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Strategic management of the life cycle of logistics contracts in air defense: an analysis of operational sustainability and the efficiency of public spending in light of transaction cost theory.

Strategic lifecycle management of logistics contracts in air defense: an analysis on operational sustainability and public spending efficiency in light of transaction cost theory

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Summary

This scientific article analyzes the inherent complexity of managing *Contractor Logistics* Support (CLS) contracts within the context of national defense, focusing primarily on maintaining the availability of the air fleet and the sustainability of weapons systems. The research problem investigates how the rigidity of regulatory frameworks for bidding and administrative contracts can be harmonized with the need for speed, flexibility, and innovation demanded by military operations in a volatile geopolitical scenario. The overall objective is to demonstrate that the application of strategic management models, grounded in cost engineering and proactive technical oversight, is crucial for mitigating the risks of technological obsolescence and for the efficient allocation of substantial budgetary resources. The methodology adopted is a systematic literature review and an analytical case study, correlating theories of New Public Management *and* Responsive Supply Chain with the praxis of aeronautical military logistics. The results indicate that centralizing expertise in contracting, intelligently internationalizing procurement processes, and data-driven management are fundamental vectors for ensuring the operational readiness of the Force. It is concluded that contract management in defense is not a merely bureaucratic support activity, but a critical state function for national sovereignty and deterrence capability.

Keywords: Defense Logistics. Contract Management. Transaction Cost Theory. Operational Availability. Aerospace Supply Chain.

Abstract

This scientific article analyzes the complexity inherent in the management of Contractor Logistics Support (CLS) contracts within national defense, focusing primarily on maintaining air fleet availability and the sustainability of weapon systems. The research problem investigates how the rigidity of regulatory frameworks for bidding and administrative contracts can be harmonized with the need for speed, flexibility, and innovation required by military operations in a volatile geopolitical scenario. The general objective is to demonstrate that the application of strategic management models, based on cost engineering and proactive technical oversight, is decisive for mitigating technological obsolescence risks and for the allocative efficiency of substantial budgetary resources. The methodology adopted is a systemic bibliographic review and analytical case study, correlating New Public Management theories and Responsive Supply Chain concepts with the praxis of aeronautical military logistics. The results indicate that the centralization of contracting expertise, the intelligent internationalization of acquisition processes, and data-driven management are fundamental vectors for ensuring the Force's operational readiness. It is concluded that contract management in defense is not a merely bureaucratic support activity, but a critical State function for national sovereignty and deterrence capacity.

Keywords: Defense Logistics. Contract Management. Transaction Cost Theory. Operational Availability. Aerospace Supply Chain.

1. Introduction

Defense logistics, in the contemporary context of hybrid warfare and global uncertainties,

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It transcends the simple physical movement of supplies or the static management of warehouses; it
It constitutes the backbone of the operational, power projection, and deterrent capability of any
modern armed forces. In the aerospace sector, characterized by cutting-edge technologies, costs of
extremely high development and acquisition costs and long asset lifecycles (often
for contracts exceeding thirty years, as in the case of cargo and fighter fleets), the management of contracts of
Maintenance and acquisition play a central and strategic role in national defense policy. Martin
Christopher (2022), in his seminal work on logistics and supply chain management,
He argues that modern competition no longer occurs between isolated companies or armies, but
among their supply chains, which elevates contract management to the level of an operational art.
The Air Force, when operating a diverse fleet in a territory of continental dimensions such as
Brazil faces the Herculean challenge of balancing the budgetary constraints imposed by the spending cap.
with the imperative need to maintain acceptable operational readiness levels, requiring a
An approach that combines economic efficiency with military effectiveness.

