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ARROW-3 AND SKY NEX – MODERN SOLUTIONS FOR THE AIR DEFENCE OF ROMANIA

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Abstract: *This paper analyses two modern air defence systems, ARROW-3 and Skynex, from a strategic and operational perspective. ARROW-3 represents an advanced exo-atmospheric anti-ballistic missile defence capability, while Skynex is a short-range air defence artillery system optimized for countering drones and low-altitude threats. The study compares their technological features, advantages, and limitations, and evaluates their relevance for the Romanian Ministry of National Defence. Considering the evolving security environment in the Black Sea region, the integration of multi-layered air defence systems is essential for ensuring national resilience and strategic deterrence. The research also considers operational lessons identified in recent conflicts, where both ballistic missile threats and large-scale drone attacks have reshaped air defence doctrines. Special attention is given to cost-efficiency, interoperability within NATO frameworks, and long-term sustainability of defence investments. The comparative perspective highlights the complementary nature of strategic and tactical air defence systems in building a resilient national security architecture.*

Keywords: *air defence; ARROW-3; Skynex; missile defence; MApN*

1. INTRODUCTION

The contemporary security environment is characterized by the proliferation of ballistic missiles, cruise missiles, and unmanned aerial vehicles. These developments require NATO member states, including Romania, to strengthen their integrated air and missile defence architectures. A modern defence posture must rely on multi-layered systems capable of countering both strategic and tactical threats. The war in Ukraine and tensions in the Black Sea region demonstrate the growing importance of layered air defence structures capable of countering simultaneous and diversified aerial attacks. Traditional air superiority concepts are increasingly complemented by defensive systems designed to protect civilian infrastructure, military bases, and command centers. In this context, Romania must evaluate not only high-end strategic interceptors but also cost-effective solutions capable of neutralizing asymmetric threats.

2. ARROW-3 AND SKY NEX – TECHNICAL FEATURES

2.1 ARROW-3

ARROW-3 is an exo-atmospheric interceptor designed to destroy ballistic missiles through hit-to-kill kinetic impact. Operating at altitudes exceeding 100 km, it forms part of Israel's multi-layered air defence architecture. The system enhances strategic deterrence and protects national territory against long-range missile threats.

Despite its operational advantages, ARROW-3 involves significant acquisition and maintenance costs and requires advanced radar and command infrastructure.

2.2 SKY NEX

Skynex is a short-range air defence system based on 35 mm automatic cannons and programmable AHEAD ammunition. The airburst projectiles release sub-projectiles near the target, increasing effectiveness against drones and low-flying threats. The system integrates radar and automated fire control.

Its main advantage lies in cost-efficiency, making it particularly suitable for countering mass drone attacks and protecting critical infrastructure.

3. COMPARATIVE ANALYSIS AND RELEVANCE FOR MAPN

ARROW-3 and Skynex operate at different defence layers. ARROW-3 provides strategic-level protection against ballistic missiles, while Skynex addresses tactical and asymmetric threats such as drones and cruise missiles. For Romania, a layered approach combining both strategic missile defence and tactical anti-aircraft artillery would enhance national resilience and contribute to NATO collective defence.

System	Advantages	Disadvantages
ARROW-3	Strategic ballistic missile interception; High deterrence value; NATO interoperability	High acquisition and maintenance costs; Limited efficiency against drones
SKYNEX	Cost-effective drone interception; High automation; Suitable for infrastructure protection	Limited range; Cannot intercept ballistic missiles

4. STRATEGIC AND FINANCIAL IMPLICATIONS

The acquisition of high-end missile defence systems such as ARROW-3 requires a comprehensive financial and strategic assessment. Beyond procurement costs, decision-makers must consider long-term maintenance, training of personnel, infrastructure adaptation, and interoperability within NATO command structures.

Such investments are justified primarily through their deterrent value and their contribution to collective defence mechanisms.

In contrast, systems like Skynex involve lower acquisition and operational costs, making them attractive for rapid deployment and protection of multiple critical sites. The increasing frequency of drone-based attacks highlights the necessity of sustainable defence solutions capable of responding to repeated engagements without exhausting national defence budgets.

From a strategic standpoint, Romania's geographic position near the Black Sea and within NATO's eastern flank reinforces the need for both strategic missile defence depth and tactical resilience. Investments should therefore prioritize complementarity rather than exclusivity.

5. OPERATIONAL LESSONS FROM RECENT CONFLICTS

Recent conflicts have demonstrated that modern warfare increasingly combines high-precision ballistic strikes with mass drone and loitering munition attacks. States relying exclusively on traditional air defence missiles often face economic pressure when intercepting low-cost aerial threats.

The experience of Eastern European battlefields illustrates that layered defence architectures significantly increase survivability. Strategic interceptors protect against high-impact threats, while short-range artillery systems provide continuous coverage against persistent low-altitude attacks.

These operational realities confirm that no single system can ensure complete airspace security. Instead, integration, automation, and real-time data sharing represent decisive factors for modern air defence effectiveness.

6. CONCLUSIONS

The analysis of ARROW-3 and Skynex highlights the importance of multi-layered air defence architectures in the modern security environment. Contemporary conflicts demonstrate the need to counter multiple aerial threats such as ballistic missiles, cruise missiles, UAVs, and loitering munitions.

Strategic missile defence systems like ARROW-3 provide an essential deterrence capability against long-range ballistic missiles. Operating in the exo-atmospheric interception layer, the system improves the protection of strategic infrastructure and population centers.

Short-range air defence systems such as Skynex are crucial for countering asymmetric threats**,** particularly drone attacks. Its programmable AHEAD ammunition and automated fire-control system allow effective engagement of multiple low-altitude targets.

No single defence system can ensure complete airspace protection**.** Research on NATO integrated air and missile defence shows that layered defence structures increase interception probability by combining systems with different operational ranges and altitudes**.**

Economic efficiency is a key factor in modern air defence planning. Using expensive missile interceptors against low-cost drones may create financial pressure, making systems like Skynex a cost-effective complement to high-end interceptors such as ARROW-3.

Romania's position on NATO's eastern flank increases the importance of developing an integrated air defence architecture**.**

The combination of strategic missile defence and tactical anti-drone capabilities would strengthen national resilience and contribute to collective defence.

Future air defence systems must focus on automation, sensor integration, and real-time data sharing. Integrated radar networks and command systems will significantly improve the efficiency of modern air defence operations.

Overall, the combination of systems such as ARROW-3 and Skynex represents a balanced and effective defence approach**,** capable of addressing both high-impact ballistic threats and low-cost asymmetric aerial attacks.

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WEAPONS & DEFENCE TECHNOLOGY CYBER WARFARE

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Abstract: *Within the broader field of Weapons and Defence Technology, cyber warfare has become an increasingly important element of modern security and military strategy. As societies rely more on digital systems, cyberspace has developed into a new operational domain where attacks can disrupt infrastructure, steal sensitive information, and affect national stability without the use of traditional weapons. This paper examines the concept of cyber warfare, the main types of cyber attacks and how they affect the infrastructure or person. It also analyzes two major cyber incidents, WannaCry and NotPetya, highlighting their global impact and the vulnerabilities they exposed in modern digital infrastructure. The study further discusses the role of cyber security technologies such as firewalls, artificial intelligence systems, security updates, and data backups in limiting the spread and damage of these attacks. Understanding these threats is essential for strengthening cyber resilience and improving defensive strategies in an increasingly digitalized world.*

Keywords*: infrastructure, cyber attack, ransomware, network, malware*

1. INTRODUCTION

In the 21st century, cyber warfare became a significant component of modern security and military strategy. With the rapid development of digital technologies and the increasing need on information systems, cyberspace has become a new domain of conflict alongside land, sea, air and space. Computers and the networks that link them together form what is known as cyberspace. Cyber warfare refers to the use of computer technologies and networks to conduct attacks against the information systems, infrastructure or military operations of an adversary.

States and non-state actors have increasingly used cyber operations to illegally disrupt important infrastructures, gather secret information or influence outcomes of different situations. These attacks often target government institutions, communication networks, private information about a person or defense infrastructure.

Many Western rely heavily on cyberspace for the daily functioning of modern society, and developing countries are becoming independent on it as well. A large part of what keeps a society together and its infrastructure stable relies, at least a part of it, on social networks. Because of its importance, the possibility of cyberwar and its potential consequences have become a major for most of the states. Several significant of cyber attacks have already occurred, and they may not seem so big, they show their massive potential.

Cyberwarfare is different from cyber war because in general cyberwarfare refers to the techniques used while engaging in cyber war. This reflects that cyber war defines the conflict at a national level, while cyberwarfare drives it forward through digital strikes.

The two are deeply connected, and together they turn infrastructures into part of the battlefield, making daily life more vulnerable than ever.
These attacks are designed to create disruption, spread fear and weaken public trust, without a single soldier on the ground.

It is very challenging to detect these types of attacks, and they can strike civilian systems with just a simple link. Cyberspace is particularly difficult to secure because of the ability of malicious actors to operate from anywhere in the world and the linkages between cyberspace and physical systems. This represents a growing threat that demands strong defenses and constant vigilance as technology advances.

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2. TYPES OF CYBER ATTACKS

Cyber attacks represent one of the most common methods used in modern cyber warfare. These attacks are designed to disrupt systems, steal sensitive information or damage digital infrastructure. There are several types of cyber attacks used by individuals, criminal groups etc.

One of the common type of cyber attack are ransomware attacks. To define what ransomware is, firstly we need to know what malwares are. Malware is a term that describes any malicious program or code that is harmful to systems, and some of its effects are:

- Your computer slows down, whether you are navigating the internet or just using your local applications.
- Unexpected pop-up ads are a typical sign of a malware infection.
- Your system crashes, getting a BSOD (Blue Screen of Death)
- A noticeable loss of disk space due to a bloated malware squatter, hiding in your hard drive
- Some of the computer files are encrypted or lost due to a randomware infection
- The antivirus product stops working and it cannot be turned back on, leaving the system unprotected

Ransomware is a type of malware that encrypts files on a device, making them, and any systems that depend on them, unusable. The attackers then demand a ransom in exchange for the decyption key. Over time, ransomware tactics have evolved to become more damaging, with attackers often stealing sensitive data and pressuring victims to pay by threatening to publicy release it. These ransomware attacks and related data breaches can have severe consequences for organizations, preventing access to critical information needed to maintain operations and deliver essential services.

Another type of cyber attack is A Man-in-the-Middle (MitM) attack. It occurs when an attacker secretly positions themselves between two parties during a transaction. By intercepting the communication, the attacker can monitor and even steal sensitive data. One common way this happens is over unsecured public Wi-Fi networks, where the attacker can insert themselves between a user’s device and the network, causing all transmitted information to pass through the attacker without the user’s knowledge. Another method involves malware that has already infected a device, where attackers can install software to capture and process all of the victim’s information as it is transmitted.

As a last example of a cyber attack, we can include phishing where attackers send fraudulent messages that appear to come from legitimate and trusted sources, most often via email, but also trough text messages or social media. The primary goal is to trick the victim into revealing sensitive information, such as usernames, passwords, credit card numbers or other personal data, which can then be used for financial gain or identity theft.

What makes phishing particularly dangerous is its reliance on human behavior; even well protected systems can be compromised if users are deceived into taking the bait.

3. SIGNIFICANT ATTACKS AND HOW THEY WERE ADRESSED

WannaCry first appeared on May 12, 2017, and rapidly spread across the globe, targeting computers running Microsoft Windows. The malware exploited a vulnerability in the Windows Server Message Block protocol known as EternalBlue, which had originally been developed by the U.S National Security Agency and later leaked online by the hacking group Shadow Brokers. Many organizations were particularly vulnerable because they had not installed a security update released by Microsoft earlier that year.

WannaCry spread extremely quickly because it acted like a worm, automatically moving from one computer to another without any user interaction. Once a single device in a network was infected, the malware could propagate rapidly to other connected systems. As ransomware, WannaCry encrypted victim's files renaming them with the .WNCRY extensions, demanding a payment of $300 in Bitcoin to provide decryption key. If the payment was not executed in the specified time, the value could've doubled or the files could be permanently deleted. The attack affected more than 230.000 computers across 150 countries in just a few days, causing chaos, with the estimated global financial damage ranging between $4 billion and $8 billion.

NotPetya emerged on June 27, 2017, just about a month after WannaCry. It initially spread through a compromised updated of Ukrainian accounting software called M.E.Doc. Attackers injected malicious code into software update system, allowing the malware to reach thousands of organizations that used it. It exploited the same EternalBlue vulnerability used by WannaCry, utilized Mimikatz to steal passwords from computer memory, and leveraged Windows administrative tools such as PsExec and WMI to spread further.

Although it appeared to be ransomware, NotPetya was actually designed to destroy data. Once a system was infected, the malware overwrote the Master Boot Record and encrypted the Master File Table of the hard drive, preventing the computer from starting properly. A fake ransom message demanded $300 in Bitcoin, but there was no way to recover the data. The global impact of NotPetya was enormous, the attack affecting at least 65 countries and caused estimated damages exceeding $10 billion, making it one of the most costly cyberattacks in history.

Technologies such as firewalls, artificial intelligence, security updates played an important role in stopping and limiting the spread of both WannaCry ransomware and NotPetya malware. These tools helped organizations detect infections, block network communications used by the malware and protect systems from further attacks. Firewalls helped to limit the spread of both malware attacks by blocking suspicious network traffics. Organizations that installed the patch, updated their operating systems, disabled outdated SMB services were largely protected from infection. After the attacks began, Microsoft also released emergency patches for older Windows version to help stop further spread. Antivirus and endpoint protection software helped detect and remove the malware from infected system.

Modern cyber security systems increasingly use AI and machine learning to detect unusual behavior. During these attacks, AI based monitoring systems helped by detecting abnormal network activity, such as rapid scanning of computers, identifying suspicious encryption of large number of files and alerting security teams about possible ransomware infections. Those systems allowed organizations to respond more quickly and isolate infected machines before the malware spread further.

Backup technologies also played a crucial role in recovery. Organizations with secure backups could restore their data without paying ransom or losing information.

After these attacks, many organizations improved their strategies by creating offline backups, increasing backup frequency and testing disaster recovery plans.

4. CONCLUSION

In conclusion, cyber warfare has become one of the most important security challenges of the 21st century. As societies and institutions increasingly depend on digital technologies and interconnected networks, cyberspace has evolved into a new battlefield where conflicts can occur without the use of traditional weapons. Cyber attacks such as ransomware, phishing, and man-in-the-middle attacks demonstrate how vulnerable modern systems can be when targeted by malicious actors.

Unlike traditional weapons, cyber weapons do not rely on physical force, yet they can cause significant damage to national infrastructure and security. Modern cyber operations can disrupt energy systems, financial institutions, transportation networks or even healthcare services. Because of this, many experts consider cyber capabilities to be a new category of strategic weapons.

One of the main advantages of cyber warfare is the ability to operate anonymously. Attackers can launch operations from anywhere in the world while hiding their identity, making it extremely difficult to determine who is responsible for the attack. This uncertainty complicates political responses and international relations.

In addition, cyber attacks are relatively inexpensive compared to conventional military operations. A small group of skilled individuals with the right tools can potentially cause damage comparable to that produced by traditional weapons. For this reason, cyber capabilities are increasingly used not only by powerful states but also by smaller actors and criminal organizations.

Major incidents like the WannaCry and NotPetya attacks highlight the massive global impact that cyber threats can have on governments, companies, and critical infrastructure. These attacks caused billions of dollars in damage and disrupted essential services around the world, proving that cyber warfare can have consequences comparable to conventional conflicts.

However, these events also showed the importance of strong cybersecurity measures. Technologies such as firewalls, antivirus software, artificial intelligence–based monitoring systems, regular software updates, and reliable backup strategies play a crucial role in preventing, detecting, and recovering from cyber attacks. Organizations and governments must continuously improve their defenses, invest in cybersecurity education, and cooperate internationally to reduce the risks posed by cyber threats.

As technology continues to evolve, cyber warfare will remain a critical issue for global security. Strengthening cyber resilience and maintaining constant vigilance will be essential to protect digital infrastructure and ensure the stability of modern society.

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THE CHIRON SYSTEM – DEVELOPMENT, CAPABILITIES, AND ITS POSITION IN MODERN MANPADS EVOLUTION

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Abstract: *This paper provides a comprehensive analysis of the CHIRON (KP-SAM), a South Korean man-portable air-defense system (MANPADS), examining its development history, technical architecture, and strategic impact on modern short-range air defense (SHORAD). As aerial threats transition toward high-agility platforms and unmanned aerial systems (UAS), the CHIRON represents a critical evolution in surface-to-air technology.*

The study details the system's integration of dual-band (IR/UV) seeker technology, which provides superior resistance to infrared countermeasures compared to legacy single-band systems. Furthermore, the paper evaluates the CHIRON's operational flexibility ranging from infantry-portable configurations to vehicle-mounted integration , and its role in the global shift toward indigenous defense manufacturing. By comparing CHIRON against historical predecessors and contemporary peers, this research demonstrates that the system's combination of high-explosive fragmentation lethality, Mach 2+ velocity, and advanced electronic counter-countermeasures (ECCM) establishes it as a benchmark for 21st-century portable air defense. The findings conclude that the CHIRON is not merely a regional asset but a globally competitive platform that addresses the complexities of contested modern airspace.

Keywords*: CHIRON; MANPADS; Surface-to-Air Missiles; Electronic Counter-Countermeasures (ECCM); Short-Range Air Defense (SHORAD)*

1. INTRODUCTION

Modern air-defense doctrine has evolved rapidly over the past decades in response to increasingly sophisticated aerial threats. The proliferation of high-agility aircraft, precision-guided munitions, and unmanned aerial systems (UAS) has significantly reshaped the operational environment of ground forces, requiring more adaptable and mobile defensive solutions (Watts, 2015: 34). As a result, short-range air-defense (SHORAD) systems have gained renewed strategic importance within layered air-defense architectures (Department of the Army, 2017: 112).

Among the most transformative developments in this domain are portable air-defense systems designed to provide rapid, flexible, and tactical protection to ground units. Since their introduction during the Cold War, MANPADS have evolved from relatively simple infrared-guided missiles into technologically advanced platforms with improved seeker accuracy and resistance to countermeasures (Gunston, 1993: 45). Within this context, the CHIRON system, developed by South Korea, has emerged as one of the most advanced man-portable air-defense (MANPADS) platforms currently in operational use (Jane's, 2022). This paper explores the system's origins, technical characteristics, and its comparative position within the broader evolution of MANPADS technology.

Through a detailed examination of both historical context and present-day performance metrics, the study demonstrates why CHIRON stands out as a benchmark of modern short-range air-defense innovation.

2. **ANALYSIS: DEVELOPMENT AND CAPABILITIES OF THE CHIRON SYSTEM**

The CHIRON system (KP-SAM – Korean Portable Surface-to-Air Missile) represents a significant milestone in the evolution of modern Man-Portable Air Defense Systems (MANPADS). Conceived as a response to the growing complexity of low-altitude aerial threats, the system was specifically designed to counter fixed-wing aircraft, attack helicopters, unmanned aerial vehicles (UAVs), and certain types of precision-guided munitions (Army Recognition, 2023). In a strategic sense, CHIRON is more than a short-range missile platform; it reflects South Korea's long-term objective of strengthening technological sovereignty and developing an indigenous, competitive air-defense capability adapted to contemporary operational realities. Its emergence must therefore be understood not only as a technical advancement, but also as a manifestation of broader defense modernization policies.

To properly assess CHIRON's significance, it is essential to situate it within the historical evolution of MANPADS. The first generation of portable air-defense systems appeared in the 1960s, with platforms such as the U.S. FIM-43 Redeye and the Soviet 9K32 Strela-2 (Gunston, 1993: 52). These early systems relied on relatively simple infrared (IR) homing seekers that tracked engine heat signatures. While innovative for their time, they were limited in range, engagement envelope, and resistance to countermeasures. Their effectiveness could be significantly reduced by basic flare deployment, and engagement accuracy was often constrained by technological limitations in seeker sensitivity and signal processing.

The 1970s and 1980s brought substantial improvements, marking the transition to second-generation MANPADS. Systems such as the FIM-92 Stinger and the 9K38 Igla introduced enhanced seeker sensitivity, better discrimination between targets and background noise, and improved reliability in diverse weather conditions (Friedman, 2006: 214). These advancements increased engagement probability and expanded the tactical utility of portable air-defense systems. However, despite these improvements, the rapid development of military aviation and electronic warfare capabilities continued to challenge short-range air-defense platforms .

By the 1990s and early 2000s, the operational environment had evolved dramatically. Aircraft began employing advanced infrared suppression techniques, multi-spectral countermeasure systems, and sophisticated electronic interference capabilities (Karako & Williams, 2017: 67-71). At the same time, the emergence of UAVs and precision-guided munitions created new categories of low-altitude threats. As a result, modern MANPADS had to evolve beyond basic heat-seeking mechanisms toward multi-spectral detection, digital signal processing, proximity fuzes, and improved aerodynamic control systems. Survivability and resistance to electronic countermeasures became as critical as range or speed.

It was within this context of technological transformation that the CHIRON program was initiated in the late 1990s. The Republic of Korea Armed Forces sought to replace aging Soviet-designed Igla systems, whose limitations in countermeasure resistance and modernization potential had become increasingly evident. Rather than continuing reliance on foreign suppliers, South Korea chose to invest in indigenous development through the Agency for Defense Development (ADD), in cooperation with domestic defense contractors.

The goal was not merely substitution, but qualitative enhancement. CHIRON was envisioned as a system that would preserve the mobility, rapid deployment, and operational simplicity of traditional MANPADS while incorporating advanced seeker architecture, improved missile maneuverability, and robust electronic counter-countermeasure (ECCM) capabilities (Jane's, 2022).

Technically, CHIRON's most defining characteristic is its dual-band seeker integrating infrared (IR) imaging with ultraviolet (UV) detection. This multi-spectral configuration significantly enhances target discrimination by allowing the missile to distinguish between genuine aerial targets and infrared decoys such as flares. The inclusion of UV detection adds an additional verification layer, reducing the likelihood of deception and increasing engagement reliability. In modern battlefields, where aircraft routinely deploy sophisticated countermeasure packages, such discrimination capability is essential for maintaining operational effectiveness.

The missile utilizes proportional navigation guidance, a method that enables continuous trajectory correction throughout flight and ensures accurate terminal-phase engagement. With a maximum velocity of approximately Mach 2, CHIRON achieves rapid time-to-target performance, minimizing the reaction window available to hostile aircraft. Its effective engagement range of around 7 kilometers and an altitude envelope suited to low- and medium-low-flying threats provide coverage against the most common tactical aerial platforms encountered in contemporary conflicts (Jane's, 2022).

Lethality is further enhanced through a high-explosive fragmentation warhead equipped with a proximity fuze. Rather than requiring a direct impact, the missile detonates within optimal distance from the target, increasing the probability of successful neutralization even in high-speed or high-maneuverability scenarios (Friedman, 2006: 219; Jane's, 2022). This feature reflects a pragmatic understanding of real combat conditions, where perfect alignment is not always guaranteed.

Operational flexibility constitutes another major strength of the CHIRON system. It can be deployed as a shoulder-fired MANPADS for infantry use, mounted on tripods for greater stability, or integrated into vehicle-based short-range air-defense (SHORAD) platforms. This modularity allows CHIRON to function both as an individual soldier-level defense asset and as part of a coordinated, layered air-defense architecture. Within the Republic of Korea Armed Forces, the system plays a crucial role in protecting maneuver units and critical infrastructure from low-altitude threats. Its export to several countries further confirms its technological credibility and operational reliability.

When evaluated against the broader trajectory of MANPADS evolution, CHIRON stands out as a mature third-generation system. Its dual-band seeker architecture, advanced signal processing, strong ECCM resilience, and modular integration capability collectively position it among the most capable portable air-defense systems currently available. Unlike earlier single-band systems that were highly susceptible to infrared decoys, CHIRON is designed to operate effectively in electronically contested environments. Furthermore, its balance between advanced performance and relative cost-effectiveness enhances its strategic attractiveness for armed forces seeking high-capability solutions without the logistical complexity of larger surface-to-air missile systems.

CHIRON should be regarded not simply as a national defense product, but as a representative example of the broader transformation of MANPADS technology. Its development reflects the convergence of technological innovation, operational necessity, and strategic autonomy. By integrating multi-spectral guidance, high maneuverability, and robust electronic resilience into a portable and adaptable platform, CHIRON illustrates the maturation of short-range air-defense systems into sophisticated and reliable components of modern military doctrine.

2. CONCLUSIONS & ACKNOWLEDGMENT

In conclusion, the CHIRON (KP-SAM) system can be understood as a representative outcome of the broader historical and technological evolution of Man-Portable Air Defense Systems. From the early infrared-guided platforms of the 1960s to contemporary multi-spectral and digitally enhanced systems, MANPADS development has consistently reflected the need to adapt to increasingly sophisticated aerial threats. Within this trajectory, CHIRON occupies a significant position as a mature third-generation solution that integrates advanced guidance architecture, enhanced discrimination capability, and strong resistance to electronic countermeasures.

The system's dual-band IR/UV seeker, proportional navigation guidance, and proximity-fuzed warhead collectively illustrate the transition from simple heat-seeking mechanisms toward complex and resilient engagement technologies. These features not only improve interception probability but also demonstrate a broader shift in design philosophy—one that prioritizes survivability and reliability in electronically contested operational environments. In this sense, CHIRON reflects the doctrinal transformation of short-range air defense, where portability is no longer sufficient without precision and counter-countermeasure effectiveness.

Moreover, the development of CHIRON under the coordination of the Agency for Defense Development and domestic industry partners highlights the strategic dimension of indigenous military innovation. The system embodies South Korea's effort to achieve technological autonomy while aligning with global trends in layered and network-integrated air defense architectures. Its modular deployment capability further reinforces its relevance within contemporary SHORAD doctrine, where flexibility and interoperability are essential.

Therefore, CHIRON should not be viewed merely as a national defense product, but as a case study in modern MANPADS evolution. It illustrates how technological refinement, operational necessity, and strategic independence converge in the development of advanced portable air-defense systems. As aerial warfare continues to evolve—particularly through the expansion of unmanned systems and electronic warfare capabilities—the principles embodied by CHIRON will likely shape the next generation of short-range air-defense solutions.

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THE IMPACT OF AIR TRANSPORT ON HYBRID THREATS

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Abstract: *In recent years, the European Union and NATO have been facing a serious threat related to the development of hybrid threats and advances in military technology. Air transport is one of the key factors affected by the hybrid threats because of its multipurpose use and its involvement in many areas.*

Keywords*: Hybrid threats; Air transport; aviation*

1. INTRODUCTION

Air transport plays one of the most strategically significant sectors in modern security. Air transport is not only about moving people and goods from point A to point B, but also a critical infrastructure system that supports diplomacy, trade and military mobility. The reason given is that aviation is deeply connected with hybrid threats. Because aviation is international, powerful and interconnected, hybrid threats can enlarge its effects. When air transport is affected by hybrid threats its consequences can reach far beyond single airline or airport. In this sense air transport is both a target and a multiplier of the consequences for hybrid threats.

For better understanding of the topic it is important to define what hybrid threats are. The Council of the European Union describes them as "coordinated harmful activities" carried out deliberately by hostile actors, most often through a mix of methods as:

- Cyber attacks
- Economic pressure
- Disinformation
- Intimidation
- Fake information

One of the most important features of hybrid threats is the fact that they are intended to stay below the threshold of open war. This is one of the main reasons why aviation is such an attractive target for these threats. Air transport sector mainly depends on the network of airports, cargo operators, airlines, satellite navigation, air traffic services and so on. Hostile force does not need to physically damage any of these to cause serious harm. Mostly affecting only one of the above segments leads to chain reaction which shuts down air transport for a specific period of time.

2. REASONS WHY AIR TRANSPORT IS IMPORTANT

One of the most important reasons why air transport matters in this context is because it increases the reach of hostile actions. Aviation depends on speed, coordination, and precision.

Because of that even a relatively irrelevant incident can quickly increase its effects and affect multiple countries at once. A cyberattack on check-in systems, reservation platforms, or air traffic services can easily create huge delays, confusion, and significant financial losses in several countries and corporations. ICAO notes that threats to civil aviation can come through "digital, physical, or hybrid vectors," which shows that modern aviation is exposed on several levels at the same time. Flights, airport services and even aircraft themselves rely heavily on software, avionics and data accuracy. For this reason, hybrid threats can combine cyber tools with physical pressure or information manipulation in ways that are difficult to identify.

Another important matter is that aviation is exceptionally vulnerable to disruption-based attacks. Main goal of hybrid threats is not always to destroy infrastructure. Often, their goal is to create instability, fear, and loss of confidence. Aviation is highly sensitive to this kind of pressure because it depends on predictability. one place can quickly affect many others. Grounded planes, rerouted cargo, or repeated technical issues can produce major economic losses and damage public trust in the institutions responsible for safety. ICAO has pointed out that cyber threats in civil aviation can affect safety, security, capacity, and efficiency at the same time. This is exactly why aviation is valuable in hybrid conflict. Even if at first glance the direct damage seems limited, the broader strategic effect can be significant. The goal is not always to cause serious damage. Sometimes exposing weaknesses, increasing uncertainty, and forcing governments to take precautions can be even more harmful. Another reason air transport is important in this discussion is its multipurpose character. Civil aviation infrastructure is not suitable only for commercial travel. It can also support military bases, humanitarian assistance and emergency response. This makes airports, logistics hubs, and shared airspace strategically important far beyond the civilian economy. NATO highlights the importance of coordination between civil and military airspace management. From the perspective of hybrid threats, this means that affecting civil aviation can have extensive security effects. The more integrated these systems are, the more useful they become to actors who want to create pressure without openly starting a war.

At the same time, it would be deceptive to present air transport mostly as a weakness. Aviation can also be a source of resilience but only if it is treated as a strategic system rather than a collection of separate technical functions. ICAO's cyber guidance argues that cyber risk management in aviation must be integrated across the sector, while IATA emphasizes the importance of "safe, secure, and resilient operations." This is a crucial point. Airlines, airport authorities, cybersecurity experts, intelligence services, and military need to cooperate much more closely. Without shared awareness and coordinated planning, aviation will remain vulnerable not only to direct attacks but also to the broader uncertainty that hybrid actors seek to create.

3. GNSS JAMMING

An exceptionally serious example of this problem is the disruption of satellite-based navigation. Modern aviation relies on GNSS, which is used for positioning, navigation, and timing. This creates another sensitive point that can be exploited in a hybrid way.

According to EASA, since February 2022 there has been a "notable increase" in GNSS jamming and spoofing, especially near conflict zones and politically sensitive areas. Even when aircraft continue to operate safely, these disruptions still create operational stress, increasing workload for crews and controllers. In 2025, EASA and IATA warned that these disruptions are increasing in both "frequency and complexity" and stressed that "we must build resilience." This is a good example of how hybrid threats work.

A relatively slight form of action can still cause increased economic costs, operational difficulties, and strategic pressure without becoming open armed attack.

4. INSIDER THREATS

The insider threat is another issue that makes aviation especially vulnerable. ICAO's Insider Threat Toolkit explains that insider threats involve aviation personnel using "authorized access" to carry out or support unlawful actions. This is important because airports and airlines depend on trusted employees who have access to restricted areas and sensitive information. If such people are recruited by hostile organizations, they can create openings that external attackers could never reach on their own. In aviation, insider activity can be particularly dangerous because the security structure is created with the idea of stopping outsiders, not people who already belong to the system. Hostile actors benefit from this kind of behavior.

5. CONCLUSIONS

To sum up, air transport has a major impact on hybrid threats because it gives them visibility and strategic effect. Aviation is highly dependent on various flight controlling systems, avionics systems and satellites. All of this makes it an attractive area for hostile actors operating below the threshold of conventional war. At the same time, aviation is so important to national and international resilience that protecting it should not be treated as a narrow transport issue. The main conclusion is that cyber-attacks, navigation issues, civil-military coordination etc. should not be seen as separate problems. In the context of hybrid threats, they are closely connected to parts of the same broader struggle over resilience, trust, and control.

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THE EVOLUTION OF LOGISTICAL SUPPORT IN THE CONTEXT OF THE WAR IN UKRAINE

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Abstract: *The war in Ukraine illustrates the modern paradigms of military logistics in high-intensity conflicts, highlighting the need to adapt quickly to challenges such as geopolitical blockades, precision strikes and logistical difficulties. The paper analyses the modernization of the Ukrainian Armed Forces' logistics system through the integration of NATO practices, technological innovations (drones, autonomous vehicles, micro-hubs) and solutions for road flexibility and critical infrastructure protection. Bureaucratic vulnerabilities, exposure to air threats and digital deficiencies are identified, proposing resilience measures based on domestic production, digitization and civil-military cooperation. The conclusions highlight the role of logistics as a decisive factor in operational sustainability.*

Keywords: *military logistics; operational resilience; micro-hubs; NATO support; logistical vulnerabilities.*

1. INTRODUCTION

In the military field, since the 19th century, there has been a significant development in the field of logistics, especially in terms of its use in conflict situations. The logistics component has always been an essential foundation for the deployment and evolution of military campaigns, which require a rigorously planned and efficient supply system (Li et al., 2014).

Logistics has been and continues to be a link between the economic factor and the state's ability to generate military potential through the efficient management of resources and the industrial sector. This field encompasses the following functional areas: supply, campaign service, life cycle equipment management, movement and transport, infrastructure, operational medical support and host nation support (HNS), highlighting the particular importance of logistics in the military system (Minculete, 2010: 15-20).

The scope of this paper is to analyze the critical transformation of logistics and sustainment capabilities within the context of the Russian-Ukrainian war. This conflict has underscored the immense complexities of managing supply chains under contested conditions. Furthermore, the war has demonstrated that the doctrinal models of contemporary military organizations must remain adaptable, evolving as operational realities dictate.

As a result of the shift in observed in the Russo-Ukrainian theater, our goal was to identify the unsustainable and vulnerable aspects of legacy, centralized military logistics. We aim to assess the efficacy of digital inventory systems (DOT Chain) and autonomous platforms (UAVs/UGVs) to design a replicable model that accelerates logistics cycles and secures "last-mile" distribution in transparent battle spaces.

Finally, the study seeks to analyze systemic structural barrier, bureaucratic inertia and fragmented digital integration in order to provide a diagnostic framework that enables military organizations to transition toward a fully optimized, resilient supply chain.

To achieve these objectives, we conducted a comprehensive case study based on the analysis of relevant military doctrine documents, institutional reports, and open-source battlefield data. Through this case study, we aimed to obtain answers to the following research questions: 1) how has the tactical reality of the contested Ukrainian battlefield forced the abandonment of legacy Soviet logistical doctrine in favor of a decentralized model? 2) to what extent has the digitization of logistical processes (through the DOT Chain system) reduced response times and increased the operational efficiency of the Armed Forces of Ukraine (AFU)? and 3) what is the critical role of integrating autonomous technologies (UAVs/UGVs) in solving the 'last-mile' resupply problem within an environment defined by persistent surveillance?

