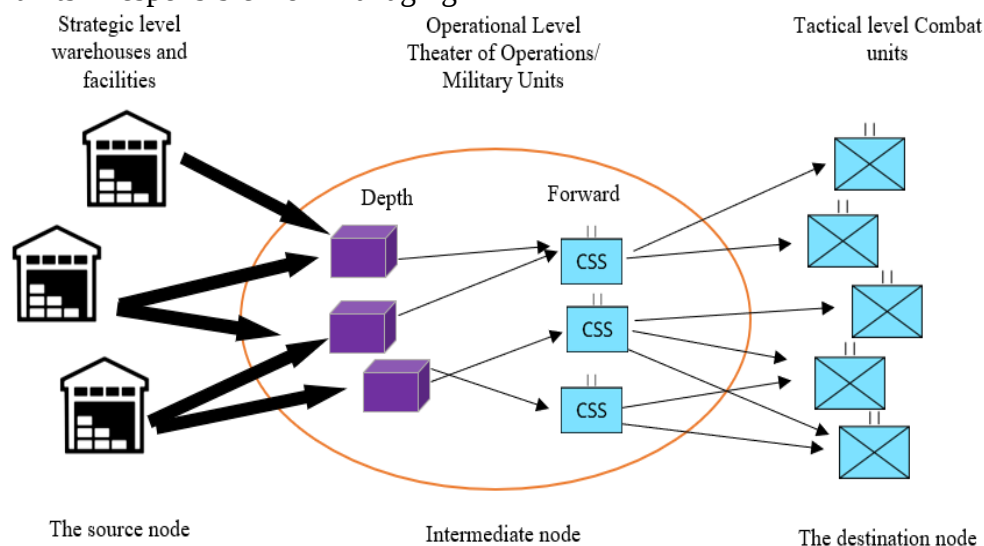


Figure 1: Military logistics network
Source: Own processing

Legend [13]:

- Military symbol for infantry battalion 
- Military symbol for combat service support battalion 

To begin understanding the levels of military logistics, it is advisable to first define each level individually and then explore their components and modes of utilization.

Strategic logistics, as defined in the previous chapter, is an aggregated, macroscopic level (national or multinational, depending on its purpose and origin), and deals with the resources and capabilities provided by the nation or alliance that implements it. It focuses on the creation, development, and maintenance of the entire national logistics infrastructure, which includes:

- Technology
- Industry
- Strategic stockpiles
- Military facilities
- Transportation
- Medical services
- C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance)

A crucial factor in strategic logistics is efficiency, as it strives to maintain a balance between defense investments in logistical capabilities and the results these investments can produce on the battlefield.

Based on the previous analyses, we propose a formal definition for the concept of operational logistics, described as: a set of resources, tools, organizational structures, and procedures, unified under the common objective of supporting military campaigns and large-scale operations. This framework, originating from strategic logistics, serves as an essential foundation for tactical logistics. The role of operational logistics is to facilitate and sustain the combat capability deployed on a large scale, both in terms of time and space.

In the specialized literature, there is a broad consensus on the characteristics that operational logistics must fulfill. Generally, the following set of properties is universally accepted:

- Flexibility
- Accessibility
- Continuity
- Cadence
- Simplicity
- Resilience
- Efficiency

While strategic logistics is primarily driven by efficiency and tactical logistics focuses on the effective use of resources and means, operational logistics is a fusion of both.

The final level of military logistics is tactical logistics. This level is responsible for producing or generating real effects on the battlefield. Tactical logistics concerns the actual support of troops with materials, food, water, equipment, fuel, lubricants, ammunition, military vehicles, and campaign services such as: billeting, medical support, evacuation of injured personnel, repair and evacuation of damaged equipment, pest control, disinfection, cleaning of uniforms/equipment, and personal hygiene services.

Tactical logistics must fulfill three crucial aspects during military operations: force protection, enhanced mobility, and firepower. While efficiency is the main criterion for strategic logistics, the primary focus for tactical logistics is effectiveness and minimizing the impacts of two key gaps: the time gap and the quantity gap. Tactical logistics must ensure that necessary resources are available in the required quantity and, more importantly, within the time frame that combat forces need them. The emphasis here is on mission success and the achievement of objectives, rather than economic or material efficiency. in-text citation is placed immediately after the text which refers to the source being cited.