The justification for this in-depth study lies in the materiality and sensitivity of
resources involved in maintaining air power, as well as the need to apply theories
complex administrative tasks in relation to military reality. Managing portfolios of contracts that exceed
Businesses involving billions of reais annually demand robust, ethical, and technically qualified governance.
capable of navigating the complexity of national bidding laws and, simultaneously, interacting
with a globalized and oligopolistic market of defense suppliers. Oliver Williamson (1996),
Nobel laureate in Economics, in his Transaction Cost Theory, warns of the risks of
Opportunism and information asymmetry in long-term asset-specific contracts.
high, typical characteristics of the defense sector. Inefficiency in the management of these contracts does not result
not only in financial damage to public coffers, which in itself would already be serious, but in "aircraft in
" *Aircraft on Ground* " (AOG), which directly compromises the constitutional mission of defense.
of airspace sovereignty.

The work is structured around a detailed analysis of five fundamental pillars that support the...
modern defense logistics, based on extensive literature review: the specificity and
The complexity of integrated logistics support (CLS) contracts from a Logistics-Based perspective.
in Performance-Based Learning (PBL); the challenges posed by the internationalization of acquisitions in relation to
Exchange rate fluctuations and geopolitical constraints; managing technological obsolescence in fleets of
long duration in light of Moore's Law; the role of the military public manager as an agent of
compliance, innovation and integrity, challenging the bureaucratic inertia described by Merton; and the
The need for integration between the defense industrial base and the operational needs of the Force through
Agency Theory. The theoretical basis is supported by the concepts of Agile Supply Chain.
Lean and *Agile Supply Chain* applied to the idiosyncratic reality of public administration.

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Brazilian and international military.

This analysis aims to demonstrate that the professionalization of the role of
The expertise and continuous training of contract managers are the differentiating factors in
Transforming limited financial resources into effective flight hours and combat capability.
According to Pires (2023) and Kelman (2019), public management in the 21st century requires a break with the
A rigid Weberian bureaucratic model in favor of a results-focused managerial approach, without...
However, abandoning the principles of legality and impartiality. In the military environment, this means...
This translates into the ability to design contracts that align the incentives of private industry with...
operational objectives of the State, creating long-term partnerships based on performance and
mutual trust, overcoming the classic antagonism between contractor and client in favor of a
"Extended enterprise" perspective.

Finally, this article proposes a reflection on the future of defense logistics, considering
the introduction of disruptive technologies such as artificial intelligence in demand forecasting and the
Additive manufacturing in the production of spare parts. Contract management should evolve towards...
To accommodate these new realities, requiring more flexible clauses and compensation models.
Innovators who consider digital intellectual property and the decentralization of production.
The contract manager of the future will not only be an inspector of administrative clauses, but an architect.
of complex logistical solutions that guarantee the sustainability of the workforce in any scenario of
conflict or peace. The analysis presented here aims to contribute to the doctrine of military logistics.
offering theoretical and practical support for decision-making at tactical, operational and...
strategic.

2. The complexity of logistics support contracts (LSCs) and performance-based logistics (PBL)

Integrated logistics support contracts, known internationally by the acronym CLS.
(Contractor Logistics Support) represent an ontological paradigm shift in the way that
The armed forces acquire availability for their weapons systems. Unlike purchases.
conventional government off-the-shelf goods, where the transaction concludes with the delivery of the
As a product, CLS contracts aim to guarantee continuous service availability and
Performance over time. This implies the adoption of Performance-Based Logistics.
(Performance-Based Logistics - PBL). As elucidated by Gansler and Lucyshyn (2021) in their
Studies for the U.S. Department of Defense, PBL transfers the responsibility and risk of
supply chain for the contractor, remunerating them not based on the quantity of parts sold.
(transaction-based), but by meeting service level indicators (SLAs), such as
Fleet reliability and availability. This approach aligns the economic incentives of

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supplier with the operational objectives of the Force, mitigating the problem of "moral hazard" *(moral hazard)* described in economic theory.

