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From Paper to Precision: Streamlining Weapon Issuance and Maintenance Through Automation

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This Food for Thought paper is a document that gives an initial reflection on the theme. The content does not reflect the positions of the Member States but consists of elements that can initiate and feed the discussions and analyses in the domain of the theme. All our studies are available on www.finabel.org

DIRECTOR'S EDITORIAL

The rapid evolution of warfare in the 21st century necessitates efficient, secure, and interoperable solutions for military logistics. One of the most overlooked yet crucial aspects of military effectiveness lies in the management and issuance of weaponry. As European armed forces strive to enhance operational readiness, the transition from manual, paper-based weapon management systems to fully automated solutions has become not only a technological advancement but a strategic imperative.



This Food for Thought paper explores the transformative impact of automating Weapon Management Systems (WMS), illustrating how digitalisation can drive innovation and interoperability within European defence structures. By streamlining weapon issuance and maintenance, automation minimises human error, enhances security, and optimises military administration, ensuring that forces are better prepared, more responsive, and strategically agile.

Beyond efficiency, the adoption of automated Weapon Management Systems contributes to European interoperability. In an era of multinational military cooperation, particularly under NATO and EU frameworks such as PESCO and the European Defence Fund, aligning digitalised weapon management across member states can bridge logistical gaps and enhance cross-border coordination. Furthermore, integration with emerging technologies, such as AI-driven inventory tracking and blockchain-based security protocols, could revolutionise accountability and traceability in military arsenals.

While the benefits of automation are evident, challenges remain. Concerns regarding data security, system standardisation, and the costs of digital transformation must be addressed through strategic investments and policy alignment. Additionally, the integration of private-sector expertise into military innovation will be key to ensuring scalable, adaptable, and future-proof solutions.

This paper serves as a starting point for critical discussions on the future of weapon management in European defence, highlighting how even seemingly administrative improvements can yield significant operational advantages. As European forces face increasingly complex security landscapes, embracing automation in military administration will not only enhance efficiency but also solidify Europe's position as a technologically advanced defence actor.

The question is no longer if automation should be adopted—but how quickly we can implement it to ensure a stronger, more resilient, and more interoperable European defence.

Mario Blokken

Director

ABSTRACT

This paper treats the topic of Weapon Management Systems and the benefits their automation would have on Innovation and Interoperability in the defence sector. It argues, specifically, that automation provides a way of improving the military landscape in its entirety with a bottom-up approach. Methodically, the research draws from the contemporary relevance of the concepts of Innovation and Interoperability to highlight how digitalising and streamlining military administration can have positive and lasting effects on the defence sector. In that, this paper finds that automation can benefit Innovation by furthering broad sections of the world of defence and the entanglement between these sections. Particularly here, the bottom-up perspective becomes an important aspect of how automation can improve the military landscape. In the discussion about Interoperability, the bottom-up perspective offers insights into the flaws of current European frameworks in enhancing the military by making it more interoperable. The automation of Weapon Management Systems therefore serves as an overview of how seemingly smaller initiatives can positively impact relevant features of current defence needs. This research thus makes a bold attempt in trying to present new ways of implementing important steps in European defence.

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LIST OF ABBREVIATIONS

ARPANET	Advanced Research Projects Agency Network
ATT	Arms Trade Treaty
CSDP	Common Security and Defence Policy
DoD	Department of Defence
DTIB	Defence Technological and Industrial Base
EC	European Commission
EDF	European Defence Fund
EDTIB	European Defence Technological and Industrial Base
EU	European Union
IoT	Internet of Things
OSCE	Organization for Security and Co-operation in Europe
PESCO	Permanent Structured Cooperation
R&D	Research and Development
SALW	Small Arms and Light Weapons
SME	Small and Medium-sized Enterprise
WAM	Weapons and Ammunition Management

INTRODUCTION

Amidst the effort to modernise European militaries and make them fit in accordance with the rising tensions in the international system, there is a growing sense that European states need to improve their military capabilities holistically. Increasing the number of recruits and the number and variety of the military's arsenal is not enough; militaries need to make improvements that allow the entire operative side of militaries to run smoothly. As they currently stand, militaries still lack the basic fundament to warrant such smooth running. One example of this condition is weapon administration and issuance. The Hungarian Company LoxoLock (2024b) argues that in the US Military, sixty per cent of the time spent on shooting training goes into administration. Needless to say, these areas desperately need improvement to ameliorate the entire operative process of militaries. LoxoLock is one of the companies trying to effect this change. Their tagline of “Bringing Weapon Management into the Digital Age” promises to move on from paper and human error, digitalise and streamline the entire process and consequently work towards a more efficient working of inner military processes (LoxoLock, 2024a, p. 1).

This paper will consider this exact process of streamlining and digitalisation and discuss how it can affect vital change in the administrative settings of the military. Specifically, it will look at how digitalising weapon management can foster greater Innovation and Interoperability in Europe. The argument pursued in this research is that the innovative and interoperable forces of a streamlined

and digitalised Weapon Management System across European militaries could drive a holistic improvement of militaries in a bottom-up way. Boldly, the aim is to show how improving such seemingly secondary issues can positively impact the defence sector as a whole. In choosing Innovation and Interoperability as the primary lens of the research, the argument holds specific relevance to current themes and issues in the defence sector.

To that end, this research begins by outlining the general facets of Weapon Management Systems. It will cover the past and present of Weapon and Ammunition Systems (WAM), work towards an understanding of the general challenges and flaws that are met in working towards coherency in these systems, as well as discussing the way international approaches have been worked and are becoming more necessary for smooth operative working of the military. In the third and fourth sections, the research will tackle the issue of streamlining and digitalisation more directly, discussing its impact on Innovation and Interoperability.

This perspective is broadened in Section 3, which will make a case for how the automation of military administration through streamlining and digitalisation can have a wide-reaching positive impact on the entire defence sector. In establishing this broadened perspective, the section covers the entanglement of the private industry and national militaries in the contemporary military landscape, the critical role of Research & Development (R&D) in the defence sector, and defence governance. It then explores how automation bottom-up benefits these specific

facets of the military landscape.

In the last section, the research will turn to Interoperability and discuss how automation can benefit this crucial topic for European military cooperation. Using the broadened basis of Section 3 as a fundament, the scope is narrowed again and focuses on more specific issues to highlight how automation can foster Interoperability. Specifically, this section

will explore how it can benefit interoperable defence governance and how such a system functions. This will provide a sound basis for what follows, namely how such governance can take effect in policy on a European level. In that way, it will strengthen further the perspective that automation can help modernise and improve the entire defence sector and its operative facets from the bottom up.

CONTEXT OF PAST AND CURRENT WEAPON MANAGEMENT IN EUROPE

The Key Principles of Weapon Management

Weapons and Ammunition Management (WAM) is a comprehensive framework that integrates regulatory, operational, and technological dimensions to oversee the lifecycle of weapons—from procurement and storage to deployment and decommissioning (UNIDIR, 2019). At its core, WAM is designed to balance security needs with risk mitigation, ensuring that weapons are accounted for, appropriately controlled, and prevented from falling into unauthorised hands (ICoCA, 2022). By addressing the weapons lifecycle, WAM aims to streamline processes, improve efficiency, and establish accountability while upholding international legal and ethical obligations (UNIDIR, 2019).