The methodology employed for this research is centered on a rigorous documentary analysis, encompassing a review of current military doctrines (NATO, U.S. Army, and AFU), This data serves as the foundation for a qualitative synthesis, which facilitates a comparative evaluation between traditional centralized logistics models and the empirical tactical adaptations observed on the Ukrainian front. By cross-referencing doctrinal theory with real-time operational outcomes, this approach ensures a comprehensive understanding of the systemic shifts in modern military sustainment.

2. HISTORICAL MILESTONES OF LOGISTICAL SUPPORT IN ARMED CONFLICTS

Thus, military logistics provides the basis for the combat power of the forces and describes how the national economy connects with the combat forces. As a fundamental element of the physical component of fighting power, sustainment serves as the primary engine generating the means to fight within complex multi-domain operations. By integrating functions such as personnel, logistics, medical support, military engineering, and finance, sustainment acts as a critical enabler that dictates the tempo, duration, and intensity of any mission. This doctrinal framework effectively bridges the national economy to the front line through the Reinforcement and Sustainment Network, a strategic construct that links domestic resources and industrial capabilities to the theater of operations. Whether through host-nation support, civil-military cooperation, or the use of customer-funded NATO agencies, the capacity of the sustainment system directly influences a commander's freedom of action, ensuring that the collective industrial and financial weight of the Alliance is transformed into enduring, tangible effect on the battlefield. (APJ 4, 2025) This vision emphasizes the central role of the soldier and the need for effective coordination of the entire logistics chain to ensure that their needs are met, and military actions are successful (U.S. Army, 2019).

The foundation of Ukraine's logistics doctrine is inherited from Soviet military traditions. Within the coordination of Warsaw Pact forces, logistics operated in a rigid, hierarchical system that prioritized large, static supply depots and relied heavily on rail transport (Skoglund et al., 2022: 99–110). Soviet approaches to logistics emphasized a logistics model in which mid-level combat units, such as battalions and lower subunits, had limited autonomy in managing their own resupply and instead depended on regimental supply structures, which determined both the timing and distribution of logistical support (Rodnikov, 1994: 4-14).

During the post-Soviet transition period and until 2014, Ukraine faced financial constraints that affected the state's ability to sustain defense spending and logistical functions.

After independence in 1991, defense spending as a percentage of gross domestic product was around 0.32% in 1992, according to official budget execution data. This reflected the budget deficit, low tax revenues and the state's economic priorities, limiting funding for the armed forces and military logistics. By 2014, defense spending had increased to around 2.97% of GDP, which was insufficient to fully support the logistical functions required for military operations. Financial constraints between 1991 and 2014 limited investment in equipment, infrastructure and logistical planning capacity, affecting the readiness and sustainability of military operations (Ukraine – Military Expenditure, 2025).

3. WAR ECONOMY: FUNDAMENTALS, TRANSITION AND IMPLICATIONS FOR MILITARY LOGISTICS

The concept of a war economy involves a fundamental reorientation of a nation's resources and capabilities from civilian production and consumption to supporting the conflict. The war in Ukraine, triggered by the large-scale invasion on 24 February 2022 by the armed forces of the Russian Federation, demonstrated the need for a country to rapidly transition from a peacetime economy to a wartime economy, with implications such as severe economic decline and social, economic, demographic, political and military imbalances (Mixon, Cebula, 2024: 1-17). Faced with this aggression, Ukraine instituted a general mobilization order in response to the need to defend the country (Irtyshcheva et al., 2022: 78-81).

3.1 Economic Mechanisms of Transition. One of the central pillars of a war economy is the ability to rapidly transform industrial production. This involves increasing the production of weapons and ammunition and adapting supply chains to meet the specific requirements of the front line. Economic activity in Ukraine has declined sharply due to disruptions in supply and production chains, increased uncertainty, risks and labor exodus (IMF, 2023: 45).

The blockade of seaports has also contributed to significant GDP losses. According to the National Bank of Ukraine, the number of enterprises that have completely ceased operations has almost halved since the start of hostilities (from 32% to 17%), but 60% of enterprises are operating below pre-war capacity (Irtyshcheva et al., 2022: 78-81). In addition, factories and infrastructure in regions such as Donbas have suffered significant direct losses, and armed clashes have led to the continued deterioration of road and rail infrastructure, which is essential for industry and distribution (Iwański, 2014: 1-7). For the continuity of Ukraine's war effort, collaboration with the private sector, including defense contractors from NATO member states, has been essential (Trif, Dumitrașcu, 2025: 1-17).

3.1.1 Digitization of military logistics through the DOT system. The implementation of DOT Chain has resulted in a significant reduction in the logistics cycle time. According to official data, the average delivery time has been reduced by about four times, from about two months to about 15 days, by eliminating redundant bureaucratic steps and automating ordering and invoicing processes. The platform handles tens of thousands of digital requests, allowing military units to submit standardized requests and track the status of deliveries in real time, which increases the transparency and predictability of logistics flows (Ministry of Defence of Ukraine, 2024).

However, despite notable progress, the scope of the DOT system remains partially limited. In its current form, the platform is mainly used for light equipment and drone-based systems, while critical categories such as heavy artillery ammunition, fuel, vehicle spare parts and complex system maintenance continue to be managed through traditional, fragmented and partially manual logistics mechanisms.

This segmentation prevents a unified logistical picture at the operational and strategic levels, limiting the ability to anticipate shortages and optimize stocks in high-intensity warfare (De Nijs, 2025: 1–15).

3.2 Implications for Military Logistics. The primary objective of logistics in wartime is to amplify combat capabilities at all levels: strategic, operational and tactical (Skoglund et al., 2022: 99-110). This involves optimizing supply by reducing the delivery time of weapons and ammunition to the front line, using automated accounting and inventory management systems, and equipping troops with the most means of transport. The experience of the conflict in Ukraine has highlighted the need for rapid adaptability of logistics systems to changes in the combat zone, demonstrating that a delayed response can be critical and sometimes fatal (Melnyk, Kuvshynova, 2025).

3.2.1 Modernization of the Logistics System and Domestic Production. Modernizing the FAU's logistics system involves implementing NATO best practices, integrating with civilian logistics companies and voluntary initiatives, and using drones and autonomous vehicles for rapid deliveries. A fundamental aspect is expanding the production capacity of the national defense industry to reduce dependence on imports, along with developing field workshops for repairing equipment directly in the combat zone and adapting Western weapons to Ukrainian operating conditions. The lack of qualified specialists in military logistics highlights the urgent need for training in accordance with NATO standards. It is also necessary to develop IT logistics solutions, such as real-time tracking systems and blockchain, to improve the efficiency and security of supply chains. NATO contributes by providing advanced weaponry and non-lethal materials (medical kits, communications equipment, winter uniforms) (NATO, 2025: Fact Sheet).

FAU's modern vision for the logistics system includes the development of logistics forces for weapons maintenance, material resource management and troop support, the creation of an efficient infrastructure system, and the planning of logistics support needs by the General Staff and commands, with organization and implementation provided by the Logistics Command. Cooperation with military and non-military structures, such as economic operators and suppliers, is essential for complementary logistical support (Minculete, 2025; Ordinul nr. 36/2008).

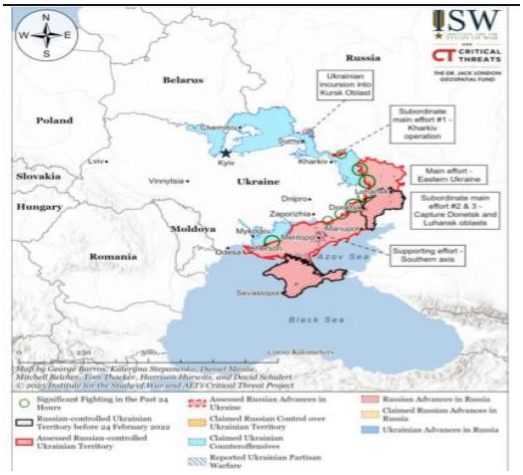

FIG. 1 Evolution of the front line in the Russian-Ukrainian war on 4 January 2026. (ISW, 2026)

Figure 1 shows the front line as of January 4, 2026, extending over 1,000 kilometers from the Kharkiv region to Kherson. The three distinct operational axes: eastern, southeastern and southern, each require continuous resupply, making centralized logistics depots an easy target and a structural weakness. This reality explains, better than any theory, why Ukraine was forced to abandon traditional supply models in favor of dispersed, semi-autonomous logistics nodes (ISW, 2026).

3.3 Route Flexibility and Protection of Logistical Infrastructure. The war in Ukraine has demonstrated, as shown in Figure 2, that in the field of military logistics there are many geopolitical problems, such as closed airspaces, blocked seaports, and the fact that Belarus cannot be used for transit. The solution to these problems has been the creation of new supply routes, the rail network's (through Poland, Slovakia, Hungary, Romania, etc.) being used to its fullest capacity, NATO's military aviation at the borders with Ukraine being enhanced, and the infrastructure of the ports on the Danube being strengthened. The protection of the logistics infrastructure, i.e. the storage of ammunition, fuel, and military equipment, the dispersal of strategic reserves, etc., is necessary not only to avoid being targeted by air raids but also to be able to actively engage in enemy reconnaissance and sabotage. The destruction of roads and bridges that are vital for the transport of goods has not only been a huge obstacle to the replenishment of the supply lines but has also led to a huge increase in the logistical costs (World Bank, 2024: 52-58).

Ukraine, on the other hand, has understood the importance of rail and has deliberately targeted railway infrastructure to prevent the Russian side from being able to use it for the transportation of supplies.

Different rail gauges between Ukraine and come countries in the EU make cross-border rail transportation difficult as goods must either be transshipped or the bogies must be changed. The World Bank's RELINC project is there to help by funding the purchase of machinery needed for the repair of bridges as well as for raising the capacity of container transport to make the transport system more resilient (Mixon, Cebula, 2024).

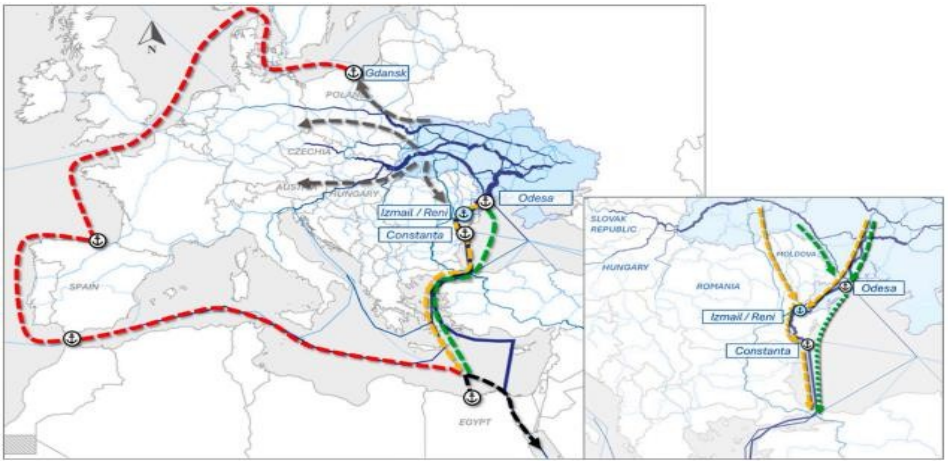

FIG. 2 Ukraine's logistics and transport system. Opportunities and challenges
Source: International Bank for Reconstruction and Development / The World Bank, 2025, www.worldbank.org, accessed on 25 January 2025.

4. TECHNOLOGICAL INNOVATIONS AND STRUCTURAL ADAPTATIONS IN UKRAINIAN MILITARY LOGISTICS

4.1 Reconfiguring the military logistics paradigm in high-intensity warfare. The move to a decentralized logistics model made of micro-hubs is the main pillar of the innovation of the Ukrainian logistics system. This tactical plan will not only diversify and reduce potential targets for enemy forces but also give important operational redundancies, so that supply continuity can be maintained even in cases when the enemy manages to strike specific strategic depots (De Nijs, 2025: 1-15).

4.2 Integration of unmanned aerial and ground vehicles into the military logistics chain. During the period of the Ukraine conflict, the special use of unmanned aerial vehicles in the military logistics chain has been recognized as one of the most significant operational

advancements in the infrastructure of Ukraine's military logistics. The drones in the air have become essential instruments for fine-tuning logistics operations. Helping in fast and safe delivery of critical equipments, necessary ammunition and medical supplies to the military units located in hard-to-access or continuously pressured areas. Naturally, UAVs have demonstrably reduced delivery times in high-tempo operational environments (Minculete, 2025).

4.3 Structural vulnerabilities of Ukrainian military logistics. A fundamental vulnerability identified in the Ukrainian logistics system lies in the persistence of bureaucratic inertia within the military-administrative apparatus. Despite reform efforts, approval, certification and logistics transfer processes are still marked by considerable administrative delays, which diminish operational responsiveness. A telling example is the blocking of deliveries of tactical drones donated by Lithuania, which remained immobilized in warehouses due to the complexity of administrative procedures and poor coordination. This deficiency becomes particularly critical in a conflict characterized by intense attrition and the need for rapid adaptation, where bureaucratic delays have a disproportionate effect on the effectiveness of front-line units, especially those whose operations depend heavily on unmanned systems for reconnaissance, offensive engagement, and last-resort resupply (Watling, 2023: 45-52).

A second major vulnerability is the significant exposure of logistics nodes to air strikes and precision strikes. According to De Nijs (2025: 1-15), most forward logistics points rely predominantly on passive defense measures, such as camouflage and strategic masking of the terrain, in the absence of adequate coverage with active air defense systems. The prohibitive costs of modern air defense systems, coupled with a shortage of specific ammunition, limit their deployment capacity to protect logistics infrastructure. In the context of intensified Russian attacks with drones and guided missiles, this fragility amplifies the risk of supply line disruption and directly compromises the sustainability of long-term military operations (Jones et al., 2024).

The third key vulnerability is the current fragmentation of logistics digitization processes. Although the DOT Chain system and its extension, DOT Chain Defense, mark remarkable progress in streamlining certain segments of logistics, they do not yet cover the entire logistics spectrum. Heavy logistics, including large-caliber artillery ammunition, fuel and essential spare parts that continue to be managed through semi-manual and unintegrated systems. This lack of digital coherence prevents a complete, real-time operational view of the entire logistics chain (Center for Economic Strategy, 2024; CES, 2025).

5. CONCLUSIONS

One of the key lessons that the war in Ukraine has revealed is the decisive contribution of military logistics in sustaining high-intensity war operations. Although the role of logistics in warfare has been understood at some level, the conflict has highlighted the need for an extensive overhaul of conventional systems moving towards more agile, decentralized, and technologized models. Besides quick adaptability and the use of modern technology like drones and autonomous vehicles, this kind of transformation also demands the safeguarding of alternative routes and the assimilation of NATO practices. Meanwhile, problems such as bureaucratic sluggishness, logistics being exposed to precision strikes, and the splitting up of digitization call for a rapid uplift of domestic manufacturing capabilities, training of professionals, and investments in infrastructure. In line with the first research question, the facts show that the tactical conditions at the Ukrainian frontline, ongoing surveillance, precision strikes on immobile depots, and the breakdown of centralized resupply chains, led to the complete dissolution of Soviet logistical doctrine and the switch to a decentralized model centered on dispersed micro-hubs and autonomous last-mile delivery (Pagonis, Cruikshank, 1992).

The Ukrainian experience during the war can be a source of many lessons for the Ukrainian Armed Forces as well as their allies. It can be a source of the creation of a logistics system that is more integrated with the civil world and based on the concepts of dispersed micro-hubs, packages, and information technologies like blockchain for traceability. The success of the system will depend on the principle of "the right supplies in the right place at the right time," as this will be the most effective way to counter logistical bottlenecks and enemy sabotage through flexibility and redundancy. Moreover, the system will be effective for the dual goal of avoiding the risks of centralized nodes and optimizing the allocation of resources due to the hybrid nature of modern warfare, where cyber and air threats coexist with land threats. With respect to the second research question, the DOT Chain system reduced the average delivery time from two months to fifteen days, a four-fold improvement, confirming the hypothesis that the AFU's efficiency was significantly improved due to the implementation of the system, despite the limitations with respect to the coverage of heavy logistics categories (Zsidisin et al., 2020; CES, 2025).

A critical lesson that Romania, along with other NATO countries, should draw from the Ukrainian experience is the importance of rapid reaction capability. As noted by the NATO Allied Joint Doctrine for Logistics, AJP-4 (2025), the logistical resilience of an alliance can be significantly improved through the implementation of regular exercises involving other countries, along with the development of effective information exchange mechanisms among military and civilian actors. Unlike the Ukrainian military, which lacked full integration into the NATO standardization framework at the time of the conflict, the Alliance countries, including Romania, benefit from the principle of interoperability, which has been demonstrated to be a critical factor for the effectiveness of the logistical response. As concerns the third research question, UAV integration proved decisive for last-mile resupply under persistent surveillance conditions, establishing autonomous platforms as irreplaceable for modern military sustainment (Minculete, 2025; Ordinul nr. 36/2008).

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WINNING TRUST, GATHERING TRUTH: HUMAN INTELLINGENCE IN THE AFGHANISTAN WAR

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***Abstract**: This paper analyzes Human Intelligence (HUMINT) within the historical and geopolitical context of the Afghanistan War (2001–2021). It begins by examining the origins of the conflict following the September 11 attacks, the subsequent international intervention, and the long-standing internal instability shaped by decades of prior conflict. The study explores how regional rivalries, cross-border dynamics, tribal structures, and shifting alliances influenced both the trajectory of the war and the methods of intelligence collection. In a complex environment marked by insurgency, counterinsurgency, and competing political narratives, locally gathered information became essential for understanding social networks, security threats, and power structures. The paper also evaluates how information was disseminated during the conflict, including military communication strategies, media coverage, and insurgent propaganda efforts. By situating HUMINT within the broader political, cultural, and strategic framework of the war, this study highlights the extent to which intelligence activities were shaped by the evolving context of the conflict. The analysis demonstrates that while technological capabilities expanded significantly, human-based intelligence remained deeply dependent on the social and geopolitical realities of Afghanistan.*

***Keywords:** HUMINT; insurgency; Afghanistan War; truth; trust*

1. INTRODUCTION

This case study started from the initial question: "How did this war, started when the New York firefighters were still trying to extinguish the fire caused by the Islamic terrorist suicide attacks on the Twin Towers on 11th of September 2001, turned into the longest war ever fought by the United States of America?". If our story begins with those terrifying images of people desperately throwing themselves from the world Trade Centre Buildings that were hit by suicidal planes, it ends with the desperate fall of Afghans from military planes that were rising in the sky from the capital of Afghanistan. In a sad symmetry, it all begins with the Islamic terrorist attack on Americans in New York City and Washington and ends with another one at the Kabul Airport which the USA army was evacuating, leaving Afghanistan forever.

Following the attacks of September 11, 2001, the United States, supported by NATO allies, launched military operations aimed at dismantling al-Qaeda and removing the Taliban regime that had provided it sanctuary. What began as a conventional military campaign quickly evolved into a protracted counterinsurgency and nation-building effort in a highly fragmented social, tribal, and political environment. In such a context, traditional military superiority proved insufficient to achieve long-term strategic objectives.

Human Intelligence (HUMINT)—the collection of information through interpersonal contact, including informants, interrogations, and liaison networks—emerged as a critical component of coalition operations. Unlike technical intelligence disciplines such as signals intelligence (SIGINT) or imagery intelligence (IMINT), HUMINT offered insight into local power structures, tribal allegiances, insurgent networks, and cultural dynamics that could not be captured through technological means alone. In Afghanistan's decentralized and relationship-driven society, counterterrorism and counterinsurgency efforts.

This project examines the strategic role of HUMINT in the Afghanistan War, analyzing its operational impact, its integration within broader intelligence frameworks, and the structural limitations that affected its effectiveness. By evaluating both successes and shortcomings, the study aims to demonstrate that HUMINT was not merely a supporting function, but a decisive factor in shaping tactical outcomes and influencing broader strategic developments throughout the conflict.

2. HUMAN INTELLIGENCE IN AFGHANISTAN: MAPPING TRIBAL NETORKS AND CULTURAL DYNAMICS IN MODERN WARFARE

2.1 Operational Context and the Centrality of HUMINT in Afghanistan

The intervention in Afghanistan began in October 2001 under Operation Enduring Freedom (OEF)- the official name for the U.S.-lead global military campaign launched in response to the September 11 , 2001 terrorist attacks, with its primary focus on Afghanistan, marking the beginning of the war on terror and sought to dismantle al-Qaeda and remove the Taliban from power for harboring terrorist leadership. In 2003, command of the broader stabilization mission transitioned to the **International Security Assistance Force (ISAF)** under NATO authority, operating with authorization from the **United Nations Security Council**. Although often referred to colloquially as a "United Nations army," ISAF was a NATO-led multinational force, not a standing UN military formation.

FIG.1 The International Security Assistance Force logo

Afghanistan presented an exceptionally complex operational environment. Political authority was fragmented across tribal networks, religious leadership structures, warlord patronage systems, and informal economic actors. Power did not flow exclusively through formal governmental institutions in Kabul but rather through localized systems of influence deeply rooted in kinship, ethnicity, and historical alliances. In such an environment, technological intelligence capabilities—satellite imagery, intercepted communications, drone surveillance—could identify targets but could not explain the underlying social architecture sustaining insurgent resilience.

Human Intelligence (HUMINT) therefore became indispensable. Understanding who held influence in a district, which tribal elder could mobilize support, which commander maintained shadow governance, or which family networks controlled smuggling routes required sustained interpersonal engagement.

Without this granular knowledge, coalition forces risked empowering corrupt actors, misidentifying adversaries, or unintentionally fueling insurgent recruitment.

2.2. Methods of gathering information on local hierarchy and influence network

American military intelligence units deployed Human Intelligence Exploitation Teams (HETs) at brigade and battalion levels. These teams conducted: Structured interviews with village elders and district officials, debriefing of detainees, source recruitment among local populations and liaison with the Afghan National Security Forces

Meetings, often conducted through interpreters, sought to map local authority structures. Intelligence officers identified: tribal leaders (*maliks* and *khans*), religious authorities (*mullahs*), informal power brokers and warlords and criminal networks with political influence. These engagements helped construct "human terrain maps," identifying both formal and shadow hierarchies. Provincial Reconstruction Teams (PRTs), operating under ISAF, combined military personnel with diplomats and development specialists. Their role extended beyond reconstruction into information acquisition. Through development projects—schools, clinics, infrastructure—they established relationships that generated valuable social intelligence.

By observing who mediated aid distribution, who resisted development initiatives, and who mobilized community participation, coalition forces identified key influence groups. Aid became both a stabilization instrument and a channel for insight into local power dynamics.

2.3. Cultural barriers, tribal allegiances and social dynamics

Afghanistan's population is composed primarily of Pashtun, Tajik, Hazara, and Uzbek communities, each with internal tribal subdivisions. Among Pashtuns—the largest ethnic group—the code of Pashtunwali governed social conduct, emphasizing honor *(nang*), hospitality (*melmastia*), and revenge (*badal*). These norms shaped cooperation, resistance, and insurgent recruitment patterns.

Failure to understand tribal allegiances often led coalition forces to misinterpret loyalties. For example: supporting one sub-tribe could alienate another, arresting a respected elder could trigger collective backlash, night raids, even when tactically successful, could violate cultural norms and undermine local trust. HUMINT collectors therefore had to distinguish between ideological Taliban supporters and individuals cooperating due to tribal obligation or economic necessity.

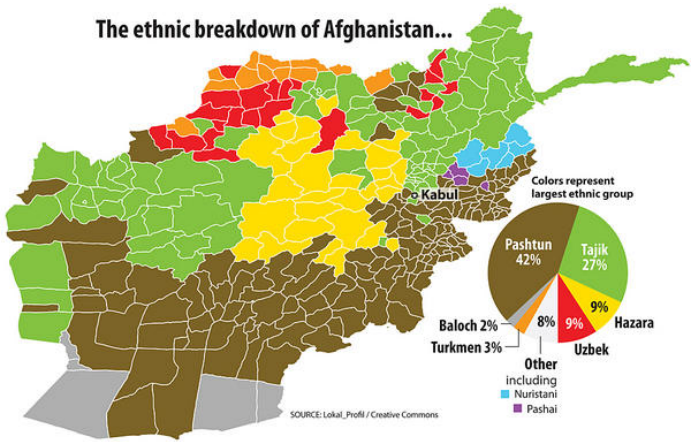

FIG.2 The ethnic breakdown of Afghanistan

2.4 The Human Terrain System (HTS)

To address cultural blind spots, the U.S. military introduced the Human Terrain System. The Human Terrain System (HTS) was a U.S- Army program designed to incorporate social science research into military decision-making during operations in Afghanistan and Iraq. Established in the mid-2000s, it embedded anthropologists and social scientists with combat units to provide cultural and sociopolitical insights for counterinsurgency and stabilization efforts.

The HTS emerged amid renewed emphasis on "winning hearts and minds" during counterinsurgency campaigns. Its goal was to help military commanders understand local norms, tribal structures, and social dynamics to reduce conflict and improve mission outcomes. Each "Human Terrain Team" included social scientists, regional experts, and military personnel embedded with brigades.

The program drew criticism from academics and human rights advocates who argued it blurred lines between scholarship and military intelligence, potentially endangering both researchers and civilians. The American Anthropological Association publicly condemned HTS for ethical violations related to consent and neutrality in conflict zones. Operational and ethical challenges, along with budgetary cuts and mixed results, led to the program's closure in 2014. Despite its end, HTS influenced later discussions on integrating cultural expertise into defense policy, and it remains a case study in the ethics of applied anthropology in military contexts.

2.5. Major influential Afghan factions

Throughout the U.S. war in Afghanistan (2001–2021), several key Afghan groups exerted significant influence on the conflict, aligning either with the U.S.-led coalition or acting as the primary insurgency against it:

The Taliban: Predominantly Pashtun, this movement controlled most of Afghanistan from 1996 to 2001 and waged a 20-year insurgency after being ousted by U.S.-led forces. They regrouped in Pakistan (notably the "Quetta Shura") and regained control of the country in August 2021.

The Northern Alliance (United Front): A coalition of mainly Tajik, Uzbek, and Hazara militias that fought against the Taliban in the 1990s. They were crucial allies for the U.S. during the initial 2001 invasion, providing ground support that led to the quick fall of Kabul. Key leaders included Mohammad Fahim and Abdul Rashid Dostum.

Anti-Taliban Pashtun Leaders: In the southern regions, the U.S. partnered with Pashtun tribal leaders, as Hamid Karzai, who helped overthrow the Taliban regime and later led the interim administration.

The Haqqani Network: An influential faction within the Taliban, particularly active in southeastern Afghanistan and Pakistan's northwest. They were known for high-profile attacks in Kabul and had close ties to Al-Qaeda.

National Resistance Front (NRF): Formed after the 2021 Taliban takeover by former officials and security forces, this group emerged as a, albeit weaker, opposition to Taliban rule, based primarily in the Panjshir Province

2.6. Strategic impact and consequences for the war's outcome

2.6.1 Tactical successes

Effective HUMINT contributed to: identification and targeting of insurgent leaders, disruption of improvised explosive devices networks, improved force protection though early warning and enhanced understanding of shadow governance systems. In many districts, actionable human-source reporting prevented attacks and dismantled local Taliban cells. Special operations forces, in particular, integrated HUMINT with signals intelligence to conduct precision operations.

2.6.2 Structural limitations and intelligence distortion

Despite tactical successes, systemic problems limited strategic effectiveness: overreliance on paid informants created incentives for false reporting, corruption within Afghan institutions distorted intelligence flows, cultural misunderstandings led to misinterpretation of motives, civilian casualties and controversial detention practices damaged trust networks essential for HUMINT sustainability. In some cases, intelligence-driven night raids and drone strikes, while eliminating high-value targets, generated resentment that insurgents exploited for recruitment.

2.6.3 Influence on the war's outcome

HUMINT proved highly effective at the tactical and operational levels but less decisive at the strategic level. Coalition forces developed increasingly sophisticated maps of local hierarchies and influence groups. However, three broader factors limited the long-term impact: the Taliban's ability to embed within kinship networks, cross-border sanctuary and regional dynamics beyond local intelligence reach, the fragility and corruption of Afghan state institutions.

Even with improved understanding of tribal allegiances and cultural dynamics, intelligence could not compensate for structural political weaknesses. When U.S. and NATO forces withdrew in 2021, the rapid collapse of Afghan security institutions demonstrated that deep social knowledge alone could not substitute for sustainable governance legitimacy.

3. CONCLUSIONS & AKNOWLEDGMENT

The Afghanistan War demonstrated that HUMINT is indispensable in irregular warfare, particularly within fragmented, tribal societies where authority is informal and relational. American and NATO forces invested heavily in mapping local hierarchies, influence networks, and cultural dynamics through field interviews, civil-military engagement, Afghan partnerships, and specialized cultural programs. These efforts produced measurable tactical gains and enhanced operational awareness.

However, HUMINT also revealed the limits of intelligence power. While it could illuminate the social terrain, it could not fundamentally transform the political structures sustaining conflict. The Afghan case thus illustrates both the necessity and the limitations of HUMINT in modern counterinsurgency: it is a decisive enabler of military operations, but not a substitute for coherent political strategy and legitimate local governance.

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ARTIFICIAL INTELLIGENCE IN CONTEMPORARY WARFARE – ASPECTS OF MORALITY AND LEADERSHIP

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Abstract: *Throughout history, humanity has experienced numerous conflicts that have profoundly shaped the evolution of international relations and legal norms. Particularly during the last two centuries, the global order has been significantly influenced by the two World Wars, as well as by a multitude of civil wars, insurgencies, acts of terrorism, and persistent geopolitical instability. Consequently, a distinct body of norms commonly referred to as the "law of war" has emerged, emphasizing ethical considerations and the protection of fundamental human rights, most notably the right to life.*

In the contemporary geopolitical landscape of 2024, the international community continues to confront a climate marked by conflict, uncertainty, and security threats. The military aggression initiated by Russia against Ukraine in February 2022, alongside the escalation of hostilities in the Middle East beginning in October 2023, has intensified global tensions and prompted major powers to engage in a renewed arms competition reminiscent of the dynamics of the Cold War. Unlike previous historical periods, however, this competition is characterized not only by advancements in conventional and nuclear military capabilities but also by the rapid integration of artificial intelligence (AI) into military systems and strategic planning.

In this context, the prospect of artificial intelligence evolving from a mere technological instrument into a strategic actor capable of influencing or even directing military operations is no longer purely speculative. This research article seeks to examine the ethical implications of allowing AI systems to assess war-related scenarios, to participate in or assume leadership roles in military decision-making, and potentially to exercise command functions traditionally reserved for human military leaders.

Keywords*: ethics; leadership; warfare; military; intelligence*

1. INTRODUCTION

Ethics has represented a central concern for human reflection since antiquity, particularly in the intellectual tradition of ancient Greece. Early Greek philosophers such as Plato and Aristotle, through their seminal works Republic and Nicomachean Ethics, developed foundational frameworks for understanding moral reasoning and human conduct (Wolfsdorf, 2020). Their philosophical contributions continue to illuminate many contemporary ethical dilemmas, emphasizing the significance of rational judgment, the cultivation of virtue, and the role of the philosopher-king as a moral guide within society (Domanski, 2012). In general terms, ethics can be defined as the discipline that examines what is morally right or wrong, as well as what constitutes good and bad conduct (Singer, 2024).

Parallel to ethical reflection stands the concept of leadership, often treated as a separate analytical domain.

Nevertheless, ethics should be understood as an essential component of leadership, particularly in fields where authority and responsibility carry significant moral implications. This is especially evident in the military domain, one of the few institutional structures legitimately empowered to employ force (Olsthoorn, 2023).

The authority to use force, command troops, and direct military operations places leaders in situations of profound moral complexity. Military decision-makers must constantly balance the obligation to fulfill their duties with principles such as proportionality and necessity. Operational imperatives may conflict with ethical concerns regarding civilian casualties, destruction of civilian infrastructure, or long-term humanitarian consequences. In this context, the present article examines the integration of Artificial Intelligence (AI) in military operations through an ethical perspective. More specifically, it explores the implications of AI-supported decision-making in warfare, focusing on issues of responsibility, leadership, and compatibility with the principles of international law.

2. INSIGHTS ABOUT USAGE OF ARTIFICIAL INTELLIGENCE IN LEADERSHIP

The integration of Artificial Intelligence into military structures occurs in a global context characterized by uncertainty and geopolitical tension. In 2024, the international system remains marked by the simultaneous occurrence of two major conflicts — the war in Ukraine and the ongoing hostilities in the Middle East — which intensify global insecurity and stimulate a renewed technological arms competition.

Within this environment, emerging technologies such as autonomous drones, robotic systems, AI-driven cyber operations, and predictive intelligence analysis have begun to transform the conduct of warfare. These innovations redefine traditional military strategies while also introducing new ethical challenges regarding the role of automated systems in conflict environments (Aerospace and Defense Review, 2024).

The rapid incorporation of AI into military capabilities is fundamentally reshaping key operational dimensions, including target recognition, autonomous combat aircraft development, advanced cyber operations, and intelligence gathering processes. Although these technologies offer significant advantages in terms of operational efficiency, precision, and strategic forecasting, they simultaneously generate complex ethical dilemmas that must be carefully addressed to avoid unintended consequences.

Scholarly literature generally presents two main perspectives regarding the use of AI in military systems. On the one hand, some researchers argue that AI-enabled combat systems may prove more reliable and potentially even more humane than human combatants, as they are capable of executing highly precise targeting procedures without being influenced by emotions such as fear, anger, or adrenaline (Arkin, 2018). From this viewpoint, automation could theoretically reduce certain forms of brutality associated with human decision-making in warfare.

Conversely, other scholars warn that the proliferation of autonomous weapons systems could generate significant ethical and security risks. These critics argue that machines inherently lack moral awareness and cannot assume genuine responsibility when lethal force is employed. Consequently, they advocate for strict limitations or even a complete abandonment of autonomous weapon deployment to prevent catastrophic outcomes (Schwarz, 2018).

In reality, the ethical landscape surrounding AI in warfare remains largely unexplored and uncertain.

Unlike human commanders, who can be held accountable for their reasoning processes and decisions, AI-controlled systems introduce significant ambiguity regarding responsibility. For instance, if an autonomous drone mistakenly identifies a civilian as a combatant and conducts a lethal strike, determining responsibility becomes highly problematic. Such scenarios raise questions regarding whether the fault lies with the programmer, the military operator, the command structure, or the algorithm itself (The Guardian, 2023).

From an ethical standpoint, three major dimensions must therefore be considered when evaluating the strategic use of AI in military contexts: the delegation of lethal decision-making to machines, accountability for AI-generated actions, and the potential escalation of autonomous weapons within the global arms race. These considerations must be analyzed in light of the principles derived from Just War Theory and international humanitarian law, which emphasize the importance of distinction, proportionality, and accountability in armed conflict (Williams Jr., 2006).

