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Small Unmanned Aircraft Systems on the Battlefield: Implementation into Tactical Units of the Czech Armed Forces within the DOTMLPF-I Concept

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Abstract

The present article examines the implementation of small unmanned aerial systems into tactical units of the Czech Armed Forces, with a focus on the systemic capabilities that such integration brings to the areas of doctrine, organization, training, equipment, leadership, personnel, facilities and infrastructure, and interoperability. Systematic reviews and structured qualitative coding are used to derive implementation measures, which are then validated by field and academic experts and prioritized. The findings indicate that priorities extend across all domains and must inform Czech Armed Forces processes and procedures.

KEY WORDS: *sUAS, Czech Armed Forces, DOTMLPF-I, systematic literature review, qualitative coding, expert validation, ISR, C-UAS, EW, interoperability.*

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1. Introduction

Prior to Russia's invasion of Ukraine, there had been a lack of focus within both the scientific and military communities on the broader use of small, inexpensive, and commercially available unmanned aerial systems (sUAS) to support individual combat operations. However, the ongoing conflict has demonstrated that a variety of sUAS can offer capabilities that generate a tactical advantage. sUAS enhance the combat capabilities of small units and facilitate relatively cost-effective and expeditious operations in the domains of intelligence, surveillance, and reconnaissance (ISR), fire support coordination (FSC), and target destruction. [1–2]

In this paper, sUAS are delineated as small UAS employed at the tactical level, commencing from the squad level. These include multicopters for ISR, first-person view (FPV) drones, and loitering munitions, including civilian variants. Recent experience in armed conflict has demonstrated the efficacy of sUAS in aerial reconnaissance, characterised by rapid target acquisition. These systems have been instrumental in reducing the "kill chain" (detection, decision, and engagement) during FSC, thereby enhancing operational efficiency. Furthermore, sUAS have been employed in the direct destruction of targets through munition drops, FPV drones, or loitering munitions. The mass deployment of sUAS supports the concept of these assets as disposable due to high attrition rates and relatively low unit costs. [1–2]

The increasing prevalence of sUAS has led to a rise in the importance of electromagnetic warfare (EW), navigation warfare (NAVWAR), and counter-UAS (C-UAS) measures. The efficacy of drones is diminished by jamming and spoofing, which necessitate the adaptation of tactics, techniques, and procedures (TTPs). UAS do not inherently constitute a "revolution"; their effectiveness is contingent on the mastery of related procedures, detection, and protection against defensive systems, including EW and NAVWAR. [3] This approach is predicated on the standardisation of procedures and institutional integration with EW, NAVWAR, and C-UAS [1], [3]. In high-intensity conflicts, the deployment of sUAS to units and the maintenance of the pace of adaptation are crucial, whilst balancing the benefits of UAS against the adversary's C-UAS measures [1–3].

The integration of sUAS within Western militaries signifies a shift in the acquisition and utilisation of sophisticated technology, with the mass deployment of affordable, commercial drones complementing established approaches [1–2]. Concurrently, civilian technologies are being incorporated into military operations, thereby engendering security and legal concerns [4]. The dual-use character of sUAS introduces complexities to regulation and export control policies, as technological advancement persists beyond the military domain [5]. The integration of military and commercial drones engenders distinct effects and necessitates doctrinal adaptation [6]. The implementation of these systems cannot be reduced to the availability of platforms, as organisational and infrastructural prerequisites, and the technological capacity of states to acquire and maintain more sophisticated capabilities, are also key factors reflected in the pace and nature of adoption [7].

The objective of this article is to analyse, based on the professional literature, current approaches to the implementation of sUAS in units, to identify relevant measures for introduction into the organisational structures of the Czech Armed Forces (CAF) through qualitative coding, and to propose prioritised recommendations across the functional areas of doctrine, organisation, training, materiel, leadership, personnel, infrastructure, and interoperability (DOTMLPF-I). The originality of this article lies in linking these insights with the DOTMLPF-I framework [1], [7].

2. Methodology and Limitations

The study is conceived as a qualitative research design that combines several mutually reinforcing analytical steps in order to translate insights from publicly available literature and documents into prioritized recommendations for the introduction of sUAS capability at the tactical level of the CAF within the DOTMLPF-I functional areas.