Some key principles of WAM are accountability, Interoperability, and transparency (UNIDIR, 2019). Accountability in WAM ensures that every weapon is traceable throughout its life cycle (Bajon, 2024). This principle hinges on robust record-keeping systems and transparent oversight mecha-

nisms that minimise risks of diversion, corruption and illicit proliferation. For example, effective accountability frameworks require precise documentation of arms transfers, end-user certificates and post-delivery verification mechanisms (Bajon, 2024, p. 5). Without clear accountability, weapons may be lost, stolen or misused, as seen in cases of surplus arms entering black markets after regional conflicts, such as in the Balkans during the 1990s (Dressler et al., 2021, p. 37).

Interoperability refers to the capacity of Weapon Management Systems to work seamlessly across national, regional, and international levels. In the European context, Interoperability is particularly crucial, given the EU's push for harmonised arms and cooperation among Member States. Differences in national policies often hinder cross-border collaboration, creating enforcement loopholes exploited by arms traffickers (Murphy, 2024). A fully interoperable WAM system would enable integrated databases, joint tracing mechanisms and shared enforcement strategies to close these gaps.

Transparency within WAM ensures public and international trust by subjecting decision-making processes to scrutiny (Kytömäki, 2023). This includes openness of arms procurement policies, export licenses and arms transfer reporting. Transparency reduces corruption, curtails illicit trade, and aligns national practices with international commitments (United Nations, n.d.). However, transparency remains a critical weakness in many weapon management frameworks (Trapnell & Kang Choo, 2024). Government contracts with defence contractors often operate behind closed doors, limiting oversight and raising ethical concerns about undue influence and conflicts of interest.

Conceptualising WAM as a multi-dimensional framework highlights its indispensable role in ensuring security while, at the same time, minimising risks such as proliferation, misuse and corruption. By prioritising Accountability, Interoperability, and Transparency, WAM can address systemic weaknesses and promote cooperation across borders. The following section will discuss weapon management in Europe by examining its historical context, identifying its flaws, weaknesses and challenges, and analysing international approaches to current weapon management. Linking past transformations with present-day challenges, it will critically assess how Europe navigates the complex landscape of arms regulation and explore opportunities for Innovation and improvement.

Weapon Management in Europe

Weapon management in Europe reflects a complex evolution shaped by historical, political, and technological forces. From decen-

tralised feudal systems to centralised modern states, weapon regulation has adapted to the demands of governance and security. This section examines how Europe's Weapon Management Systems have evolved, identifying key transformations and challenges. This discussion establishes the foundation for analysing Europe's current role in global arms management and the emerging challenges posed by advanced technologies and international obligations by linking historical precedents to contemporary frameworks.

Weapon management in Europe has undergone significant transformations over the centuries, reflecting the continent's shifting political, social, and technological landscape. During the feudal era, arms control was decentralised (Beeler, 2018, p. 18). Nobility and knights managed their own weapons, which served as symbols of status and means of defence (Beeler, 2018, p. xv). However, with the rise of centralised states in the early modern period, weapon regulation became a state prerogative. Monarchies established arsenals, regulated the production of firearms and restricted weapon possession among the general populace to maintain social order and suppress uprisings.

The Industrial Revolution further altered weapon management by allowing for mass production of arms, which required more sophisticated oversight mechanisms (Eunomia Journal, 2020). National militaries centralised the procurement, storage and distribution of weapons, often relying on government-owned or regulated manufacturers (McDonnell, 2020). During the 20th century, the scale and sophistication of weaponry increased dramati-

ically, ignited by two World Wars and the Cold War, necessitating comprehensive policies on arms control, export regulations and international agreements to manage the proliferation of weapons (Tulliu & Schmalberger, 2003, p. 5).

Today, Europe faces a complex weapon management landscape shaped by internal and external challenges. Internally, European nations maintain strict regulations on civilian firearm ownership (European Commission, 2024b). The European Union (EU) has played a pivotal role in harmonising Member States' laws through directives such as the EU Firearms Directive, which aims to prevent the misuse of firearms while balancing the needs of sport shooting, hunting and cultural heritage (European Commission, 2024b).

Externally, Europe is a significant actor in the global arms trade. Several European nations, such as France, Germany and the United Kingdom, are among the largest exporters of military equipment (Wezeman et al., 2024). This necessitates robust mechanisms to manage exports and ensure compliance with international laws, such as the Arms Trade Treaty (ATT) (Woolcott, 2013). Additionally, Europe's proximity to conflict zones, particularly in the Middle East and North Africa, has amplified concerns over illicit arms trafficking and the use of European-manufactured weapons in human rights violations (Pinson, 2022).

In conclusion, European weapon management has evolved through a dynamic interplay of historical, political and technological influences, transitioning from feudal decentralisation to highly regulated modern

systems. This progression underscores the continent's adaptability in addressing the challenges posed by advancements in weaponry and shifting geopolitical landscapes. Europe's contemporary framework, characterised by stringent domestic firearm regulations and active participation in international arms control, reflects a commitment to balancing security, governance and ethical responsibilities. However, the ongoing challenges of illicit arms trafficking, compliance with international treaties and the implications of emerging technologies highlight the need for continued innovation and cooperation. As Europe navigates its role in the global arms landscape, its historical foundations provide valuable insights for addressing present and future complexities.

Flaws, Weaknesses and Challenges in Weapon Management

While European nations have sought to standardise weapon management practices, significant differences persist. For instance, countries like Finland and Switzerland have relatively permissive firearm laws due to cultural and historical factors, while nations like the Netherlands or the United Kingdom impose stringent restrictions (GOV.UK, 2022; Netherlands Enterprise Agency, n.d.; Overton, 2024). These disparities complicate cross-border enforcement, enabling potential loopholes for arms trafficking. European nations face criticism for inconsistencies in their arms export policies (Maletta, 2021). Despite commitments to uphold human rights, European-manufactured weapons often find their way to regimes accused of human rights abuses (Maletta, 2021). For example, Ger-

man arms exports to Saudi Arabia during the Yemeni conflict raised ethical and legal questions about compliance with international humanitarian laws (Maletta, 2021). The illicit trafficking of Small Arms and Light Weapons (SALW) remains a significant challenge in Europe (United Nations, 2024). The Balkan wars of the 1990s left a legacy of surplus weapons, many of which entered black markets across Europe (Arapi, 2015). Criminal networks exploit weak border controls and inconsistencies in enforcement to smuggle weapons, contributing to violent crime and terrorism (Arapi, 2015).

Moreover, the advent of advanced technologies, including 3D printing and digital supply chains, poses new challenges to weapon management (Sholademi, 2024, p. 262). 3D-printed firearms, in particular, bypassing traditional production and registration systems, present difficulties in enforcement (Sholademi, 2024, p. 262). Similarly, integrating artificial intelligence (AI) in weapon systems raises ethical and practical concerns regarding accountability and control (Sholademi, 2024, p. 262). A persistent flaw in Europe's weapon management framework is the lack of transparency in decision-making processes (Ohlsson, 2006). Government and defence contractors often operate behind closed doors, limiting public scrutiny and raising concerns about corruption and undue influence.