One of the most controversial issues concerns the delegation of lethal authority to autonomous systems such as AI-controlled drones. Critics argue that machines cannot fully comprehend the complexity of ethical reasoning involved in life-and-death decisions. Although artificial intelligence can be trained to identify patterns and behavioral indicators, such capabilities remain fundamentally dependent on programming parameters defined by developers. If these parameters are altered or disabled, the system may operate without consideration for human empathy or contextual moral judgment (Perry, 2023). Consequently, AI-driven military technologies remain vulnerable to manipulation or misuse, potentially leading to violations of international humanitarian norms.

To illustrate this dilemma, one may imagine a scenario in which an AI-operated military aircraft is authorized to neutralize enemy combatants occupying a specific territory. In executing this task, the system might deploy lethal force without recognizing that civilians have been taken hostage within the targeted location. Such a situation would inevitably lead to severe ethical and legal disputes regarding accountability.

This leads to the second major ethical concern: responsibility for AI-generated outcomes. When automated systems cause unintended harm, determining accountability becomes extremely complex. Responsibility may potentially lie with the system's developers, the operators supervising its deployment, or the institutional structures authorizing its use. In this regard, accountability remains a fundamental pillar in the governance of artificial intelligence technologies (Novelli, 2023).

Finally, the broader geopolitical implications of AI-driven military development must also be considered. The rapid advancement of autonomous weapon systems may intensify the global arms race and further destabilize international security structures. In an already fragile geopolitical environment, such developments could increase the risk of escalation and potentially lead to more destructive forms of conflict.

Moreover, the integration of AI into military structures introduces a new dimension of strategic competition among global powers. States seeking geopolitical influence or territorial expansion may pursue AI-driven military superiority in order to strengthen their strategic advantage. Due to its cross-domain applicability, artificial intelligence has the potential to influence both traditional warfare and hybrid threats, while simultaneously generating new mechanisms for conflict management and response (Petrovski, 2022).

The contemporary international environment reflects a growing tension between technological optimism and concerns regarding the potential consequences of rapid innovation.

On one hand, global powers are investing heavily in artificial intelligence research and military modernization. On the other hand, analysts increasingly warn that this technological competition may lead to destabilizing geopolitical outcomes.

In this evolving context, major actors such as Russia, China, and the United States are allocating substantial resources to AI-driven research, strategic modeling, and advanced military technologies. By contrast, European states have traditionally approached the weaponization of artificial intelligence with greater caution, focusing more heavily on regulatory and ethical considerations (Csernatoni, 2019).

Artificial intelligence possesses the capacity to process vast quantities of information with a level of speed and analytical precision far beyond human capabilities. As a result, AI-enabled decision-support systems are increasingly integrated into military command structures, assisting commanders in tasks such as operational planning, intelligence analysis, and battlefield prediction.

This dynamic has given rise to the concept of human-machine symbiosis in military leadership. Through machine learning and predictive analytics, AI systems may gradually assume a greater role in strategic forecasting, tactical planning, and troop deployment decisions. Although human commanders remain formally responsible for final decisions, AI may function as a de facto strategic actor by shaping the range of options presented to military leaders.

However, the progressive reduction of human involvement in military leadership raises significant ethical concerns. The gradual transition from human-centered command structures to technology-dominated decision-making processes may weaken the moral responsibility traditionally associated with military leadership.

The idea of a fully autonomous AI commander may currently appear speculative, resembling scenarios commonly associated with science fiction. Nevertheless, the rapid pace of technological innovation suggests that such possibilities cannot be entirely dismissed. Governments around the world are investing significant financial resources in artificial intelligence development for defense purposes. For instance, the United States Department of Defense has requested more than three billion dollars in funding for AI research and Joint All-Domain Command and Control (JADC2) initiatives designed to enhance both military coordination and intelligence capabilities (Harper, 2023).

Simultaneously, countries that once lagged behind in technological innovation have rapidly emerged as influential actors in the global AI landscape. China, for example, has experienced remarkable growth in the number of artificial intelligence companies, reaching nearly 1,200 firms by 2019, while the United States maintained just over 2,000 AI-focused enterprises during the same period (Tong, 2021).

Looking toward the future, it remains uncertain whether artificial intelligence could ever assume a fully autonomous leadership role within military structures. Some theorists speculate about the possibility of AI systems acting as neutral arbiters capable of preventing war by eliminating human motivations such as nationalism, economic ambition, or political rivalry. However, such a scenario remains highly speculative and raises profound ethical questions.

A more plausible short-term scenario involves AI functioning as a de facto operational commander responsible for executing lethal actions while human personnel remain responsible for strategic oversight. In such circumstances, the delegation of lethal authority to machines may reduce the psychological burden experienced by soldiers, potentially distancing them from the moral weight traditionally associated with acts of war (Johnson, 2023).

3. CONCLUSIONS & ACKNOLEDGMENT

The expansion of Artificial Intelligence across all sectors of society appears inevitable, and the military domain is no exception. As global powers compete to achieve technological supremacy, the integration of AI into military operations and leadership structures will likely continue to accelerate.

However, the deployment of AI in strategic military decision-making processes raises serious ethical concerns. Applications such as operational mapping, predictive planning, and automated troop deployment may significantly enhance military efficiency, yet they simultaneously challenge traditional principles of responsibility and moral judgment.

For this reason, international law and global governance institutions must approach the regulation of artificial intelligence with caution and responsibility. The development of comprehensive international frameworks is essential to ensure that AI technologies are used in a manner consistent with humanitarian principles, legal accountability, and global security.

Artificial intelligence has the potential to reshape geopolitical dynamics and transform the nature of warfare. Yet the prospect of granting AI systems full authority to conduct military operations or execute lethal actions raises serious ethical risks. Unlike human beings, whose moral values are shaped by lived experience and ethical reflection, AI systems rely entirely on programmed parameters defined by developers.

Furthermore, determining responsibility for AI-generated outcomes remains a complex challenge. When autonomous systems cause unintended casualties or infrastructural destruction due to algorithmic errors or misinterpretations, establishing accountability becomes extremely difficult.

Consequently, artificial intelligence should only be integrated into military operations through carefully regulated frameworks that prioritize transparency, responsibility, and human oversight. Even in a future where technological systems play a greater role in conflict management, ethical decision-making must remain fundamentally grounded in human judgment. The ethics of power may sometimes prove difficult for human leaders to uphold, yet they remain even more inaccessible to autonomous artificial intelligence systems.

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ON PATTERNS OF MILITARY IDIOMS: A TENTATIVE ANALYSIS

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Abstract: *Military idioms are everywhere in English, even in conversations that have nothing to do with war or the Armed Forces. We bite the bullet when we face a difficult decision, find ourselves on the front line of a crisis, or call the shots in a team meeting. Most of the time, we use these expressions without giving any thought to their military origins. What makes these idioms especially intriguing is how easily they move beyond their original domain. Language associated with combat, hierarchy, and survival is routinely used to talk about office politics, social conflict, or personal challenges. This process invites a closer look at how meaning is preserved, reshaped, or expanded as idioms travel from literal to metaphorical contexts. The present paper studies English military idioms from (a) a semantic and (b) cognitive perspective, focusing on their metaphorical motivation and their capacity for contextual adaptation. By looking at how these expressions function in present-day usage, the study reveals that military idioms are not static relics of specialized language, but flexible and culturally grounded tools of everyday communication.*

Keywords: *idiomatic flexibility; compositionality; semantic transparency; contextual adaptation; military idioms*

1. INTRODUCTION

Language is alive. It grows, shifts, and bends to fit the people who use it. One of the clearest ways we see this is in the way war talk has snuck into everyday English. We might be negotiating a tricky project, dealing with a chaotic schedule, or navigating a personal crisis, and suddenly, we find ourselves speaking like we're on a battlefield. We say we're "in the trenches", "under fire," or "calling the shots", rarely thinking about the literal wars these phrases come from.

What is striking is how naturally these expressions have moved out of their original world. Words that once described strategy, combat, and survival now describe teamwork, office politics, and personal struggles. Their meanings have stretched and shifted, carrying echoes of the battlefield but gaining new life in everyday situations. It's a reminder that language isn't static, it's a living tool that adapts to what we need to say.

This paper explores why we reach for these metaphors and how we bend them to fit our own experiences. Military idioms aren't just leftover phrases; they're flexible, culturally rich ways to talk about challenges, hierarchy, and strategy in a world far removed from war.

2. THEORETICAL FRAMEWORK: IDIOMATIC FLEXIBILITY AND SEMANTIC TRANSPARENCY

2.1 Idiomatic expressions: The main issues.

Idioms have traditionally (Bruening 2010a, 2015, Kim 2012, Bruening et al 2015, Gehrke and McNally 2018, Larson 2017, O'Grady 1998 a.o.) been described as fixed expressions whose meanings cannot be derived from the meanings of their individual components. However, more recent approaches (Fellbaum 2019, Nunberg 1994) challenge this uniform view, arguing that idioms differ significantly in terms of semantic transparency and structural flexibility. Rather than forming a uniform category, idioms range from highly opaque expressions (see (1a) below), to partially compositional ones as suggested in (1b), where aspects of the figurative meaning can be associated with individual lexical items.

(1) a. kick the bucket
b. spill the beans

In (1a) above "kick the bucket" is considered opaque because its overall meaning ("to die") cannot be inferred from the literal meanings of its individual components (kick + bucket). Neither element contributes independently to the figurative interpretation. As a result, the idiom is semantically non-compositional and resistant to internal modification (for example, "kick the old bucket" does not naturally preserve the idiomatic meaning). In contrast, (1b) is compositional, or at least partially transparent. Its figurative meaning ("to reveal a secret") can be connected to the literal meanings of its parts: spill suggests causing something to come out, and beans can metaphorically represent pieces of information. Because the components maintain a semantic link to the idiomatic meaning, the expression is more analyzable and more flexible syntactically (for example, "spill the juicy beans" remains interpretable).

In light of this view, Nunberg (op. cit.) differentiates between idiomatic phrases and idiomatically combining expressions. While the former function as indivisible semantic units, the latter distribute their figurative meaning across their components, allowing for a degree of internal structure and interpretation. For example, a non-compositional idiom such as "bite the bullet" does not tolerate internal modification, since its individual components do not contribute separate meanings to the overall interpretation. By way of contrast, an idiomatically combining expression like "lose ground" permits adjectival insertion (e.g., "losing significant ground") because the figurative meaning of "progress" is directly tied to the noun "ground", which makes the idiom semantically transparent and syntactically flexible.

Moreover, Nunberg (op.cit) identifies idioms as conventionalized constructions that exhibit a cluster of characteristic properties. Among these are conventionality, relative inflexibility, figurative meaning, and, in many cases, informality and affective or evaluative force. What distinguishes idioms from freely generated phrases is not the presence of any single feature, but the way these properties engage within established patterns of use. Conventionality plays a central role in idiomatic meaning: an idiom's interpretation is not freely constructed on the spot, but relies on common language knowledge within a speech community. At the same time, idioms are often described as inflexible in the sense that their form and meaning cannot be altered without constraint. However, as Nunberg argues, this inflexibility is only relative.

One common form of modification that supports Nunberg's view is adjectival insertion. Consider (2a) where the adjective "political" does not alter the figurative meaning of the idiom. Instead, the adjective narrows the domain of interpretation, anchoring the idiom within a particular institutional or ideological context.

The modification works because the noun "potato" retains a metaphorical role within the expression, allowing the adjective to refine rather than disrupt the meaning.

(2) a. political hot potato

Quantification offers further evidence. Consider (3a) where idiomatic elements can combine compositionally with quantifiers to convey intensity or accumulation. The noun "strings" functions as a meaningful unit that can be counted or intensified, which would not be possible if the idiom were a completely opaque block. Syntactic processes such as topicalization provide additional confirmation. Consider (3b) where idiomatic elements can combine where the fronting of the idiomatic component does not eliminate the figurative interpretation. The meaning remains recoverable because the semantic relation between the parts is still intact.

(3) a. pull yet more strings (Dickinson 1969:26)

b. those strings, he wouldn't pull up for you. (Nunberg 1994:501)

Similar evidence comes from ellipsis and anaphora. Consider (4a) and (4b) where parts of the idiom are targeted by ellipsis or picked up by pronouns. This would be difficult to explain if idioms were entirely indivisible units. Instead, these patterns suggest that idiomatic components can function as discourse referents and interact with general principles of cohesion and economy. Taken together, these phenomena support Nunberg's (op. cit.) central claim: idioms should not be treated as uniformly rigid or semantically opaque. Rather, they are conventionalized constructions whose degree of flexibility depends on how their internal semantic structure is organized and how accessible their components are to speakers.

(4) a. my goose is cooked, but yours isn't

b. we thought tabs were being kept on us, but they weren't. (Nunberg 1994:501-502)

Similarly, Fellbaum (2019) discusses in her corpus-based work that idioms are not necessarily frozen forms, but can tolerate modification, variation, and recontextualization without losing their idiomatic status. To illustrate this point, consider the idiom in (5a) below:

(5) a. fall off the wagon (Fellbaum 2019:746)

Although it is traditionally treated as a fixed phrase meaning a return to drinking alcohol after a period of abstinence, everyday usage shows that speakers do not handle it as a rigid, frozen unit. Instead, they use it as a productive semantic pattern. This can be seen in variations such as "fall off the [x] wagon," where a noun or adjective is inserted to specify the type of commitment that has been broken. Whether someone says they have fallen off the "sugar wagon", the "exercise wagon", or the "productivity wagon", the structure of the idiom stays the same, but its meaning is extended creatively to new contexts.

For speakers, the element "wagon" has developed a particular sub-meaning, referring to a "regime", "commitment", or "disciplined path". Because this component carries its own metaphorical meaning, it can be specified or adjusted without eliminating the broader figurative sense of relapse. (cf. Fellbaum 2019)

Drawing on naturally occurring data from online texts, Fellbaum (op cit) demonstrates that even idioms traditionally classified as fully fixed, such as kick the bucket, can appear in unexpected syntactic environments. She identifies attestations of such idioms in the passive voice, a context long assumed to be incompatible with their idiomatic interpretation. The existence of passive constructions challenges the idea that idiomatic expressions are syntactically inert. Instead, it suggests that speakers can manipulate idiomatic material creatively, as long as the figurative meaning remains recoverable within the context.

These findings uphold the view that idioms, including those considered maximally fixed, participate in general grammatical processes to a greater extent than traditional accounts would predict.

These observations are especially relevant for what Nunberg (op. cit) terms “idiomatically combining expressions”, that is, idioms whose components make identifiable contributions to the overall figurative meaning. Because interpretation in such cases is distributed across lexical items, these idioms remain accessible to a range of systematic modifications without losing their idiomatic status.

So far we have seen that both Nunberg (op. cit.) and Fellbaum (op. cit.) challenge the traditional view of idioms as fixed, opaque, and syntactically inert expressions. Instead of treating idioms as indivisible lexical blocks, they argue that many of them display internal semantic structure and interact with general grammatical processes.

Nunberg (op. cit.) argues that idioms vary in their degree of compositionality. While some are fully opaque, others are “idiomatically combining,” meaning that their components retain identifiable figurative roles. This explains why certain idioms permit modification or syntactic operations without losing their figurative meaning, depending on how semantically accessible their parts are.

Fellbaum (op. cit.) extends this view by showing that, in actual usage, idioms are not simply stored as fixed strings. Speakers can modify and adapt them to new contexts, which suggests that idioms may function as productive patterns rather than rigid expressions.

Taken together, these perspectives suggest that idioms are best understood as conventionalized constructions whose flexibility depends on their internal semantic organization.

2.2 The classification of idioms (Bruening 2010). To really understand how these expressions are structured, we need to look at how idioms work in ditransitive constructions. Bruening (op. cit.) points out that idioms aren’t just random strings stored in our memory. Instead, their use is guided by the internal structure of the Verb Phrase (vP). By examining the patterns that are logically possible, he shows that some structures never occur, which suggests that idioms follow strict syntactic rules rather than appearing by chance.

A. Logically possible fixed ditransitive idiom patterns

In fixed patterns, the idiom is tied to a specific grammatical configuration. Bruening identifies three attested classes and one systematically absent class. (NP below represents Noun Phrase: a group of words centered around a noun. In those formulas, NP represents the objects.)

(6) a. Class 1: Verb NP NP (e.g. "give X the creeps", where X: represents the open variable, the "slot" where a speaker can freely insert a name or object that is not part of the fixed idiom).

b. Class 2: Verb NP to NP (e.g. "give rise to X").

c. Class 3: Verb NP to NP (e.g. "send X to the showers").

d. Class 4: Verb NP NP with a fixed first object and a variable second object.

(Bruening 2010:536)

B. Logically possible alternating ditransitive idiom patterns

Beyond fixed patterns, Benjamin Bruening (op. cit.) also looks at idioms that can change their grammatical form while keeping the same figurative meaning. This alternation shows that idioms are not fragile expressions. If an idiom can undergo a structural change and still preserve its meaning, this suggests that it is firmly integrated into the basic rules of English syntax and that its internal structure is stable enough to support reordering.

(7) a. Alternating Classes 1 & 2: The Dative Shift Success (e.g. "read X the riot act" ↔ "read the riot act to X")

b. Alternating Classes 3 & 4: The Nonexistent Pattern (no attested idioms)

2.3 Military idiomatic expressions.

2.3.1. A syntactic analysis of military idioms.

The following section presents a selection of military-derived idioms that have developed stable figurative meanings in contemporary English. Although originally rooted in literal combat contexts, these expressions are now widely used in political, economic, and everyday discourse. Each item is accompanied by a brief gloss indicating its conventionalized figurative meaning.

In the case of military idioms, this flexibility is closely tied to the productivity of war-related metaphors, which continue to structure how speakers conceptualize abstract domains such as work, politics, or personal struggle.

The list below illustrates commonly used military idioms:

1. "be in the trenches" – to work directly and intensively in difficult conditions
2. "hold the fort" – to maintain control in someone's absence
3. "go AWOL" – to disappear or neglect responsibilities without permission
4. "sound the retreat" – to withdraw from a difficult situation
5. "be under siege" – to be under sustained pressure or attack
6. "take no prisoners" – to act ruthlessly and show no mercy
7. "fight fire with fire" – to respond with equal force or aggression
8. "sound the alarm" – to warn others about danger
9. "go down in flames" – to fail completely
10. "be on the front lines" – to be directly involved in a demanding situation
11. "beat swords into plowshares" – to turn from conflict to peaceful activity
12. ."call in reinforcements" – to request additional help
13. "fight the good fight" – to struggle for a worthy cause
14. "bite the bullet" – to endure hardship bravely
15. "have / got your six" – to protect someone; watch someone's back
16. "catch flak" – to receive strong criticism
17. "take the flak" – to accept blame or criticism
18. "no man's land" – a dangerous or unprotected area
19. "nuclear option" – an extreme or drastic measure
20. "on the double" – very quickly
21. "balls to the wall" – at maximum effort or intensity
22. "down the tubes" – in Air Traffic Control flights are documented on pieces of paper; when the aircraft takes off the strip is put in a holder and is sent from the ATC tower down to the ground-level radar controllers
23. "embrace the suck" – to accept and endure hardship
24. "boots on the ground" – personnel physically present and actively engaged
25. "give X the green light" – to authorize something
26. "raise the white flag" – to surrender
27. "hold the line" – to resist pressure or maintain a position
28. "draw the battle lines" – to define opposing sides in a conflict
29. "close ranks" – to unite against opposition
30. "dig in" – to become firmly established or resistant to change
31. "launch an attack" – to begin strong criticism or action
32. "come under fire" – to be criticized
33. "take fire" – to receive strong criticism
34. "in the line of fire" – exposed to danger or criticism

35. "in someone's crosshairs" – targeted for attack or criticism
36. "on the warpath" – very angry and ready to confront
37. "a war of attrition" – a prolonged struggle that gradually weakens opponents
38. "fight an uphill battle" – to struggle against difficult odds
39. "win the battle but lose the war" – short-term success but long-term failure
40. "behind enemy lines" – in hostile territory (literal or figurative)
41. "storm the gates" – to enter forcefully or aggressively
42. "man the barricades" – to prepare to defend a position
43. "pull the trigger" – to make a decisive move
44. "give marching orders"- to fire, dismiss, or order someone to leave a place or job immediately

cf. Military.com (https://www.military.com/join-armed-forces/military-terms-and-jargon.html); Reader's Digest (https://www.rd.com/list/military-words-phrases/); post on Facebook (https://www.facebook.com/share/p/1BCP9X2hBL/?mibextid=wwXIfr).

At a closer look, a small subset of idioms can be analyzed using Bruening's (op. cit.) framework.

Idioms compatible with Class 1 (V NP NP) patterns, in which the first element is a variable argument and the second is a fixed idiomatic core:

(8) a. "have/got your six"
b. "give X the green light"
c. "give X marching orders"
d. "give X the flack"

For instance in (8a) the first element ("your") is variable, referring to the person being protected, while the second element, "six," forms the fixed idiomatic core. The idiom demonstrates how a cohesive verb-core unit can tolerate a variable argument without losing its figurative meaning.

In (8b) X is a variable argument representing the recipient of permission, while "the green light" is the fixed idiomatic core. This idiom also fits Class 1 because the figurative meaning remains stable regardless of the variable argument, showing structural flexibility within the ditransitive framework.

A few idioms can be analyzed as fitting Class 2 (V NP to NP) patterns, where the fixed idiomatic element is placed right after the verb and the variable argument follows in a prepositional phrase.

Genuine Class 2 idioms are difficult to identify within the military dataset. This pattern requires a fixed idiomatic element adjacent to the verb, followed by a variable argument introduced by "to." However, most military expressions function either as fixed verb phrases (e.g. "stick to your guns", "take no prisoners") or as nominal constructions (e.g. "on the radar", "boots on the ground"), rather than as V NP to NP templates.

Classes 3 and 4, which involve patterns where the idiomatic element appears in a prepositional phrase or where the first object is fixed and the second is variable, are mostly absent among military idioms.

On the other hand, there is a clear tendency in the dataset toward simple transitive idioms rather than true ditransitive ones. Expressions such as "be in the trenches," "take no prisoners," or "fight fire with fire" usually function as single, fixed phrases or simple verb phrases with no internal variation. These idioms are compact units whose figurative meaning cannot be broken down into separate parts, which means they do not conform to Bruening's ditransitive classes that require two internal arguments in specific positions.

This supports Bruening's observation that certain argument structures are systematically blocked: idioms cannot "skip over" an intervening element to link a fixed core with a more distant variable.

Overall, the military idioms examined show a clear distinction between those that can fit into ditransitive argument structures and those that remain rigid, fixed expressions. While a few examples, such as "have/got your six" or "give X the green light," display structural flexibility consistent with Bruening's classes, the majority function as compact, stable figurative units. This pattern suggests that Bruening's geometric constraints on the Verb Phrase mainly apply to idioms with argument structure, whereas most military-derived expressions are fixed phrases whose figurative meaning is embedded directly at the lexical level.

Many of the military idioms in the list are simple transitive verb–object expressions. Examples such as "bite the bullet", "pull the trigger", "launch an attack", or "raise the white flag" all follow a clear V + NP pattern, but their figurative meaning depends on the whole phrase rather than on the separate parts. The same can be said for expressions like "draw the battle lines", "hold the line", "catch flak", or "sound the alarm". Although they are grammatically straightforward, they function as fixed combinations in contemporary usage. Because they involve only one internal object, they do not fit into Bruening's ditransitive classes. Instead, they show that most of the military idioms identified here tend to appear as compact transitive units whose meaning is stored and interpreted as a whole.

2.3.2. Flexibility and semantic transparency, according to Fellbaum (2019) and Nunberg (1994).

The previous section looked at military idioms from a syntactic perspective, examining how they fit with Bruening's ditransitive patterns. In this section, we shift the focus to their semantic and structural flexibility, following the approaches of Fellbaum (op. cit.) and Nunberg (op. cit.). From this point of view, idioms are not necessarily fixed or rigid: they can often tolerate internal modification, the addition of adjectives, quantification, or certain kinds of syntactic rearrangement without losing their figurative meaning. This perspective helps us identify which idioms are rigid and which can be adapted creatively to new contexts, showing different levels of compositionality and transparency. The following analysis applies these criteria to the military idioms discussed earlier, highlighting which expressions allow modification, which remain resistant, and the patterns of flexibility that can be observed in the set of idioms.

(9) a. stick to your guns – to remain firm in one's position; to maintain a decision, opinion, or course of action despite pressure or opposition.

"Despite harsh criticism, she's sticking to her guns on this issue."
(https://dictionary.cambridge.org/dictionary/english/stick-to-guns)

b. on the radar – to be noticed, considered, or monitored.

"Five years ago, having a child wasn't even on my radar."
(https://dictionary.cambridge.org/dictionary/english/on-radar)

We now turn to examples (9a) "stick to your guns" and (9b) "on the radar" to examine their flexibility from the perspective of Fellbaum (op. cit.) and Nunberg (op. cit.).

The idiom (9a) has a clear military origin. Literally, it referred to soldiers who stayed at their artillery positions during battle and did not abandon them, even when the situation was dangerous. Over time, the phrase moved away from this literal meaning. Today, when we say that someone "sticks to their guns", we usually mean that they refuse to change their opinion or decision, even when they are under pressure. It is often used in political discussions, workplace situations, or everyday disagreements to describe someone who remains firm.

If we look at it from the perspective of Nunberg, Sag, and Wasow (op. cit.), (9a) fits better into the category of idiomatic phrases.

Its meaning cannot really be broken down into the meanings of its parts. The word "guns" does not normally stand for "arguments" or "beliefs" on its own. The figurative meaning only appears when the words are used together in this specific form. Because of that, the expression behaves like a single unit and does not allow much internal change. This can be seen when we try to apply syntactic transformations. A passive version such as "the guns were stuck to" sounds unnatural and completely loses the idiomatic meaning. In other words, once the internal structure is disturbed, the figurative sense disappears. This supports Bruening's (op. cit.) idea that some idioms are tightly connected at a structural level and cannot easily be separated. There are small variations, such as "stick to your original guns," but these are limited. Compared to the types of flexibility described by Fellbaum (op. cit.), (9a) seems relatively fixed.

At the same time, it is still very much alive in modern English. The reason is probably not structural, but pragmatic. The idiom carries a strong evaluative meaning: it presents persistence as something positive, often linked to integrity. Even if speakers no longer think about artillery or battlefields, the idea of "standing your ground" remains powerful.

A different situation can be observed with (9b). This expression also comes from military terminology, where radar systems detect objects. Its figurative meaning, however, is easier to understand. In everyday language, saying that something is "on the radar" simply means that it has become noticeable or important.

Unlike (9a), (9b) is quite flexible. It can be modified in different ways: something may be barely on the radar, firmly on the political on the radar, or off the radar. The metaphor of visibility is still clear, which makes the expression easy to adapt to various contexts, especially in media or political language.

Because the metaphor is transparent, the parts of the idiom still contribute to the overall meaning. In this sense, (9b) is closer to what Nunberg calls an idiomatically combining expression. Even though both have military origins, they do not behave in the same way. One is more rigid and opaque, the other is more flexible and transparent.

3. CONCLUSIONS & ACKNOLEDGMENT

This paper examined military-derived idioms from syntactic and semantic perspectives to identify their structural patterns and flexibility. Syntactically, most idioms are transitive or fixed verb phrases and do not fit neatly into ditransitive classes, indicating that many function as compact units outside standard argument structures. Semantically, idioms vary in transparency and adaptability, with some being relatively fixed while others allow modification and contextual expansion. Overall, military idioms show differing degrees of compositionality and flexibility, highlighting the need to integrate syntactic and semantic approaches in idiom studies.

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LEADERSHIP BEYOND WORDS: THE COMMUNICATIVE POWER OF BODY LANGUAGE

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Abstract: *Communication represents the foundation of human interaction, shaping relationships, influencing perceptions, and guiding collective action. While verbal expression has traditionally been considered the primary vehicle of communication, nonverbal elements, particularly body language, play an equally significant, and often decisive, role in how messages are interpreted.In professional, educational, and organizational environments, leaders are not evaluated solely by the content of their words, but also by how those words are delivered. Gestures, posture, facial expressions, eye contact, and tone of voice can reinforce, contradict, or even replace verbal communication. Consequently, the ability to understand and intentionally use body language becomes an essential competence for modern leaders. This paper examines the theoretical foundations of nonverbal communication and analyzes its practical implications in leadership contexts. It discusses how body language contributes to credibility, trust-building, emotional intelligence, persuasion, and conflict management. Furthermore, it addresses cultural considerations and the potential risks of misinterpretation in diverse environments. The motivation behind this study arises from the increasing complexity of contemporary communication, where leaders must navigate multicultural teams, hybrid work settings, and high-stakes interactions. In such contexts, awareness of body language is not merely advantageous but indispensable. Ultimately, this paper seeks to emphasize that successful leadership is not only about what is said, but also about what is silently communicated.*

Keywords*: communication; leadership, interaction, body, language.*

1. INTRODUCTION

Communication represents one of the fundamental pillars of human interaction, playing a crucial role in both personal and professional environments. Within the complex process of communication, messages are transmitted not only through words but also through nonverbal elements such as gestures, facial expressions, posture, eye contact, and tone of voice. These elements form what is commonly known as body language. In leadership contexts, where influence, credibility, and trust are essential, body language becomes a strategic component of effective communication.

Research in the field of communication studies suggests that nonverbal signals significantly shape how messages are interpreted. According to studies conducted by Albert Mehrabian, "Communication without words", *Communication theory,* Routledge, 2017. 193-200, nonverbal elements can strongly impact the perception of emotions and attitudes in face-to-face interactions. Although his findings are often oversimplified, they highlight the importance of understanding the relationship between verbal and nonverbal communication.

In leadership, the ability to project confidence, authenticity, and authority often depends on the alignment between spoken words and body language. A leader who maintains open posture, steady eye contact, and controlled gestures is generally perceived as more trustworthy and competent. Conversely, incongruence between verbal messages and nonverbal cues may reduce credibility and weaken influence.

The purpose of this paper is to examine the importance of body language in the process of communication and leadership. It aims to analyze how nonverbal behavior contributes to leadership effectiveness and how it shapes followers' perceptions.

The central research question guiding this study is: How does body language influence leadership effectiveness in professional contexts?

Before addressing the main aspects of this topic, it is essential to clearly define, based on existing literature, the concepts of verbal communication, nonverbal communication, body language, and leadership.

1. Verbal communication - Communication occurs when signals carry information-bearing messages between a source (or sender) and a destination (or receiver). Krauss, Robert M. "The psychology of verbal communication." *International Encyclopaedia of the Social and Behavioral Sciences. London: Elsevier* (2002): 16161-16165.
2. Nonverbal communication - Non-verbal communication can be best defined as a silent form of communicating with a person or party without using any form of speech to grab the attention of audience or to exploit a message. Phutela, Deepika. "The importance of non-verbal communication." *IUP Journal of Soft Skills* 9.4 (2015): 43.
3. Body language – Body language can include any non-reflexive or reflexive movement of a part, or all of the body, used by a person to communicate an emotional message to the outside world. Fast, Julius. *Body language*. Vol. 82348. Simon and Schuster, 1970.
4. Leadership - Leadership appears to be, like power,an 'essentially contested concept'"(Gallie, 1955 cited in Grint, 2004, p1)

By exploring theoretical perspectives and practical implications, this paper seeks to demonstrate that body language is not merely a complementary aspect of communication, but a fundamental element in the construction of successful leadership.

2. LEADERSHIP BEYOND WORDS: THE COMMUNICATIVE POWER OF BODY LANGUAGE

2.1 Body Language – a Theoretical Overview

Nonverbal communication - Non-verbal communication can be best defined as a silent form of communicating with a person or party without using any form of speech to grab the attention of audience or to exploit a message. Phutela, Deepika. "The importance of non-verbal communication." *IUP Journal of Soft Skills* 9.4 (2015: 43). Many types and forms of nonverbal communication have been studied, the most well-known being the following:

1. Kinesics - refers to body movements used in communication, including gestures, posture, facial expressions, and overall body orientation. These movements can reinforce, contradict, or substitute verbal messages. For example, an open posture may signal confidence and receptiveness, while crossed arms might suggest defensiveness or discomfort.
2. Facial Expressions - are among the most powerful forms of nonverbal communication, as they directly convey emotions such as happiness, anger, fear, or surprise.

They are often spontaneous and can significantly influence how a message is interpreted. In leadership contexts, controlled and appropriate facial expressions contribute to credibility and emotional connection.

3. Eye Contact (Oculesics) - plays a crucial role in regulating conversations and expressing attention, confidence, and sincerity. Maintaining appropriate eye contact can create trust and engagement while avoiding it may be perceived as insecurity or dishonesty. However, cultural differences influence how eye contact is interpreted.

4. Proxemics - refers to the use of physical space in communication. The distance individuals maintain during interactions can communicate intimacy, authority, or formality. In professional settings, leaders often manage space strategically to establish authority or encourage collaboration.

5. Haptics - involves communication through touch, such as handshakes, pats on the back, or other forms of physical contact. In leadership, a firm handshake, for example, may convey confidence and professionalism. The appropriateness of touch depends heavily on cultural and social norms.

6. Paralanguage (Vocalics) - Paralanguage includes the vocal elements that accompany speech, such as tone, pitch, volume, rhythm, and pauses. These features influence how verbal messages are perceived. A steady and controlled tone may project authority, while hesitation or inconsistent volume might reduce perceived confidence.

7. Chronemics - refers to the use and perception of time in communication. Punctuality, response time, and the amount of time dedicated to interactions all send nonverbal signals. In leadership, effective time management often reflects professionalism and respect.

8. Physical Appearance - includes clothing, grooming, and overall presentation. These factors influence first impressions and perceptions of competence, authority, and credibility. In leadership, professional appearance often reinforces the leader's status and role.

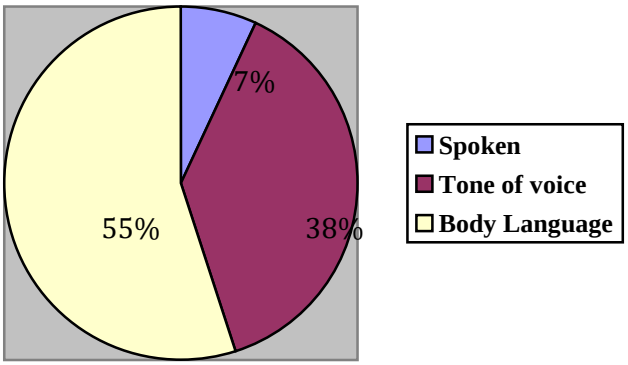
The classification of nonverbal communication has been developed progressively through the contributions of several scholars in the fields of anthropology, psychology, and communication studies. The concept of kinesics, referring to body movements and gestures, was introduced by Ray Birdwhistell,"The methodology of kinesics is extremely crude" (Birdwhistell, 2010:180) who emphasized the systematic nature of body motion in interpersonal interaction. The study of spatial behavior, known as proxemics, was developed by Edward T. Hall," Proxemics, the study of how a man unconsciously structures microspace." (Hall, 1963:1003-1026) , who also contributed to the understanding of chronemics, or the role of time in communication. Vocal elements accompanying speech, described as paralanguage, were examined by George L. Trager," We may characterize these kinds of communication, for the sender, as the motile, tactile, and vocal instrumen□talities; for the receiver, as the visual, sensory, and auditory instrumen□talities.", highlighting the importance of tone, pitch, and rhythm in conveying meaning (Trager, 1966: 70-84). There is a very important theoretical perspective which may lead to a better understanding of the importance of body language in daily use of communication and leadership. Albert Mehrabian proposed a model emphasizing the relative impact of verbal and nonverbal elements in conveying emotions and attitudes in face-to-face communication. Albert Mehrabian is an Iranian-American psychologist best known for his research on nonverbal communication and the expression of emotions. During the 1960s and 1970s, he conducted influential studies on interpersonal communication, focusing on how people convey feelings and attitudes through verbal and nonverbal channels.