The DOTMLPF-I analytical framework was selected for structuring the analysis and coding the findings. It represents a standard tool of NATO and the U.S. Department of Defense for the comprehensive development and assessment of military capabilities [8]. The framework divides capabilities into eight interrelated areas: DOTMLPF-I [9]. The primary purpose of the framework is to ensure that any capability gap solution is not assessed in isolation - for example, solely as an equipment procurement - but that all mutually interconnected aspects of the system are considered [8]. DOTMLPF-I thus makes it possible to identify capability gaps, minimize risks arising from uneven development across individual areas, and ensure the efficient allocation of resources throughout the entire capability lifecycle [10]. The use of this framework for capability gap analysis in the context of introducing new capabilities into armed forces is evidenced by foreign studies [11–13].

The methodology consists of the following sequence of steps:

1) A Systematic Literature Review (SLR) focused on the current employment of selected sUAS types in high-intensity conflicts at the tactical level, and on implementation aspects including EW, NAVWAR and C-UAS measures. Sources published between 2014 and 2026 in English and Czech are included in the analysis. The source base consists of 30 documents and comprises doctrinal and conceptual documents from NATO and the United States, technical reports from reputable research institutions (RAND Corporation, ETH Zürich, JAPCC), and specialized military publications. Sources relating to the tactical employment of sUAS in conventional conflict or to implementation aspects of their introduction into armed forces were included. Sources focused exclusively on civilian applications or on technical system parameters without operational context were excluded. The predominance of sources from 2021–2026 reflects the study's intent to draw primarily from current conflict experience.

The SLR analytical procedure is oriented toward three main outputs: (1) thematic classification of the literature on sUAS employment in conventional conflict; (2) identification of recurring tactical, organizational, and doctrinal patterns; (3) derivation of implications for capability implementation within the CAF environment. The output of this step is an annotated bibliography of sources with identified literature claims relevant to the introduction of sUAS capability within the CAF environment, which serves as the input for the subsequent DOTMLPF-I framework coding step.

2) A systematic content analysis of selected sources using qualitative coding (e.g. [14–15]) according to the DOTMLPF-I framework. The unit of analysis is an 'evidence claim' (typically 1–3 sentences or a paragraph conveying a single finding or recommendation). Each claim is assigned a primary analytical category corresponding to the dominant DOTMLPF-I area and, where applicable, supplementary subcategories capturing cross-domain overlaps. To increase analytical precision, each claim is supplemented with a set of cross-cutting tags capturing command and control level (C2_level), sUAS tactical role (Role_sUAS), platform type (Platform_type), threat environment (Threat_env), type of impact on tactical units (Impact_type), and evidence strength (Evidence_strength). This multi-dimensional coding enables

identification of each claim's primary DOTMLPF-I domain while also tracking horizontal patterns across domains — for example, which sUAS tactical role generates the greatest demands on training or interoperability.

3) Converting coded findings into concrete measures and prioritizing them across DOTMLPF-I. Each measure is assessed against three parameters: (1) Impact (1–5): the contribution to effectiveness, speed of introduction, capability sustainability and resilience in EW and C-UAS environments (1 = marginal, 5 = critical contribution); (2) Feasibility (1–5): the demands in terms of time, resources, and organizational dependencies (1 = immediately implementable, 5 = systemically conditioned); (3) Time horizon: divided into 0–6 months for quick internal measures primarily in D, T, and M; 6–18 months for structural changes in O and F and sustainability; and 18+ months for programmatic solutions in I, standardization, and larger-scale acquisition. The output is a package of measures ranked by a weighted priority index for expert discussion and validation, with the aim of establishing priority measures supporting sUAS implementation at the tactical level of the CAF.

4) Targeted expert validation complements the open literature base and enhances the practical applicability of the recommendations. Experts from operational and academic practice were engaged, each meeting at least one of the following criteria: direct experience with sUAS deployment or training; capability planning or management within the Czech Armed Forces or NATO structures; or subject-matter expertise in sUAS, EW, NAVWAR and C-UAS. Experts were invited to provide contextual information typically absent from public sources and to assess the relevance and confidence of selected claims and proposed measures for prioritization and potential implementation at the tactical level of the Czech Armed Forces. Input was collected through a structured template (Expert Validation) aligned with the DOTMLPF-I coding scheme, within which each expert: (1) added a practical annotation, clarification, or counter-argument; (2) assigned relevance (1–5) and confidence (1–5) ratings; (3) provided a brief justification of feasibility, blockers, or preconditions. The purpose is not statistical representativeness but targeted verification of SLR and DOTMLPF-I conclusions. Validation outputs feed into the weighted priority index (Priority_Rank) through relevance, confidence, and inter-expert consensus ratings, yielding prioritized measures with descriptions, implementation horizons, and key risks (Risk/trade-off).