Outdated, non-digitised and non-automated Weapon Management Systems present significant challenges that undermine their effectiveness, security, and alignment with modern operational and regulatory require-

ments. These systems, which often rely on manual processes, fragmented record-keeping and paper-based documentation, exacerbate inefficiencies, increase vulnerabilities and hinder accountability. As weapon management grows increasingly complex in national and international contexts, the persistence of non-automated frameworks highlights a critical weakness in addressing contemporary security and governance demands.

Manual processes inherent in non-digitised systems significantly slow down decision-making and operational response times (Impact Digital, 2024). Weapon management requires real-time information to support informed decision-making and rapid responses to security incidents (Booz Allen Hamilton, 2023). Without automated systems, data collection, retrieval and verification become labour-intensive and prone to delays. The lack of centralised digital systems in arms procurement leads to bureaucratic bottlenecks, impeding the timely allocation of resources, which can weaken national and regional security. In a world where threats evolve rapidly, such inefficiencies can represent a significant liability. On the contrary, adopting a fast-access weapon storage and identification system might optimise the time spent for military administration and allow soldiers to retrieve their guns rapidly and efficiently (LoxoLock, 2024b).

Non-automated systems are highly susceptible to corruption, theft and mismanagement due to lack of transparency and reliable oversight (Jack, 2024). Paper-based or decentralised records can easily be manipulated, falsified or misplaced, creating opportunities for di-

version and misuse. For example, incomplete inventories or manually updated logs increase the risk of weapons being stolen or illegally sold without detection. Adopting remote control and monitoring systems would enable authorised personnel from a controlling data centre to unlock all electronic locks temporarily or any of them individually, thus enhancing their real-time awareness of the weapons' movements at any time. Moreover, inserting a passive chip on or in the weapon would make it possible to identify a single gun in case of any issue (LoxoLock, 2024b). Conversely, the absence of automated tracking systems also limits the ability to audit arms movement efficiently. This is particularly problematic in regions where surplus arms, often stored in poorly monitored facilities, are prone to diversion to black markets, as seen in post-conflict zones (United Nations, 2015). Corruption further compounds these vulnerabilities as officials operating in non-transparent systems can exploit gaps for personal or political gain, thus undermining both national and international arms control efforts.

Non-digitised systems exacerbate the problem of incompatibility, limiting Interoperability between national and international agencies tasked with weapon management. Weapon control requires cooperation across various stakeholders, military agencies, law enforcement, customs authorities and international bodies, each of whom may operate disparate systems with little to no integration. Differences in how member states record and track weapons in the EU can hinder effective cross-border enforcement and information sharing. Countries with advanced digital frameworks may struggle to align their

systems with others, relying still on manual processes, thus creating loopholes that arms traffickers exploit. This incompatibility undermines broader regional and international efforts such as those outlined in the ATT, emphasising the need for collaboration and transparent arms control mechanisms. If several allied countries were to adopt advanced automated systems, statistics regarding the use of specific weapons could be collected and potentially shared to be compared at the EU or NATO level, despite the traditional closeness to information-sharing of the military sector.

The weaknesses of non-digitalised, non-automated Weapon Management Systems—manifesting as inefficiency, vulnerability and incompatibility—expose significant flaws that hinder national and international security efforts. Manual systems are not suited to meet the demands of modern weapon management, where real-time data, transparency and Interoperability are critical; addressing these weaknesses requires investment in digital infrastructure, automation technologies and integrated systems that can streamline operations, reduce vulnerabilities and enhance accountability.

In conclusion, Europe's weapon management framework faces numerous challenges, compromising its effectiveness and alignment with contemporary security needs. Persistent disparities in firearm regulations, arms export policies and border enforcement among EU member states exacerbate vulnerabilities, thus enabling arms trafficking and undermining international arms control efforts. The advent of advancing technologies like 3D printing

and AI introduces further complexities, while outdated, non-digitalised systems hinder accountability, efficiency and Interoperability across national and international levels. Significant reforms are necessary to address these multifaceted issues. Investment in digital infrastructure and automation technologies must become a priority to modernise Weapon Management Systems, streamline operations and strengthen transparency and oversight. Enhancing cross-border cooperation and harmonising regulatory practices across Europe are critical steps towards addressing the gaps exploited by criminal networks and arms traffickers. By embracing these advancements, European nations can better navigate the evolving security landscape, ensuring a robust, accountable and collaborative approach to weapon management.

International Approaches to Current Weapon Management

Europe is an active participant in global initiatives to regulate arms. The ATT, adopted by the UN in 2013, aims to establish common standards for international arms transfers (United Nations, 2013, p. 11). Most European nations are signatories, committing to prevent arms exports that could exacerbate conflict or human rights abuses (Arms Trade Treaty, 2024). However, enforcement remains uneven, and major arms exporters like the United States have not ratified the treaty, limiting its global effectiveness (Arms Trade Treaty, 2024). European nations collaborate through regional organisations like the Organization for Security and Cooperation in Europe (OSCE), which focuses on preventing the proliferation of SALW (OSCE, 2023).

The EU also supports disarming programs in conflict-affected regions, demonstrating a commitment to addressing the global dimensions of weapon management (European Union, 2024).

Internationally, efforts are underway to harness technology for better weapon management. Systems like blockchain are being explored to create transparent and tamper-proof records of weapon transfers (Akello et al., 2022). Similarly, electronic tagging and tracing mechanisms are being deployed to track weapons and ammunition, reducing the risk of diversion of unauthorised users (Akello et al., 2022). Despite these initiatives, international weapon management faces significant obstacles. Enforcement mechanisms for treaties like the ATT are weak, relying on voluntary compliance and peer pressure. The lack of universal participation undermines the effectiveness of these frameworks. Additionally, geopolitical rivalries often hinder consensus on arms control measures, as seen in the limited progress on regulating technologies like autonomous weapons. Europe plays a pivotal role in global arms regulation efforts, leveraging international treaties like the ATT and regional initiatives under organisations such as the OSCE to combat the proliferation and misuse of arms. European nations have demonstrated leadership in supporting disarmament programmes and exploring advanced technologies, such as blockchain and electronic tagging, to enhance transparency and accountability in weapon management. However, significant challenges continue to persist. The uneven enforcement of treaties like the ATT and the absence of key global players, such as the United States, undermines

the efficacy of these frameworks. Geopolitical rivalries and limited consensus on emerging technologies like autonomous weapons further complicate the international arms control landscape. To enhance its impact, Europe must continue supporting collaborative efforts, investing in innovative technologies and advocating for more vigorous global participation in arms regulation. By addressing these challenges, Europe can strengthen its contribution to creating a safer and more accountable global weapon management architecture, aligning security objectives with humanitarian and ethical responsibilities. Overall, this section has highlighted that weapon management plays a critical role in safeguarding security while mitigating the risks associated with arms proliferation, misuse and corruption. By integrating regulatory, operational and technological dimensions, weapon management provides a comprehensive framework that spans the entire weapons' lifecycle. Weapon management embodies a multidimensional framework, which must balance security

needs with ethical responsibilities. Europe's experience underscores both the progress achieved and the persistent gaps undermining effective arms control. WAM can evolve into a more robust and resilient system by prioritising accountability, Interoperability, transparency and embracing technological innovations. However, this requires collective commitment from national governments, regional entities and the international community to overcome entrenched challenges and seize opportunities for improvement. The path forward involves not only addressing the technical and operational flaws but also navigating the ethical dilemmas and geopolitical complexities that shape the global arms landscape. Europe's role as a major actor in the arms trade and its proximity to conflict zones amplify its responsibility to lead by example, demonstrating that effective weapon management is both a security imperative and a moral obligation to pursue global peace and stability.