He is widely recognized for developing the 7–38–55 rule, which examines the relative impact of words, tone of voice, and body language in expressing emotions. Although his findings have often been oversimplified in popular culture, his research played a significant role in establishing nonverbal communication as a serious field of academic study.

According to his findings, the 7-38-55 rule stands for:

- 7% of meaning is transmitted through words,
- 38% through vocal elements such as tone and intonation,
- 55% through facial expressions and body language.

For a better understanding of how important body language is, bellow is an illustration of the 7-38-55 rule as a pie chart.



However, this model applies specifically to situations where verbal and nonverbal messages are inconsistent and primarily concerns the communication of feelings and attitudes. Despite frequent misinterpretations, Mehrabian's work significantly contributed to highlighting the importance of nonverbal communication in interpersonal interactions and leadership contexts.

Consider the following example: a leader addressing their team during a period of organizational crisis. The leader says, "There is no reason to worry. Everything is under control.". By analysing this simple sentence, we discover:

- 7% – Words: The literal meaning of the words ("no reason to worry") conveys a reassuring message.
- 38% – Tone of voice: If the leader speaks in a calm, firm, and steady voice, it strongly affects how employees perceive confidence and authority. A shaky or hesitant tone would reduce credibility.
- 55% – Body language: Nonverbal cues such as eye contact, upright posture, open gestures, and confident facial expressions are the most influential in conveying trustworthiness and reassurance. If the leader's body language shows tension or avoidance, the message is likely to be perceived as insincere or uncertain, regardless of the words.

According to Albert Mehrabian, when verbal and nonverbal messages are inconsistent, listeners tend to rely much more on tone of voice and body language than on the actual words spoken. In leadership, this illustrates why nonverbal communication is critical for building trust, authority, and credibility during high-stress situations.

2.2 The Role of Body Language in Leadership.

In this section of the paper, answers will be provided to the following questions:

1. *How does body language influence trust and authority?*

Body language plays a crucial role in influencing trust and authority, particularly in leadership contexts. Nonverbal cues such as posture, gestures, facial expressions, and eye contact often communicate confidence, credibility, and reliability more effectively than words alone. A leader who maintains an open posture, makes steady eye contact, and uses controlled gestures is generally perceived as more trustworthy and authoritative. Conversely, inconsistent or negative body language such as crossed arms, lack of eye contact, or tense facial expressions can undermine confidence in the leader, even if their verbal message is positive. Albert Mehrabian emphasizes that when verbal and nonverbal messages are inconsistent, people rely heavily on nonverbal cues. This demonstrates that effective use of body language is essential for establishing trust and authority in communication.

During his presidency, Barack Obama was often cited for his effective use of body language to build trust and authority. When addressing the nation, he maintained an upright posture, made steady eye contact with the audience, and used calm, deliberate gestures. Even when discussing difficult or sensitive topics, his composed tone and confident facial expressions conveyed credibility and reassurance. For instance, during the 2009 economic crisis, his speeches combined careful wording with controlled nonverbal cues, helping to reassure the public and convey authority. According to Mehrabian's model, although his words were important, much of the audience's perception of confidence and trust came from his tone (38%) and body language (55%). This illustrates how nonverbal communication can strongly reinforce leadership effectiveness.

Dwight D. Eisenhower, Supreme Commander of the Allied Expeditionary Force during World War II, was renowned for his calm and confident body language in high-pressure situations. Before major operations like D-Day, Eisenhower addressed his troops with an upright posture, steady eye contact, and measured gestures, conveying both authority and reassurance. His composed facial expressions and deliberate tone helped build trust among soldiers who faced enormous uncertainty.

2. What is the congruence between verbal and nonverbal messages?

Congruence between verbal and nonverbal messages refers to the alignment or consistency between what a person says and how they express it through body language, facial expressions, gestures, tone of voice, and posture. When verbal and nonverbal cues are congruent, the message is clear, credible, and easier for the audience to trust and understand. In contrast, incongruence when words and nonverbal behavior contradict each other can create confusion, reduce credibility, and undermine trust.

During World War II, Winston Churchill delivered numerous speeches to boost British morale. In his famous speeches, he often said phrases like "We shall never surrender." What made his message powerful was the congruence between his words and his nonverbal communication. Churchill maintained an upright posture, firm gestures, steady eye contact, and a strong, deliberate tone of voice.

Because his body language and tone matched the confidence and determination of his words, the message was perceived as authentic and inspiring. Soldiers and citizens alike trusted his leadership and felt reassured, even during the darkest times of the war. This example demonstrates how aligning verbal and nonverbal cues reinforces credibility, strengthens authority, and enhances the overall impact of communication.

In practical use, congruence is critical for anyone aiming to communicate effectively—leaders, managers, teachers, or public speakers. People naturally rely on nonverbal cues to interpret meaning, often giving more weight to tone of voice and body language than to words alone, especially when evaluating emotions or attitudes.

This is why awareness and control of nonverbal behavior can enhance trust, authority, and overall communication effectiveness.

3. What is the difference between dominance and empathy?

When it comes to a person's nonverbal communication skills, the discussion of dominance or empathy also comes into play. Dominance and empathy are two contrasting aspects of leadership communication, often expressed through both verbal and nonverbal behavior.

Dominance refers to a leader's ability to assert authority, influence others, and establish control in a situation. Nonverbal cues associated with dominance include upright posture, expansive gestures, firm tone of voice, steady eye contact, and confident facial expressions. Dominant behavior conveys power, decisiveness, and command, which can help leaders take charge in high-pressure situations.

Empathy, on the other hand, is the ability to understand, recognize, and respond to the emotions of others. Empathetic leaders use nonverbal signals such as nodding, leaning slightly forward, soft facial expressions, gentle tone of voice, and open gestures. These cues communicate approachability, understanding, and support, fostering trust and collaboration.

The key difference lies in their purpose and effect: dominance establishes authority and leadership control, while empathy builds emotional connection and trust. Effective leaders often balance both, using dominance when decisiveness is required and empathy when understanding and motivating people is crucial.

Vladimir Putin is often cited as a leader who projects dominance through nonverbal communication. His posture is usually upright and controlled, gestures are deliberate and minimal, and his facial expressions are calm and composed, projecting authority and self-control. These cues, combined with a firm and measured tone of voice, reinforce his image as a decisive and powerful leader. In high-stakes situations, his dominant nonverbal signals communicate control and command, emphasizing authority over emotional connection.

Volodymyr Zelenskyy, on the other hand, often communicates empathy through nonverbal cues. He frequently uses open gestures, expressive facial expressions, and forward-leaning posture during speeches or interactions with citizens and international leaders. His tone of voice conveys concern, solidarity, and emotional connection, helping him build trust and motivate people during crises. These empathetic nonverbal behaviors make him appear approachable and supportive, emphasizing understanding and connection alongside leadership.

2.3 Practical Implications of Body Language in Organizational Context.

Nonverbal communication also has benefits in terms of practical engagement within organizations.

Body language plays a critical role in organizational communication, influencing teamwork, leadership effectiveness, and overall workplace culture. Leaders who are aware of their nonverbal cues can foster trust, motivate employees, and convey authority without relying solely on verbal instructions.

1. Building Trust and Credibility: Open posture, steady eye contact, and controlled gestures signal honesty and confidence, helping leaders earn the trust of employees. In contrast, crossed arms, fidgeting, or avoiding eye contact can create doubt or reduce credibility.

2. Enhancing Leadership Effectiveness: Nonverbal signals allow leaders to reinforce their verbal messages. For example, during presentations or meetings, confident gestures, appropriate facial expressions, and tone of voice enhance clarity and persuasiveness.

3. Conflict Resolution and Negotiation: Empathetic body language, such as nodding, forward-leaning posture, and calm tone, helps leaders manage conflicts, mediate disputes, and foster collaboration among team members.
4. Influencing Organizational Culture: Consistent positive nonverbal communication from leadership can shape workplace norms, encouraging open communication, cooperation, and psychological safety.
5. Remote and Hybrid Work Considerations (modern approach): Even in virtual meetings, body language matters. Facial expressions, gestures visible on camera, and vocal tone affect how messages are received, emphasizing the need for conscious nonverbal communication in digital environments.

In summary, the strategic use of body language in organizations is not just a supplementary skill—it directly impacts leadership credibility, employee engagement, and the effectiveness of communication across all levels

3. CONCLUSIONS

This paper highlights the critical role of nonverbal communication in the process of leadership and organizational interaction. Nonverbal cues such as body posture, facial expressions, gestures, eye contact, and tone of voice, often carry more weight than verbal messages in shaping perceptions of authority, trust, and empathy. Research by Albert Mehrabian emphasizes that, particularly in emotionally charged situations, only 7% of communication is conveyed through words, while 38% comes from tone of voice and 55% from body language, underscoring the importance of congruence between verbal and nonverbal messages.

Effective leaders use body language strategically to convey dominance when decisiveness and authority are required, and empathy when building trust, motivation, and collaboration among their followers. Examples from political, military, and corporate contexts such as Barack Obama (2009-2017) Dwight D. Eisenhower, Vladimir Putin, Volodymyr Zelenskyy, demonstrate how nonverbal communication reinforces leadership effectiveness in both high-pressure and routine situations.

In organizational settings, the practical implications of body language are profound. Leaders who maintain open posture, confident gestures, and empathetic expressions foster trust, engagement and a positive organizational culture. Even in remote or hybrid environments, conscious control of nonverbal cues such as tone, facial expressions, and visible gestures, remains essential for sustaining credibility and influence.

In conclusion, nonverbal communication is not merely a supplementary aspect of leadership but a foundational tool that shapes perception, builds trust, and enhances organizational performance. Leaders who master both verbal and nonverbal channels are better equipped to motivate, guide, and inspire their teams effectively, making body language an indispensable component of modern leadership.

Leaders who master both verbal and nonverbal communication create a more cohesive, motivated, and responsive workplace.

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TACTICAL VALENCE OF LUCID DREAMING IN FLIGHT PERSONNEL TRAINING

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Abstract: *The study explores the correlation between neural pathway activation during REM sleep and subsequent wake-state motor performance. Three primary directions are examined: mental rehearsal of Emergency Procedures (EPs), desensitization to kinematic stress factors, and the stimulation of creative tactical problem-solving within contested airspaces. The implementation of these techniques can lead to enhanced muscle memory and reduced reaction times in critical scenarios. Furthermore, utilizing lucid dreaming as a form of Neuro-Cognitive Simulation (NCS) contributes to mitigating symptoms associated with combat-related stress and bolstering the psychological resilience of pilots during long-duration missions. Ultimately, the paper asserts that these NCSs function as a critical "biological simulator", bridging the gap between psychological resilience and operational excellence to ensure a decisive advantage in the multidomain battlespace.*

Keywords: *Military aviation; Operational Readiness; Neuro-Cognitive Simulation; Mental rehearsal.*

1. INTRODUCTION

Modern military aviation requires an unprecedented amount of cognitive resilience and rapid motor response, while the human mind remains the primary limiting factor in high-stress, multidomain environments. Although traditional high-fidelity simulators provide essential preparation, recent advances in neuro-psychology point toward an untapped training modality: Neuro-Cognitive Simulations. Once dismissed as a subjective phenomenon, the state of lucid dreaming was scientifically verified at Stanford University as early as 1981, mainly through Stephen LaBerge's work. Through signal-verified REM sleep, characterized by rapid eye movements and also known as the last stage of the sleep cycle, supported by EEG (electroencephalogram), EOG (electro-oculogram) and EMG (electromyogram) data, it was proven that the prefrontal cortex can functionally remain "online" while the body is in deep rest. Over four decades of research confirm that the brain in this state presents neural equivalence, where the activation of motor pathways during a simulated task mirrors real-life execution. This study aims to explain how flight personnel can effectively convert mandatory rest cycles into an asymmetric advantage regarding operational readiness, by engaging in this type of "biological simulator".

2. COGNITIVE FRONTIERS IN MODERN AIR WARFARE

The evolution of the multidomain battlespace has drastically tilted the burden of aerial combat from physical endurance to extreme task management.

As 5th and 6th generation platforms integrate sensor fusion, AI-driven data streams and complex Electronic Warfare (EW) suites, the pilot's role has progressed from the traditional "stick and throttle" operator to a high-level systems manager. This shift has pushed the human's operating system to its absolute threshold. In high-intensity contested airspaces, the rate of information influx often exceeds the brain's ability to process, prioritize, and act. For lack of sufficient training, the OODA loop (Observe-Orient-Decide-Act) breaks down, leading to delayed actions in crucial situations. Compounding this issue are the material and physiological constraints of military aviation: the cost of flight hours for advanced aircraft, which are prohibitively high, and both the mental and physical exhaustion pilots and their flight crew face after just a day of classic intensive training. Furthermore, ground-based flight simulators, while highly effective, are geographically fixed assets that cannot address the cumulative physiological fatigue inherent in long or highly demanding missions. Pilots, for example, are frequently required to operate in a state of chronic fatigue, where the brain's ability to consolidate new skills is significantly impaired. This creates a paradox: the mission demands peak cognitive performance, yet the biological substrate is often at its most exhausted.

Furthermore, the cognitive frontier is not limited to the management of external data, but includes the internal management of cumulative combat-related stress. In the current environment of modern warfare, the psychological "wear and tear", often manifesting as sub-clinical PTSD (posttraumatic stress disorder) or chronic anxiety, represents a significant threat to mission longevity. Traditional training often overlooks this "mental friction", where unresolved stress that loops in the officer's subconscious can lead to hesitation and reduced situational awareness, regardless of the branch of the armed forces they are part of. Consequently, mitigating the neuro-psychological impact of combat is no longer merely a medical concern, but a strategic necessity for maintaining resilient and combat-ready military personnel.

To address this gap, military training doctrine must look beyond traditional external hardware and explore the optimization of internal neurological processes. Facilitated through controlled REM-state activation (lucid dreaming), it is here that Endogenous Flight Simulation (EFS) emerges as a vital supplementary training modality. Rather than viewing sleep as a period of operational "downtime", this framework treats the mandatory rest cycle as a zero-cost extension of the cockpit, or a period for active neurological recovery. By utilizing the neuroplasticity available during REM sleep, pilots can even engage in what is effectively "synthetic flight hours". This modality does not seek to replace traditional simulators at all, but to augment them by providing a platform for the mental rehearsal of high-stakes scenarios where the startle response must be neutralized. This integration of neuro-cognitive techniques into existing training protocols represents a new frontier in human performance enhancement and stress reprocessing, ensuring that the pilot's mental "wetware" is as updated and resilient as the hardware they command.

3. NEUROPHYSIOLOGICAL FOUNDATION

The efficacy of EFS is predicated on the principle of neural isomorphism, which dictates that the brain's functional organization during a lucid dream mirrors the structural and temporal dynamics of the waking state. Unlike standard dreaming, where motor commands are often fragmented, actions performed within a lucid state maintain a one-to-one temporal correlation with physical reality. This phenomenon was objectively demonstrated for the first time by Martin Dresler and his team in their landmark study from 2012.

Utilizing fMRI (functional Magnetic Resonance Imaging), researchers observed that when subjects performed volitional hand movements within a lucid dream, the sensorimotor cortex exhibited activation patterns almost identical to those recorded during actual wake-state execution. Supplementary EEG data concluded that brain areas which are normally deactivated during REM sleep, such as the prefrontal and motor cortices, turn out to be active only during lucid dreams. This suggests that for a pilot, the neural "code" for flipping a toggle switch or moving the flight stick in a certain direction is the same whether the action is performed in the cockpit or the REM cycle.

Beyond the rehearsal of physical movements, the lucid state functions as a complex, safe-state simulator for emotional regulation and controlled exposure therapy. In this neurochemical environment, characterized by low levels of norepinephrine, one can engage with high-arousal stressors in a safe environment, such as combat-related trauma, while maintaining conscious agency. This allows the brain to reprocesses a threat without the "paralyzing" startle response. First research on this topic was made by Victor I. Spoormaker and Jan van den Bout in 2006, consisting of a 23-person experiment where 3 groups, treated in slightly different methods, reported significant reduction of nightmares after just a few weeks of lucid dreaming treatment (LDT). This study suggests that gaining lucidity during stressful dream states significantly reduces the frequency and intensity of stress and anxiety-based cognitive loops, especially in the case of PTSD-related recurring nightmares. Spoormaker's pilot investigation in the domain was followed by more, the most recent one having taken place in 2024 at Northwestern University, each of them strengthening the same conclusions. For military personnel, this means that such type of REM-state mental simulations could be used to desensitize the nervous system to kinematic stress and combat trauma, effectively decoupling the event from the physiological panic response.

Additionally, the unique neurobiology of REM sleep, defined by hyper-connectivity between distant brain regions, makes it a formidable tool for tactical problem-solving. In this state, the human mind is freed from the rigid top-down logic, which makes the brain avoid "weird" or "unlikely" ideas to keep it focused on standard protocols. History and science alike confirm the dream state as a catalyst for breakthrough: from Dmitri Mendeleev's visualization of the Periodic Table to Niels Bohr's structure of the atom, the sleeping brain has a proven track record of solving problems that were stymied by the waking mind. Lucid dreaming is what serves as the vital cognitive interface that allows people to consciously harness the hyper-associative processing of the REM state and direct it towards complex tactical puzzles, or operational challenges.

4. OPERATIONAL APPLICATIONS

The practical integration of "biological flight simulators" into military aviation doctrine manifests in three primary operational tiers: procedural hardening, physiological desensitization, and strategic synthesis. The most immediate application lies in the high-fidelity rehearsal of EPs and "black swan" events. In traditional flight training, pilots are often limited by the safety parameters of ground-based simulators, which, despite their sophistication, cannot fully replicate the sheer existential pressure of a cockpit emergency. Within the lucid state, however, a pilot can volitionally induce catastrophic scenarios such as dual-engine flameouts, total hydraulic failure or rapid decompression, and practice the required switch-ology and trim adjustments with absolute neural realism. Because the brain perceives these actions as „real", the pilot develops a hardened procedural muscle memory that bypasses the delay of conscious thought during a live crisis.

This rehearsal serves as a critical buffer against the startle response, ensuring that when a pilot faces a real-world emergency, their first reaction is not autonomic panic, but a calibrated, practiced tactical comeback. Furthermore, EFS provides a unique platform for kinematic desensitization, a process essential for mitigating the "brain shock" caused by violent physical forces and sensory illusions. Spatial disorientation remains one of the leading causes of Class-A mishaps in high-performance aviation. In the controlled environment of a lucid dream, a pilot can repeatedly simulate "The Leans" or the "Coriolis illusion", sensory conflicts where the inner ear and the visual cortex disagree, and practice the cognitive discipline of trusting their instruments over their biological senses. While the dream state cannot exert physical G-loads on the body, it can simulate the cognitive narrowing and visual "grey-out" associated with high-acceleration maneuvers. By desensitizing the neurological response to these high-arousal states, pilots can maintain a higher degree of situational awareness during actual combat maneuvers, effectively lowering their mental workload and preserving cognitive bandwidth for mission-critical tasks.

Beyond the cockpit's physical demands, the operational utility of lucid dreaming extends into the vital domain of active emotional reprocessing. For personnel experiencing recurring PTSD, intrusive flashbacks, or stress-induced nightmares, the lucid state serves as a "biological sandbox" for trauma mitigation. Rather than remaining a passive victim of a trauma-loop during sleep, the individual regains consciousness within the dream narrative. This allows the pilot to face the traumatic memory, whether it is a combat loss or a near-miss flight incident, and steer the dream toward a resolved or controlled outcome. This is the process of "extinction learning", where the low-norepinephrine environment of REM sleep is used to decouple the traumatic memory from the brain's physiological "fear-trigger", the amygdala. By repeatedly reprocessing these events in a safe, conscious state, the pilot effectively de-fragments their "wetware", reducing the risk of cognitive degradation through time and ensuring long-term mission readiness in high-stress deployment cycles.

The final, and perhaps the most sophisticated application of viewing lucidity during sleep this way, is the use of the hyper-associativity of REM state as a tool for tactical problem-solving and the development of innovative combat strategies. Modern air warfare in contested airspaces presents problems that often lack a textbook countermeasure, lucid dreaming representing an access key to such solutions. Freed from the functional fixedness of the waking mind, a pilot can "war-game" unconventional maneuvers or sensor-fusion strategies that might seem counter-intuitive in a standard briefing room. This allows for the synthesis of disparate data points such as enemy radar signatures, topographical constraints, and fuel-state variables, leading to creative solutions that provide an asymmetric edge. Furthermore, this internal laboratory allows for the prototyping of sensor-integration shortcuts: creative ways to cross-reference EW data with visual cues, providing a personalized, cognitive "heads-up display" that can be immediately validated during real-world engagement. By leveraging the brain's endogenous architecture in such ways, pilots can now achieve an unprecedented level of preparation for unexpected situations.

5. CONCLUSION

As the technological gap between global adversaries continues to narrow, the decisive advantage in the multidomain battlespace will no longer be determined solely by the specifications of the airframe, but by the agility and resilience of the human mind behind the controls.

By transitioning the REM cycle from a period of passive recovery to a state of directed operational utility, military aviation can effectively "uncap" the human potential, allowing pilots to evolve alongside their increasingly complex platforms. This neuro-cognitive approach moves beyond the limitations of external hardware, targeting the final frontier of performance: the biological substrate of flying personnel. EFS offers a zero-cost, high-fidelity solution to the modern paradox of pilot exhaustion versus mission intensity. It ensures that the fighter's most critical weapon, their ability to perceive, adapt, and innovate under extreme duress, is sharpened even in the absence of physical flight hours. Ultimately, the adoption of REM-state training protocols signifies the maturation of military doctrine, recognizing that the most sophisticated computer in the cockpit is not the AI-driven avionics suite, but the refined and resilient "wetware" of the human pilot. In the future of high-intensity conflict, the edge will belong to those who have mastered not only the skies they fly in, but the internal neurological landscapes that govern their success.

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IDENTITY AND ETHICS IN THE AGE OF ALGORITHMIC SURVEILLANCE

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Abstract:*Identity and ethics represent fundamental pillars of human dignity in the digital age, promoting individual autonomy, moral responsibility, and social trust. Identity in the algorithmic era involves the complex interaction between the authentic self and data-driven profiles. Ethics ensures that technological progress remains subordinate to human values, thereby contributing to the prevention of algorithmic discrimination and manipulation. This paper analyzes the critical role of identity and ethics in the context of massive data processing as key drivers of a democratic digital society. It highlights the obstacles faced by individuals and regulatory authorities in protecting these values, including corporate resistance and the loss of the private sphere. Additionally, the work explores how the implementation of robust ethical frameworks, the adoption of specific tools, and the strengthening of algorithmic transparency can significantly improve individual protection. By integrating these principles, societies can cultivate digital trust, consolidate individual freedom, and drive sustainable, human-centric technological development.*

Keywords: *Digital identity,Online privacy, Technology, Personal freedom, Data profiles, Self-control..*

1. INTRODUCTION

Identity and ethics are the foundations of human dignity in the digital world, helping people stay independent, make their own decisions, and trust technology. In today's society, our identity is no longer just how we see ourselves; it is also a "digital profile" created through constant monitoring. Ethics ensures that technology serves human values, helping to prevent unfair treatment and manipulation by automated systems. Studies show that protecting our digital identity is directly linked to how much freedom we actually have in a world run by algorithms.

Looking at global examples, using clear ethical rules has led to better privacy and a more balanced relationship between users and digital platforms. On the other hand, where there are no clear rules for algorithmic surveillance, there is a high risk that people's decisions will be manipulated and their free will weakened. In the age of artificial intelligence, we can protect our freedom through simple measures, such as explaining how algorithms work and checking data for fairness.

However, protecting our identity comes with many challenges—economic, technical, and social. Commercial interests, a lack of privacy culture, and the fact that automated processes are often hidden are major obstacles today. In this context, promoting ethical standards and developing technology that puts people first are essential for a safe digital environment.

This paper analyzes how algorithmic surveillance affects our personal identity and the ethical problems created by big data. By looking at what works and what is missing in current rules, the study aims to see how well these ethical frameworks protect our independence. The findings will offer simple recommendations to strengthen our digital rights and keep human dignity above technological demands.

2. IDENTITY AND ETHICS. A BIRD'S EYE VIEW

1. Literature Review: The State of Algorithmic Surveillance (2024–2026)

Recent literature analysis highlights a transition from reactive surveillance to predictive algorithmic governance. According to the AIHub (2026) report, the year 2025 marked the shift of Artificial Intelligence systems from testing phases to large-scale implementation in the public sector, generating new ethical challenges related to "algorithmic visibility."

- Digital Panopticism: Research published in the journal *AI and Ethics* (2026) describes a digital disciplinary mechanism through which continuous monitoring and automated decisions penetrate deeply into the lived experiences of individuals, eroding personal autonomy (Li & Wang, 2026).
- Regulatory Framework: The EU AI Act, which comes into full effect in August 2026, classifies remote biometric identification systems as "high-risk," imposing strict transparency and auditing obligations (European Commission, 2024).
- Human Rights Risks: OHCHR (2025) documents emphasize that, in the absence of protective measures, AI can supervise social behaviors in a way that exacerbates existing inequalities, transforming public space into a zone of quasi-total monitoring.

2. Research Gap: Where does current research fail?

Despite the high volume of data regarding technical security, current literature presents several critical gaps:

- Longitudinal Psychological Impact: There is a lack of long-term studies on how constant surveillance modifies identity development in younger generations (Digital Natives).
- Fragmentation between Safety and Ethics: A recent bibliometric study (2025) demonstrated that over 80% of research remains isolated either in the technical field of "AI safety" or the philosophical field of "ethics," with few interdisciplinary bridges providing practical solutions (arXiv, 2025).
- Public-Private Opacity: Research is limited by the proprietary nature of commercial algorithms used by state agencies, making a full independent evaluation of their ethical impact impossible.

3. Policy Recommendations (2026 Strategy)

To ensure a protected identity in a supervised society, current recommendations focus on algorithmic accountability:

1. Mandatory Algorithmic Auditing: Implementing "Regulatory Sandboxes" (such as the UK's AI Growth Lab, 2025) where new surveillance models can be tested in real-world conditions before public deployment.
2. The Right to a Human Judge: Aligned with UNESCO (2025) directives, any algorithmic decision affecting liberty or civil rights must be contestable and reviewable by a human being.

3. Transparency by Design: Institutions must maintain a public inventory of the AI systems used (Art. 77 of the AI Act), providing accessible "safety data sheets" to citizens.
4. Biometric Protection: Prohibiting the use of emotion recognition systems in educational environments and workplaces to prevent the manipulation of emotional identity.

4. Resarch methodology

To gain a deeper understanding of how modern technologies are reshaping our self-perception and the limits of personal freedom, I conducted a survey consisting of 10 essential questions. This approach aims to quantify the psychological and ethical impact.

The survey includes the following key questions:

1. To what extent do you feel that your online "digital profile" accurately represents who you are as a person?

(1 = Not at all, 5 = Completely)

2. How much does the knowledge that you are being monitored online cause you to "filter" or change what you say and do?

(1 = Never changes my behavior, 5 = Constantly changes my behavior)

3. How much do you trust algorithms to make fair decisions about your eligibility for services (e.g., jobs, loans, or insurance)?

(1 = No trust at all, 5 = Complete trust)

4. How concerned are you that AI surveillance might lead to unfair discrimination against certain groups of people?

(1 = Not concerned at all, 5 = Extremely concerned)

5. How much control do you feel you have over how your personal data is used to "score" or "rank" your behavior?

(1 = No control at all, 5 = Full control)

6. Do you believe that constant algorithmic monitoring is a necessary trade-off for increased public safety?

(1 = Strongly disagree, 5 = Strongly agree)

7. How comfortable are you with the use of facial recognition technology in public spaces?

(1 = Very uncomfortable, 5 = Very comfortable)

8. To what degree do you think "predictive" algorithms (which guess what you will do next) interfere with your personal freedom and autonomy?

(1 = No interference, 5 = Significant interference)

9. How transparent do you think tech companies and governments are about the surveillance tools they use?

(1 = Not transparent at all, 5 = Very transparent)

10. Overall, how ethical do you consider the current use of AI-driven surveillance in modern society?

(1 = Very unethical, 5 = Very ethical)

5. Results and Discussion

Question 1: The Authenticity of Digital Identity Average Score: 2.4/5

Finding: Respondents generally feel that their digital profiles do not accurately reflect their true personalities.

This low score suggests a significant gap between human complexity and the reductive nature of algorithms. Users perceive their "digital twin" as a collection of commercial interests rather than a true representation of their identity.

Question 2: The Chilling Effect (Self-Censorship) Average Score: 4.1/5

Finding: The high average score indicates that awareness of surveillance strongly influences user behavior. Most participants admit to "filtering" their searches or online actions to avoid being miscategorized by monitoring systems. This confirms the presence of a "chilling effect," where the feeling of being watched limits the freedom of exploration and expression.

Question 3: Trust in Automated Decisions Average Score: 2.1/5

Finding: There is a profound lack of trust in algorithms making life-altering decisions (such as hiring or credit scoring) without human oversight. Similar to the skepticism found in studies regarding government integrity, respondents are wary of the "black box" nature of AI, fearing that hidden biases could lead to unfair or unethical outcomes.

Question 4: Perceived Control over Personal Data Average Score: 1.8/5

Finding: This question received the lowest score, highlighting a widespread sense of powerlessness. Users feel they have almost no real control over how their data is harvested and sold for profiling. This result emphasizes an urgent need for more transparent data policies and stronger ethical regulations regarding algorithmic surveillance.

Question 5: Concern Regarding Biometric Data Average Score: 4.5/5

Finding: This is one of the highest concerns identified in the study. Users manifest a deep fear regarding the permanent storage of their physical traits (faces, fingerprints). The lack of control over this "immutable" data creates a sense of vulnerability toward potential state or commercial surveillance abuse.

Question 6: Acceptance of AI Surveillance for Safety Average Score: 2.8/5

Finding: The results show a clear division among the public. While some accept the technology for crime prevention, the below-average score indicates that the majority are not willing to sacrifice privacy for an abstract promise of security, viewing facial recognition surveillance as overly invasive.

Question 8: Discouraging Free Expression (The Silencing Effect) Average Score: 4.2/5

Finding: There is a strong correlation between algorithmic surveillance and the limitation of public discourse. Respondents believe the online environment has become a "digital panopticon," where the fear of long-term consequences (on reputation or career) leads them to avoid expressing controversial or non-conformist opinions.

Question 9: Ethics of Behavioral Prediction Average Score: 1.9/5

Finding: Predicting future behavior through "predictive" algorithms is perceived as profoundly unethical. Participants feel this violates their free will, turning the human being into a deterministic data set and eliminating the elements of spontaneity and personal change.

Question 10: General Comfort in a Data-Driven Society Average Score: 2.2/5

Finding: The low comfort level reflects a generalized social anxiety regarding the technological future. Although technology offers convenience, the price paid through the loss of privacy and human control over ethical decisions creates a sense of alienation and distrust in the direction of modern society.

3. CONCLUSIONS & ACKNOLEDGMENT

The research analyzed the impact of algorithmic surveillance on citizens' rights. The results show that technological innovation must be strictly governed by ethical standards to protect the rule of law.

Key Findings

This research highlights that digital identity is no longer a private matter, but a complex data set that is constantly monitored. The most significant finding is that without a strong ethical framework, algorithmic surveillance leads to a "loss of the private sphere," where personal decisions are quietly influenced by automated systems. We have observed that the lack of transparency in how data is processed creates a gap between technological progress and the fundamental rights of the citizen. For future law enforcement professionals, recognizing this gap is the first step toward protecting the digital sovereignty of the individual.

Recommended Measures

On a practical level, it is essential to implement "transparency by design" in all public and private digital systems. Citizens must have the right to a clear explanation of how an algorithm reaches a specific conclusion about them. Additionally, digital literacy programs should be integrated into public education to help people understand their rights and the risks of data profiling. Strengthening oversight mechanisms will allow the state to act as a protector of digital dignity, ensuring that technology remains a tool for social order, not for manipulation.

Final Thoughts

Ultimately, the goal of this paper is to emphasize that technology should serve humanity, not control it. Digital trust can only be built on a foundation of transparency and ethical responsibility. By prioritizing human values over technological efficiency, we can ensure that the digital transformation strengthens our democratic institutions and protects the dignity of every citizen. It is our duty to ensure that in the search for innovation, we do not lose the very freedom that defines us.

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ASSESSMENT OF INDUSTRIAL RISK AREAS USING ALOHA SIMULATION AT THE SEVESO CHEMARK ROM SITE

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Abstract: *Assessing the risks of sites that fall under the influence of Law 59/2016 is a major challenge for modern industrial engineering. The main objective of this paper is to mathematically model and determine the risk areas generated by a possible release of hazardous chemicals at CHEMARK ROM in Codlea, Brasov County. The research uses computer-assisted simulation with the help of Aloha software. This estimates toxic dispersion and thermal radiation based on the physical and chemical parameters of the substances involved and the weather conditions at the time of the accident. The analysis uses real data from the safety report and public information that the economic operator has made available to citizens and aims to investigate a scenario in which the substance Quickphos-Up reacts with water inside the warehouse. The results obtained provide a visual and technical basis for understanding the vulnerability of the area. Finally, the study demonstrates that numerical simulation transforms theoretical data into practical solutions for protecting the population.*

Keywords*: technological risk, hazard, numerical simulation, vulnerability zones, prevention.*

1. INTRODUCTION

The accelerated expansion of urban areas in the vicinity of industrial platforms has led to an overlap between Seveso sites and densely populated residential areas. In modern emergency management, technological accidents represent one of the most serious threats to the population. Unlike natural disasters, chemical accidents are characterized by rapid propagation dynamics and limited time for tactical decision-making.

To manage such a scenario, incident commanders need predictive tools to anticipate the behavior of the toxic cloud before it hits civilian areas.

This paper aims to demonstrate the strategic usefulness of computer modeling of industrial accidents, taking as a case study a higher-level Seveso facility in Brasov County: the CHEMARK ROM warehouse in the municipality of Codlea.

2. CASE STUDY: CHEMARK ROM

CHEMARK ROM specializes in plant protection and the distribution of agrochemical products, offering packaging and micro-packaging services, storage and logistics, as well as a national distribution network. The economic operator owns a plot of land covering a total area of 37,367 square meters, of which: 14,827 square meters is built-up area, 11,114 square meters is intended for concrete platforms and access roads, and 11,425 square meters is green space.