Limitations

The study's findings are subject to several limitations: (1) The analysis draws primarily from publicly available sources, which precludes direct assessment of internal, non-public doctrines, training materials, or exercise evaluations of the CAF and allies. This limitation is partially mitigated by expert validation in Step 4, which allows contextual information from operational practice to be incorporated. (2) Given the scope of the problem and the volume of available literature, selected claims are presented as representative examples for potential further development, rather than as an exhaustive review. (3) The SLR captures primarily what is explicitly discussed in the literature — certain implementation aspects may be unevenly covered in open sources. Multi-dimensional coding using cross-cutting tags nevertheless enables these gaps to be systematically identified. (4) Expert validation is by definition non-statistical and may be subject to expert selection bias or differences in the frame of their experience. This validation therefore primarily serves to verify practical relevance and identify points of contention, rather than to support quantitative generalization.

3. Investigation Results

3.1 Systematic Literature Review (Step 1)

The results of the systematic literature review (2014–2026) and the subsequent analytical synthesis were translated into the DOTMLPF-I implementation framework. Evidence statements (consisting of one to three sentences per paragraph, containing a single finding or recommendation) were formulated from the identified findings and subsequently grouped according to the dominant functional area of DOTMLPF-I.

For each area, specific implications were expressed in the form of "literature statements" (e.g., D1–D4 … I1–I4), which explicitly describe what needs to be changed (e.g., standard operating procedures (SOPs) and tactical-technical procedures (TTPs), organisational anchoring, "train as you fight" training systems, communications resilience, infrastructure, interoperability etc.). The output of this process is a set of implications of the literary statements (E001–E032) which are clearly traceable, and which serve as a direct basis for subsequent qualitative coding and the derivation of measures.

Doctrinal (D) for sUAS defines integration into operations management and establishes SOPs/TTPs for planning, tasking, and safe operation, including airspace control and deconfliction. At the same time, it permits the use of UAS similarly to manned aircraft within established principles and documents, but emphasizes the specific characteristics of UAS, particularly the criticality of communication links, Beyond Line Of Sight (BLOS)/remote-split modes, and procedures for loss of link (lost-link) with implications for safety and C2. [16–17]

D1: sUAS planning and tasking should be integrated into established processes and output documents and into airspace control, with explicit coverage of communication dependencies, BLOS/remote-split, and emergency procedures in the event of a link loss [16–17]. D2: sUAS can be difficult to detect visually or via radar and often lack a distinct electromagnetic signature, requiring special procedures for airspace allocation, coordination with other users, and the ability to distinguish between friendly, neutral, and hostile entities [17]. D3: TTPs and SOPs for sUAS are evolving rapidly, but there is no mechanism for sharing TTPs and SOPs; therefore, it is necessary to have a process for collecting, validating, standardizing, and securely sharing knowledge, and to distinguish stable principles from subordinate tactical publications [18]. D4: Effective integration requires that staffs be able to plan rapidly within the framework of ISR and airspace control, and that units operate using rehearsed "kill chains" and standardized procedures for coordinating sUAS, airspace, and fire [17–18].

Organizational (O) for sUAS defines the integration of capabilities into the structure of units and staffs, including roles, responsibilities, and processes, to enable the planning and management of sUAS across all levels of command, standardize implementation responsibilities, and facilitate realistic use in training as well as scaling in operations [18].

O1: The integration of sUAS should not be viewed as a separate new task, but rather as a change in the execution of existing tasks and their incorporation into the standard processes of units and staff across all levels of command [18–19]. O2: Given the rapid evolution of TTPs and SOPs for sUAS, an institutional mechanism for sharing and standardizing procedures is necessary; without it, fragmentation occurs among units and the transfer of knowledge is slowed, which hinders training and capability development [18], [20]. O3: If sUAS attrition during training is linked to administratively burdensome financial accountability processes, a deterrent effect arises that limits the realistic use of sUAS. Organizational arrangements must therefore address the tolerance for training losses and record-keeping rules [21]. O4: Organizational management of sUAS should maintain minimum common standards (e.g., common architecture) without standardization hindering agility and innovation in sUAS implementation [19], [21].