AUTOMATION AND INNOVATION IN MILITARY ADMINISTRATION

The Broadened Innovative Effects of Automation

The previous section discussed how past and present Weapon Management Systems are weakened by a lack of coordination, which makes human errors far too likely and reinforces a system far too inefficient for an increasingly dynamic sector in a digitalised world. In outlining this, it was highlighted that automation is necessary to modernise and streamline military administration to make it fit the realities of the 21st century. In

what follows, this paper intends to take this even further by stressing the necessity and the broadened advantages that automated Weapon Management Systems would have for the entirety of the defence sector. In doing so, this section will widen the discussion, entangle military administration with broadly connected themes and highlight how automation could improve their interplay and, as a whole, have a broad, innovative effect on militaries. To that end, the discussion will first revolve around the creative

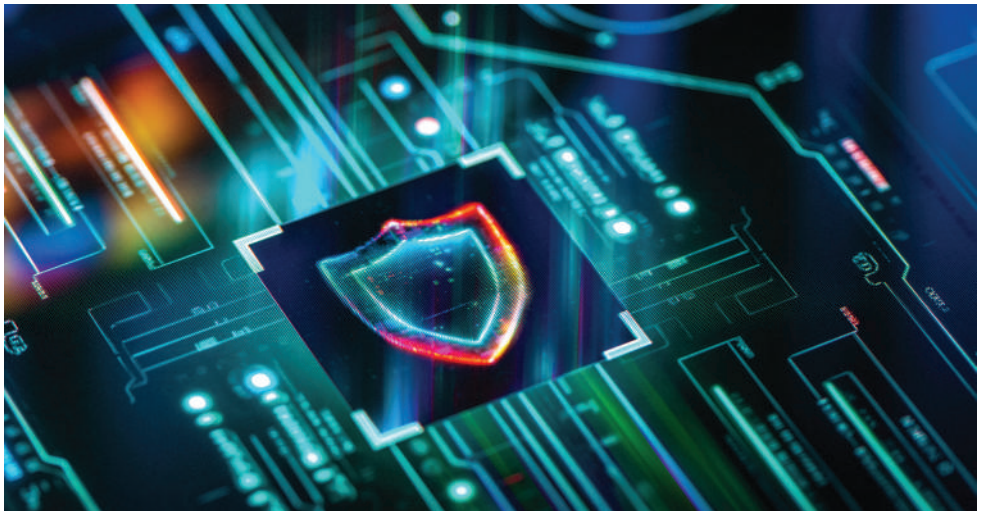
force of automation regarding the contemporary entanglement of the private sector and national militaries before discussing its possible implications on R&D and defence governance. That will be the basis for understanding the importance of automating military administration for Innovation. This broadened understanding will serve as a basis for the evaluation in Section 4, in which the benefits of automation will be addressed in terms of Interoperability.

Entanglement of the Private Sector and National Militaries

The private sector is playing an increasingly relevant role in the defence sector (Gronlund, 2019). Private companies provide services that range from repair activities, training and logistical management to sending soldiers into the theatre of operations (Ianakiev, 2019). Since the end of the Cold War, this trend has intensified (Bautista Forcada, 2019). Private firms affect the current military administration, from administrative support for defence

departments to the supply, integration, maintenance and operation of weapons systems (Heidenkamp, 2014). Such an impact stems from the growing digitalisation and automation of services in several fields (Stowsky, 2004). Compared to the past, advanced technologies require more specialised skills and expertise, which the military apparatus does not necessarily possess anymore (Neuman, 2006). Therefore, since it has become challenging to manage all aspects of military administration directly, it is of utmost importance to involve the private sector in the military and delegate the execution of certain functions to those firms which can perform them more efficiently (Lee & Park, 2019).

In particular, private companies have become transformative actors in R&D surrounding Weapon Management Systems. Their contribution consists of their ability to invest in Innovation, drive digitalisation and leverage advanced technologies. Although most militaries and governments are wary of private



companies accessing classified information, a fruitful collaboration could benefit the modernisation of armed forces and increase the efficiency of several processes (Lizzo, 2024). For example, since private firms are frontrunners in artificial intelligence and machine learning research, adopting secure external systems and software programmes could streamline and automatise weapon issuance and maintenance. It has to be noticed that, besides their involvement in manufacturing, a constant of the last century, private companies can integrate advanced sensors into common platforms and develop real-time data analytics to increase efficiency and facilitate the soldiers' access to the armoury and the collection of their small arms (LoxoLock, 2024b). Furthermore, they can provide software tools for inventory management and weapons lifecycle administration.

Although traditional big firms execute critical functions and are integral parts of the military-industrial complex, they are not the only relevant actors in the collaboration between the military and industrial sectors. Small and medium enterprises (SMEs) and startups have the potential to develop new ideas to modernise some concrete aspects of military administration that could otherwise be overlooked (Ianakiev, 2019). An example is the development of dual-use technologies. The dual-use capability expands the military's technological base and increases the innovation potential (Blockmans, 2018). While many technologies developed for the military have become part of everyday life, notably the 1960s US Department of Defence (DoD) ARPANET project, which would have established the first net of computers, this process

is not unidirectional (Schafer et al., 2019). At the same time, technologies developed for civilian purposes have been adapted for military applications (Rath et al., 2014). For example, Internet of Things (IoT) devices, whose first applications were developed by multinational enterprises, directly affect advanced Weapon Management Systems, reducing costs and enhancing the logistics and maintenance of military assets (Kufakunesu et al., 2025).

The private sector's role is indispensable in military R&D. Several firms invest in developing new, cutting-edge technologies for predictive maintenance, real-time monitoring and supply chain optimisation (GAO, 2022). On the one hand, predictive maintenance uses data analytics, sensors monitoring performance metrics and AI algorithms to predict when a weapon or system may fail, enabling pre-emptive action (Judson, 2023). On the other, inventory management is gradually incorporating automated systems to reorder components or ammunition when stocks run low, preventing inefficiencies or shortages (Burke & Ewing, 2014). Furthermore, new technologies can be employed to ensure that weapons systems upload data to a secure and centralised cloud, making them easily accessible (Gootzen & Hognes, 2021). These are some cases, among many others, of companies collaborating with government agencies to tailor solutions to specific military needs. Defence contractors offer comprehensive lifecycle management services, ensuring that weapons systems remain operational and effective throughout their service life (DAU, n.d.). Some firms specialise in integrating components of Weapon Management Systems into a cohesive framework, from di-

agnostics to inventory systems. At the same time, others have built algorithms to interpret sensor data and automatise military supply chains (Cunningham, 2023). Moreover, safe cloud platforms could serve to store and analyse logistics and maintenance data.