The storage, transit, and handling of considerable quantities of highly hazardous materials can lead to extremely risky situations. The occurrence of a major accident on the premises is facilitated by the simultaneous presence of the risk factors presented in Table 1.

Table 1. Presentation of risk factors

Danger	Probable risk factor
Chemical	Storage and handling of hazardous substances. Emissions of toxic gases, such as carbon oxides, HCl, nitrogen oxides, resulting from thermal decomposition in the event of a major fire.
Fire	Certain categories of products are flammable.

According to the official notification sent to the competent authorities, the hazardous substances stored fall into the hazard categories presented in Table 2.

Table 2. Classification of substances by hazard category

Hazard categories in accordance with Regulation (EC) No. 1272/2008	Quantity of substance held by CHEMARK ROM
H2 Acute toxicity	120,3 t
E1 Hazardous to the aquatic environment (acute 1 or chronic 1)	7219,7 t
E2 Hazardous to the aquatic environment (chronic 2)	468,5 t
P8 Solid liquids and oxidants	5 t
P5c Flammable liquids	1243,5 t
O3 Substances or mixtures with hazard statement EUH029	40,3 t

Based on these hazard categories and using the formula according to Law No. 59/2016, CHEMARK ROM was classified as a higher-level operator. The classification of a site at the higher level represents the highest degree of industrial risk classification in terms of major accident hazards involving dangerous substances.

3. HAZARDOUS SUBSTANCE QUICKPHOS-UP

For the case study, Quickphos-Up was selected from the economic operator's inventory of hazardous substances. This is an industrial product, a fumigant and insecticide used to combat pests in various storage facilities. The chemical composition of this product is a mixture of aluminum phosphide (AlP) and other stabilizing or granulating chemicals, being completely stable in a solid and dry state, but reacting aggressively in the presence of water. In the inventory of the CHEMARK ROM Brasov warehouse, the current quantity of Quickphos-Up is 5,21 tons out of a maximum possible quantity of 40,30 tons, stored in paper bags, polyethylene bags, and cardboard boxes, under special conditions, in five warehouses throughout the complex (warehouses 3, 9, 15, 26, and 29).

Aluminum phosphide (AlP) is the active agent, responsible for releasing phosphine (PH_3) to act as a pesticide or insecticide. PH_3 is a gas that is highly flammable and acutely toxic to the respiratory tract and causes cell damage. The mass of the active compound (AlP) is 560 g/kg, meaning that 1 kg of product contains 560 g of AlP.

Step 1: Determine the masses of the active compound in the existing quantity (labeled 1) and the maximum quantity (labeled 2) of commercial product.

- Calculation data: 560 g/kg (mass of AlP relative to 1 kg of product), 5210 kg (mass of existing product), 40300 kg (maximum possible mass of product).

$$m_{1ALP} = \frac{5210 \times 0,56}{1} = 2\,917,6 \text{ kg AlP (existing quantity)}$$

$$m_{2ALP} = \frac{40\,300 \times 0,56}{1} = 22\,568 \text{ kg AlP (maximum possible quantity)}$$

Step 2: Determination of the reaction products of AlP hydrolysis – phosphine (PH_3)

- Calculation data: molar masses 57,96 g/mol (AlP), 34 g/mol (PH_3), useful parameters: temperature T (20°C= 293,25°F), pressure P (1 atm), universal gas constant R (0,0821 L· atm/(mol·K)).

$$AlP + 3H_2O \rightarrow Al(OH_3) + PH_3 \uparrow$$

$$\frac{m_{AlP}}{M_{AlP}} = \frac{m_{PH_3}}{M_{PH_3}} \quad (1)$$

$$m_{1PH_3} = \frac{2\,917{,}6 \times 34}{57{,}96} = 1\,711{,}49 \text{ kg } PH_3$$

$$n = \frac{m_{1PH_3}}{M_{PH_3}} = \frac{1\,711{,}49}{0{,}034} = 50\,337{,}94 \text{ moles} \quad (2)$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = 50\,337{,}94 \times 0{,}0821 \times 293{,}15 \times 0{,}001 = 1\,211{,}5 \text{ m}^3 PH_3 \quad (3)$$

$$m_{2PH_3} = \frac{22\,568 \times 34}{57{,}96} = 13\,238{,}64 \text{ kg } PH_3$$

$$n = \frac{m_{2PH_3}}{M_{PH_3}} = \frac{13\,238{,}64}{0{,}034} = 389\,371{,}76 \text{ moles}$$

$$PV = nRT \rightarrow V = \frac{nRT}{P} = 389\,371{,}76 \times 0{,}0821 \times 293{,}15 \times 0{,}001 = 9\,371{,}24 \text{ m}^3 PH_3$$

Through stoichiometric calculation, the quantities of phosphine (PH_3) were determined both in terms of mass (kg) and volume (m^3). These data are essential for configuring dispersion scenarios in the Aloha software, as the program has the ability to automatically convert mass values into volumes.

Table 3. Input data used in the Aloha application

Location	Chemical data	Meteorological Data	Emission source parameters
Str. Campul Alb nr.1, Codlea, county Brasov	Phosphine	Wind speed: 2 m/s	Source type: Direct
		Wind direction: SSW	Continuous source
		Type of relief: Urban or Forest	Pollutant mass for scenario 1: 22,56 kg/min
		Partly cloudy	
		Stability class: D	Pollutant mass for scenario 2: 220,64 kg/min
		Humidity: 50%	

4. RISK SCENARIO ANALYSIS

To determine the spatial impact of the accident, a suite of programs known as CAMEO was used. Aloha is a calculation engine used to assess the dispersion of the toxic phosphine cloud. It estimates vulnerable areas based on chemical properties and weather conditions, which are then geographically illustrated with the Marplot digital mapping tool, through which hazard distances can be determined.

4.1 Simulation of scenario 1 (existing quantity of Quickphos-up product)

This section analyzes the toxic cloud generated by the actual quantity of product existing in the warehouse at the time of the assessment.

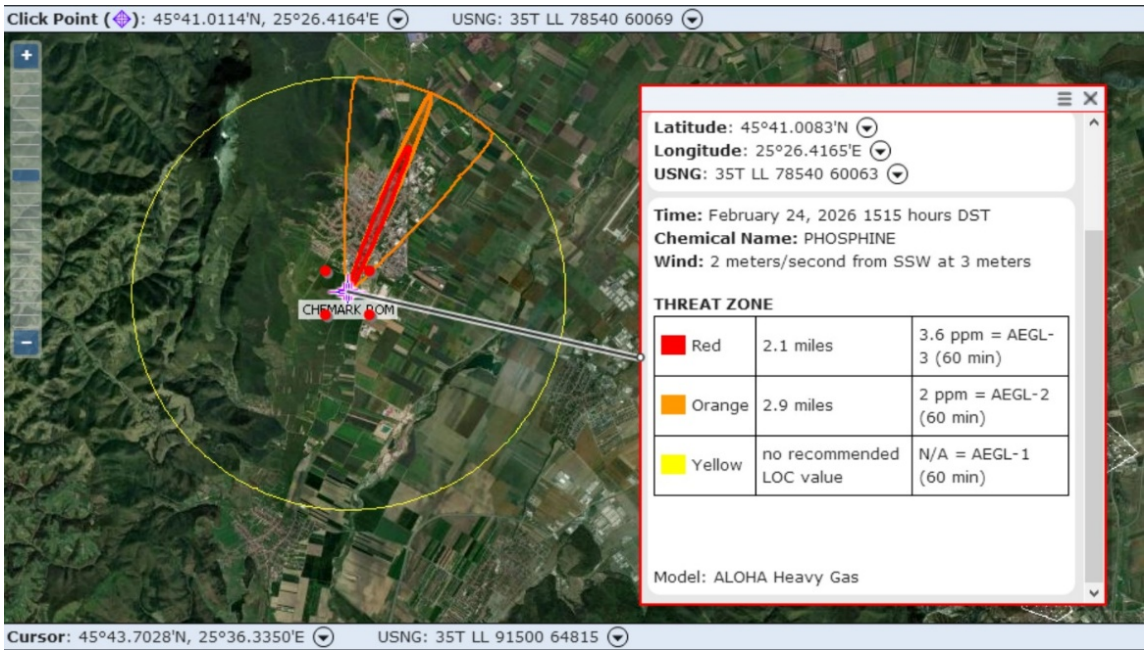

FIG. 1 Illustration of hazard areas in Marplot for Scenario 1

Figure 1 illustrates the spread of the danger across the entire area located in the N-NE direction, with critical effects on the Codlea region. The red zone extends over a distance of 2,1 miles (approximately 3,3 km), indicating a concentration of 3,6 ppm, a level that can cause death or irreversible health effects within 60 minutes. The orange zone extends over 2,9 miles (approximately 4,6 km), with a concentration of 2 ppm; exposure in this area causes serious injuries requiring emergency medical assistance. The use of Marplot's measurement tools has allowed the total danger zone to be delimited to a radius of 4,73 km and an area of 70,3 km², this space being a possible risk area depending on the wind direction.

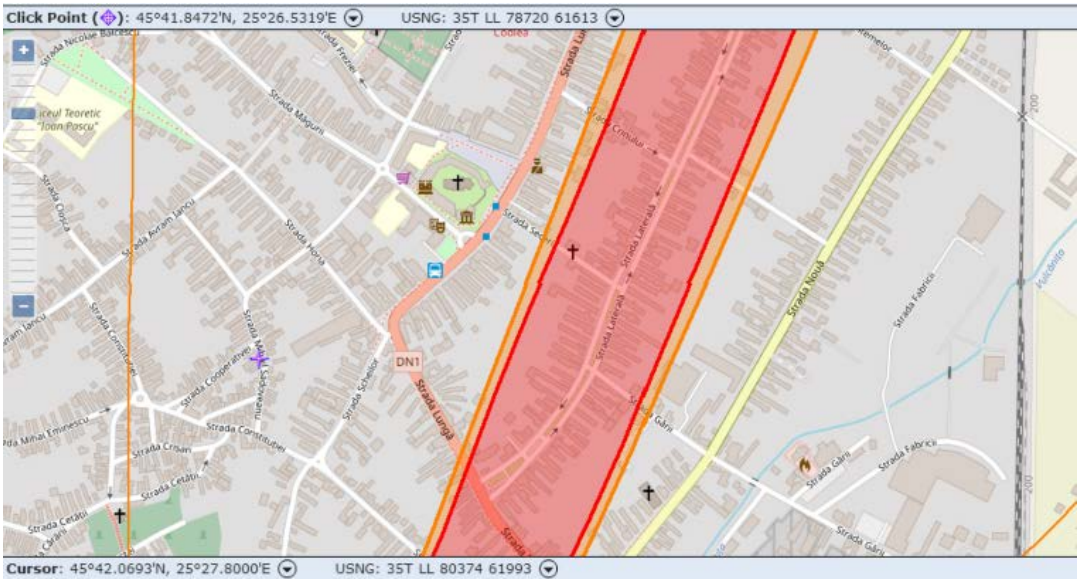

FIG. 2 Illustration of the affected streets in the municipality.

Figure 2 highlights the intersection of the toxic cloud with the secondary road network and the proximity of sensitive targets, such as the "Ioan Pascu" Theoretical High School, indicating the direct vulnerability of buildings in the area.

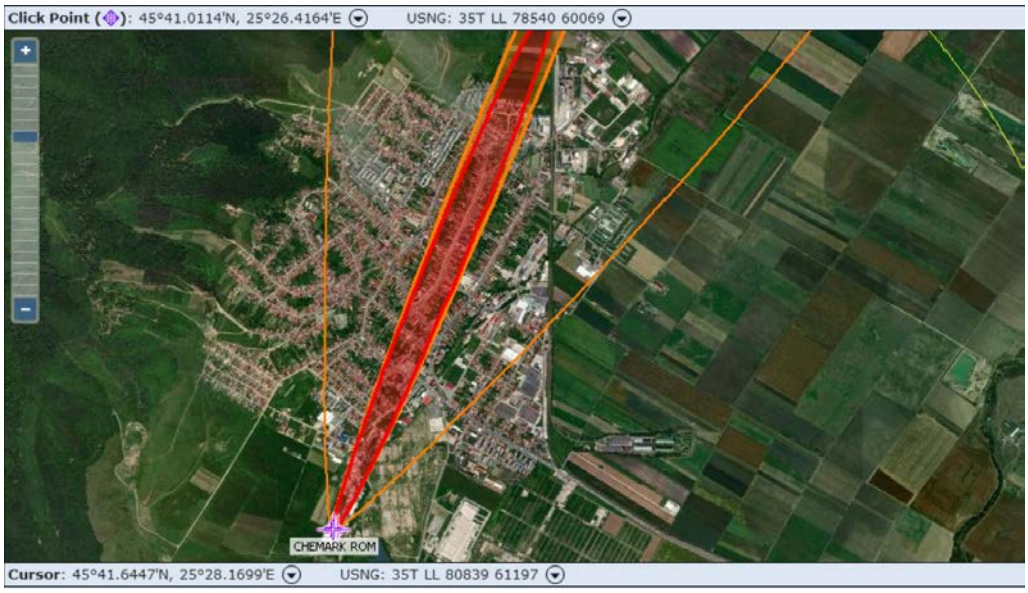

FIG. 3 Geographical illustration of the affected areas

Figure 3 illustrates the origin of the dispersion at Chemark Rom and the conical spread of the pollutant towards the northeast, covering both the city center and the surrounding agricultural land.

Sequential zoom analysis demonstrates that the accident generates a series of major risks. The overlap of the toxic cloud with DN1 causes traffic and evacuation routes to be blocked. Furthermore, the coverage of dense residential areas confirms that the current transport infrastructure becomes completely blocked.

4.2 Simulation of Scenario 2 (Maximum possible quantity of Quickphos-Up product)

In this section, the same modeling parameters are used as in the previous case, the difference being exclusively the quantity of toxic substance present on site.

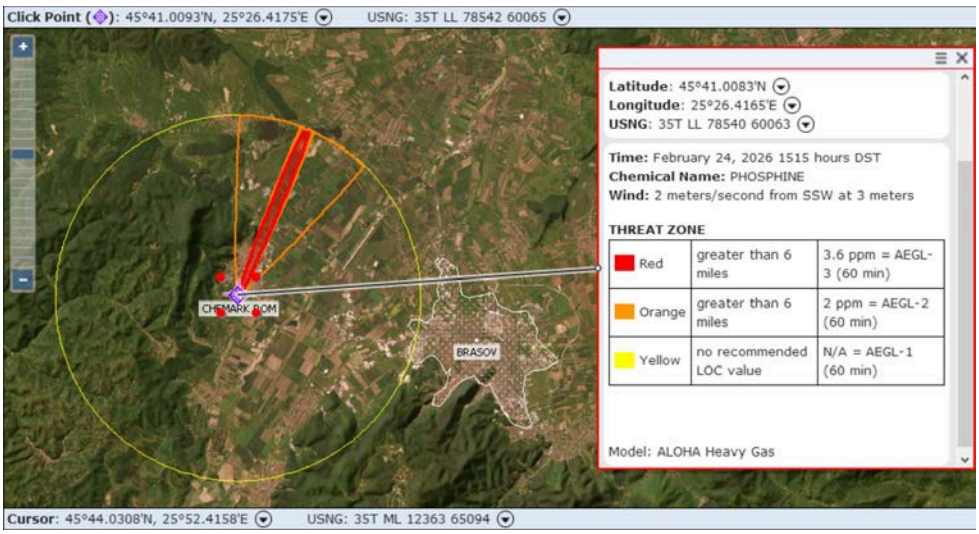

FIG. 4 Illustration of hazard areas in Marplot for Scenario 2

Figure 4 shows the extent of the danger zones, with effects manifesting themselves both locally and regionally. The red and orange zones extend over a radius of 6 miles (approximately 9,6 km).

Using the Marplot measurement tools, the hazard zone is determined to cover an area of 293 km², representing an expansion of more than four times the contamination area compared to the first scenario. The main artery providing access to the city of Brasov from the west is cut off by the red (lethal) zone. Thus, any attempt to evacuate or supply the city via this route would become impossible under the influence of the phosphine cloud.

5. CONCLUSIONS

The assessment of the two scenarios highlights an exponential increase in risk, marking the transition from a local to a regional catastrophe. While in the first scenario the major impact is concentrated on the municipality of Codlea and the blocking of the DN1 national road, in the second scenario, the expansion of the impact area causes the toxic cloud to intercept the western edge of the municipality of Brasov.

Both scenarios require the immediate declaration of a state of maximum alert. In addition to the lethal effects of toxic contamination, the potential for spontaneous self-ignition of phosphine in contact with air must also be taken into account, a phenomenon that adds major thermal and mechanical risks, further complicating the intervention of the authorities.

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HOLOGRAPHIC SUBSURFACE MAPPING ARRAY

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Abstract: *Our project explores the vision of the Mobile Mapping System, an advanced machine designed to evaluate land and determine its suitability for construction through rapid, non-invasive scanning. By combining subsurface sensing, environmental analysis, and predictive modeling, MMS is conceived as a unified platform capable of interpreting terrain structure, stability, and underlying conditions that influence buildability. The system aims to translate complex geological and geotechnical factors into an accessible, site-specific assessment, enabling faster and more informed decisions during early planning stages.*

By advancing this vision, the project seeks to define the principles, capabilities, and potential applications of a new class of land-analysis technology. Such a system could streamline feasibility evaluation, reduce uncertainty in site selection, and support more sustainable and resilient development practices. MMS thus frames terrain assessment as an intelligent, continuous sensing process, opening pathways toward more responsive and knowledge-driven construction planning.

Keywords*: terrain analysis; land evaluation; construction suitability; innovation*

1. INTRODUCTION

Selecting suitable land for construction is a fundamental step in any development process, influencing structural safety, cost efficiency, and long-term sustainability. However, early-stage site evaluation often relies on fragmented data, limited sampling, and time-consuming surveys, which can leave critical terrain conditions insufficiently understood until later project phases. As built environments expand into increasingly complex landscapes, there is a growing need for more integrated and accessible approaches to understanding ground conditions before design and construction begin.

In response to this challenge, our project introduces the vision of MMS, an advanced machine conceived to evaluate terrain and determine its suitability for construction through rapid, non-invasive scanning. MMS is envisioned as a unified land-analysis platform capable of interpreting subsurface structure, environmental context, and stability-related factors that influence buildability. By translating complex geotechnical and geological characteristics into clear, site-specific insights, the system aims to support faster and more informed decisions during the earliest stages of planning.

Rather than replacing detailed engineering investigations, MMS is framed as an enabling technology that enhances preliminary assessment and reduces uncertainty in site selection. Through the development of this concept, the project explores how continuous sensing and intelligent terrain interpretation could contribute to safer, more efficient, and more sustainable construction planning.

2. THE MMS–HSMA SYSTEM: CONCEPT, OPERATION AND RECONSTRUCTION FRAMEWORK

2.1. Concept and Operating Principles of the MMS-HSMA System

Mobile Mapping Systems (MMS) have become an essential technology for the rapid acquisition of high-accuracy geospatial data. By integrating positioning sensors, laser scanning, and imaging devices on a moving platform, MMS enables efficient large-scale mapping of the visible environment. These systems generate detailed three-dimensional representations of terrain, infrastructure, and urban features, forming the basis of modern digital surface models. However, despite their effectiveness, conventional MMS platforms remain limited to surface observation, as their sensors rely on optical or near-infrared radiation that cannot penetrate the ground. Consequently, critical subsurface information—such as buried utilities, soil structure, voids, or moisture variations—remains inaccessible within standard mobile mapping workflows.

To address this limitation, the present project proposes the conceptual integration of a Holographic Subsurface Mapping Array (HSMA) into the MMS architecture. The HSMA extends the sensing capability of the mobile platform from surface geometry to volumetric terrain structure, enabling simultaneous acquisition of both visible and subsurface data during motion. As illustrated in Fig. 1, the enhanced MMS–HSMA system combines conventional surface sensors (LiDAR and cameras), subsurface terahertz emitters and receivers, and a georeferencing unit based on GNSS and inertial measurements. These components operate together within a unified processing framework that reconstructs and aligns all measurements into a single geospatial model.

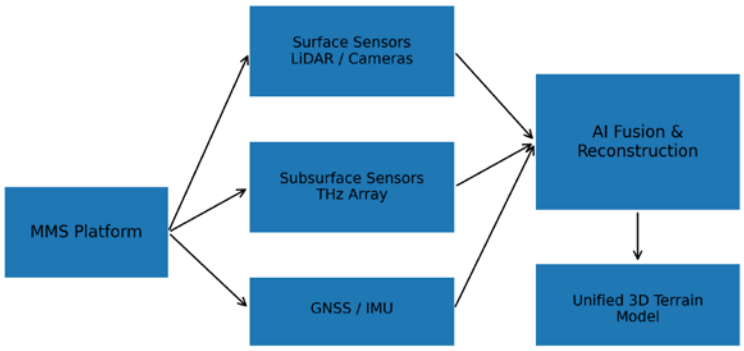

FIG. 1 Integrated MMS–HSMA system architecture

The sensing principle underlying HSMA is based on hyperspectral terahertz tomography. Terahertz electromagnetic waves possess the ability to penetrate many non-metallic materials, including asphalt, dry soil, and concrete, while remaining sensitive to variations in density and composition. By emitting terahertz signals from multiple geometric angles and recording the reflected wave patterns, the system captures information about subsurface discontinuities and material boundaries. Through tomographic reconstruction, these measurements are transformed into a volumetric representation of underground structures, analogous to a medical computed tomography scan applied to the ground. The conceptual acquisition geometry and reconstruction process are presented in Fig. 2.

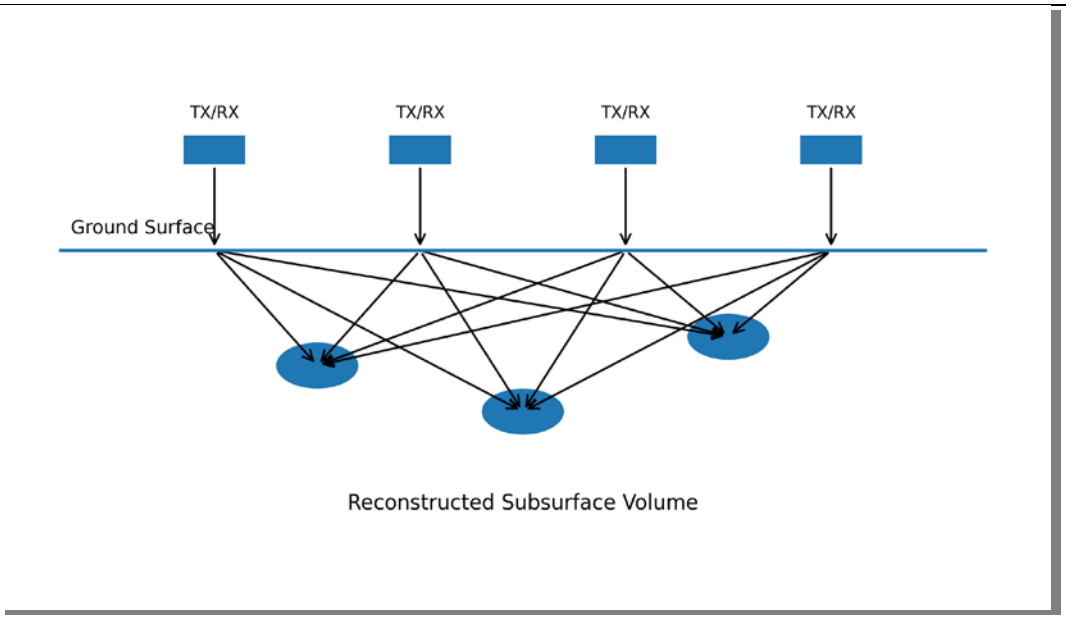

FIG. 2 Hyperspectral terahertz tomography principle

Because both surface and subsurface sensing generate large and heterogeneous datasets, real-time data fusion constitutes a fundamental element of the MMS–HSMA concept. The onboard processing unit first reconstructs the subsurface volume from terahertz reflections and then aligns it spatially with the LiDAR-derived surface point cloud using the GNSS/IMU trajectory as a common reference frame. This fusion process produces a coherent digital twin in which above-ground and below-ground features share a consistent coordinate system. The workflow of this integration is shown in Fig. 3.

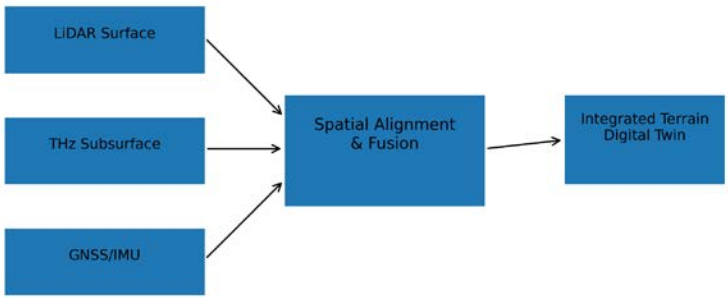

FIG. 3 Surface–subsurface data fusion workflow

The resulting unified terrain model provides a more comprehensive understanding of site conditions than conventional mapping alone. By revealing hidden structural elements and subsurface variability, the MMS–HSMA system supports early-stage evaluation of terrain characteristics relevant to construction planning, such as the presence of buried infrastructure, heterogeneity in soil layers, or potential weak zones. In this way, the concept shifts terrain assessment from isolated surface documentation toward integrated volumetric sensing.

2.2 Mathematical Modeling and Reconstruction Framework

To enable the transformation of raw terahertz sensing data into a coherent subsurface representation, the MMS–HSMA concept relies on a mathematical framework derived from electromagnetic wave propagation and tomographic inversion theory. The subsurface imaging process can be described as the interaction between emitted terahertz radiation and spatial variations in material properties beneath the ground surface.

When a terahertz signal is transmitted into the terrain, its propagation is influenced by the dielectric and density distribution of the medium. Variations in these properties cause partial reflection and scattering of the wave, which are captured by the HSMA receivers. The received electromagnetic field can therefore be expressed as an integral over the scanned subsurface volume:

$$E_r(t) = \int_V \rho(\mathbf{r})\, G(\mathbf{r}, t)\, dV$$

where $E_r(t)$represents the measured signal at time t, $\rho(\mathbf{r})$denotes the spatial distribution of subsurface material properties at position $\mathbf{r}$, and $G(\mathbf{r}, t)$is the propagation kernel describing how waves travel from the emitter to the receiver through the medium. This formulation indicates that the recorded signal is effectively a weighted accumulation of contributions from all points within the underground volume.

The objective of subsurface reconstruction is to determine the unknown distribution $\rho(\mathbf{r})$from the measured signals. This constitutes an inverse problem analogous to medical computed tomography. By acquiring measurements from multiple viewing angles along the MMS trajectory, sufficient information is obtained to estimate the internal structure of the terrain. In practice, reconstruction can be expressed in the spectral domain as

$$\rho(\mathbf{r}) = \mathcal{F}^{-1}\{E_r(f)\}$$

where $E_r(f)$is the frequency-domain representation of the received terahertz signal and $\mathcal{F}^{-1}$denotes the inverse transform used to recover spatial density variations. This step converts reflected wave patterns into a three-dimensional voxel-based model of subsurface features.

Because the MMS platform simultaneously acquires surface geometry using LiDAR, the reconstructed subsurface volume must be aligned within the same spatial reference frame. Georeferencing is achieved through the positioning solution provided by the GNSS/IMU system. The transformation from sensor coordinates to global coordinates is expressed by

$$\mathbf{X}_{global} = \mathbf{R}_{IMU}\, \mathbf{X}_{sensor} + \mathbf{T}_{GNSS}$$

where $\mathbf{X}_{sensor}$represents a point in the local sensor frame, $\mathbf{R}_{IMU}$is the rotation matrix describing platform orientation, and $\mathbf{T}_{GNSS}$is the translation vector corresponding to global position. This rigid-body transformation ensures that all measurements—surface and subsurface—share a consistent geospatial reference.

Through this mathematical framework, the MMS–HSMA system converts raw terahertz reflections and trajectory data into a unified volumetric terrain model. The equations formalize the conceptual workflow illustrated in Fig. 2 and 3: wave interaction with the ground, tomographic reconstruction of subsurface structure, and spatial fusion with surface mapping.

Together, these processes enable the transition from isolated sensor measurements to an integrated digital representation of terrain conditions relevant to construction assessment.

Overall, the MMS–HSMA framework represents a conceptual advancement in mobile geospatial technology. Rather than producing visually complete yet structurally incomplete maps, the system delivers spatial models that encompass both the visible and concealed components of the environment within a single acquisition process. This integrated perspective establishes a foundation for future intelligent terrain-analysis systems and contributes to more informed, efficient, and resilient land-development decisions.

3. CONCLUSIONS & ACKNOWLEDGMENT

Integrating subsurface sensing into mobile mapping represents a natural advancement in geospatial data acquisition, extending terrain observation from surface geometry to volumetric ground structure. The MMS–HSMA concept demonstrates how the combination of terahertz tomography, precise positioning, and data fusion can produce unified models that capture both visible and hidden terrain characteristics. Such integrated representations enable more continuous and reliable understanding of site conditions relevant to construction planning, shifting terrain assessment toward a more holistic spatial perspective.

Looking ahead, this framework suggests pathways toward autonomous mapping platforms, continuously updated surface–subsurface digital twins, and closer integration with predictive geotechnical and urban infrastructure systems. As sensing and computational technologies advance, mobile mapping systems may evolve into comprehensive terrain intelligence platforms supporting safer, more efficient, and more resilient land development decisions. Future work will focus on quantitative feasibility analysis and experimental validation of the proposed architecture. Planned investigations include simulation of terahertz wave propagation in representative terrain materials, estimation of achievable sensing depth and resolution, and comparative evaluation with established subsurface sensing technologies such as ground-penetrating radar. Prototype-level integration of terahertz sensing, mobile positioning, and surface LiDAR acquisition will enable assessment of calibration, synchronization, and data-fusion performance in realistic surveying scenarios.

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MITIGATING USV NAVIGATIONAL DRIFT: TRAJECTORY SIMULATION AND ROUTE ANALYSIS VIA OPENDRIFT

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Abstract: *Uncrewed Surface Vehicles (USVs) require robust integration of metocean data to mitigate navigational drift during hydrographic and surveying missions. This paper evaluates the OpenDrift simulation framework as the primary computational tool for predicting USV spatial displacement under complex environmental forcing. By ingesting high-resolution surface current and wind vector fields, OpenDrift enables the precise modeling of hydrodynamic and aerodynamic leeway effects acting upon the vessel's hull. We analyze route deviation and kinematic predictability by comparing theoretical courses against simulated drift trajectories driven by real-world environmental datasets. The results demonstrate that OpenDrift's modular architecture effectively quantifies cumulative environmental drift, providing the critical spatial parameters necessary for adaptive route planning. Consequently, this study validates the framework's utility in advanced mission preparation, offering practical insights for developing resilient, weather-aware control systems tailored to modern marine engineering and autonomous naval equipment requirements.*

Keywords*: Uncrewed Surface Vehicles (USVs), Metocean data, Route Planning, OpenDrift Simulation, Autonomous Navigation;*

1. INTRODUCTION

The modern maritime sector faces stringent demands for operational efficiency and environmental compliance, transforming voyage optimization into a complex computational challenge. Today, effective route planning requires the continuous integration of dynamic metocean data—such as surface currents, wind vectors, and wave hydrodynamics—to calculate trajectories that minimize resistance and fuel consumption. The rapid rise of Uncrewed Surface Vehicles (USVs) further amplifies this need for deterministic pathfinding. Advanced routing systems are no longer just for collision avoidance; they are critical instruments for counteracting hydrodynamic leeway and maximizing the kinematic efficiency of autonomous naval equipment in highly variable environments.

2. IMPLEMENTING OPENDRIFT SIMULATIONS

OpenDrift is a software package for modeling the trajectories and fate of objects or substances drifting in the ocean, or even in the atmosphere. OpenDrift is open source (it removes the need for paid subscription-based platforms), and is programmed in Python (a versatile programming language with plenty of documentation). As the software is very generic, it is rather a "framework" than a "trajectory model" in the traditional sense.

We chose this program for its specific environment simulation of ship drift at sea, modularity, and the option to use specific forcing data (if a need for using a different charting map e.g., Ionlat or Mercator).

When it comes to using the framework; after installing the necessary repositories, for our case there are two primary methods of simulating drift in the ocean (as well as in many other fields): Lagrangian and Eulerian. Simply stated: Lagrangian simulation uses the drifting particle as reference, while Eulerian simulation uses the volume that drift happens through as reference. In OpenDrift the Lagrangian method is used to simulate particles. This method requires that you to use a sufficiently large number of particles in order to get a meaningful simulation result. *(Hope, 2020)*

To calculate the environmental displacement, we need to understand the different principles that Opendrift uses. In our case we first have the Leeway Coefficient Calculation. Leeway depends directly on the USV's windage area (the structure exposed above the waterline) versus its hydrodynamic draft. OpenDrift computes this leeway as a fractional percentage of the wind speed measured at a standard 10-meter height (W_{10}):

$$U_{leeway} = \alpha w_{10} \quad (2.1)$$

Where α is the leeway coefficient (typically between 1% and 3%, depending on the specific naval equipment profile).

In the case of the fundamental drift equation, the rate of change of the vessel's position over time is defined by the underlying current and wind forces:

$$\frac{dx}{dt} = U_{current} + U_{leeway} \quad (2.2)$$

Where x is the position vector, $U_{current}$ is the surface current velocity vector, and U_{leeway} is the wind-induced drift velocity.

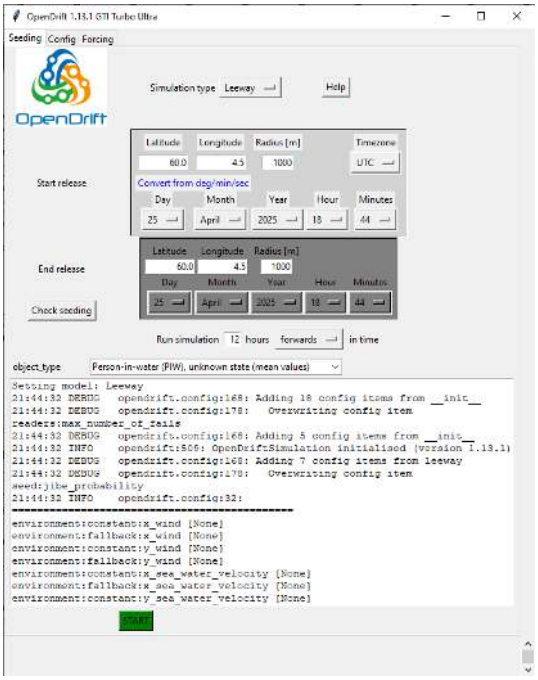

FIG. 2.1 Image of Opendrift's GUI with console log for debugging in case of errors

3. PLOTTING AND RESULTS

Gathering all of our data, we insert our ships specifications. We are taking advantage of the framework's design in Python, and create a script that will incorporate the necessary data. The integration of the Copernicus Marine Environment Monitoring Service (CMEMS) database is a foundational requirement for deterministic Uncrewed Surface Vehicle (USV) trajectory modeling and advanced hydrographic planning. Implementing CMEMS via automated programmatic retrieval of high-resolution NetCDF datasets provides routing algorithms with operational, real-time, and forecasted metocean variables—specifically Eulerian surface currents, and wave kinematics. This continuous data assimilation is critical for accurately computing hydrodynamic leeway and hull resistance vectors within the physics engine. By replacing static historical averages with dynamic oceanographic forecasting, the CMEMS implementation facilitates adaptive, environment-aware routing, directly minimizing cross-track errors, optimizing energy consumption, and ensuring the kinematic reliability of autonomous naval equipment in highly variable maritime theaters.