Training (T) for sUAS encompasses the requirements, processes, and supporting capabilities for building, maintaining, and verifying individual and collective competence in the safe and effective use of sUAS; It includes standards, operator and instructor qualifications, rules, and infrastructure for realistic training, integration into collective training, and preparation of staff for ISR and airspace management during mass deployment [17–18].

T1: The mass deployment of sUAS requires a "train as you fight" system for realistic and extensive training both within and outside training areas; obstacles include capacities and rules for managing firing ranges and training areas, airspace management, spectrum management, and related administrative barriers, without the removal of which units cannot train with the necessary intensity [17–18]. T2: The deployment of sUAS depends on scalable production and the retention of instructors and experts to qualify operators and support commanders in implementing training plans; without this, a shortage of trainers and trained operators arises across units. At the same time, personnel must be allocated and trained under peacetime conditions to ensure operational readiness [16], [18]. T3: Effective use of sUAS in combined units requires the development of collective SOPs/TTPs for integration into maneuver, fire, and ISR operations, and training must be supported by a mechanism for the rapid sharing, validation, and updating of SOPs/TTPs. At the same time, airspace control must be practiced as a whole, as realism and safety depend on the interaction of all airspace users [17–18]. T4: The expansion of sUAS places greater demands on staff; effective integration into operations requires rapid ISR planning, airspace control, and coordination among staff elements for the execution and evaluation of combat operations; otherwise, the use of sUAS remains fragmented and slow [16–18].

Material (M) for sUAS encompasses the selection, configuration, acquisition, and replacement of platforms and their key physical and digital subsystems (particularly the airframe, propulsion system, sensors, and payloads, Ground Control Station (GCS), communication and data links, positioning, navigation, and timing (PNT) elements, and onboard computing capacity) and takes into account operation in an electromagnetically threatened environment as well as the expected loss rate of sUAS components. [22]

M1: The material design of sUAS must account for operation in a jammed electromagnetic spectrum. The resilience of radio links and navigation is a determinant of combat effectiveness, and single-band links and Global Navigation Satellite Systems (GNSS) increase vulnerability. [22] M2: The high expected loss rate of sUAS precludes planning based on protecting every platform. An sUAS asset must be understood as a resource with a limited lifespan, the loss of which is operationally acceptable upon achieving the desired effect [23–24]. M3: The sUAS hardware architecture should be modular (replacement of airframes, sensors, and payloads based on mission requirements and component availability) to shorten recovery times after losses, reduce costs, and enable rapid configuration adaptation without dependence on long acquisition cycles [22–23]. M4: An effective material solution distinguishes between centrally procured and managed components (e.g., GCS, selected communication elements) and items considered consumables (airframes, simple payloads) to combine standardization of key elements with inexpensive and rapid replacement of lost platforms [21], [24].

Leadership (L) domain for sUAS defines how commanders manage the pace of implementation, adaptation, and institutional learning during the widespread use of sUAS in both operations and training. It encompasses change management, risk and attrition management, support for experimentation, and the translation of insights into adjustments to processes, capabilities, and skills, focusing exclusively on sUAS.

L1: In the context of shortened cycles of sUAS use and adversary countermeasures, leadership must set the pace for rapid iteration through experimentation, rapid feedback, and continuous adjustment of procedures and capability configurations. Rapid innovation-adaptation cycles are, in this context, people-driven. [25–26] L2: The widespread deployment of sUAS requires adjustments to structures, processes, and incentives so that sUAS become a standard part of unit operations. This involves shortening adoption cycles, standardizing minimum requirements, and maintaining the pace of change in education, training, and roles for integration into teams and procedures. [24–25] L3: High attrition requires managing the risk of loss. Commanders' efforts to "avoid losing assets" limit the practical use of sUAS and slow down training, whereas accepting attrition as a parameter supports scaling up deployment and the pace of adaptation. [24] L4:

Leadership must ensure the systematic use of sUAS information in decision-making and provide space for lower echelons to act based on local situational superiority; the effect will be evident in supporting decentralized initiative within the mission framework and investing in human skills and resilient communication and coordination procedures [25].

Personnel (P) includes measures to establish and maintain the capabilities required for the safe and effective deployment of sUAS, including the definition of roles, requirements for initial and ongoing training, standardization, and the assessment of readiness and performance in real-world operations.