Expressing the potential of such collaboration will also reveal extremely important in the context of great power competition. In general, states characterised by the existence of a private sector with an inclination towards Innovation could ensure that their armed forces maintain or acquire a technological advantage over potential adversaries (Klempner et al., 2024). Two of the most notable examples are the United States and China, while many European states still lag in fruitful engagement with their national private sectors. Inside a regulatory power like the EU, companies must navigate strict regulations concerning export controls, classified information and ethical considerations (Immenkamp, 2018). While this trait is undoubtedly one of the EU's strengths, excessive bureaucratisation could hinder private companies' risk tolerance and de-incentivise investments (Moutii, 2024). As the 2024 report on the future of European competitiveness indicates, a push towards Innovation is needed to keep a comparative advantage in specific areas and improve the overall efficiency of European militaries (European Commission, 2024a).

Recently, the traditional model of defence Innovation has revealed its limits. Conversely, although an open Innovation model entails firms and policymakers using internal and external assets to create value and develop new projects, it has been considered inapplicable

to the closed context of military bureaucracies (Briant, 2022). However, such a new approach encourages end-users feedback and new opportunities for co-creation between them and the providers of technologies. European states may need to adapt Innovation governance and rethink the interactions between the state, the scientific community and the industry to remain relevant (Heeren et al., 2024). This paradigm shift draws a new relationship between the civilian and military sectors, underscoring the need to find new ways to manage dual-use technologies (Alvarez-Aragones, 2024). Nowadays, it is clear that innovative technologies relevant to developing military capabilities can emerge from any industrial segment. In this context, the conventional conceptualisation of a Defence Technological and Industrial Base (DTIB) risks being undermined, as it is often associated with a closed perimeter of actors (Briani et al., 2013). By collaborating with new actors, defence policymakers must now appropriate several new technologies, some undriven by military needs and budgets. This transformation's speed depends on national cultures. However, a close entanglement between private companies and the military sector poses some relevant challenges (Kramer, 2023). First, relying entirely on such companies to perform specific functions at the core of the whole system can create vulnerabilities if supply chains are disrupted or commercial interests are prioritised. A similar issue has been observed in outsourcing logistical services (Hesketh, 2018). Second, SMEs usually struggle to accommodate the constraints of military rationales once the maturation process has already advanced.

To conclude, the implications of the increasing weapon management automation for the entanglement between the private and military sectors will be discussed. The adopted new technologies have often been pioneered in the private industry. Several big companies specialised in these fields, like Palantir Technologies, Lockheed Martin and Raytheon Technologies, have developed automation for military logistics and weapon management (Harper, 2024). Governments recognise the importance of finding new ways to stimulate cooperation since automation, driven by private R&D, fosters rapid Innovation cycles (Brandon III, 2024). Therefore, they tend to sign longer-term contracts. The complexity of such innovations has led the armed forces to delegate several aspects to private firms. However, such a close partnership raises some serious concerns. Since tech companies could have a role in managing it, the vast amount of data produced by automated systems, such as weapon usage history, creates issues of data ownership, control and exposure. However, national militaries often use their own encrypted and protected software and digital systems to prevent data breaches (LoxoLock, 2024b). Integrating them into automated systems purchased from the commercial sector will be a relevant challenge for modernising the militaries. Moreover, privatising the data management process can pose security risks if sensitive military data is vulnerable (Catanzano et al., 2023). This could happen if adversaries target the less secure commercial systems employed in these activities through cyberattacks. In addition, such automation might make it more complex to determine who is responsible for design flaws or miscon-

figurations, with likely buck-passing. Finally, as military organisations progressively rely on automated systems, there is a risk of growing dependence on private companies for long-term support and software updates, which may have strategic implications and affect military readiness (Freedberg, 2022).

In the future, increased regulation and oversight of the private sector's involvement in military technology development could be required to regulate the role of private companies as critical strategic partners. In some cases, as technologies evolve, there might be the danger of large corporations assuming the responsibility for managing weapons stockpiles and issuance. This will raise questions about the balance of power between public military organisations and private interests. The broader trend toward automating supply chains, weapon stockpiles and maintenance routines relies more on private technology firms to provide both the necessary infrastructure and Innovation.

R&D: Automation for Innovation in Defence Governance

Having discussed the entanglement of national militaries and the commercial defence sector, arguing that automated weapon systems management would be highly beneficial for the ever-growing interplay between them, this research now turns to R&D, making the case that automation would impact it in a way that could permanently foster greater Innovation and effective defence governance. R&D is a vital aspect of the development of militaries and, in the context of defence governance, Park Min Jae and Lee Jun Gon are right to argue that “innovative defence R&D gover-

nance must be considered as a compulsory factor” for the effective execution and management of a policy sector that is experiencing increasing (inter)-dependency (2019, p. 1). This section, therefore, addresses in what specific ways automation can contribute and provide long-term benefits to R&D and how this can improve national militaries and innovate defence governance specifically. With that, the research continues to highlight how the automation of weapon systems management can have a broad impact on the defence sector.

The importance of defence R&D cannot be underplayed. Considering that a central task of the state is to protect their population and sovereign territory, steady investments into defence are necessary to maintain this safety, as well as to be able to adapt security in regards to the development of potential new threats (Hendrickson et al., 2018). It is precisely in this context that R&D efforts are vital, and in the context of this research, automation could play an important role in making it more effective. This paper has alluded to this in the previous section by arguing that it would improve the communication between the private sector and national militaries regarding maintaining, repairing and reordering weapons, munition and spare parts. However, the greater overall point is the impact automation

can have on innovative R&D efforts in that context.

Specifically, automation benefits the four types of Innovation included in the Oslo model, described in Figure 1.1 below (Lee & Park, 2019, p. 4). Digitalised and data-driven automation contributes to product, process, and organisational Innovation by using information that helps improvements from material and functional characteristics, improvements of available techniques and the implementation on the organisational level. On a singular level, these benefits could be reduced to minor improvements. However, if viewed on a whole-level analysis, they could lastingly contribute to Innovation in the entire military development and acquisition process, at which R&D stands at the centre. Digitalised administration systems warrant precisely that, by making general data available at all times. In the hands of procurement specialists, this data could be used to further R&D, by, for example, understanding preferences and the timings of maintenance (LoxoLock, 2024b). Automation could, therefore, provide a way to provide R&D efficiency and match the external competitiveness of the defence industry through having a far more intricate range of data at their hands to foster a “culture of innovation” in defence governance (Lee & Park, 2019, p. 4).

<p>Product Innovation</p>	<p>The Introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. (Technical Specification, Components and Materials, Incorporated Software, User Friendliness)</p>
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Process Innovation	The Implementation of new or significantly improved Production or Delivery methods. (Changes in techniques, equipment and/or software)
Marketing Innovation	The Implementation of a new marketing method involving significant changes in product design.
Organisational Innovation	The Implementation of a new organisational method in the firm's business practices, organisations or relations.