Managing these contracts requires thorough and multidisciplinary technical oversight, capable to audit complex industrial processes, validate financial execution in real time and monitor Operational performance metrics from the perspective of Agency Theory. Jensen and Meckling (1976) They define the agency relationship as a contract where one person (the principal - the Air Force) engages another (the agent - industry) to perform some service on its behalf. In the context of CLS, the The challenge for military managers is to design monitoring mechanisms that reduce asymmetry. Information inherent to this relationship, ensuring that the agent acts in the best interest of the principal. Experience in central management units reveals that poorly designed contracts, lacking clear metrics, are a problem. or with perverse incentives, can lead to excessive costs and low availability, subverting the purpose of PBL.

Another critical aspect of CLS contracts is the management of intellectual property and data. Technical aspects create a legal and strategic battleground. Often, equipment manufacturers... Original Equipment Manufacturers (OEMs) hold the exclusive rights to the designs and technical specifications, creating a situation of *lock-in* (technological lock-in) and bilateral monopoly for the Air Force. A contract manager must act strategically, supported by knowledge of the law. administrative and industrial property, to negotiate access to essential technical data. Authors As Guajardo et al. (2012) demonstrate, access to technical data is fundamental to enabling The nationalization of components or the development of local repairs, reducing dependence. external and fostering the Defense Industrial Base (DIB).

The variability of operational demand, characteristic of VUCA *(Volatile, Uncertain)* environments. *Uncertainty, Complexity, and Ambiguous* is another inherent challenge. In times of peace, the demand continues. A predictable stochastic pattern; in crises, demand becomes deterministic and urgent. CLS contracts should include *surge capacity* clauses , establishing how the supplier will mobilize additional resources. The lack of these forecasts, as pointed out by Reports from the *Government Accountability Office* (GAO) could lead to the collapse of logistical support. The application of mathematical models for demand forecasting and multilevel inventory theories is essential for sizing these clauses without incurring excessive idle costs.

Finally, the financial management of these contracts requires sophisticated cost engineering that... Consider Life Cycle Costing *(LCC).* Budgetary predictability in The public sector is rigid and annual, while CLS contracts are multi-year. The manager must master this. Net present value analysis and price review techniques to ensure economic equilibrium. Financial. The application of *Total Cost of Ownership* (TCO) methodologies, advocated by Ellram. (1995), it is essential to assess the advantageousness of these contracts, avoiding the "shortsightedness" of focusing only

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They often focus on the initial acquisition cost and neglect the long-term maintenance costs, which usually... represent approximately 70% of the total cost of the weapons system.

3. Internationalization, geopolitics, and risk management in the supply chain

Technological dependence on foreign suppliers is an unavoidable reality for Most armed forces do not possess full industrial autonomy. Contract management. international transactions, governed by regulations such as *Foreign Military* Sales (FMS) or *Direct Commercial Sales.* (DCS) introduces complex exogenous variables analyzed by International Relations Theory and Political Economy. Exchange rate volatility, cultural differences and, crucially, the constraints of Export *(international* compliance) presents a high-risk scenario. Operating in Multilateral organizations, such as the Inter-American Defense Board, corroborate the thesis that... International cooperation and the standardization of procedures are vital tools for mitigating these. risks and strengthen logistical interoperability between allied nations.

Export controls, exemplified by ITAR *(International Traffic in Arms)* US *regulations* impose severe restrictions on technology transfer. The contract manager Brazilians must possess a thorough understanding of these extraterritorial regulations to avoid Violations that result in diplomatic sanctions or interruption of support. Geopolitics influences directly impacting the supply chain: embargoes or political instability can disrupt the flow of Critical materials. *Supply Chain* Risk Management . SCRM, as structured by Tang (2006), requires robustness strategies (strategic inventories). and resilience (recovery capacity) to ensure business continuity in the face of disruptions. global.