3.2. Civil chain of supply

The supply chain in the civilian sector, much like its military counterpart, represents a complex and interconnected logistics system, composed of interdependent production entities responsible for transforming raw materials into finished products and distributing them to end consumers or beneficiaries. In this context, supply chain management refers to the optimization and coordination of the flow of goods, information, and financial

resources through distribution channels, with the aim of ensuring maximum operational efficiency and strategic alignment among the involved actors. This specialization incorporates processes such as:

- Planning
- Implementation
- Monitoring
- Optimization



Figure 2: A basic supply chain network diagram

Source: Own processing

A standard supply chain model is divided into two major stages: the production stage and the distribution stage. The production stage involves the manufacturing of semi-finished parts and components within production centers. Following the manufacturing process, these components are assembled or integrated together at an assembly center [14]. The final stage consists of distributing these products to regional centers, warehouses, and hubs that transport the finished goods to customers and end consumers [15]. Mentzer et al. suggest that at least three entities are required for a “supply chain” to exist [16]. The primary objective of supply chain management is to meet the requirements of customers and end consumers through the most efficient use of available resources, including distribution and transportation capabilities, maximizing inventory turnover, and utilizing the workforce in the most productive way. Theoretically, a supply chain aims to balance supply and demand while maintaining a minimal inventory level.

The design of a new product directly influences the supply chain and its requirements, impacting areas such as:

- Production

- Transportation
- Quality
- Volume
- Manufacturing scheduling
- Selection of raw materials
- Production technologies
- Industrial policies
- Compliance with regulations and current legislation

In essence, the performance of the supply chain is directly affected by the final product design and logistical capabilities; however, these aspects can also be interdependent: the success of a product depends on the efficiency and resilience of the supply chain supporting it.

4. Analysis and comparison: SWOT analysis

Logistics, as a critical enabler of operational effectiveness, constitutes a foundational pillar underpinning success in both military and civilian domains, notwithstanding the marked differences in their respective objectives, constraints, and strategic paradigms. Within the military sphere, logistics assumes a decisive role in sustaining combat operations, facilitating the mobility of forces and materiel,

ensuring maintenance, and securing the continuous provision of vital resources in contested and austere environments. In contrast, civilian logistics is predominantly driven by the imperative to optimize supply chains in response to market dynamics, prioritizing cost efficiency and profit maximization, even where such pursuits may compromise the quality of goods and services delivered.



Figure 3: SWOT analysis of military logistics
Source: own processing

A comparative SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of these domains not only elucidates their distinct structural characteristics but also uncovers intersecting dimensions and the latent potential for synergistic integration.

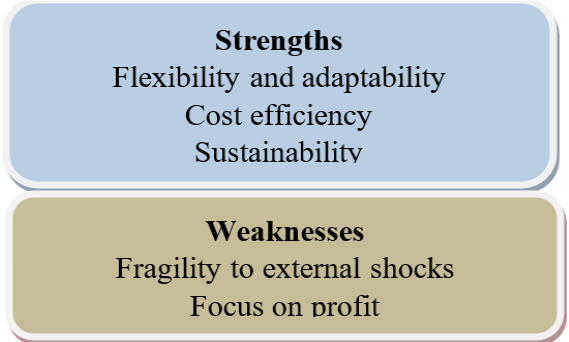


Figure 4: SWOT analysis of civil logistics
Source: own processing

5. Conclusions

In summary, while military and civilian supply chains share a common structure as complex, interconnected systems, they differ markedly in their objectives and operational focus. Military logistics, divided into strategic, operational, and tactical levels, supports national defense by ensuring resource availability, sustaining operations, and enabling battlefield effectiveness. Conversely, civilian supply chains aim to balance demand and supply efficiently, focusing on cost reduction, customer satisfaction, and productivity. Despite these differences, both systems rely on integrated planning, coordination, and adaptability. The by design choices, logistical capabilities, and resilience mechanisms. Understanding these distinctions and parallels offers valuable insights for enhancing supply chain robustness in both military and civilian contexts. Moreover, as global security environments and commercial markets grow increasingly volatile, the need for flexibility and interoperability between military and civilian supply chains becomes more evident. Advances in technology, such as digitalization and automation, offer opportunities for mutual learning and capability enhancement across both domains. By aligning strategic frameworks and adopting best practices in logistics management, both sectors can improve their efficiency, resilience, and readiness to respond to emerging challenges.

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