Table 1. Four Types of Innovation in the Oslo Model (Lee & Park, 2019, p. 4)

For the sake of effective defence governance, the data gained from the interplay between automation and R&D presents a crucial tool to foster innovative and effective defence governance. Jay Stowsky (2004) has made an excellent case for how this data and information can shape defence governance effectively and innovatively. Writing in the context of the emerging digital age and the post-Cold War World, Stowsky's (2004, p. 257) analysis concerns itself with how national militaries can conduct R&D in a way that could navigate this "dramatically different environment." Making the case that most military equipment now derives from "highly sophisticated commercial technology" in a global technological market which is no longer dominated by the US and experiences increasing technological diffusion through the internet, Stowsky believes that instead of 'shielding' military R&D, we should use it for defence governance with an approach he calls "shared innovation" (2004, p. 258). 'Shared innovation', he argues, is aimed at "advancing a general technological capability," "driving the curiosity and ambition to drive the trajectory of technological ambition," "and making cross-communication between participants in projects easier" (2004, p. 258). Stowsky ar-

gues that defence governance must lean into the new facets of increasing digitalisation, globalisation and commercialisation to foster Innovation.

In returning to automating Weapon Management Systems, it is exactly this that the data yielded by automated systems can provide. Through having more data on hand that can be used for R&D in a freer exchange of information, the development of militaries can proceed more innovatively and efficiently. Stowsky purports a more plural level and intertwined system of R&D between the increasing number of stakeholders that can work in and codependently towards developing defence capabilities—and through automation, weapons systems could provide R&D with exactly that data-driven interchangeability. Automation can, therefore, embrace the openness Stowsky sees necessary for defence governance (2004, p. 267). This speaks to the overall argument of our research, underlining the far-reaching, innovative benefits that automation can have on the entire military sector. In the following sub-section, this paper will use the present findings to solidify the broad, innovative implications automated Weapon Management Systems could have to reify its meaning.

Reflections on Innovative Facets of Automation in the Security Sector

It has hitherto been underlined that the automation of Weapon Management Systems enhances Innovation in military administration through the vast benefits it yields to the broader but deeply ingrained fields of the Security Sector. The specific focus on the contemporary entanglement between the private defence sector and national militaries and the vital role R&D efforts play in the development of militaries have signalled that military administration in the 21st century requires the efficiency that only automation can offer. Put into practical terms, automation provides a data-driven answer to the questions formulated by Lee Jun Gong and Park Min Jae in regards to defence acquisition and development, namely “what, when and how” to acquire and the sustainable upkeep and development of this acquisition system (2019, pp. 1-2). Tracing this back to the narrower theme of military administration, automation not only makes weapon management and maintenance more efficient but also helps it become an intrinsic part of the continuous development of the defence sector. In the context of this research, answering the question of ‘what, when and how’ is a way to solidify the broadened link between military administration and the defence industry at large.

This broadened perspective equally offers insights into the current conditions of the defence industry and the way in which it desperately requires innovative governance, which is particularly perceptible in the current geopolitical situation and its intricate political, economic and military vectors. Defensive capacity and its industry at large are

both an important diplomatic instrument for leverage, as well as, as Joshua R. Hendrickson argues, a “necessary condition for sustained economic growth” (Hendrickson et al., 2018, p. 171; Neuman, 2006). In the current rising global tensions and economic instability, defence governance is thus facing considerable challenges. On one side, continuous investments need to be made into the defence to have the diplomatic leverage necessary in the international system; on the other, spending cannot supersede the “marginal social benefits of capital accumulation” (Hendrickson et al., 2018, p. 172). Global inflation and the ever-escalating prices for military technology provide the current political dilemma that mainly European countries face in the wake of Russia’s War on Ukraine (Neuman, 2006, p. 438). It is in that context that R&D must be conducted efficiently. Automating military administration can be a cost-efficient way to affect this, in addition to bringing forward more precision in weapon management.

The overall point made in this section is, therefore, that streamlining and digitalising weapon systems and administration is as innovative as it is a necessary transition for the challenges that beset the defence industry in the 21st century, the necessity becoming increasingly evident considering the global challenges the West is facing. With countries toiling to modernise and improve their militaries, a greater emphasis on technology integration in the administration that embraces particularly the increasingly commercial face of the industry would be one way to quicken the improvement of militaries through having the ability to use the added layer of data with the private sector of defence (Stowsky, 2003).

Equally, digitalised and inferentially more data-driven Weapon Management Systems will yield information vital for cost-efficiency in R&D and weapon operation management (Choi & Suh, 2020). Therefore, the necessary thing to consider for weapon administration and its innovative facets is the broad implications it has on the defence industry as a whole. It can and will benefit the R&D of militaries while making acquisition and

general contact with the commercial sector easier and more efficient. In discussing Innovation, this section broadened the ways to think about weapon administration to allude to its importance for the whole system. The following section will tighten the discussion again by analysing how, in the context of Interoperability, streamlining weapon systems can improve processes of mutual cooperation in defence governance.

WEAPON MANAGEMENT AND INTEROPERABILITY

Driving Interoperability Through Automation: An Introduction

Moving on to applying the broadened understanding of the innovative features that automated Weapon Management Systems can have on the military sector, this paper wants to make use of the final section to evaluate its positive impact on Interoperability. Specifically, the argument is that this innovative nature drastically enhances the opportunities for Interoperability and, therefore, makes an excellent feature of military cooperation. In working towards this argument, the discussion will first, as a continuation of the themes covered in Section 3, outline how interoperable defence governance will work and improve through automation. As the next step, this section will work towards understanding how it can be applied in policy, for example, for initiatives and policies like the Permanent Structured Cooperation (PESCO) and the Common Security and Defence Policy (CSDP). As a whole, this will, in the greater scheme, allude to the argument set out in the beginning, namely, that automation of Weapon Management Systems offers a bottom-up

improvement to the entire military sector.

Interoperable Defence Governance

In the previous section, the discussion was centred around the positive impact automation has on R&D and the importance of this for defence governance. Specifically, it was concluded it makes answering the question of ‘when, how and what’ to acquire a far easier task, and, additionally, makes communication with the private sector as an increasingly important player in developing new defence capabilities a lot easier. In this subsection, these previous insights are built upon to establish a way in which this automation can take hold in interoperable defence governance. It shall, therefore, discuss interoperable defence governance based on, first, how it affects international cooperation and R&D and, second, how automation could work towards a defence governance network capable of national militaries functioning as semi-attached nodes.

For Europe, automating Weapon Management Systems would be sensible in advancing defence governance. It is so because it invariably strengthens the cooperation capabili-

ties of militaries, especially in the context of R&D. This can be understood best in terms of how the digitalisation of administration would affect the field. Digital output for armoury management that would, for example, allow the movement of weapons to be monitored while providing statistical and real-time data and granting greater oversight over the inventory would make common investments into security much easier because the data would be readily available and easy to access (LoxoLock, 2024b). Not only would this make defence governance more effective, but the effect on R&D would be that this data could be shared accordingly in different national projects. This links to a point Lee and Park (2019) make for national defence governance, namely that when a governance structure emphasising policy coordination and integration can cooperate from the very beginning, defence R&D will be more efficient and cost-efficient. Seen in an international

context, and indeed a European context, this may permanently sustain the international efforts to strengthen Europe's defences—and without causing a high-cost potential. This then refers back to the main point: automation can broadly benefit the entire security sector bottom-up.