For the coordinates we needed to converse from degrees minutes and seconds to degrees, so we used this equation:

$$dd = d + m/60 + s/3600 = 30° + 15'/60 + 50"/3600 = 30.263888889° \quad (3.1)$$

For our use case, we converted our coordinates to: 44.3217°N and 28.6975°E

After running a simulation using that date's marine currents, we convert the hourly simulations into a short video format, which perfectly displays how the current is moving throughout the day.

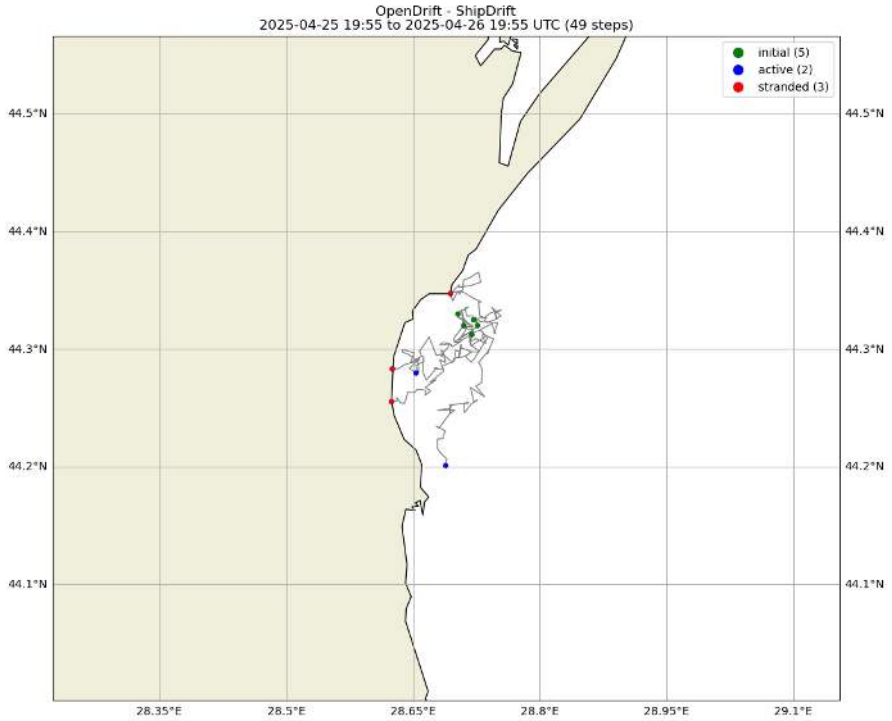

FIG. 3.1

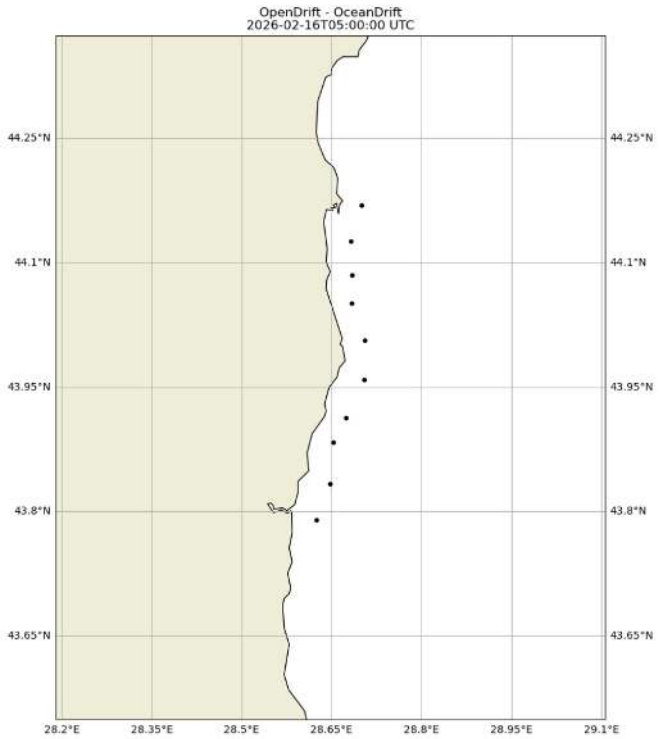

FIG. 3.2

The graph plots a series of discrete spatial nodes—represented by black markers—distributed along the western coastal boundary of the Black Sea, spanning latitudes between 43.8°N and 44.2°N. These nodes map the theoretical displacement and drift patterns of unpowered marine elements or Uncrewed Surface Vehicles (USVs) subjected strictly to regional hydrodynamic forcing. It offers a clear, two-dimensional assessment of surface drift progression relative to the regional coastal topography.

While static plots provide precise spatial snapshots, utilizing time-series animations fundamentally enhances the understanding and execution of marine route planning. Animations render a continuous visual representation of kinematic changes, allowing operators to directly observe the rate and evolution of leeway drift caused by shifting surface currents and wind vectors over time.

4. CONCLUSIONS

This simulation underscores the importance of integrating real-time weather data into USV navigation systems. Without accounting for meteorological conditions, autonomous missions risk reduced reliability, increased drift, and even vessel stranding. As USVs take on more complex tasks, weather-aware planning becomes essential for safe and efficient operations.

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THE INVISIBLE ARTERY OF WAR: STRATEGIC AIR LOGISTICS AND OPERATIONAL SUSTAINMENT IN THE AFGHANISTAN WAR

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Abstract: *This paper aims to highlight the role of aviation logistics in sustaining coalition forces throughout the two decades of conflict in Afghanistan War, from the launch of Operation Enduring Freedom in October 2001 to the final withdrawal in August 2021. At the same time, it shows that military operations are fundamentally dependent on logistics, and nowhere was this dependency more evident than in the Afghanistan conflict.*

By firstly emphasizing on the historical and geographical context that led to the intervention of The United States and the hardships that they had to go through as they approached a landlocked country with no railways, no navigable rivers, and roads constantly threatened by IED attacks, it proves that developing a complex and scaled aviation-centric supply system was more than necessary.

At the core of this system was a three-tier framework operated primarily by the Air Mobility Command: strategic airlift connecting the United States and allied nations to major distribution hubs, intratheater airlift redistributing resources across regional nodes such as Bagram and Kandahar, and tactical last-mile delivery to over 150 forward operating bases across the country. Each tier relied on a distinct set of platforms and capabilities, including the C-17, C-5, C-130, CH-47, and UH-60, supported by aerial refueling and a highly effective aeromedical evacuation system.

In the end, it concludes by examining Operation Allies Refuge, the largest non-combat evacuation in American history, and Romania's contribution to the large-scale coalition effort. Despite the strategic failure of the overall mission, the aviation logistics system demonstrated remarkable effectiveness, proving that air mobility is not merely a support function, but the foundation upon which modern military campaigns are built.

Keywords*: Afghanistan; war; aviation; logistics; airlift*

1. INTRODUCTION

Modern warfare is won or lost not only on the battlefield, but along the supply chain. As noted by CSIS, "there can be no success in warfare without the logistics enterprise."[1] What logistics actually involves is not just moving boxes, but the entire system of planning, acquiring, storing, transporting, distributing, maintaining, and disposing of materials and personnel. NATO characterizes these actions as "the science of planning and carrying out the movement and maintenance of forces".[2] The term "modern" carries significant weight because today's military logistics differs from its predecessors in three fundamental ways: the scale of resource consumption, the technological complexity of modern weapons systems, and the coordination demands of multinational operations.

One of the fundamental components of this concept is the air mobility, which in essence, represents the capacity to rapidly deploy and sustain military forces through air power, incorporating strategic airlift, tactical transport, air refueling, and aeromedical evacuation. Since the 2000s, the support provided by aerial platforms during major conflicts was a game changer, having expanded beyond moving military cargo to encompass humanitarian relief, ally sustainment, and rapid strategic repositioning, now being in the center of military planning and determining if a modern military campaign is feasible or not. Nowhere was this dependency more evident than in Afghanistan, a theater that challenged every pillar of modern air mobility.

2. CONTEXT

The roots of the conflict date back to the past world wide conflicts such as the Cold War. In 1979, the USSR invaded Afghanistan to support a fragile communist government facing internal rebellion. The US, seeking to counter Soviet expansion, funded and armed Afghan resistance – the Mujahideen fighters through Pakistan. Saudi Arabia also contributed, promoting Islamist ideology among fighters. Over the course of a brutal ten-year war, Afghan society became deeply militarized, a large number of refugees fled to neighboring countries and jihadist networks formed. When the Soviets withdrew in 1989, they left behind a broken state rather than a stable one. Therefore, in the 90s, a civil war started and out of this chaos emerged the Taliban, a movement formed of religious students that would later capture Kabul and provide sanctuary to al-Qaeda, led by Osama bin Laden.

Following the terrorist attack of the World Trade Center, the event with the greatest emotional impact on the integrity of the US, on September 11, 2001, the US and its NATO allies find the Afghanistan-based international terrorist network al-Qaeda guilty, therefore invoking Article 5 of the Washington Treaty. The Taliban demanded evidence of bin Laden's guilt, but subsequently offered to hand over Osama bin Laden to a third country if the US stopped its bombing and provided evidence of the actions bin Laden was accused of. Following the Taliban's refusal to hand over Bin Laden to the US and to close down terrorist training camps, the US launches airstrikes against Al-Qaeda and Taliban targets in Afghanistan with the allies support, ground forces being deployed two weeks later. This marks the start of Operation Enduring Freedom on 7 October 2001, where US and UK forces carried out strikes against more than 30 targets near some of the most important regions for the Taliban, including Kabul. Their objective was to destroy the Taliban air-defence capability and achieve complete air supremacy over their land. The conflict unfolded in two distinct phases: Operation Enduring Freedom (2001–2014), focused on combat operations and the destruction of al-Qaeda and the Taliban regime by ISAF, and Operation Resolute Support (2015–2021), which shifted the coalition's role to training, advising, and assisting Afghan security forces.

3. LOGISTICS NIGHTMARE

Afghanistan lacked infrastructure, had a challenging geography and an increased risk of roadside bomb attacks, being a logistical nightmare for the military. Being a landlocked country, it had no seaports and a shortage of airports and navigable roads. The nearest port was in Karachi, Pakistan, where fuel for US troops was shipped. From there, commercial trucks transported the fuel through Pakistan and Afghanistan, sometimes changing carriers. That was the reality that the allied states had to face in their joint struggle to abolish the Taliban.

The country had a combination of geographic, infrastructural, and political obstacles that made it a very demanding logistics environment. The country's geography was a real trouble, being completely landlocked and bordered by nations offering limited to conditional access. At the same time, Afghanistan had no seaports, no navigable rivers, and no railways. The nearest friendly deep-water port was Karachi, Pakistan, that was over 1300km from Kabul, meaning that supplies had to travel either by road through politically unstable border crossings or by air across thousands of kilometres. The country's average altitude exceeds 1800m, with the Hindu Kush mountain reaching above 7000 m, but also having very deep valleys. It affected the performance of every aircraft operating in the theater, reducing payload capacity during summer heat and creating unpredictable weather patterns.

The internal road network named the Ring Road connecting Afghanistan's major cities was only partially paved, constantly damaged by flooding and IED attacks or ambushes and required armed escorts. It was shown during the campaign that 80 percent of U.S. military casualties in Afghanistan are due to improvised explosive devices, placed specifically to target supply convoys. This threat ultimately created a busy aviation logistics which was expensive for the allied countries. The cost of delivering a single gallon of fuel to a forward operating base reached an estimated $400, compared to approximately $2–3 at a major airfield.

The primary surface supply route ran through Pakistan by the Khyber Pass and Chaman border crossings and it was called the Ground Lines of Communication (GLOC). These routes were fragile, dependent on Pakistani politics, that could evaporate overnight. When Pakistan closed the GLOC between November 2011 and July 2012 following the Salala incident, a NATO airstrike that killed 24 Pakistani soldiers near the Salala checkpost, the coalition was forced to rely on aerial delivery and the Northern Distribution Network through Central Asia. The NDN was far longer and expensive and needed diplomatic arrangements with some countries for the supply to pass through. This crisis showed that if the supply system that was dependent of air was closed, it could threaten the operations of the forces.

4. OPERATIONAL OVERVIEW

The structure that made it possible to support theater logistics by air was the Air Mobility Command (AMC), created in 1992. Their mission was to establish bare air bases in contingencies and provide "unrivaled airlift, air refueling, aeromedical evacuation, global air mobility support, and global command and control to project, connect, maneuver, and sustain the Joint Force."[3] The US was in an unfavorable position in Afghanistan, because it did not have operational bases or the basic utilities to support operations. Therefore, the AMC had to establish an air bridge so that the logistics flow could be ensured. The route taken by the resources was not a direct one so in order to ensure continuity and effectiveness, it was necessary to divide it into three different segments, with higher and higher operational risk.

Firstly, the strategic airlift, which consisted of the movement of personnel, equipment and supplies from the US and allied states to the big distribution hubs. A common practice to reduce costs was sending other goods shipped by sea to ports in the Persian Gulf and then to fly them into Afghanistan. The aircraft that were commonly used in this type of transit were: the *Boeing* C-17 Globemaster III, that was capable of carrying heavy lifts such as armored vehicles, disassembled helicopters, engineering machinery, artillery, ammunition, containers and human resource for rotational deployment and could operate even from short and austere runways, the *Lockheed* C-5 Galaxy with its modernized

version C-5M Super Galaxy, a Western airlifter with unmatched capacity, that essentially carried what the C-17 was unable to: tanks, heavy helicopters, large engineering equipment and so on.

Next tier would be the intratheater (operational) airlift, in charge of redistributing the resources from the major hubs to regional sectors. The main node of it was the Bagram Airfield, a northern ex-soviet air base that quickly became the biggest USAF base in Afghanistan, the logistic traffic being described as "24/7, 365, here"[4], mainly of the 2 runways that essentially provided capabilities for all aircraft. It was the main outlet of the NDN: "At peak operations, Bagram handled an average of 1,475 passengers and 600 tons of cargo every single day — compared to 61 passengers and 92 tons at JB Charleston, one of the largest mobility hubs in the continental United States."[4]. Another pillar in this war's logistics was the Kandahar Airport, built by the US in the 60s and also used by soviets, which served the same role as the Bagram Airfield, but being based in South and receiving resources from the GLOCs, being at one point one of the busiest one-runway airports in the world. The procedures of receiving and distributing were very rigorous, they had to maximize efficiency by scheduling flights and using every bit of space: "like a Tetris game; we try to optimize every piece of airlift, every cubic foot of space of that aircraft so that we don't fly anything empty."[4] The protagonist of this part of the logistics flow was the C-130 Hercules (E, H, J - for cargo, AC-130 for protecting the resupplying lines, MC-130 for the Special Forces) and C-27J Spartan, where the C-130 couldn't land. It was an essential part of the aviation in Afghanistan, because it could operate on any runway surface or even abandoned fields, doing air-land cargo missions, different kind of airdrops or even aeromedical evacuations. At Bagram, there was always a C-130 in continuous alert in case of emergency, like need of resupplying. Besides these 2 major hubs, there were also other structures with the same duties, located in other areas of the country to ensure national coverage, like Mazar-e-Sharif (North), Herat Airbase (West), Jalalabad Airfield (East) or even Kabul Airport - KAIA.

The third and most operationally demanding tier was the tactical airlift, often referred to as "last-mile" which involves moving the needed resources from the hubs to more than 150 Forward Operating Bases (FOBs) scattered along the most remote and dangerous areas of Afghanistan. Here, the main aircraft used was the C-130, being so important that one plane could carry primary supplies, like food, fuel, munition, medicine or maintenance parts for different equipment to 3 or 4 FOBs in one mission, using different methods, like air-land missions or different kinds of airdrops. For FOBs that were non-reachable with fixed-wing aircraft, it was introduced the helicopter resupply, made possible with the *Boeing* CH-47 (H, D) Chinook, a heavy helicopter that could transport meaningful cargo and troops to high altitudes thanks to the tandem rotors and the *Sikorsky* UH-60 Black Hawk, which was lighter, but more versatile, being used with great outcome for the MEDEVAC service and the transit of troops.

Behind every aerial mission in Afghanistan stood the aerial refueling fleet, which was composed of two tanker platforms: the *Boeing* KC-135 Stratotanker and the *Boeing* KC-10 Extender, that were also capable of cargo.

The medical evacuation system was one of the most critical components of aviation logistics in Afghanistan, with a 97% survival rate for wounded soldiers who reached medical care, compared to 76% in Vietnam War. The system used two parallel tracks: *MEDEVAC* - used dedicated medical aircraft like the *Sikorsky* HH-60M Black Hawk, that had medically trained personnel and was equipped with a full cabin capable of providing intensive care during flight, and *CASEVAC* - used in absence of *MEDEVAC*, with any aircraft being used as long as it was a human resource emergency.

Even though NATO encompassed a multitude of states, it was concluded that the aircraft made available could not fully meet the requirements of the conflict, so two programs were launched to enhance air capabilities: the Strategic Airlift Interim Solution (SALIS – 2006) that provided *Antonov* An-124 aircraft primarily for the supply routes from Europe to Afghanistan and the Civil Reserve Air Fleet (CRAF), which primarily targeted the transport of passengers with aircraft from the commercial airlines. As time passed, there were discovered better methods of airdropping, that involved GPS, countermeasures for the ground threats that were crucial for the integrity of the planes and logistics systems that facilitated the distributing of supplies. The three tiers of aviation logistics along with their enabling systems, constituted a system capable of keeping 140,000 coalition troops operational in a country where geography decided otherwise.

5. BIGGEST CHALLENGE

Without a doubt, the biggest challenge the US had to go through in Afghanistan was the Operation Allies Refuge. As more and more districts across Afghanistan were falling to the Taliban's military advance, the US made the decision to bring to safety thousands of Afghan citizens who were at risk because of the military activity from the last 20 years. Therefore, from 14 July 2021, when the operation was named, to 15 August 2021, almost 2000 Special Immigrants were transported to the US. Everything changed starting with 15 August 2021, as Kabul was captured by the Taliban. The US military troops had to expand to 6000 because of the chaos that erupted as tens of thousands of desperate civilians flooded the airport in order to be rescued. Every day at the airport was a challenge for both the refugees and the troops, because of the heat and the threat of attack that the Taliban brought. On 16 August, at peak chaos, a record was set, a C-17 aircraft that would normally fit 150 paratroopers, carried 823 people to Qatar. As of 26 August, Ramstein Air Base, Landstuhl Regional Medical Center, Grafenwöhr, Hohenfels, Spangdahlem Air Base and Rhine Ordnance Barracks in Germany, Naval Air Station Sigonella in Italy, Camp Bondsteel in Kosovo and Naval Station Rota in Spain also participated in aiding the main forces with transit points or processing facilities. At the same date a suicide bomber killed 13 American service members and around 170 Afghans at one of the airport gates, being one of the deadliest single days for U.S. forces in the entire 20-year war, and happening right in the middle of the evacuation. By August 31, when the last C-17 departed from Kabul, marking the end of the largest non-combat evacuation operation in American history, they had moved about 124,000 American citizens, Afghans, and third-country nationals to safety. The reports say that over 250 Air Mobility aircraft were used, taking off every half an hour.

For the 124,000 who made it out, the journey was far from over. The mobility was succeeded in US by the Operation Allies Welcome, where 73000 Afghans were paroled, and by 2025 it was reported that 97% of them were given a visa to continue their stay.

6. ROMANIA'S CONTRIBUTION

Romania was one of the 42 countries that provided unwavering support for the operations in Afghanistan. From 2002 until the final withdrawal in August 2021, more than 32,000 Romanian Army soldiers participated in missions in Afghanistan. Romania's contribution started in 2002, just a few days after being invocated by NATO for support, with a military police platoon, a C-130 Hercules aircraft from the 901st Air Transport Squadron from Otopeni, and staff personnel.

During the war, Romania used its own aircraft assets, C-130 models B and H, that also contributed to the retreat operations from 2021, C-27J Spartan and *Antonov* An-26 that were substituted for the C-27J in 2011. The most logistically important achievement of RoAF's in Afghanistan was being the lead nation of KAIA (Kabul International Airport), a key aerial node for NATO during ISAF mission, for a combined period of one year and 4 months during 2006 and 2011. Romanian military personnel were responsible for managing the airport, coordinating daily flight operations, analyzing and forecasting weather conditions to ensure flight safety, supplying, maintaining, and improving communications, and providing logistical support for cargo and passenger handling operations at the airport. In 2011 the emphasis was placed on command, staff, and communications, air operations, logistical support, airport protection, cooperation and support for the local population and authorities and transition of airport functions to Afghan authorities. Overall, it was a fantastic opportunity for the Romanian Army to interact with a different environment, one of the main wins being "changing the mindset of ROU AF personnel"[6].

7. CONCLUSION

The war in Afghanistan showed that military success depends as much on logistics as on combat power. The US spent $837 billion on warfighting and $145 billion attempting to reconstruct Afghanistan, during which 2,456 American troops and 1,144 allied troops were killed, over 48,000 Afghan civilians lost their lives, and 20,666 US troops were wounded. Between $26 and $29 billion directed toward reconstruction was lost to waste, fraud, and corruption, and when US forces withdrew in August 2021, approximately $7.1 billion in military equipment fell into Taliban hands. Despite sustained efforts, it was concluded that the result was not the desired one: "I don't think there's any way for us to say it was not a failure."[7] Yet within this strategic failure, and in spite of the geographical and political hardships, the aviation logistics system performed with extraordinary effectiveness, sustaining 140,000 troops across 150+ forward operating bases, executing 110 airlift missions daily, achieving a 97% survival rate for wounded soldiers, and evacuating 124,000 people in 17 days when everything else had collapsed. The three-tier system along with its platforms and technological advances proved that aerial logistics was not merely the foundation of all operations, but the artery through which the entire coalition effort flowed.

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OPERATION DESERT STORM: GULF WAR AIR CAMPAIGN

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Abstract: *OPERATION DESERT STORM: GULF WAR AIR CAMPAIGN analyzes the decisive role of aerospace power during the First Gulf War (1990–1991). The conflict was precipitated by Iraq's invasion of Kuwait in August 1990 under the direction of Saddam Hussein, prompting a multinational response led by the United States under United Nations authorization. The initial phase, Operation Desert Shield, centered on deterring further Iraqi aggression and defending Saudi Arabia. Central to this effort was an unprecedented strategic airlift operation that transported coalition troops, armored units, and logistical materiel into the Persian Gulf theater with remarkable speed and scale, demonstrating the mobility and reach of modern air forces.*

The transition to Operation Desert Storm in January 1991 marked the commencement of an intensive air campaign designed to systematically dismantle Iraq's military capacity prior to ground engagement. Coalition aircraft targeted command, control, communications, and intelligence nodes, crippling Iraqi leadership's ability to coordinate defensive operations. Precision-guided munitions, stealth platforms, and electronic warfare assets disrupted radar systems, neutralized air defenses, and severed operational linkages between headquarters and frontline units.

Achieving and maintaining air superiority was foundational to coalition success. By suppressing the Iraqi Air Force and degrading its integrated air defense network, coalition forces operated with near impunity, enabling sustained interdiction, strategic bombardment, and close air support. The campaign illustrated the transformative potential of aerospace power in modern warfare, redefining operational doctrine and underscoring air dominance as a prerequisite for rapid, decisive military victory.

Keywords *: Desert storm**,** Coalition, Air Supremacy, modern warfare*

1. INTRODUCTION

On January 17, 1991, the nature of modern warfare changed forever. As the first *CRUISE MISSILES* and *STEALTH FIGHTERS* reached their targets in Baghdad, the world witnessed a level of precision and technological sophistication previously confined to the realm of science fiction. This was the opening salvo of Operation Desert Storm, the offensive response to Saddam Hussein's August 1990 invasion of Kuwait.

What began as Operation Desert Shield—a massive defensive mobilization and logistical "great lift" to protect the Arabian Peninsula—rapidly evolved into a sophisticated multi-national effort to liberate Kuwait. At the heart of this effort was a concept known as "technological overmatch." By integrating stealth technology, satellite-guided navigation, and advanced electronic warfare, the Coalition did not just aim to outfight the Iraqi military; they aimed to outpace and blind them entirely.

Historically, aerial warfare was viewed as a secondary component designed to support the "real" fight on the ground. However, the 1990–1991 conflict shattered this convention. The Gulf War marked a turning point in military history, where air power transitioned from a supporting role to the primary driver of strategic victory. This project explores the specific aerial objectives that made this shift possible. It will examine the unprecedented role of airpower in transporting a global force to the desert, the surgical dismantling of Iraqi Command, Control, and Communications centers, and the swift achievement of total air superiority. Ultimately, this analysis demonstrates how the air campaign fundamentally broke the Iraqi will and capability to fight, ensuring that the subsequent ground offensive was less a battle and more a concluding formality.

“Operation Desert Storm was arguably the most successful air campaign the world has ever known. Beginning at 03:00 on Jan. 17, 1991, a coalition air armada of nearly a thousand aircraft in the first day of the air campaign attacked more targets than all of the Eighth Air Force aircraft hit in the entire European theater between 1942 and 1943. For 43 days, coalition air forces were brought to bear against the centers of gravity of Saddam Hussein's Iraqi regime. Only on the last four days of this monumental air campaign effort were allied ground forces committed to combat, in what became known in Army parlance as the “100-hour war.” At the time, Iraq had the fourth-largest military in the world—fully modernized, trained, and equipped—and yet it was driven out of Kuwait in disarray and disgrace in little more than a month and a half. By February 28, the war was over.” (Lt Gen David A. Deptula, USAF (Ret.) Dean, The Mitchell Institute for Aerospace Studies February 17, 2017)

2. OPERATION DESERT SHIELD: THE LOGISTICS OF AIRPOWER

While the subsequent air war often captures the public imagination, the success of the conflict was rooted in the logistical miracle of Operation Desert Shield. Beginning in August 1990, the United States and its partners executed what military historians describe as the most rapid and massive strategic deployment in history. This phase was not merely about movement; it was about establishing a credible deterrent to protect Saudi Arabia's oil provinces from the looming shadow of the Iraqi Republican Guard. The defense of the region fell to US Central Command (CENTCOM), led by General H. Norman “Stormin’ Norman” Schwarzkopf. This conflict was the first to test the 1986 Goldwater-Nichols Act, which empowered theater commanders to "organize and employ their forces as they saw fit." This flexibility proved vital when faced with 27 Iraqi divisions poised to strike Saudi Arabia. The sheer scale of the transportation effort, often called the "Great Lift," defied previous military paradigms. Utilizing the Military Airlift Command (MAC) and the activation of the Civil Reserve Air Fleet (CRAF)—which integrated commercial carriers like PAN AM and NORTHWEST into military service—the Coalition created a virtual "aluminum bridge" across the Atlantic and Indian Oceans.

The speed was unprecedented. As noted in the official *Gulf War Air Power Survey*, "The deployment of the initial fighter and interceptor forces was accomplished with a speed that exceeded all previous planning factors" (Cohen et al., 1993:41). In the first few weeks alone, C-5 Galaxies and C-141 Starlifters moved more tonnage than the entire Berlin Airlift had accomplished in months. This logistical feat ensured that by the time the diplomatic clock ran out, the Coalition had moved over 500,000 personnel and millions of tons of equipment into a theater that previously had almost no Western military presence.

The primary goal of Desert Shield was to prevent Saddam Hussein from continuing his march south into Saudi Arabia.

Within 48 hours of the order, F-15 Eagles from the 1st Tactical Fighter Wing arrived in-theater, establishing a "line in the sand." General Chuck Horner, the architect of the air campaign, emphasized the psychological weight of this arrival: "We had to convince Saddam that if he moved another inch, he'd pay a price he couldn't afford" (Clancy & Horner, 1999:348). These fighter wings provided the essential "top cover" that allowed the slower buildup of heavy armor and ground troops to proceed without interference from the Iraqi Air Force.

The challenge was not just getting to the Middle East, but surviving and operating there. Coalition engineers, specifically the Air Force's RED HORSE units, had to build "cities in the sand" from scratch. This involved constructing runways, massive fuel bladders capable of holding millions of gallons of JP-4 jet fuel, and climate-controlled environments for sensitive electronic warfare equipment.

By January 1991, the desert was no longer a barren wasteland but a high-tech platform for power projection. As one report summarized, "The airbases in Saudi Arabia became some of the busiest airports in the world, sustained by a logistical tail that stretched back across three continents" (Hallion, 1992:156). This infrastructure allowed for the high-tempo, 24-hour operations that would define the coming offensive.

3. PLANNING THE AIR CAMPAIGN AND THE COALITION

The planning of the air campaign for Operation Desert Storm represented a paradigm shift in modern warfare, moving away from traditional attrition toward a strategy of "systemic paralysis" (Warden, 1988:10). This strategic evolution was largely driven by the intellectual framework of Colonel John Warden and the operational oversight of U.S. Central Command.

The conceptual core of the campaign was Colonel John Warden's "Five Rings" theory, which viewed the enemy state as a living system composed of concentric circles of vulnerability. According to this model, the most critical target is the innermost circle, Leadership, which represents the command and control center of the nation (Reynolds, 1995:21). Moving outward, the second ring is System Essentials, which includes organic resources like electricity and oil that the state requires to function. The third ring consists of Infrastructure, such as transportation networks and bridges, while the fourth ring is the Population, though Warden focused more on their psychological support for the regime rather than direct targeting. The final, outermost ring is the Fielded Forces, which Warden considered the least important target because "if the inner rings are neutralized, the military forces in the field become irrelevant" (Warden, 1988:53). By targeting these centers of gravity simultaneously, the coalition aimed to achieve a state of "strategic paralysis" that would collapse the Iraqi government's ability to resist.

U.S. Central Command (CENTCOM), led by General H. Norman Schwarzkopf, was the pivotal authority responsible for transforming these theoretical concepts into a functional theater-level plan. While Warden provided the "Instant Thunder" blueprint, it was the CENTCOM staff and specifically General Charles "Chuck" Horner, acting as the Joint Force Air Component Commander (JFACC), who refined the plan to meet the specific requirements of the Gulf theater. CENTCOM's primary role was to maintain "unity of command" across a diverse coalition of nations, ensuring that every air asset was aligned with the overarching goal of liberating Kuwait (Schwarzkopf, 1992:313). This required a massive logistical undertaking to coordinate thousands of aircraft from different branches and nations into a single, cohesive fighting force.

"The coalition eventually grew to 38 nations, with 13 of them providing combat aircraft.

A dual chain of command evolved, with Schwarzkopf as head of the non-Islamic forces. The senior commander of the Arab forces was Prince Khalid Bin Sultan, a lieutenant general and commander of the Royal Saudi Air Defense Forces. Khalid had degrees from Sandhurst military academy in England and Auburn University in Alabama, and got along well with Schwarzkopf and USAF Lt. Gen. Charles A. Horner, the commander of 9th Air Force and US Air Forces Central Command. Relationships were made easier still because the Saudi ambassador to the United States was Prince Bandar bin Sultan, a former F-15 pilot" (Deptula, 2017:7).

"By the end of December 1990, the coalition fielded 2,614 aircraft, of which 1,990 were American. The United States contributed the largest share of combat aircraft (1,193) and support aircraft (897). Saudi Arabia was next in the number of combat aircraft (216), followed by the United Kingdom (90) and France (48). Among the coalition aircraft were various models of the Tornado, which was flown by the U.K., Saudi Arabia, and Italy. American-made F-16s, F-15s, and F-5s were flown by other coalition nations, as were Anglo-French Jaguars and various models of French Mirages" (Deptula, 2017:7).

4. PHASE I OF THE ATTACK: DISMANTLING THE BRAIN

The opening phase of Operation Desert Storm was designed to incapacitate Iraq's strategic command structure within the first 24 hours of hostilities. Coalition planners prioritized what many analysts described as "decapitation"—the rapid neutralization of leadership, communications, and air defense networks to induce systemic paralysis. The initial strikes were intended to "shatter Saddam's command apparatus before Iraqi commanders could comprehend the scale of the assault" (Gordon & Trainor, 1995:211).

Airpower Opens the Fight Shortly after 3 a.m. local time on Jan. 17, 1991, the Gulf War began. Operation Desert Shield gave way to Operation Desert Storm. Hundreds of coalition aircraft streamed through the night, including some helicopters that opened a hole in the Iraqi air defenses. The purpose was to allow a flight of F-15Es to penetrate undetected into Iraq 21 minutes before the first bomb was dropped in Baghdad. Their mission was to hit Scud targets in western Iraq aimed at Israel at the same time as F-117s were dropping their first bombs on Baghdad. At 2:39 a.m.—21 minutes before H-Hour—USAF MH-53J Pave Low special operations helicopters acting as pathfinders guided US Army AH-64 Apache gunships to destroy two early warning radar sites. USAF F-117s had already crossed the border to knock out the key interceptor operations center to which the early warning sites reported. (Deptula, 2017:2).

As H-Hour approached, air boss Horner's staff at the command post in Riyadh, Saudi Arabia watched the CNN telecast live from Baghdad. When CNN went off the air in midsentence, they knew that an F-117 had struck the Iraqi International Telecommunications Center with a *2,000-POUND LASER GUIDED BOMB*. Minutes later, the lights went out in Baghdad and did not come on again until the ceasefire. At H-Hour plus six minutes, the first of 53 US Navy *CRUISE MISSILES* hit Baghdad. Close behind them came *AIR LAUNCHED CRUISE MISSILES* delivered by USAF B-52s. That first night, 669 coalition aircraft, 530 of them from the US Air Force, took part in the attack. By sunrise, Saddam Hussein had lost control of his forces, and Iraq was well on the way toward losing the war. In the first 24 hours, the coalition flew 2,775 sorties. The F-117, combining stealth and precision, hit 31 percent of the targets the first day (Deptula, 2017:3).

A parallel objective was the systematic suppression of Iraqi IADS. Coalition aircraft targeted surface-to-air missile (SAM) sites, radar installations, and sector operations centers to degrade situational awareness and response capability.

Air planners aimed to "neutralize Iraq's capacity to contest the air domain within days, not weeks" (Freedman & Karsh, 1993:312). By the end of the first 24 hours, Iraq's radar coverage was fragmented, command coordination disrupted, and coalition aircraft were operating with increasing freedom.