P1: The expansion of sUAS is limited primarily by the availability of personnel capable of certifying operators and maintaining their proficiency, including advanced training and integration into combat operations. The shortage of training facilities and certified instructors (master trainers) negatively impacts both the number and quality of qualified operators and unit training programs. P2: The long-term maintenance of sUAS capabilities requires an explicit definition of specializations and billets, along with personnel management to ensure they are filled by qualified personnel and regularly engaged in peacetime exercises. Concurrently, personnel must be allocated, trained, and engaged in peacetime exercises to ensure operational readiness. P3: The mass deployment of sUAS increases the demands on the training of staff personnel, particularly specialists in airspace planning and control and the integration of airspace, ISR, and fire control. Brigade and battalion staffs must possess the expertise and capacity commensurate with the future scope of sUAS use in airspace. [18] P4: Personnel approaches include standardizing qualifications and ensuring their transferability across system types to enable rapid replenishment and retraining of personnel. At the same time, the practices of tactical units demonstrate the need for multi-tiered manning based on the complexity and role of the drone, which limits the long-term replacement of core functions and allows for maintaining the pace of specialized tasks. [20]

Facilities (F) for sUAS/UAS include physical facilities and digital support systems that enable safe operation, rapid restoration of operational capability, and the achievement of the required sUAS availability in a timely manner [27–28].

F1: The required sUAS availability cannot be achieved if the infrastructure is addressed only after the assets have been deployed. It must be designed and sized according to realistic needs and the unit's rapid response requirements. [28] F2: The introduction of sUAS requires a digital infrastructure that standardizes the recording of qualifications, flights, and logistical status and ensures the availability of binding documents for safe operation [27]. F3: Key obstacles to "train as you fight" often stem from the limitations of Area F. Without the ability to fly and train realistically, training remains fragmented, and collective sUAS capabilities are not systematically built in the domestic environment. [18] F4: Power supply is becoming a limiting factor for sUAS endurance and operational tempo; without standardized "docking/charging" solutions, time out of mission increases and operational usability decreases [29].

Interoperability (I) domain addresses the functionality of sUAS and data across units, services, and allies: standard control/transfer-of-control interfaces, interoperable data links for ISR, and unified formats for video and target information; the goal is to reduce vendor lock-in and increase the usability of ISR within the coalition and across C2/C4ISR [30].

I1: Standardized UCS interfaces enable the control of platforms/payloads and the integration of sUAS into C2/C4ISR. They also reduce "siloing" and increase ISR sharing. C2 interoperability and information exchange via tactical data links for planning availability and frequency deconfliction are doctrinally critical. [16], [30] I2: Operations require nearly continuous data exchange for flight and payload control, bandwidth protection, interference resilience, and "lost-link" procedures. Interoperable data links and C2 reduce the risk of misidentification and support deconfliction [17], [30]. I3: Interoperability must be incorporated into requirements and acquisition and based on the UCS–platform–C4I/C4ISR interface for data exchange and capability sharing [30]. I4: For the exchange of ISR data via LOS links, direct exchange of ISR data between the national collection platform and the operational elements and users of another state is required [30].

3.2 Qualitative Coding (Step 2)

A qualitative content analysis was conducted using deductive coding [14–15], with the DOTMLPF-I model serving as the a priori coding structure and artificial intelligence being used to assist in the creation of the initial coding scheme. The dataset comprised 32 statements of evidence (E001–E032) derived from a comprehensive literature review across the individual subcategories D1–D4, O1–O4, T1–T4, M1–M4, L1–L4, P1–P4, F1–F4, and I1–I4, which represent the implications identified in the review section (E001–E032).

The unit of analysis for this study was a single statement (typically one paragraph) containing a single finding or recommendation. Each statement was assigned a primary code based on the prevailing DOTMLPF-I domain. Secondary codes (0–3) were utilised exclusively in instances of substantial overlap into another domain (e.g., SOP/TTP, training; "train as you fight" training, infrastructure; interoperability of standards, datalink, and technical interfaces).

In order to enhance analytical precision, cross-cutting sub-domains were implemented. The following factors must be taken into consideration: a) command and control level (C2_level), b) sUAS role (Role_sUAS), c) platform type (Platform_type), d) threat environment (Threat_env), and e) type of impact on tactical units (Impact_type). The application of these attributes was contingent upon their explicit articulation within the claim; in instances where such explicit statements were absent, the value "Cannot be determined from the data" was designated. For each statement, a qualitative measure of evidence strength (Evidence_strength) was added, taking into account the nature of the supporting evidence cited directly in the statement (e.g., standards/normative documents vs. more general arguments). The output of this process is a coded database (Coded_Korpus) of literary claims (E001–E032) with code justifications, enabling the tracing of conclusions and the subsequent creation of matrices and conversion into recommended measures.