Taking this further, specifically discussing the adaptability of this to Interoperability, automation benefits the broad aims of modernising and improving European security. This is posed in the way in which automation can help construct an interoperable European security and defence system that functions as a deeply integrated network consisting of semi-detached nodes. What this paper means by this is that the defence sector is, at least in the current international system, a sector that eventually constantly feeds back into the conditions of the independent nation-states and their specific security needs. The interopera-



ble European defence network is structured around exactly this condition. Knowing that governance must “be applied at the national level for the most effective decision making”, it is important that European security does not supersede national defence, economic and even civil-military capabilities (Lee & Park, 2019, p. 1). Automation of Weapon Management Systems offers one way to make this fine balance work. An automated system capable of providing multi-level access and parallel control of several armouries would make it easy to customise individual requests according to need and, finally, can easily be integrated into existing systems. This would be one way to work towards higher integration of European security while keeping the very vital condition of the national contexts intact. Therefore, it would be an important step to introduce automation, especially in the context of efforts such as the CSDP and PESCO; this article now turns to the potential application of similar structures.

Building European Interoperability: PESCO, the European Defence Fund and Future Perspectives

At the European level, efforts to build a common EU defence governance have been conducted by Member States since the implementation of the CSDP (Blockmans & Crosson, 2021). Since it is central to the state's survival and brings additional benefits to it, this area has historically been jealously guarded by nation-states. This makes collaboration and partnerships in defence particularly difficult. For this reason, EU institutions have strived to find effective incentives to stimulate cooperation among Member States. PESCO,

the widest and most promising among these, was announced in 2017 to improve defence cooperation and leverage EU resources (Biscop, 2018). It was conceived as an operational tool to use resources more effectively and make EU Member States more autonomous in terms of military capabilities (De France et al., 2017).

The PESCO agenda was dynamic and aimed to deepen technical and institutional Interoperability among nationally organised armament markets and militaries. The underlying assumption is that European national armament industries are redundant because their technological and economic performance is structurally inferior to what could be achieved through joint efforts (European Commission, 2024a). Besides centralising the supply and demand sides of the armament market, PESCO aims to standardise military equipment and serve as an organisational framework for technological Innovation (Dossi, 2019). When launched, PESCO was considered promising by several scholars and officials (Biscop, 2018; Eilertsen, 2020). About it, former President of the European Commission Jean Claude Juncker stated that “the protection of Europe could not be outsourced any longer” (Deutsche Welle, 2017, para. 5; Pengili & Santos, 2022, p. 2).

The voluntary mechanism for participation was meant to avoid commitment problems, while agreements stipulated by states became legally binding to minimise the risk of late opting-outs (Houdé & Wessel, 2023). Despite its flexibility as a force that generates positive integration, it was considered to have produced the most inclusive expression of en-

hanced cooperation, thus de-fragmenting the EU defence market (Blockmans & Crossons, 2021). PESCO's *raison d'être* is that the Member States commit to spending more intelligently on defence equipment to reach higher levels of investment expenditure and pool capabilities, reduce shortfalls, and encourage cooperation in logistics. By harnessing synergies and economies of scale, PESCO enhances burden-sharing (Leuprecht & Hamilton, 2021). Some of PESCO's projects focus heavily on Innovation since EU Member States have recognised that certain technology projects require a financial and industrial critical mass exceeding their national capabilities (Dossi, 2019).

The lack of political will and mutual trust among EU Member States has been an obstacle to cooperation in security and defence. The high levels of politicisation in the defence sector have thus downsized PESCO's innovative contribution (Blockmans & Crossons, 2021). In the CSDP framework, the appeal of integration has been low due to low levels of interdependence among states in the security area. While PESCO may have led Member States to acknowledge common geopolitical interests and threat perceptions, it did not fully manage to consolidate the CSDP as a community of practice or relevantly foster Interoperability. PESCO has promoted a structural harmonisation amongst national military organisations, but the more ambitious projects acquired more political significance, thus often becoming less attractive (Dossi, 2019). The absence of legally binding commitments and supranational enforcement mechanisms implies that national sovereign decisions will remain the norm. National pro-

tectionism in the defence sector remains high.

Besides PESCO, the establishment of the European Defence Fund (EDF) mobilised the EU budget to support collaborative defence R&D (Ianakiev, 2019). It was the first time the EU budget was employed to support collaborative defence R&D projects. By including incentives for cross-border engagement, it implied higher levels of participation of small and medium-sized enterprises. The EDF fosters research and Innovation: its grants are assigned to industries that promote the excellence and competitiveness of the EDTIB (Csernatonni & Martins, 2019). Therefore, the EDF incentivises joint R&D of products and technologies and is expected to increase the efficiency of public expenditure (Blockmans, 2018). Its financial tool should scale up home-grown European joint strategic defence projects, especially concerning disruptive technologies and streamlining defence spending (Csernatonni & Martins, 2019). The European Commission intends to foster the development of common industry standards, supporting the European Investment Bank in improving access to SMEs, start-ups and other suppliers to fund the development of dual-use goods and technologies (European Investment Bank, 2024). This new approach aims to create an open and competitive defence market, helping smaller companies in the supply chain to operate across borders. While the EDF stimulates the European defence industry by opening supply chains, PESCO's governance system should facilitate the research, development and operationalisation of new capabilities, including weapon management (Blockmans, 2018).

Collaborative defence programmes allow for sharing the R&D costs, overcoming national budgetary constraints and achieving high production volumes and economies of scale (Ianakiev, 2019). They enable improved technological Innovation in the European defence sector and provide Europe with cutting-edge, interoperable defence technology and equipment (Csernatonni & Martins, 2019). They improve Interoperability and enable further savings when collaboration is pursued in later lifecycle stages, such as maintenance and repair. The European Commission invites applications for innovative defence products, solutions, materials and technologies, including those that can create a disruptive effect and improve the readiness, reliability, safety and sustainability of Union forces in the whole spectrum of tasks and missions. However, even in this case, several factors prevent collaboration. Member States struggle to agree on common requirements, synchronise their budgetary procedures and engage in common defence planning (Ianakiev, 2019). Another concern is that the defence industries of states that have the means to co-finance costly projects are also expected to be the main beneficiaries of the EDF.

To conclude, PESCO is a compromise between divergent policy visions and preferences. Its objectives are ambitious, but some natural limitations to its technological and political scope are unlikely to be overcome (Dossi, 2019). The entire military-technology sector is characterised by the trade-off between maximising efficiency or effectiveness. This productivity dilemma influences all aspects of the industrial Innovation process, from organisational necessities to how prob-

lems are conceived. Focusing on efficiency means pursuing technological standardisation and reaching economies of scale at the expense of a static understanding of technology. Conversely, adopting an effectivity-based approach relies on technological specialisation but implies fragmentation and economic overload (Dossi, 2019).

The inherent risks of a lasting deficit in defence R&D go far beyond the issues of industrial competitiveness and touch at the very core of the security of the EU (Ianakiev, 2019). Defence R&D enables Member States' armed forces to act together. The technologies affected can only be effectively developed and deployed by states that can afford the necessary critical investment levels. This is not necessarily true for many EU Member States when taken separately. Fragmentation of the defence R&D also leads to underinvesting in disruptive technologies central to digitalising and automating weapon management. The potential effects of underinvestment in disruptive defence research can reach beyond the defence sector since such activities can be at the origin of major technological breakthroughs with spin-off effects in the civil economy. In the defence sector, private investments cannot compensate for limited public spending since Innovation needs to occur at the technology frontier, resulting in high cost and risk levels.