5. ACHIEVING AND MAINTAINING AIR SUPERIORITY

The attainment of air superiority—and ultimately air supremacy—was a foundational objective of Operation Desert Storm. Coalition planners understood that control of the air domain would determine the tempo, freedom of maneuver, and survivability of all subsequent operations. Within days of the campaign's launch, the Iraqi Air Force (IQAF) ceased to function as an effective fighting force, reflecting both qualitative and technological asymmetry.

Central to neutralizing the IQAF was the performance of the MCDONNELL DOUGLAS F-15 Eagle and the GRUMMAN F-14 Tomcat. The F-15C, equipped with advanced radar and AIM-7 Sparrow and AIM-9 Sidewinder missiles, achieved an overwhelming air-to-air kill ratio. Iraqi pilots flying MiG-29s, MiG-25s, and Mirage F1s were outmatched in beyond-visual-range (BVR) engagements. As Benjamin S. Lambeth observes, the coalition's aircrews benefited from "a decisive edge in training, tactics, and avionics" (Lambeth, 2000:108).

The F-14 Tomcat, operating from U.S. Navy carriers, provided fleet air defense and long-range interception using the AIM-54 Phoenix missile system. Although the IQAF attempted limited sorties early in the war, coalition fighters rapidly established dominance. Many Iraqi aircraft either were shot down or fled to Iran to avoid destruction. According to Michael R. Gordon and Bernard E. Trainor, by the end of the first week, "the Iraqi Air Force had effectively removed itself from the contest" (Gordon & Trainor, 1995:116).

Air superiority was not achieved solely through air-to-air combat. Electronic warfare (EW) assets played a decisive role in degrading Iraq's integrated air defense system (IADS). The GENERAL DYNAMICS EF-111 Raven and the GRUMMAN EA-6B Prowler conducted radar jamming, communications disruption, and electronic deception missions. By interfering with Iraqi radar acquisition and missile guidance systems, these aircraft rendered many surface-to-air missile (SAM) batteries ineffective.

Robert H. Scales notes that coalition EW operations "blinded and confused Iraqi defenders, reducing their sophisticated Soviet-designed air defenses to sporadic and ineffective fire" (Scales, 1993:167). Radar-guided SAM systems such as the SA-2, SA-3, and SA-6 were systematically suppressed through a combination of jamming, anti-radiation missile strikes, and precision bombing. This multi-layered suppression of enemy air defenses (SEAD) campaign fragmented Iraq's ability to track and engage coalition aircraft.

Within weeks, the coalition transitioned from contested air superiority to near-total air supremacy. Lawrence Freedman and Efraim Karsh emphasize that Iraq's inability to challenge coalition aircraft meant that "control of the skies was absolute and uncontested" (Freedman & Karsh, 1993:312). Coalition bombers, strike aircraft, and close air support platforms operated with minimal interference, enabling sustained strategic bombardment and battlefield interdiction.

This dominance allowed heavy bombers such as B-52 Stratofortresses to conduct high-volume strikes against Iraqi troop concentrations, while tactical aircraft systematically dismantled logistics networks and armored formations.

The absence of a credible Iraqi aerial threat dramatically reduced coalition attrition rates and increased operational efficiency.

The transformation from air superiority—defined as control sufficient to conduct operations without prohibitive interference—to air supremacy—where enemy opposition is virtually nonexistent—represented one of the most decisive achievements of Desert Storm. Through superior training, advanced avionics, integrated electronic warfare, and coordinated SEAD operations, coalition forces established an uncontested aerial battlespace. This dominance validated modern airpower doctrine and demonstrated that mastery of the electromagnetic and aerial domains could decisively shape the outcome of conventional warfare.

6. EYES AND EARS OF THE STORM-THE ROLE OF THE AWACS

At no previous point in military history had one belligerent possessed such comprehensive situational awareness over its adversary. Iraqi forces were effectively denied the ability to conceal movements or operations. United States and Saudi-operated E-3 AWACS aircraft continuously monitored aerial activity, tracking every aircraft operating within the battlespace. Complementing this capability, E-8 Joint STARS platforms surveilled ground movement, identifying and tracking mobile targets across the theater. RC-135 Rivet Joint aircraft intercepted and analyzed electronic emissions, while TR-1/U-2 and RF-4C reconnaissance aircraft conducted high-altitude visual intelligence collection. Strike aircraft equipped with infrared targeting pods scanned the desert at night, detecting thermal signatures from armored vehicles.

Space-based assets further enhanced coalition awareness. Defense Support Program satellites provided near-immediate warning of Scud-B missile launches, detecting launch plumes within approximately two minutes. Throughout the conflict, three E-3 aircraft operated simultaneously along the Saudi-Iraqi border, maintaining uninterrupted radar coverage from the Red Sea to the Persian Gulf (Keaney & Cohen, 1993:248). The E-3's pulse-Doppler radar, mounted within its rotating dorsal dome, was capable of detecting hostile aircraft at ranges of several hundred miles. Data from AWACS, RC-135 signals intelligence platforms, and Joint STARS were fused into a comprehensive operational picture displayed at the Coalition Tactical Air Control Center.

Joint STARS, though still in developmental stages, deployed two aircraft that flew nightly missions, detecting virtually all significant ground movement. In stark contrast, Iraqi leadership—under Saddam Hussein—was deprived of reliable information regarding both coalition maneuvers and the disposition of its own forces. "Coalition air strikes targeted seventy-eight key command and control nodes to induce systemic paralysis." (Keaney & Cohen, 1993:71). Within twenty-eight minutes of the opening attacks, many Iraqi units were severed from higher command, deprived of intelligence, and left without operational direction.

This information dominance enabled General Schwarzkopf to reposition ground forces westward in preparation for the "left hook" maneuver without detection. Concurrently, Iraq's communications infrastructure was systematically dismantled. "By the second week of the war, Saddam was reportedly forced to transmit orders from Baghdad to Kuwait via courier, a journey requiring no less than forty-eight hours under wartime conditions (Keaney & Cohen, 1993:73)."

7. CONCLUSION

The swift conclusion of the ground war during Operation Desert Storm demonstrated the decisive impact of airpower in modern conflict. Coalition forces liberated Kuwait in approximately 100 hours, a result made possible largely by weeks of continuous, precision-focused aerial operations that had systematically degraded Iraq's command, control, communications, and armored formations. As Michael R. Gordon and Bernard E. Trainor note, "the ground campaign was a formality; Iraqi forces had already been shattered by air strikes and interdiction" (Gordon & Trainor, 1995:331). The rapid operational tempo was a testament to the planning, integration, and technological superiority achieved during the preceding air campaign.

A central lesson from Desert Storm was the operational and strategic value of precision-guided munitions and stealth technology. The deployment of "smart bombs" and the LOCKHEED F-117 Nighthawk introduced a level of accuracy and survivability previously unseen in combat. Lawrence Freedman and Efraim Karsh emphasize that these innovations "reshaped expectations of what airpower could achieve against fortified targets with minimal collateral damage" (Freedman & Karsh, 1993:338). The conflict also set the stage for the development of fifth-generation fighter programs by demonstrating the operational advantages of reduced radar signatures, integrated avionics, and precision strike capability.

The war reaffirmed the primacy of air forces in modern warfare. By achieving near-total air supremacy and systematically dismantling Iraqi defenses, coalition airpower enabled freedom of maneuver for ground forces, reduced casualties, and accelerated mission success. Benjamin S. Lambeth observes that Desert Storm "illustrated airpower's potential to shape the battlefield before ground forces are even committed" (Lambeth, 2000:241).

In summary, Operation Desert Storm validated the principles of the "AirLand Battle" doctrine, demonstrating that integration of air and ground forces, combined with superior intelligence, electronic warfare, and precision munitions, could achieve rapid and decisive outcomes. The campaign set a new benchmark for operational art in the post–Cold War era, establishing a paradigm in which airpower is not merely a supporting arm but a central instrument of strategic effect, fundamentally shaping modern military doctrine and the future of joint warfare.

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THE IMPORTANCE OF LOGISTICS IN WORLD WAR II

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Abstract: *The scientific papers "The Importance of Supply in World War II" highlights the fundamental role of logistics in the conduct and outcome of the 1939–1945 conflict. In a war of global scale, which involved the mobilization of unprecedented human and material resources, supply became a vital element of military strategy. Food, fuel, ammunition, equipment, and means of transport had to be managed efficiently to support operations across multiple fronts.*

The industrial superiority of the United Nations provided a decisive advantage, reflected in the constant production and distribution capacity of resources to the Allies. Through the Lend-Lease program, the United States significantly supported the Allied war effort, providing essential equipment and materials that sustained their operational capacity. Concurrently, the efficient organization of military transport, exemplified by the Red Ball Express system, allowed for the maintenance of a continuous flow of provisions to the troops on the European fronts.

In contrast, the logistical difficulties encountered by Germany severely affected the conduct of operations, demonstrating that military success depends not only on strategy and combat power but also on the capacity for material support. Thus, supply proved to be a determining strategic factor in the outcome of the war.

Keywords*: supply; military logistics; World War II; Lend-Lease; Red Ball Express.*

1. INTRODUCTION

Supply is an essential element of military logistical support and constitutes one of the fundamental factors ensuring the efficient operation of military structures during armed conflicts. In a military sense, supply encompasses the entirety of specific activities related to the planning, coordination, procurement, reception, management, accounting, and distribution of material resources required to achieve the logistical support objectives of military forces, both in peacetime and in situations of crisis, mobilization, or war.

These activities are indispensable for maintaining the operational capability (combat readiness) of an army, as they secure the resources necessary to conduct military operations. Among these resources are combat rations for personnel, fuel for vehicles and aviation, ammunition, military equipment, spare parts, medical supplies, and other materials vital to the survival and combat effectiveness of troops on the battlefield.

World War II, waged between 1939 and 1945, was the largest military conflict in human history, involving the majority of the world's nations and mobilizing economic, industrial, and human resources on an unprecedented scale. The conflict pitted two major military alliances against each other: the Axis powers and the United Nations, also known as the Allies.

The Axis primarily consisted of Nazi Germany, Fascist Italy, and Imperial Japan, joined later by other states, including Romania in 1941.

Conversely, the United Nations included the United States of America, the Soviet Union, the United Kingdom, France, and China, with Romania joining this alliance after August 23, 1944.

Throughout this global conflict, the success of military operations depended not only on the strategies and tactics employed on the battlefield but also on the nations' ability to ensure the uninterrupted supply of their armed forces. An army deprived of essential resources cannot sustain long-term military operations, regardless of its troops' level of training or the superiority of its tactical doctrines.

Consequently, supply logistics became a decisive strategic factor that heavily influenced the course and outcome of World War II.

FIG. 1

2. THE ROLE OF SUPPLY

2.1 The Role of Supply in the Conduct of Military Operations. During World War II, supply played a critical role in sustaining the combat power of the troops. Modern armies required massive quantities of resources to conduct complex military operations across vast frontlines.

Logistical supply enabled the preservation of the military's combat capability by providing necessary rations, ammunition, and military hardware. Furthermore, it contributed to maintaining troop morale and establishing the conditions required to sustain military operations over prolonged periods.

Another vital aspect was troop mobility. The advent of mechanized warfare led to the intensive employment of military vehicles, armored formations (tanks), and aviation, all of which demanded tremendous quantities of fuel (POL - Petroleum, Oil, and Lubricants). Without a steady supply of fuel and spare parts, the army's maneuverability would have been severely compromised.

Supply operations also played a critical role in ensuring the survival of soldiers in extreme environments. On the Eastern Front, where sub-zero temperatures and harsh climatic conditions posed a major challenge, the supply of winter clothing, rations, and medical provisions was vital for maintaining combat effectiveness.

2.2 Military Supply Systems. To sustain the war effort, the belligerent states developed complex logistical systems relying on multiple modes of transport and resource distribution.

Rail transport represented one of the primary means of supply. Freight trains allowed for the rapid movement of vast quantities of ordnance, fuel, and military equipment to railheads close to the frontline.

Road transport was essential for distributing resources to frontline units. Military convoys transported supplies to sectors where rail networks were either unavailable or destroyed.

Maritime transport was critical for supplying the Allies across vast distances. Naval convoys shipped armaments, fuel, and provisions between continents, heavily escorted by naval warships to screen against enemy submarine (U-boat) attacks.

Additionally, the military logistical network integrated supply depots, distribution hubs, and centralized planning systems, enabling the efficient coordination of resources and their allocation based on operational requirements.

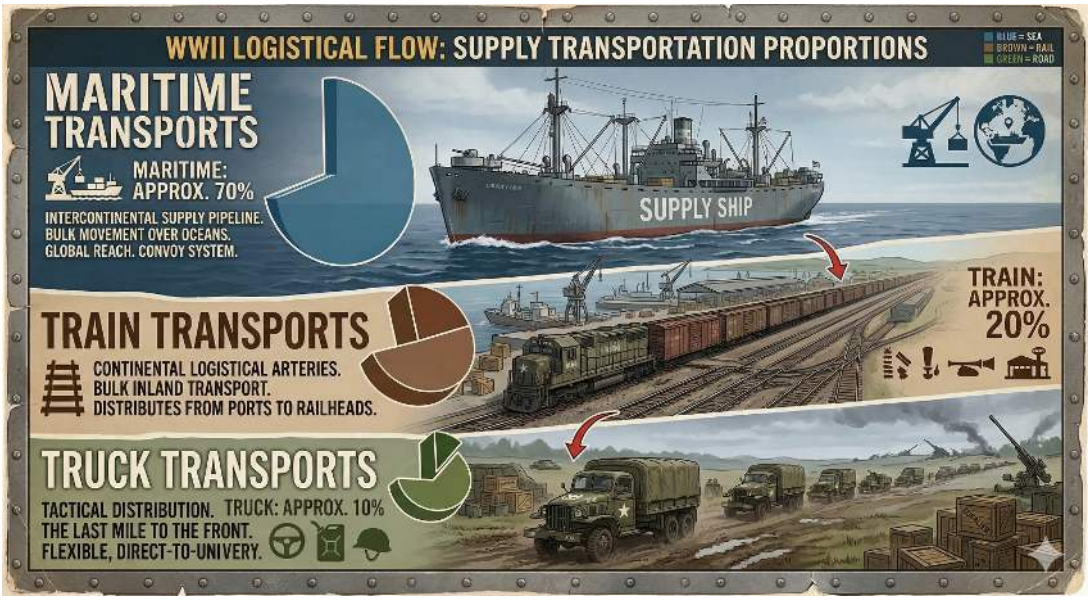

FIG. 2

2.3 The Logistical Superiority of the United Nations. One of the decisive factors in the United Nations' victory was their industrial and logistical supremacy. The United States of America served as the central pillar of this global logistical framework.

A prime example is the Lend-Lease program, enacted in 1941, through which the United States supplied the Allies with military hardware, vehicles, fuel, and provisions valued at over $50 billion (adjusted to the historical value of that era).

The Soviet Union significantly benefited from this logistical backing, receiving over 400,000 trucks, locomotives, and vast amounts of materiel. These assets proved instrumental in increasing the mobility of the Red Army and facilitating the rapid deployment of troops and supplies.

Another benchmark of logistical efficiency was the Red Ball Express, established following the Normandy landings in 1944. This logistical network relied on massive truck convoys that hauled thousands of tons of supplies daily to Allied forward lines in France, maintaining the high tempo of the military advance.

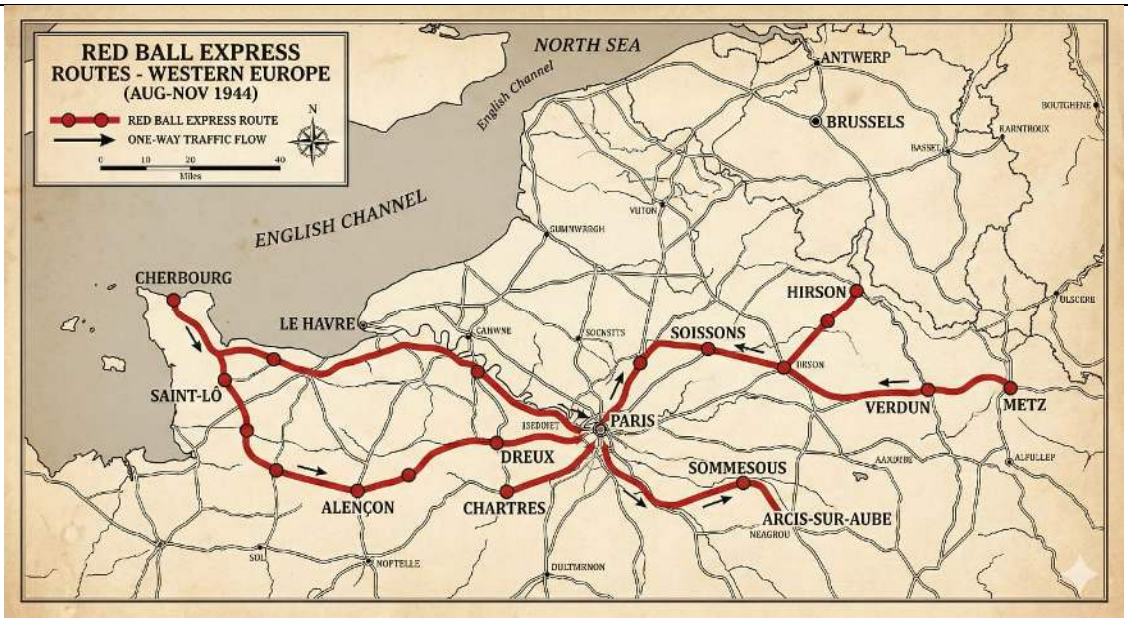

FIG. 3

2.4 The Logistical Issues of the Axis and the Role of Romania. In stark contrast to the United Nations, the Axis powers faced severe logistical constraints. The scarcity of natural resources, primarily fuel, constituted a critical vulnerability for Germany.

The vast overextension of the Eastern Front severely hampered the transportation of supplies to combatant units. Furthermore, the Allied strategic bombing campaigns crippled industrial and logistical infrastructure, severely degrading the Axis's capacity to produce and distribute resources.

Romania held a vital strategic position within this conflict, predominantly due to its petroleum resources. The oil fields of Ploiești served as a crucial source of fuel for Germany and the broader Axis war effort.

However, the Romanian Army's own logistics were plagued by numerous difficulties. An underdeveloped road network, a heavy reliance on horse-drawn transport, and dependence on the German transportation system heavily impeded the supply of Romanian troops on the Eastern Front.

Moreover, the allocation of resources was not always equitable, as the German transport command often prioritized its own formations. This systemic bias frequently degraded the Romanian Army's ability to receive critical provisions.

Following August 23, 1944, Romania switched sides to join the United Nations, a strategic realignment that severely impacted Germany's logistical posture. The loss of Romania's petroleum reserves and strategic geostrategic position critically impaired the German military's supply capabilities.

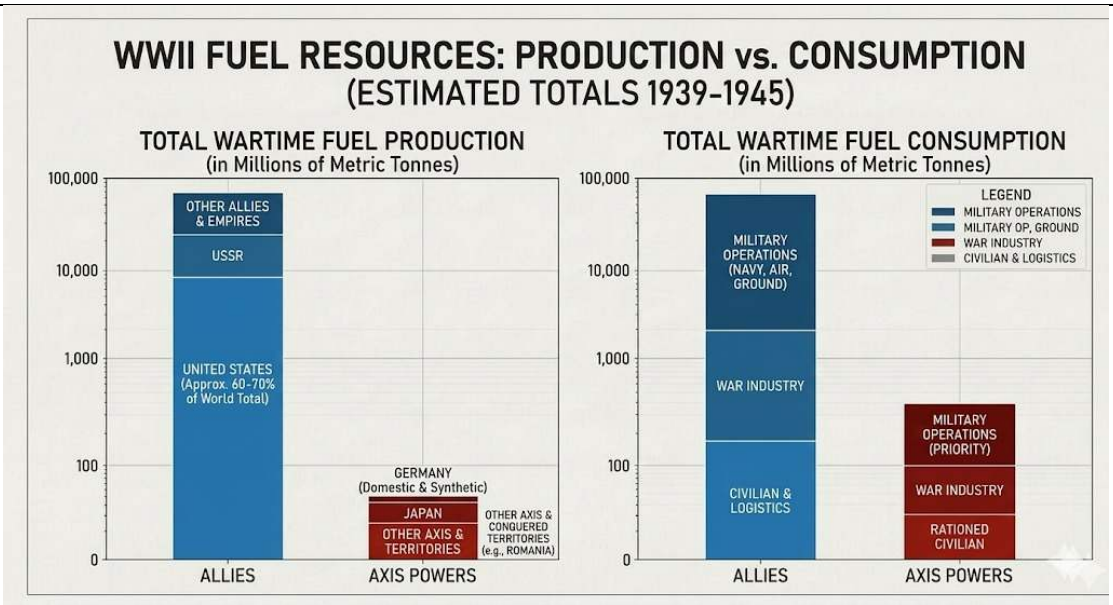

FIG. 4

3. CONCLUSIONS

An analysis of the role of supply in World War II demonstrates that military logistics was one of the decisive elements of the conflict.

In a war of global magnitude, military success did not rely solely on the strategic doctrines adopted or the sheer number of personnel, but heavily on the states' capacity to efficiently produce, transport, and distribute the resources demanded by the front.

The United Nations leveraged a significant logistical superiority, underpinned by a robust industrial base, deep inter-allied cooperation, and highly effective transport and supply networks. Initiatives such as the Lend-Lease program and logistical lifelines like the Red Ball Express sustained a continuous flow of resources to combatant forces.

Conversely, the Axis powers were ground down by systemic logistical failures, driven by a lack of raw materials, relentless strategic bombing, and the severe overextension of their frontlines. These vulnerabilities progressively attired their combat power and ultimately contributed to their final defeat.

In the case of Romania, supply held exceptional strategic significance—both through the petroleum resources that initially fueled the Axis war machine and through its subsequent logistical contributions to the United Nations' military operations post-1944.

In conclusion, the strategic lessons of World War II validate the principle that supply forms the backbone of modern warfare. An effective army is sustained not only by its kinetic combat power but by a meticulously organized logistical system capable of delivering necessary resources exactly when and where they are needed.

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THE EVOLUTION OF PROPAGANDA FROM WORLD WAR 2 TO THE RUSSIA-UKRAINE WAR

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Abstract: *Propaganda remains one of the most effective tools to manipulate people's perception of reality during times of geopolitical crises. This paper seeks to explore the way persuasive methods have evolved in tandem with technological advancements, drawing parallels between the analog methods used during World War 2 and the contemporary digital or hybrid means of manipulation in the context of the Russia-Ukraine War. The research follows the evolution of propaganda, from state-centralized narratives to networked or computational propaganda spread through social media. By means of a comparative analysis, the results show that in an age of unprecedented information availability, new vulnerabilities have emerged.*

Keywords *: propaganda; World War 2; Russia-Ukraine; manipulation*

1. INTRODUCTION

Propaganda is defined as communication with the purpose of influencing public behaviour and perception, based on selectively presenting information at the expense of objective reality, or using emotionally charged language designed to bypass rational judgement. The term emerged in the 17th century, in the context of the Catholic Church facing the rise of Protestantism, at which point it simply referred to the dissemination of religious doctrine. The meaning of the term evolved to refer to the spreading of any idea or ideology, but only entered the political sphere in the 18th century. At this time, the word had neutral or even positive connotations, with the turning point occurring in the context of WWI. It was during this period of hardship that propaganda was used as a tool of mass manipulation, when images, slogans and exaggerated or fabricated stories began being spread in order to boost the population's morale, indoctrinate soldiers and influence the civilian population.

If WWI provided an incipient stage of modern persuasion, WWII refined it to industrial perfection. This era was defined by the institutionalization of propaganda, with states having implemented dedicated ministries that ensured every form of media, including press, films, books and radio stations, followed a monolithic, state-driven narrative. Furthermore, this period led to an informational conflict, referring to the rise of weaponized disinformation and censorship, a tactic that would lay the groundwork for the asymmetric informational warfare prevalent in the 21st century.

Despite moving away from the state-driven approach, the contemporary era continues to be subjected to propaganda. Through the use of newly developed technological means, such as social media, the dissemination of propaganda has moved from a top-down narrative to a decentralized, participatory ecosystem.

In this digital landscape, non-state actors can bypass the boundaries of state control, becoming active agents through means of creating, sharing and engaging with emotionally charged, polarizing content. This phenomenon facilitates asymmetric warfare, where the political power of a state holds less importance, as even a small agent can destabilize the public reception of an event. This is made more evident by the existence of such means as bot networks, programmed, automated accounts posing as authentic users, strategically deployed to further certain agendas and simulate consensus.

2. PROPAGANDA DURING WORLD WAR 2

By the onset of WW2, propaganda had been used by most nations to raise morale of the population and to encourage domestic efforts in the context of the total war, mobilizing the collective psyche. Among the efforts to manipulate the public perception, some common elements of invoking national pride and ridiculing the enemy were present. This Manichaean perspective, referring to dividing the world in two polarized sides, good and evil, led to the representation of enemy nations or leaders as grotesque creatures or as laughable caricatures in contrast to allied nations, presented as heroes.

Propaganda posters were known as "weapons on walls" and, as such, were considered a priority in the efforts of war. Warring states had created dedicated institutions to spread state-approved narratives and censor opposing opinions, as well as institutions specializing in disinformation and weaponized propaganda directed to rival nations. This phenomenon led to the emergence of "black propaganda", clandestine operations which spread fabricated information subversive to the state driven agenda, designed to create the impression it was created by those it was discrediting.

The means of propagation exploited in this era were word-of-mouth, posters, fliers, radio, cinema, cartoons, books, magazines, currency showing portraits of leaders or symbols of victory, spectacles and rallies, arts and literature. Furthermore, young generations were subjected to propaganda via educational indoctrination. Studied subjects, such as biology and history, were changed and school manuals were written according to the state's ideology.

On the German side, the institution in charge of propaganda was named *The Ministry of Propaganda*. The director of the ministry, Joseph Goebbels, stated that "The essence of propaganda consists in winning people over to an idea so sincerely, so vitally, that in the end they succumb to it utterly and can never again escape from it". Germany's defeat following the end of WWI was exploited to instill feelings of rage withing the German population, while the technological, cultural and military achievements were used as a tool to build national pride. The ministry used all communication media to further their ideology, vilifying their rivals and censoring opposing viewpoints. Soldiers on the front-lines had limited media exposure, but they received daily newspapers and had access to radio and cinema vans. Polarizing propaganda came to a start with the release of the book *"Mein kampf" ("My struggle")*, which dedicates its first two chapters to the study of propaganda. Itself a propaganda tool, it was later accompanied by *Völkischer Beobachter* and *Der Angriff*, two newspapers published by the *Nazi Party*. The goals of the publications, and of the Ministry and Party as a whole, was to establish enemies as "inferior" and to unite Germans to the common goal of independence. The state notoriously misled its people, with the leader stating to his generals on the 22nd of August 1939 that *"I will provide a propagandistic casus belli. Its credibility doesn't matter. The victor will not be asked whether he told the truth"*, in the context of starting a war against Poland, accusing them of tolerating the ethnic cleansing of citizens of German origin.

Films were considered particularly efficient tools and deemed appropriate for indoctrinating children.

Schools were provided with motion picture projectors and the term "military education" referred specifically to films designed for propaganda directed to children. By 1936, the entirety of the German film industry became nationalized. Artistic freedom was strictly regulated, and modern or abstract art was stigmatized and deemed "degenerate". Approved art commonly expressed idealized biological traits desired by the Party, as well as national archetypes and themes of camaraderie, tradition or the heroic glorification of labor and military sacrifice. This aesthetic, often categorized as Heroic Realism, sought to see the "ideal citizen" as the sole permissible subject of art.

Radio broadcasting was used to deliver speeches in the entirety of Germany, the radio itself being widely introduced by the Ministry of Propaganda. Cheap, mass produced radio receivers designed for limited reception range, named *Volksempfänger, the people's receiver,* were created and sold to most households. The technical limitation was imposed to prevent access to foreign broadcasts, establishing total monopoly over the radio waves and transforming a luxury item into a primary tool of manipulation. Public places, such as restaurants or bars, were expected to turn on the broadcast in case there was a speech, ensuring every person will have heard it. Beyond internal control, radio was used as a front for warfare. External broadcasts were used in both occupied and enemy states, in an attempt to subvert states from within. "Black radio" is a term that refers to radio transmissions pretending to originate from within a state, disseminating defeatist narratives, undermining authorities' credibility, or inciting civil unrest.

The British state institution for spreading propaganda was named the *Ministry of Information*, and it had the same goal of influencing the population's support toward the war effort. Among the wider range of commonly addressed themes, some specific topics targeted by the British were conserving metal and resources, motivating people to practice agriculture and motivating women to work in the factories.

In contrast to the Axis, who were counting on emotional control and censored objective information, the British operated under the "Operation of Truth", prioritizing long-term credibility. By including reports on military defeats, they secured the public's trust when reporting on victories. British radio stations maintained a calm, analytical tone, providing the preeminent source of information for German occupied Europe.

The British operations reached a high level of sophistication, combining domestic security with aggressive external subversion. Domestic operations include vigilance campaigns, encouraging the public to keep silence regarding military operations in order to deter espionage and resistance campaigns that targeted occupied states. One of the main external operations the British mastered was the use of "black propaganda" through the Political Warfare Executive. Under the direction of Sefton Delmer, who was knowledgeable on the German mentality, British stations infiltrated the German broadcasts and posed as authentic German stations. At first, they provided usual transmissions, such as German music and sports news, in order to captivate and maintain credibility. Once credibility was built, incorporated lies about the war and leading Party, accusing them of corruption, instilling public paranoia and distrust. Another method of spreading disinformation was through strategically placed or even airdropped leaflets. Among others, these leaflets contained false rations or false information that German soldiers could falsify illness to escape the battle front.

While German films portrayed themselves as heroes, British films were used to bring the reality of the war to the general public, motivating them to join the effort against the still vilified enemy.

British propaganda held a significant role in India. Despite Indian Nationalists' objections to the British rule following the war's consequences, the latter made it an objective to censor opposing opinions.

During the United States' of America's involvement in the war, the goal of propaganda was to instill hate against the Axis, increase support for the Allies, determine civilians to join the battle or support it domestically. The main theme of the propaganda was patriotism, and propaganda was considered as important of a resource as ammunition and weaponry. American propagandists were instructed to design the propaganda in such a way that the message conveyed is that failure to contribute to the war efforts has to feel like a personal failure to the individual subjected to the propaganda.

While at first reluctant to turn to propagandistic posters, the Government was eventually persuaded to do so, while claiming that they were not spreading propaganda, but providing information. The institution in charge was the *Office of War Information*, created in 1942 by Franklin D. Roosevelt. The office used means as the press, Hollywood movies and radio to communicate to the public.

One of the main channels used was the visual medium of posters, with the USA having created an unprecedented amount of material, with as many as 200.000 designs made during the period, more than any other nation involved. The posters served as a civic reminder to the public to conserve resources, to support production by working in factories, to maintain secrecy regarding operations and to encourage enlisting in the military. The posters were strategically placed in public places, such as post offices, stores, railroad stations, and even schools and on the windows of private homes. A key difference between American posters and other nation's designs is that the former kept a mostly positive tone with themes of tradition, patriotism and duty, while the latter leaned heavily on ridiculization and dehumanization. Despite this, posters that depicted German and Japanese leaders or soldiers as grotesque creatures were still widely available.

A unique dimension to the American propaganda effort was commercial advertising. Companies launched advertising campaigns for their products, capitalizing on the ongoing war effort to align their brand values with the national cause. By portraying commodities as efforts to support soldiers on the battlefields, the line between consumerism and propaganda became blurred and the public's personal life became invaded with war imagery.

Propaganda targeted children via cartoons. Well known and beloved characters starred in politically charged narratives that simplified the intricacies of war and world politics into accessible stories. Examples of cartoon characters being exploited for propagandistic means include Bugs Bunny and Popeye fighting, outsmarting and defeating Japanese caricatures, and Donald Duck featured in the short film *Der Fuehrer's Face*, a satirization of daily life under Nazi Regime rule. By embedding political agendas into cartoons, the state achieved the idea that the enemy is not only a political rival, but also a comedic villain, and that victory is inevitable for the righteous.

3. CONTEMPORARY PROPAGANDA

With the dawn of the 21st century, the centralized information monolith that defined the 20th century has been dismantled. In this new participatory ecosystem, state-driven narratives made way for a fragmented, decentralized landscape and the line between consumer and provider becomes blurred, as any individual can become an actor in the spreading of propaganda. This evolution gave birth to a new type of informational warfare, characterized by asymmetry and exploitation of global networks.

Driven by hidden algorithms, this transforms the user from a passive recipient of state-approved truth, into an active agent, that unwittingly contributes, amplifies, or validates narratives through the simple act of digital involvement. Consequently, the Russia-Ukraine War serves as the definitive case study for propaganda in the 21st century, representing the first global "social media war".

The current approach used in propaganda is hyper-individualized delivery. Every smartphone functions as a 24/7 terminal where personalized feeds dictated by data-driven algorithms can ensure propaganda reaches people in a way that specifically targets their psychological and emotional profiles, biases and interests. This creates a cognitive proximity, where the war is no longer a distant geopolitical event, but instead a constant and intimate reality. Algorithms are at the base of this new phenomenon, and they function on a principle that prioritizes engagement over accuracy. Social media apps are designed for user retention, therefore content that stimulates intense emotional responses is amplified and more likely to be shown. Engaging with a certain narrative will determine the algorithm to provide more of the same, systematically filtering out opposing views, leading to a phenomenon known as "echo chambers", where the user is captured in a curated vision of reality. This approach changes the user's view of the world incrementally, one post at a time, by keeping them in a recursive feed-back loop. By exploiting cognitive biases and the brain's chemical reward system, this form of propaganda masks itself as a found truth, instead of a manufactured lie.

A defining feature of modern propaganda is the deployment of bot networks, massive clusters of automated or semi-automated social media accounts designed to mimic human behavior. These "digital soldiers" are not intended to engage in debate, but to manipulate the perception of popularity. By flooding platforms with synchronized posts and engagement, bot networks create an artificial consensus, a phenomenon known as Astroturfing. Another similar event is known as Engagement Inflation, where bots artificially raise the view count of certain posts. These phenomena make a narrative more likely to be adopted by authentic users, by making it seem like the majority point of view. Beyond mere amplification, bots serve as a tool for algorithm exploitation. Because social media platforms prioritize "trending" topics, the sheer volume of bot activity can force a specific propaganda narrative into the "Recommended" or "Trending" feeds of unsuspecting real users. Furthermore, these networks are often used for coordinated harassment; they can "swarm" dissenting voices, drowning out factual information or reporting accounts en masse to trigger automated bans. These networks can make some information impossible to find via a process known as "hashtag hijacking", where bots drown out public opinions by disabling their respective discussion grounds through massive amounts of irrelevant posts.