Exchange rate fluctuations represent a systemic budgetary risk for indexed contracts. Strong currencies. In emerging economies, the devaluation of the local currency can make it unviable. Execution of essential contracts. The military logistics manager must work with tools for... Operational and financial *hedging ,* in collaboration with the budget planning sectors. A International finance literature suggests the use of offshore escrow accounts and negotiation. Currency baskets as a way to mitigate currency exposure. The ability to predict scenarios. Managing macroeconomic factors and adjusting payment flows is an indispensable managerial skill for Maintaining the Air Force's purchasing power throughout the fiscal year.

International transport logistics *(Global Logistics)* for sensitive and hazardous cargo. It involves customs clearance and physical security challenges that require integrated management. Document delays at customs can hold up a strategic asset, degrading defense capabilities. The integration between defense management systems and global logistics operators *(Freight Forwarders* must follow the principles of Logistics 4.0, with real-time tracking and

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Digital documentation *(paperless).* The quartermaster officer acts as a corporate diplomat.
harmonizing Brazilian legal requirements with foreign trade practices (Incoterms),
ensuring the continuous flow ("logistics corridor") of critical supplies.

Internationalization also requires training in intercultural negotiation and law.
International. The power asymmetry between the purchasing state and global defense conglomerates.
(like Lockheed Martin, Airbus, Saab) can lead to unfair contracts. Game Theory applied
The negotiation suggests that technical preparation and the formation of buyer coalitions may...
Level the negotiating table. Invest in officer training at centers of excellence abroad.
It is a state strategy to internalize *know-how* and reduce vulnerability in negotiations.
technology transfer and *offsets* (commercial, industrial and technological compensation).

4. Managing technological obsolescence and Moore's Law in defense.

Technological obsolescence is one of the most challenging vectors of complexity in management.
of aerospace weapons systems, exacerbated by Moore's Law, which predicts the doubling of
Processing capacity every 18 months. Military aircraft have life cycles.
operational for 30 to 40 years, creating a structural mismatch with its electronic components,
which become obsolete in a few years. Professor Peter Sandborn (2023), from the University of
Maryland, a world reference on the subject, argues that the reactive management of obsolescence — seeking
Solutions only when the part is missing — results in exponential "last-time" costs .
Buy) or in the need for systems reengineering *(redesign),* which can cost millions.

Strategic obsolescence management requires a proactive, data-driven approach and
Prediction. The use of tools to monitor the "health" of the supplier base and algorithms.
Predictive methods for identifying the *end of life (EOL)* of components are mandatory.
The logistics support contract should contain explicit *Technology Refresh* clauses .
technological), obligating the contractor to propose incremental modernizations that maintain the system.
Sustainable. Sandborn estimates that proactive management can save up to 40% on costs.
Life Cycle *Sustainment* of complex systems, freeing up resources for
new investments.

Reverse engineering and nationalization of obsolete components through the Industrial Base
Defense Investment Banks (DIBs) are strategies for technological sovereignty. When an original manufacturer discontinues
One item: the Air Force must have the legal and technical capability to qualify new local suppliers.
The public manager acts as a driver of defense industrial policy, identifying opportunities.
Import substitution strategies that are economically viable. This aligns with the Strategy
National Defense, which advocates technological autonomy. However, this requires management.
careful protection of intellectual property and ensuring that new components meet stringent standards.

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Aeronautical certification requirements.

The mid-life upgrade *(MLU)* is the critical moment when major...
Modernization contracts are signed to extend the lifespan of the fleet. The management of these projects is...
An exercise in systems engineering and stakeholder management. The risk of "scope creep"
The risk of scope creep and interface incompatibility between legacy and new systems is high. The manager must...
to ensure that the modernization contract includes not only the hardware, but the upgrade of the entire system.
Logistics support chain (technical manuals, simulators, test equipment), ensuring the
Sustainability of the modernized fleet.