The current trends are no longer sustainable, and the European defence industry can not afford the existing levels of fragmentation and the scale of efficiency gains foregone through wasteful duplications, incapacity to take advantage of the scale economies and exclusion

of innovative partners because of a strong domestic bias (Ilanakiev, 2019). Advancements in Interoperability suffer from supply chains built on national bases and from projects not based on common requirements, which result in the multiplication of national versions. For example, joint procurement is still insufficient at the European level: only eighteen per cent of total procurement from the European Member States was pursued via European frameworks in 2022 (Niehus, 2024, p. 10).

The launched initiatives are linked to the desire to develop a robust EDTIB and safeguard Europe's technological power in the long term (Csernatonni & Martins, 2019). Since defence is a highly technological industry characterised by disruptive Innovation, massive R&D investments are required to maintain strategic parity (European Commission, 2024a). Several segments nowadays call for pan-European coordination, and the spillovers from defence R&D to other sectors of the economy are significant. Eventually, European funding for R&D should be increased and concentrated on shared initiatives.

Europe at a Crossroad: Automating Logistics to Remain a Global Leading Actor

In the digital age, data Interoperability is critical for the military (McMahon, 2021). Without it, information derived from data cannot be shared among soldiers and command centres. Electronic system standardisation enables it since it allows coalitions deployed in foreign countries to function coherently and maximise efficiency (LoxoLock, 2024b). At the technical level, the issue is compatibility, the degree to which electronic systems can operate with each other (NATO, 2023). At

the system level, interconnectivity is the main focus.

In contrast, at the operational level, Interoperability concentrates on the organisational and doctrinal aspects of how national forces can operate with other nations in a coalition (Beaumont, 2021). European efforts to improve Interoperability have only led to limited results. While several obstacles stem from political divergencies and Member States' reluctance to share knowledge and strategic objectives, promoting Interoperability from the bottom through automation would likely generate positive forces of integration, with spillovers on the entire defence governance architecture and thus on European security.

Therefore, previously existing or recently launched mechanisms could focus on automation to reach their strategic objectives and fulfil their mandate. Although automation is often discussed on the tactical level of warfare, with experts and the industry focusing on how it could change the battlefield, there is less consideration of its impact on the military structure and administration far from the frontline. Indeed, it offers military logisticians considerable advantages in "distributing more things to more combatants more quickly" (Beaumont, 2021), thus helping them be more productive. The adoption of new technologies which are based on the creation of networks for exchanging all kinds of information, serves to 'expand the pie' and creates additional capacities in the military supply chain.

Autonomous technology may profoundly impact the entire military organisation, with relevant implications for the militaries' mod-

ernisation and global transformation over the coming decades (Beaumont, 2021). As Innovation in autonomic systems will likely come from the private sector and automation implies adopting more and more complex and advanced technologies, the military will have to improve at incorporating civilian resources into their operations and, on their part, industry partners will have to provide the expertise that militaries need. This will also lead to national militaries starting a competition

CONCLUSION

This research's overarching and bold aim has been to highlight that the automation of Weapon Management Systems could have a lasting positive effect on the entire defence sector, improving it from the bottom up. In the current military setting, using the highly relevant themes of Innovation and Interoperability to make this case, the research used the challenges that weapon administration has and still meets daily to lead a discussion of how the main themes chosen further the improvement of the defence sector bottom-up.

Discussing Innovation in the third section underlined a broadened perspective on how Military Administration allows perceiving the wide-reaching positive effects on the defence sector if digitalised. Discussing the links between national militaries and private industry, as well as R&D and defence governance, the research did not simply underline the benefits of streamlining and digitalisation but also made the critical point that the deep entanglement of all these essential aspects of the defence sector requires a coherent, functional and above all a data-driven system that is ca-

to secure cutting-edge technologies from the private sector. As many European states do not possess the adequate resources to compete with great powers on international markets, a common European strategy would highly benefit Europe's capacity to remain at the forefront in terms of automation in the defence sector. In that regard, PESCO still has a long way to bolster investments in autonomous systems for logistics purposes.

pable of lastingly contribute to the innovative requirements of the defence sector. This is what the automation of Weapon Management Systems can warrant.

This was followed by an analysis of the impact it would have on Interoperability. Continuing to explore interoperable defence governance and the path towards European Interoperability, Section 4 narrowed this broadened perspective onto more specific examples of furthering the defence sector. So far, it evaluated the innovative effects of automation and applied it to the political facets of the military landscape. It particularly stressed how digitalisation and streamlining will make the cooperation of European states easier and more coherent. It underlined how digitalisation can warrant this, all the while being appreciative of the different states' respective defence needs. Applying this to the PESCO initiative, the discussion alluded to how a common European strategy would benefit the continent's defence capabilities. Henceforth, while the EU is aware of the need to cooperate in this endeavour and recognises the need to invest

in joint strategies, investments are too fragmented and split from one another to run efficiently and effectively. Automation could be an important first step towards that and particularly help this process from the bottom up.

The most important takeaway from this research must be the centrality of understanding the various ways in which the military can improve and run more smoothly. In times of greater unrest and geopolitical uncertainty, Europe cannot afford to suffer the consequences of incoherence. At the moment, as Gerlinde Niehus states, “Billions of Euros are

wasted year by year due to duplication, insufficient pooling and joint procurement” (2024, p. 10). If Europe wants to prepare itself for potential conflict and to be able to show a united front, this condition cannot hold. To prepare the defence sector for the emerging challenges of the 21st century, Innovation is needed alongside measures focusing on Interoperability and cooperation. The automation of Weapon Management Systems would present a small but nonetheless decisive way of working this change from the bottom-up, and, therefore, can be seen as an important first step in the right direction.

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Finabel aims to be a multinational-, independent-, and apolitical actor for the European Armies of the EU Member States. The Finabel informal forum is based on consensus and equality of member states. Finabel favours fruitful contact among member states' officers and Land Force Commanders in a spirit of open and mutual understanding via annual meetings.

Finabel contributes to reinforce interoperability among its member states in the framework of the North Atlantic Treaty Organisation (NATO), the EU, and *ad hoc* coalition; Finabel neither competes nor duplicates NATO or EU military structures but contributes to these organisations in its unique way. Initially focused on cooperation in armament's programmes, Finabel quickly shifted to the harmonisation of land doctrines. Consequently, before hoping to reach a shared capability approach and common equipment, a shared vision of force-engagement on the terrain should be obtained.

In the current setting, Finabel allows its member states to form Expert Task Groups for situations that require short-term solutions. In addition, Finabel is also a think tank that elaborates on current events concerning the operations of the land forces and provides comments by creating "Food for Thought papers" to address the topics. Finabel studies and Food for Thoughts are recommendations freely applied by its member, whose aim is to facilitate interoperability and improve the daily tasks of preparation, training, exercises, and engagement.



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