The most technically advanced frontier of modern propaganda is the emergence of Deepfakes and Artificial Intelligence, representing the final erosion of the believing what you see process. Through the use of generative AI, synthetic media can be created depicting world leaders, soldiers or other preeminent figures making declarations or doing actions they never made or done in real life. Deepfakes (portmanteau of the words "deep learning" and "fake") are considered the first step in the generative AI landscape, having limited technical power but potentially very dangerous consequences. A landmark case in the Russia-Ukraine War is a fabricated video featuring Ukrainian president Volodymyr Zelenskyy instructing his troops to retreat. While the technical quality was relatively low and quickly debunked, it signaled a new era of psychological warfare. A possibly unintended effect is that while the public knows any piece of media can be fabricated, the credibility of authentic footage is undermined.

Unlike Deepfakes, that require a source material to be edited, newer models of generative AI can create fully synthetic material from only a prompt, while understanding concepts of reality and physics.

Despite the exponential leap in technological advancements, the human component remains the strategic architect of the contemporary propaganda systems.

Within the complex social media algorithms, certain actors, ranging from state agents to platform administrators, may intervene in the process, actively altering the digital flow of information. This ensures that certain approved narratives are shown to more users, while other opinions remain obscure. In some cases this process transcends digital manipulation, leading to silencing of specific actors. This gradual process takes place through the means of removal from the platform, censorship, legal measures, or in more extreme cases, the elimination of the source through physical means.

In stark contrast to those who are silenced, a new class of digital actors has been strategically amplified: the "Warfluencer". These individuals, ranging from front-line soldiers and volunteers to military bloggers, serve as the human face of contemporary conflict, bridging the gap between state ideology and personal experience. Their effectiveness lies in the authenticity trap: because their content is delivered via shaky smartphone cameras, often featuring tactical gear, battlefield sounds, or glimpses of trench life, it is perceived by the public as being real. Unlike the institutionally mediated broadcasts of the past, Warfluencer content fosters a para-social relationship with the audience. Viewers do not feel they are consuming state propaganda, but as if they are following the personal journey of an acquaintance. This creates a powerful emotional investment where the character of the soldier overrides the message of the state. Cases of this phenomenon are the "Z-bloggers" on *Telegram* or Ukrainian soldiers on *TikTok*, presenting and making the fabricated narrative indistinguishable from personal testimony.

4. COMPARISON

The evolution of propaganda from the mid 20th century to the 21st century represents a transition from a industrialized "factory" model to a digital "ecosystem" model. While the end goals remain the manipulation of the public reception, the means by which this is achieved have drastically changed with the advancement of technology.

In WW2, propaganda was centralized and unidirectional, a top-down broadcast from a ministry to a passive audience. Thus, a key concept is verticality. The audience's interaction with propaganda was limited to consumption, unable to alter the outcome. In the Russia-Ukraine War, in the context of growing distrust for the state, the approach taken is horizontal propaganda: decentralized, participatory, where every member of the audience can become an active agent able to amplify views they agree with. This shift from a "monolithic truth" to a "fragmented reality" marks the point where the main weapon for propaganda is not the lie itself, but the engineered erosion of truth.

In contrast to the methods used in WW2, which were mostly physical broadcasts, the contemporary means are digital and hyper-individualized, with the smartphone replacing the public square. While a propaganda poster can remain visible for weeks at a time in the same place, a viral post can be seen around the world in seconds, propelled by algorithms that prioritize viewer retention and emotional engagement over factual accuracy. This fluid propagation allows for agility, with state agents able to carry different versions of a narrative simultaneously. This marks the shift from the "weapon on the wall" approach to a "weapon in your pocket" concept.

A pivotal difference is the collapse of geographical barriers, a concept known as "the death of distance".

Through advanced communication means, the contemporary information battleground has moved from means of fliers and broadcasts meant to influence enemy population, to the individual's private device. The methods of disinformation of the past required the physical presence of troops in the proximity of the rival state, while currently, any person with access to a smartphone can be subjected to propaganda through the use of algorithms, creating a state of permanent psychological proximity.

Despite the technological advancement, the psychology behind propaganda is consistent. While the means of administrating propaganda have changed, the emotional persuasion remains a highlight of the process. A consistent element is the polarizing world view: while during WW2 the enemy was considered barbaric or sub-human, the war in Ukraine claims to be fought by "defenders of democracy" and "nazis", the goal being dehumanizing the enemy in order to not only justify violence against them, but make it a moral necessity. Another consistency is the presence of atrocity propaganda, images of high emotional shock value meant to instill intense emotion within the viewer, bypassing the rational filter. The cult of the leader remains present, referring to the concept that the leader is never only a politician, but a symbol of national strength and resilience.

Propaganda during both eras pushed the general population to join in the war effort. In WW2, this was done by encouraging the public to conserve resources or produce material in factories, while in the contemporary era, it is done by encouraging users to "report" enemy accounts, damaging their rival's information infrastructure. Both of these phenomena transform the civilian into a participant, ensuring the whole society feels at war.

5. CONCLUSIONS & ACKNOWLEDGEMENTS

In spite of the digital revolution, the key component of manipulation remains virtually unchanged. Human psychology has remained the constant anchor in a shifting sea of technology. While the delivery methods have evolved, the target remains the same: people's emotional landscape. Whether it is through handmade posters on a wall or AI posts on a smartphone, the same goal of bypassing the rational mind and instilling rage, fear or pride is pursued.

The transition from the industrial propaganda of the 20th century to the algorithmic propaganda of the 21st century demonstrates that while our tools have become precise, our instincts remain ancestral. In the end we are shown that the most vulnerable frontier of modern warfare does not lie in equipment or hardware, but remains the human psyche.

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THE EVOLUTION OF THE INTENDANCY IN ROMANIA BETWEEN 1878 AND 1916: ORGANIZATION, ROLE AND INSTITUTIONAL IMPACT

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Abstract: *This study analyzes the evolution of the Romanian Army's intendancy between 1878 and 1916, focusing on its organization, institutional development, and strategic role within the military system. Following the War of Independence, the Romanian state initiated a process of military consolidation in which the intendancy—responsible for supply, administration, and financial management—became an essential component of the army's operational capacity and its broader system of military logistics. Drawing on legislative changes, organizational reforms, and institutional developments, the paper examines how the intendancy gradually transformed from a centralized administrative structure into a more decentralized and integrated apparatus of military administration capable of responding to the practical needs of the troops.*

Keywords: *intendancy, military logistics, Romanian Army, military administration, institutional modernization, mobilization, First World War.*

1. INTRODUCTION

To analyze the evolution of the Romanian Army's intendancy during a specific period—namely from 1878 until Romania's entry into the First World War in 1916—we must first define the term "intendancy" and then detail how the Military Intendancy Corps was established.

The intendancy represents the logistical branch of the army, responsible for the supply, administration, and management of the financial and food resources necessary for the functioning of the armed forces, both in times of peace and war. It ensures the material conditions without which military activity would be impossible, thus being vital for the proper functioning of the army.

The Military Intendancy Corps was established for the first time in the modern Romanian state during the reign of Alexandru Ioan Cuza, through the High Order of the Day No. 29 of February 1, 1861, published in the Official Gazette No. 11 of February 16, 1861.

Now that we have defined this term and learned when the Military Intendancy Corps was established, we can begin analyzing its evolution during the chosen period.

2. THE DEVELOPMENT OF THE INTENDANCY AFTER THE WAR OF INDEPENDENCE

Following the conclusion of the Russian-Romanian-Turkish war—the war after which Romania regained its independence - a period of strengthening the army ensued.

The experience of the recently concluded war was full of lessons; thus, in the years that followed, the army developed based on these lessons acquired from the War of Independence. Following the war, the country incurred enormous expenses, which hindered the full development of all branches within the army's "administrative organism."

Consequently, after the campaign ended, the position of General Intendant, who held the entire responsibility for maintaining the army, was abolished. In return, the role of the services and the number of intendancy and administrative officers were increased.

The centralization of intendancy and administrative organs at the ministry, detached from the realities of war or a soldier's life, could no longer be maintained. The lessons drawn from the War of Independence dictated that military administration organs had to break away from "office abstractions" and collaborate with real-life conditions.

Thus, a dispersion of intendancy officers from the center to the periphery can be observed—meaning from the ministry to the commands—bringing them as close as possible to the needs and realities of the troops.

Regarding the army's endowment, the Company of Workers for the Clothing, Encampment, and Subsistence Service was maintained. By merging with the General Clothing Depot, it was renamed the Administration Workers Company. The carriages, horses, and personnel were organized into two field squadrons: one for the sanitary ambulance and another for transporting the troops occupying Dobruja.

To more closely control the progress of military administration within the army corps, intendancy officers were assigned to the army's five divisions. For a short time after the war ended, intendancy services continued to operate independently from the commands to which they were attached. Realizing that this independence from the command was detrimental, the military intendancy was brought under the authority and organization of the command it depended on, through the amendment of the Law on the Organization of Commands (promulgated in 1882) and the Law of Army Administration (promulgated in 1883).

Also during this time, in 1883, the Regulation for Intendancy Services and Military Controllers was promulgated, establishing the rights and obligations of intendancy officers, administrative officers, and military controllers regarding the maintenance, order, and accounting of the army.

Along with the development of combat units, the administrative apparatus also developed. In 1881, replacing the Manufacturing Workshop which was abolished, the Administration Company was established, completing its ranks with personnel from equipment depots and tradesmen drawn from the troop corps. The Administration Company was intended to form the future cadres for equipment depots and workshops, organizing the labor for manufacturing and repairing military gear.

The Central Commissariat (Military Bakery), established in 1855 under Barbu Știrbei, later abolished and subsequently re-established during the Balkan War, developed increasingly in relation to the army's needs.

The Central Equipment Depot (established in 1860), the Army Tannery (organized in 1881 on the French model), the Târgșor Workshop (established in 1882), regional manufacturing workshops (established in 1883), and the subsistence and administration companies, as well as garrison commissariats, continued to develop, succeeding to a large extent in satisfying all the army's needs.

The army's administrative personnel, which included intendancy and administration officers, began to be recruited through much more careful selection. However, the governing bodies were preoccupied not only with the selection of intendancy officers but also with their training.

The recruitment of administrative officers, which had been done through direct examination, began to be conducted through schooling starting in 1882, for which purpose the School of Administration was established.

Therefore, from the end of the War of Independence until the start of the Second Balkan War in 1913, the intendancy of the Romanian army developed considerably. One could observe a decentralization of intendancy services, a development of administrative organs and establishments, and a more rigorous selection of personnel.

In conclusion, although the intendancy of the Romanian army developed significantly, it could not do so to its fullest potential due to a lack of funds.

2.1. The intendancy of the Romanian army in the 1913 war

The military administration, although permeating all the "joints" of the army, was not adequately prepared when entering the campaign in Bulgaria either.

The 1913 war triggered in the Balkans, in which our army also took part—acting as a prelude to the Great War—naturally revealed all the gaps in the organization, preparation, and endowment of the army and its administrative services.

The army's governing bodies made continuous efforts so that the military and its administration could enter the 1913 campaign prepared. In 1913, the intendancy operated on the basis of clear regulations, with well-organized depots and supply lines adapted to the rapid movement of troops south of the Danube.

An essential aspect of the intendancy's evolution was its adaptation to the geographical and climatic conditions in the Cadrilater. The arid zones and limited infrastructure required flexible logistical solutions, including the use of railway and fluvial transport, as well as cooperation with local authorities. The intendancy managed to maintain a steady flow of resources, preventing shortages and contributing to the maintenance of troop morale.

In 1913, the intendancy demonstrated that it had functional structures capable of supporting rapid mobilization and troop movements in territories with limited infrastructure. However, the campaign's experience also highlighted certain deficiencies: a lack of sufficient reserves, difficulties in coordination between logistical and military units, and the need to standardize procedures. These findings prompted military authorities to initiate reforms aimed at strengthening the army's administrative and supply capacity.

Furthermore, the 1913 conflict underscored the importance of professionalizing the personnel within intendancy services. Officers and non-commissioned officers specialized in logistics proved that military success depends not only on combat strategy but also on the army's administrative capability.

In conclusion, the war for the integration of the Cadrilater represented an important test for the Romanian army's intendancy. The 1913 experience became invaluable material for preparing the next campaign.

2.2. The Modernization of the Intendancy during the Period of Neutrality (1914–1916)

The organic institutions of the army, along with all the personnel, material, and means necessary for its maintenance, developed continuously from 1914 until August 1916, when we entered the war. Thus, at the onset of the war for national reunification, and following the experiences of the Balkan war, our army's administration and intendancy were at a higher level of development compared to the past, in terms of organization, personnel staffing, supplies, and maintenance materials.

Several administrative laws and measures related to the endowment of the military household continuously increased the power of the army's administrative apparatus.

The Ministry of War placed a special emphasis on reorganizing the intendancy services. Regulations were revised, the duties of logistical structures were clarified, and a better integration of these structures into the military command system was pursued. Better-organized regional depots were created, transport networks were improved, and logistical mobilization plans for crisis situations were established. These measures aimed to ensure the continuity of supply under the conditions of a prolonged war.

An important aspect of the intendancy's evolution during this period was the professionalization of personnel. Intendancy officers received specialized training in areas such as military accounting, inventory management, transport organization, and cooperation with the civilian economy. The goal was to form a corps of specialists capable of responding to the complex demands of a modern conflict. Simultaneously, an emphasis was placed on discipline, responsibility, and transparency in resource administration to prevent waste and corruption.

Against the backdrop of the outbreak of the First World War in 1914, Romania entered a period of armed neutrality, which provided time to prepare its military structures, including the intendancy. During this interval, strategic stockpiles of food, equipment, ammunition, and sanitary materials were accumulated. The intendancy collaborated with the national industry and external suppliers to secure the necessary quantities of resources, anticipating supply difficulties that could arise under blockade or economic instability conditions.

Additionally, detailed plans were developed to support general mobilization. These included organizing distribution points, establishing transport routes, and coordinating with railways and fluvial services. The intendancy had to ensure not only the food and equipment of the soldiers but also the maintenance of draft animals, the functioning of sanitary services, and the supply of units on the front lines or in reserve. The complexity of these tasks required close cooperation between military and civilian structures.

At the same time, technological evolution and changes in military doctrine influenced the intendancy's activities. The increase in troop numbers, the diversification of weaponry, and the intensified consumption of resources demanded more sophisticated logistics. The intendancy had to adapt to the requirements of industrial warfare, characterized by a rapid pace, severe material wear and tear, and constant needs for resupply. Thus, the focus shifted from occasional supplying to the continuous and systematic management of resource flows.

By August 1916, when Romania decided to enter the First World War on the side of the Entente, the army's intendancy was in a more advanced state of organization and preparation than in 1913. Although certain vulnerabilities persisted—particularly related to the country's limited industrial capacity and insufficiently developed transport infrastructure—the progress made was significant. The intendancy had become a more coherent, better-coordinated structure, more aware of its strategic role.

In conclusion, the period from 1913 to August 1916 was one of transformation for the Romanian Army's intendancy. Building on the practical experience of the 1913 campaign, it evolved through organizational reforms, professionalization, and integration into the state's strategic plans. The preparations during neutrality consolidated the army's logistical capacity, even if they did not completely eliminate all structural deficiencies. Thus, the intendancy affirmed itself as an essential element of Romanian military power, contributing decisively to the war effort that was to begin in the autumn of 1916.

3. CONCLUSIONS & ACKNOWLEDGMENT

The evolution of the Romanian Army's intendancy between 1878 and 1916 reflects an extensive process of institutional modernization, professionalization, and adaptation to the requirements of modern warfare. Originating from the experiences of the War of Independence, the intendancy structures were reorganized, decentralized, and more efficiently integrated into the command system, gradually becoming an essential component of the army's combat capability.

The development of administrative institutions, the creation of military depots and workshops, and the formation of a specialized corps of intendancy officers contributed to the consolidation of the army's logistical base. The 1913 war represented a decisive test, highlighting both the progress made and the existing limitations, while also offering valuable lessons for subsequent reforms.

The period of neutrality between 1914 and 1916 allowed for the deepening of these reforms through the establishment of strategic stockpiles, the modernization of supply networks, and the drafting of coherent logistical plans for general mobilization. Thus, upon Romania's entry into the First World War, the army's intendancy was at a higher organizational stage than in previous decades, although vulnerabilities related to economic resources and national infrastructure persisted.

Overall, the intendancy affirmed itself as a fundamental pillar of Romanian military power, demonstrating that the success of military operations depends not only on strategy and combat force but also on the state's administrative and logistical capacity. The transformations undergone during the analyzed period laid the foundations for a modern logistical system, indispensable for the war effort and the institutional consolidation of the Romanian army.

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THE WINGED KNIGHT, GENERAL ANDREI POPOVICI

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Abstract: *"We know what we are, but know not what we may be". This Shakespearean quote captures the life of one of Romania's greatest aeronautics visionaries, Andrei Popovici. The date of 14 August 1883 marks his birth and the beginning of a journey defined by brilliance and "fearful symmetry", a voyage which unexpectedly started in a railroad station.*

From the very start, his future appeared uncertain. Despite this, he never lost hope, eventually becoming one of the key figures in the development of national civil and military aviation. Although the dawn of his military career was marked by the School of Infantry and Cavalry, his sheer devotion to something greater led him to become one of the first breveted pilots of Romania. He occupied many positions over the course of his activity, including commander of the most important aeronautical group during the air campaign to save Romania in the fiery summer of 1917, founder of the Regal Aeroclub and director of the first national air transport company, "L.A.R.E.S.".

Even after his resignation from active service, Popovici remained deeply connected to aviation, giving interviews to the press of the time, writing articles in specialized magazines and revealing the shortcomings and the true state of the aeronautical industry during periods of economic crisis.

Some may boast about such a great number of achievements, but one fact about General Popovici that remains undeniable is his humility, a quality found only in true winged knights.

Keywords*: Popovici; aeronautics; military; aviation; devotion*

1. INTRODUCTION

Many biographical studies contain inaccurate data about General Popovici's place and date of birth. In reality, he was born on the date of 14 August 1883, in Coteşti railroad station, Goleşti Commune, Plasa Marginea, Râmnicu Sărat County, which is today known as Coteşti Commune, Vrancea County (Tănase, 2024: 9-10), information validated by Vrancea County Service of the National Archives. One of the 6 sons of Ion and Olga Popovici, Andrei completed the first four grades at Boy's School no. 4 in Focşani from 1890 to 1894 and the three middle grades until 1897 at high school "Unirea" in the same county. Feeling a calling to a military career, he was admitted to the Military Sons School in Iaşi, where he met his future brother-in-law and world-renowned scientist, Henri Coandă. Finishing what would eventually become the military high school, the newly promoted second lieutenant decided to opt in 1902 for the Infantry and Cavalry School in Bucharest.

His unparalleled skill and naturalness in riding brought him appreciation from the school's commander, and with his posting in 1905 to the 11th Regiment Călăraşi for military training in the Special School of Cavalry, he was decorated with the *"Carol I Jubilee Medal"*.

His positive activity continued with his reassignment to the 2nd Roşiori Regiment in 1906, but a year later, in contradiction to his good conduct, he was punished twice by the commander of the regiment with several days of confinement. Apparently, during the general sanitary inspections he left the garrison without permission and the reason for that was to hide the fact that he had contracted typhoid fever, not that he wanted to escape from duty. It seems like he was already flying by the seat of his pants because of the sacrifice he was willing to make for his activity but this decision of his didn't pass unnoticed, as for this display of devotion he was granted 50 sick leave days by the Minister of War.

In 1908, an evaluation note of Popovici belonging to the commander of the 7th Cavalry Brigade captures the next assessment of the officer: "over the course of this year he had never given another occasion for discontent to his superiors. The acts attributed to him were more the result of youthful impulse, of which I think he has already gotten rid of" (Tănase, 2024:11). Subsequently, his promotion to first lieutenant was advanced and not soon after, he was posted to the 4th Călăraşi Regiment. In 1910, due to the establishment of military aviation, the training and certification of the first military pilots, a dream had started taking shape: Andrei Popovici wished to attend Cotroceni Military Aviation School.

2. A DIFFICULT TAKE OFF

2.1 Development of Romanian Military Aeronautics and the N.A.L.

In keeping with his aspiration to roam the skies, Popovici was posted in 1912 at the Railway Battalion, the piloting school, alongside First Lieutenants Eugen Adamovici, Gheorghe Caranda and Constantin Fotescu. They were going to be instructed by some of Romania's first breveted pilots, such as Gheorghe Negrescu and Ştefan Protopopescu. Behind the curtains, however, a conflict of interests with serious repercussions was taking place.

It was largely caused by Prince George Bibescu, the weed in the garden of early national aviation. Although he was part of the first batch of breveted Romanian pilots, he had no intention of becoming a flight instructor in the military field. Moreover, he encouraged the import of *BLÉRIOT* aircraft from France, thus resulting in the closure of the Romanian Aeronautical Complex Cerchez & Co. , which produced the first series of *FARMAN III* aircraft. This decision proved to be catastrophic, as "it determined the leadership of the Engineering Directorate to buy the license of the *FARMAN MODEL 1912* from France, an aircraft with design flaws which was going to be mass-produced in the workshops of the Cotroceni Military Aviation School" (Avram, 2012:8). Despite these difficulties, Negrescu and Protopopescu continued to pass their knowledge on to student pilots, who gained important experience in piloting and air navigation techniques through teaching activities and training air raids.

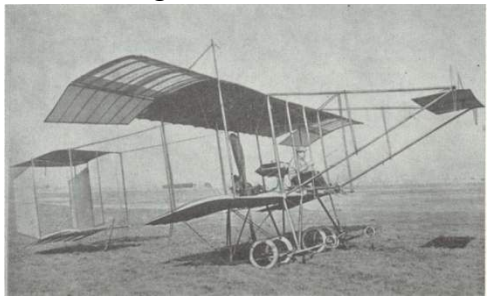

FIG. 1 FARMAN III, Chitila, 1911 - Romanian Aeronautical Construction 1905-1974 (1983)

Unfortunately, on 20 June 1912, during a training flight in preparation for the pilot's brevet exam, Lieutenant Caranda, who was flying a *FARMAN 1912*, pitched it up too much, thus losing speed and entering an uncontrolled spin which plummeted the biplane to the ground. His death marked the first entry on the long list of sacrifices for the progress of national aeronautics, but it also contributed to showing Popovici and the other flying officers the true risk that pilots faced every flight, even if it was just a training one.

FIG. 2 FARMAN 1912, near Montpellier - Les aéronefs de l'Aviation maritime 1910-1942 (2002)

Not approving the military guardianship, Bibescu took advantage of the Romanians' wish to fly so he founded the National Air League (N.A.L.) and also established a flight school at Băneasa, appointing himself as its technical director. He also sought to initiate a policy to impose on the Minister of War for personal gain, ultimately succeeding and thus negatively influencing military aviation for many years. The relationship between the Cotroceni and Băneasa flying schools also kept on growing colder, which ultimately prompted Negrescu and other flying officers to write a memorandum addressed to the Minister of War: "National Air League needs to limit its purpose to just raising the necessary funds for the acquisition of aeroplanes, operation that must be made through the Minister of War who will consult with the flying officers about the aircraft which will be given to the military. N.A.L. prevents the formation of a strong military aviation." (Avram, 2012:9). To resolve these tensions, a commission was organized by the Minister of War, and it was decided that several pilots, including Andrei Popovici, Adamovici and Fotescu would no longer be posted to the school in Băneasa. The curriculum of both piloting schools was to be unique and the duration of pilot training had to last 6 months.

FIG. 3 Workshop of Cotroceni Military Aviation School, 1911 - Romanian Aeronautical Constructions 1905-1974 (1983)

2.2 Becoming a Pilot

At the start of 1913, having received a generous budget, the Cotroceni flying school admitted Popovici and Emilovici as instructor pilots.

In April of the same year *the Law on the Organization of Military Aeronautics* was voted by the National Parliament, and one of the provided aspects was: "clear distinction between pilots and aerial observers. The pilot brevet has 2 levels: the inferior and the superior one, the latter one being conferred to experienced aviators. An instructor pilot with a superior brevet receives off the payroll an extra 12 lei, one with an inferior brevet- 10 lei, a pilot officer with a superior brevet- 9 lei, a pilot officer with an inferior brevet- 7 lei, a non-commissioned officer with a superior brevet- 4 lei and a student pilot- 1 leu. Military pilots are obligated by law to execute a minimum of 120 flight hours yearly" (Avram, 2012: 10-11).

In order for Lieutenant Popovici to receive his pilot brevet, he was posted, alongside Second Lieutenant Protopescu, by *order no. 3711 of 17/27 June 1912* at the Amesbury Flying School in England. In July of the same year Popovici was ordered to go to Paris to receive his superior pilot brevet at "Casa Morane Saulnier", where he will also finish his courses. In March of next year, due to a lack of flight instructors for the new batch of future aviators, Popovici and Adamovici were posted at the Cotroceni Military Aviation School.

Because of his proven superior qualities, Popovici was promoted to the rank of captain and finally obtained the *brevet no. 11* on 7 June 1913. In the report card of that year Lieutenant Colonel Mihail, commander of Specialty Batallion, noted: "distinguished officer, he will prove useful as a teacher in this specialty" (Tănase, 2024:13). After so many challenges, setbacks and institutional rivalries, this achievement symbolized for Popovici something way more than just the completion of formal training. It marked the fulfillment of a destiny that had begun far from the airfields, in a modest railroad station. The young and naive cavalry officer had become a certified aviator, ruler of the skies. The knight had finally spread his wings and was ready to reach heights far from human comprehension. He was now ready to contribute decisively to the shaping of a still-fragile national aeronautics.

3. THE EMERGENCE OF A GREAT COMMANDER

3.1 Military Aeronautics Reorganization

Soon after his promotion, Captain Popovici was selected to go to England at Bristol works where he underwent training on the *BRISTOL-COANDĂ* aircraft, period in which he also obtained the superior English pilot brevet. Popovici managed to "save his friend's reputation, proving the qualities and performances of this flight device which with some adjustments, enters the Romanian army service" (Avram, 2007:314-315). Despite the danger he could have encountered piloting Coandă's monoplane, due to a previous accident which resulted in the death of 2 pilots, his unbeatable courage and sense of duty did not deter him. He was aware that his fate could have been similar to that of late Caranda, yet he pressed on and eventually influenced the national military aviation to be provided with 16 aircraft of this type.

FIG. 4 BRISTOL-COANDĂ aircraft, 1912 - Romanian Aeronautical Constructions 1905-1974 (1983)

In the summer of 1914, when the Russian Emperor Nicholas II and his family visited Constanța, where they were guests of the Romanian royal family, Popovici and six other aviators welcomed the imperial yacht in flight, off the Romanian coast. In the autumn of the same year, Andrei Popovici made the first night flights in the history of Romanian aviation. He was also appointed technical director of Cotroceni Military Flying School, where despite his remarkable activity regarding the control of the tight allocated budget, he resorted to addressing the higher echelons through a report: "(the budget) is insufficient for small reparations, fuel and oil. We have great pilots, but they have nothing to fly.'' (Tănase, 2024:14). Because of the international situation, Popovici's worries were well founded, so in order to ensure the training of Romanian pilots for the military campaign, he, alongside Protopopescu and Negrescu, elaborated *"Instructions on the use of airplanes".* According to this document, in the event of mobilization, military aviation would form 4 squadrons, 2 for each flight school. The end of the year marked the Minister of War's approval of the document and the entrustment of Squadron no. 2 to Popovici.

A decisive milestone in the development of national aviation was the foundation of Romanian Aviation Corps through the *Ministerial Decision no. 305 of 10/23 august 1915*. However, since staff officers unfamiliar with aviation's role in wartime were appointed to command, the decision ultimately had serious negative consequences. The closure of Cotroceni's flying school, a decision heavily influenced by Prince Bibescu, further aggravated the situation while revealing Bibescu's indifference towards the matter as long as he could enrich himself at the expense of the military budget.

Due to the catastrophic disorganization of aviation, all pilots and aerial observers were ordered to reassign from October 1915 to April 1916 to their original branch for a period of 6 months, while the damage would be repaired by the French military mission. Its purpose was reorganizing the Romanian military into 3 aeronautical groups and an aerostation corps, a change which would be observed during the fiery summer of 1917. Thus, Popovici returned at 4th Călăraşi Regiment, where he took part in the operations of the Cavalry Division. This reassignment did not discourage the captain, who soon showed signs of success on the ground he had tried so hard to fly away from.

3.2 The War of National Unification

In the autumn of 1916, when Romania freshly entered World War I, the captain highlighted himself in the battles of Porumbacu where he managed to save an infantry unit.

On 13 October Popovici was brought back into aviation with the mission of preparing a fully equipped airfield at Tecuci, where the Romanian Aviation Corps would be moved after the Battle of Bucharest. He was promoted to major on April 1st 1917 while being in command of Aeronautical Group 2 Tecuci which became, during preparation for the great battles that would commence in the summer, "the biggest and strongest aviation unit, having under its command: the reconnaissance and light bombing squadrons F. 4, F. 5, F. 9, the Caudron G. 4 Long-range Reconnaissance and Bombardment Squadron, the fighter squadrons N. 3 and N. 11, five aerostation companies, a repair park and two hydrogen plants" (Avram, 2007:316).

The aviators of Aeronautical Group 2 Tecuci carried out several dangerous missions that required nerves of steel, but under the command of Major Popovici, they knew they had nothing to be afraid of. Such an example is the squadron F. 5, which "on the timeframe from 23 January to 5 February ... bombed "Union" Factory which was operating under Austro-Hungarian occupation. The 5 *GROS BOMBS* hit the production halls and a lumberyard, igniting them on impact. The crew was attacked by a German aircraft; They repelled the *ALBATROS* with machine gun fire.

The dogfight lasted a quarter of an hour and was dangerous for us- noted the observer of the aircraft in a report- , as on board we had more bombs. A bullet was enough to hit one of our 16 kilograms bombs and the *FARMAN* would have been pulverized. Only 4 bullets hit the aircraft" (Avram, 2012:143).

On the days of 7 to 20 July 1917, squadron F. 6 observed, between Oituz and Lemnia, uninterrupted convoys, more than 600 carts and over 50 trucks. These new objectives were marked on the general map of the front, allowing the pilots of Aeronautical Group 2 to accomplish 15 fight missions and over 8 dogfights in just one day, and Major Popovici to notice the increase of enemy air missions in Mărăşeşti- Mărăşti area, thus regrouping the air force. During the preparation of the Nămoloasa offensive, the major managed to move his whole Aeronautical Group, in just 5 days, without any means of transport, at Călmăţui and Ciora. He also served with his troops the needs of both 1st Army and the Russian Corps.

Aeronautical Group 2 Tecuci carried out a remarkable activity, being indispensable in photographic reconnaissance, low-altitude attacks and repeated bombings. They were nevertheless commanded by a good organizer, which resulted in obtaining 27 aerial victories during the Battle of Mărăşeşti. Despite their succes, Popovici made sure to always reward his subordinates first, thus refusing the decoration with "*Order of the "Crown of Romania" with Swords in the Rank of Officer"* because his subordinates, who were proposed for decorating, never received their rewards and he knew they deserved it more. This gesture attracted the attention of King Ferdinand I of Romania, who "ordered that all of the reward proposals for Popovici's subordinate crew must be implemented" (Avram, 2007:316).

FIG. 5 Pilots of Aeronautical Group 2 Tecuci, Tecuci aerodrome, 1917 - National Museum of Romanian History

Many thanks were given to both Popovici and his squadrons, most notable being those of General Eremia Grigorescu, commander of Romania's 1st Army: "He commanded from 25 June 1917 to 15 May 1918, with great skill, Aeronautic Group 2, subordinate to 1st Army." (Tănase, 2024:17). For his great achievements during the military campaign, Popovici was decorated with the next national and foreign orders:

"The Star of Romania with Swords in the rank of Knight" ; *"Crown of Romania with Swords in the rank of Officer"* ; *"St. Anne, 3rd class, with Swords and Bow"* ; *"St. Stanislas cls. II with Swords"* ; *"Queen Mary Cross, 2nd class"* . He was also the first Romanian pilot to be decorated with the *french order "Legion of Honor in the rank of Knight"*.

After the end of the war and the Great Union of Romania, the major received the mission to transform Group 2 into the 4th Aviation Training Group, institution which he would be in charge of starting July 1st 1918. His duty now was the search of pilots capable of taking over the noble duty of a flight instructor. On April 1st 1920 Popovici was promoted to lieutenant colonel and appointed as director of Aeronautics at the Ministry of War until his resignation from active service in April 1923. He won't leave aviation, however, and would never part with it.

4. FOLDING WINGS

Over the following years he held various positions, such as director of the "ASTRA" Air Factory in Arad from 1923 to 1925. That was where the *PROTO-1* plane was designed by Protopopescu, which with some upgrades became the *PROTO-2 school plane*. In November 1925 the Romanian Aeronautical Industry was founded at Braşov. Popovici was named deputy director general of this society, which over the next 12 years became one of the most modern aircraft factory in Europe. During this time, he was also promoted to the rank of colonel in reserve. Popovici was the initiator and director of the magazine *"Aripa"* , which remained one of the finest aeronautical periodicals of the time, symbolising his profound spiritual connection to both writing and aviation.

Between 1936 and 1941 he served as director general of the national air navigation company "L.A.R.E.S.", during which he was decorated with the *"Aeronautical Medal" 3rd class*. He was dismissed from office, being wrongly accused for over 2 years of administrative irregularities. Despite this injustice, which was planned beforehand, Popovici remained "the same upright, fair and honest man, always devoted to the prosperity of Romanian aviation" (Avram, 2007:319). After the Second World War and the establishment of the communist regime, he was promoted to general aviator, quietly passing away on 13 August 1967. The winged knight finally returned to the land he galloped across all those years ago.

FIG. 6 Captain Popovici decorated on the collar with the "little BLÉRIOT ", 1913
Aeronautics Museum "General Andrei Popovici"

5. CONCLUSIONS

Throughout his life, Andrei Popovici embodied the evolution of Romanian aviation from its fragile beginnings to institutional maturity. His trajectory reflected a life shaped by determination, responsibility, and unwavering devotion to the national progress of aeronautics. From his early cavalry days to the decisive leadership during the Great War of National Unity, he contributed not only to operational success, but also to the reform of military thinking. As a cavalryman, he demonstrated the true devotion required in military service, putting duty above his own well-being. As commander of Aeronautical Group 2 Tecuci, he showcased the importance of being down to earth with his subordinates, a quality that only strengthened the bonds with his fellow crewmen. Despite this, it seems like in the end what he sought to avoid ultimately prevailed.

Popovici's biography reveals a striking "fearful symmetry": indifference can be discerned both at the beginning and at the end of his life. From being born prematurely in a railroad station, a fate many wouldn't dare give a second look at, to ending up the director general of an air navigation company that was cunningly removed from his position by those who wanted to be in power without making much of an effort. The branches he served in also symbolize this symmetry, as being a cavalryman tied him to the real, physical world which is limited to time and space, while being an aviator meant living in the astral reality, the realm of the absolute, the undying and never-ending universal plane, the source of his creative brilliance.

Having lived in both of these worlds, that is how General Andrei Popovici became a true winged knight. His whole legacy continues to thrive and reflect the disciplined and visionary spirit of Romanian aviation.

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