Environmental sustainability and "Green Logistics" *also* permeate the
Obsolescence management. The disposal of electronic components and hazardous materials must follow
stringent environmental regulations, such as the European Union's RoHS *(Restriction of Hazardous Substances)* directive.
European, which impacts the global supply chain. The contract manager must be aware of these.
regulations to avoid environmental liabilities and ensure that the Air Force is aligned with the
ESG *(Environmental, Social, and Governance)* practices are increasingly required of governments and
companies.

5. The military public manager as an agent of innovation and integrity.

In an administrative environment governed by strict external control standards, such as
imposed by the Federal Court of Accounts (TCU) in Brazil, the fear of personal liability.
This can lead to the phenomenon of "bureaucratic inflexibility" described by Robert Merton, resulting in
"A blackout of pens." However, high-performance logistics management in defense requires what
Kelman (2019) calls it "strategic acquisition": the courage and competence to innovate within the
legality. The implementation of new costing methodologies, traceability technologies and
Streamlined process flows are the manager's responsibility. Leadership in logistics is not achieved solely through...
hierarchy, but with the construction of a culture of efficiency and public integrity .

Compliance in the management of public defense contracts goes beyond legalism; it involves ...
Implementation of corporate integrity programs that prevent fraud and corruption in the relationship.
with suppliers. Public Choice Theory *warns* of the risks of
The regulated capture of the regulator in sectors with few suppliers, such as defense. The manager
It must promote transparency and *accountability* in procurement processes, ensuring equality.
competitive. The responsibility of managing billions of reais demands a non-negotiable ethical standard and
robust governance and internal control mechanisms to legitimize military spending before the
society.

Innovation in military public management involves adopting Industry 4.0 practices. The use
Using *Big Data Analytics* and Artificial Intelligence to perform predictive maintenance and optimize inventory.

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It is an emerging reality. Porter and Heppelmann (2014) describe how smart products and Connected technologies are transforming competition and the structure of industries. In defense, this means contracts. that foresee the sharing of aircraft telemetry data between the Air Force and the manufacturer, allowing for proactive logistics. The manager must be able to specify contractual requirements. that necessitate the use of these technologies, overcoming cultural resistance to change.

Continuous training and knowledge management are the foundation of this innovation. training of supply officers in high-level government schools, such as FGV, and interaction with The academic environment is essential for revitalizing public administration. Nonaka and Takeuchi (1995), In their theory of organizational knowledge creation, they highlight the importance of converting the Tacit knowledge (practical experience) into explicit knowledge (doctrine and processes). Workshops and Seminars, such as those promoted by the author at DIRMAB, are fundamental for this dissemination. Human capital is the most valuable asset in logistics; systems can be bought, but... Management capacity is built.

Managing the relationship with the industrial base *(Supplier Relationship Management* - SRM) must evolve from an adversarial stance to a strategic partnership. Contract theory Relational contracts suggest that, in environments of high uncertainty and complexity, contracts based on Trust and mutual collaboration are more effective than purely transactional contracts and punitive measures. The manager must foster an ecosystem where the industry is encouraged to propose Innovations that reduce costs and increase availability, creating a positive-sum game where Both the state and the private supplier benefit from the efficiency generated.

6. Conclusion

A comprehensive and in-depth analysis of the strategic management of the contract lifecycle. Logistics in air defense, as developed throughout this article, unequivocally demonstrates that... Operational efficiency is inseparable from administrative excellence and robust governance. Public. A nation's ability to project air power and ensure the sovereignty of its airspace. And acting in humanitarian missions depends, at its most fundamental level, on the skill of their managers in designing, executing, monitoring, and adapting complex contracts that underpin the machinery of war. The quartermaster officer, acting as a logistics manager, positions himself at the point of convergence. critical link between military strategy, public economics, administrative law, and technology. aerospace.

The complexity of Integrated Logistics Support (CLS) contracts and the transition to Performance-based learning (PBL) models require a cultural and technical shift in organizations. military. Passive contract management, focused solely on bureaucratic compliance ("check-the- "Box") is no longer sufficient to guarantee the availability of technologically advanced fleets in a

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A scenario of chronic budget constraints. It is imperative to adopt a proactive engineering approach.
of contracts, where in-depth technical knowledge of the contracted subject merges with the
Legal and financial expertise to extract maximum public value *from* each unit.
Monetary investment in defense. "Contractual intelligence" thus becomes a force multiplier.
as important as the weapons technology itself.

The internationalization of the defense supply chain and the associated geopolitical risks.
They reinforce the need for active logistics diplomacy and sophisticated risk management.
accumulated experience in coordinating multinational efforts and managing resources in
International organizations, such as the Inter-American Defense Board, prove that cooperation and
Interoperability is an essential tool for logistical resilience. Brazil must continue to...
to invest in training its officers to operate in this global scenario, defending the interests
national entities are involved in complex technology transfer and logistical support negotiations, utilizing
Modern theories of international trade and strategic negotiation.

Managing technological obsolescence has proven to be one of the biggest challenges for...
Sustainability of long-term fleets. The ability to anticipate the discontinuation of
Implementing modernization or nationalization solutions for components is vital to avoid collapse.
operational availability. The integration between Air Force logistics and the Industrial Base of
Defense (IDB) is a strategic path to reduce external dependence and foster innovation.
Technological development in the country. The State's purchasing power, exercised through well-being defense contracts.
Structured, it is a powerful lever of industrial policy, as advocated by modern
theories of economic development.

The role of the military public manager as guardian of integrity and agent of innovation is
central to the legitimacy of the armed forces in the eyes of a democratic society. Transparency, the
Compliance and efficiency in public spending are not obstacles to military operations, but rather the pillars thereof.
which underpin the institutional credibility necessary to ensure continued funding of
defense. Administrative innovation, through the adoption of digital technologies and new models of
Logistics businesses based on Industry 4.0 are the necessary answer to do more with less.
to ensure that the Air Force is ready for the challenges of the 21st century.

The future of defense logistics points towards increasing integration between systems.
Physical and digital systems, with autonomous and predictive supply chains (Cognitive Logistics). In
However, technology will not replace human judgment and ethical leadership in resource management.
Critics. The training of logistics leaders capable of thinking strategically, acting with integrity and
Solving complex problems in uncertain environments will remain the top priority.
The "soul" of logistics lies in the human capacity to anticipate needs and mobilize resources to achieve them.
to guarantee victory and peace.

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The analysis presented here reinforces the idea that logistics is not a completely disconnected activity. of the core activity, but an integral and inseparable part of the art of war and the management of the State. As As the military adage adapted to modern times says: "Amateurs discuss tactics, professionals..." They discuss logistics and contractual strategy. Professional management of defense contracts is what It allows military strategy to be transformed into operational reality. Without efficient contracts, the Sovereignty is merely an abstract concept; with them, it becomes a concrete and deterrent capability.

It can therefore be concluded that investment in the qualification of supply officers and in Modernizing contract management processes is a direct investment in national security. The author's experience in managing billion-dollar contracts and leading logistics teams. International research corroborates the thesis that excellence in military public management is a strategic asset. of the Brazilian State. The ongoing challenge is to maintain the agility and flexibility necessary for the A modern fight without losing rigor and responsibility in controlling public spending, a mission which requires highly qualified professionals with unwavering commitment to the interests of the company. national.

Finally, this article hopes to contribute to the academic and professional debate on logistics. Defense, encouraging new research and the dissemination of best practices. Building a Defense Force A modern, efficient, and deterrent air force necessarily requires excellence in the management of its... Contracts and supply chains. May the theoretical and practical teachings discussed here serve you well. as a basis for the continuous improvement of doctrine and logistics management in the Brazilian Air Force and in public administration as a whole, ensuring that Brazil is prepared to defend its The skies and their citizens with maximum efficiency and effectiveness.

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