3.3 Prioritization of Measures and Expert Validation (Steps 3–4)

The creation of a set of 12 measures (R01–R12) was undertaken, with the basis of this set being the coded statements in the Coded_Korpus dataset (E001–E032). The mapping of these measures to the DOTMLPF-I framework was also conducted.

In the Recommendations table, the measures are clearly linked to supporting statements (Supporting IDs) and supplemented with DOTMLPF-I assignments, descriptions, assumptions, risks, and notes on uncertainty. The Priority_Rank is derived from a combination of the following parameters: the impact score (1–5), the feasibility score (1–5), and the time horizon (0–6/6–18/18+ months). An expert validation was performed on the ten highest-rated items (E003, E004, E009, E013, E030; R01, R02, R04, R05, R07). This validation provided quantitative assessments of the items' relevance and confidence, as well as suggestions for refining the wording. The majority of items were rated as highly relevant (typically 4–5) by the majority of experts, with the greatest consensus being observed regarding the integration of sUAS outputs into ISR/fire control and C2 (E004, R02), the requirement for realistic "train as you fight" training (E009, R04), and the need to scale up the number of instructors (R05). Concurrently, points of contention began to emerge: At the doctrinal level, the debate centres on the tension between the need for stability in doctrine and the imperative for systematic revision. Standardisation of practice is achieved through the implementation of SOP/TTP, which undergoes continuous validation.

With regard to data link interoperability, two evaluations affirm its relevance and confidence, while a third evaluation expresses low confidence, recommending the consideration of alternative communication methods.

The issue of material resilience against EW/GNSS is addressed, with evaluations yielding high ratings, but also highlighting concerns regarding technical and economic feasibility. The trade-off between qualitative reinforcement and quantitative saturation is also noted.

In light of the commentary provided by the authorities in the field, the results underwent a process of refinement to ensure that they were expressed in a more precise and doctrinally sound manner. In the case of E003/R01, the emphasis was placed on the controlled nature of the mechanism for updating, verifying and securely sharing SOPs/TTPs outside the doctrinal level. In addition, the necessity to update the doctrine within a controlled revision cycle was highlighted. In E004/R02, the integration of sUAS outputs was expressed as a normative framework linked to the operational cycle and anchored in the targeting process, including the definition of roles, responsibilities, and TTPs. In E009/R04, the concept of "train as you fight" underwent refinement as the functional alignment of capabilities and processes, with a simultaneous emphasis on controlled availability and coordination of airspace, spectrum, and training areas, as well as on safety. In E013/R07, the vulnerability was explicitly linked to design and system choices (e.g. reliance on single-band links and GNSS), and measures were expanded to the material, design, and system levels (redundancy/diversification). In E030, the terminology was clarified by distinguishing between ISR data and products, and the role of the standard was defined as data exchange interoperability, while the specific transmission architecture (e.g., LOS or other means) is left as an implementation choice.

3.4 Measures for the Implementation of sUAS in the CAF

As outlined in the final synthesis (Step 5_Final_Recommendations), a set of twelve measures (R01–R12) was established for the implementation of sUAS capabilities into the Czech Armed Forces. These measures were structured across DOTMLPF-I and ranked by Priority_Rank (1 = highest priority). The measures encompass a combination of rapidly implementable doctrinal and procedural interventions (0–6 months), medium-term changes in training, organisation, and infrastructure (6–18 months), and long-term programmatic solutions in the areas of materiel and interoperability (18+ months).

The highest priority is given to steps focused on institutional learning, process standardisation, and the secure sharing of best practices. R01 proposes a regulated process for the ongoing updating, verification, and secure dissemination of SOPs/TTPs as a mechanism for unifying unit practices beyond the doctrinal level (impact 5; feasibility 4; timeframe 0–6 months; rank 1). R02 standardises the organisational and procedural integration of sUAS outputs into ISR, fire control, and C2 processes. This anchoring in the targeting process is accompanied by the definition of roles, responsibilities, and TTPs at the doctrinal framework level. The impact of this work is ranked at 5, its feasibility at 4, and its timeframe is 0–6 months. The rank is 2. R03 proposes an enhancement to the existing regulations governing airspace control for UAS, with a particular focus on deconfliction, identification and risk management procedures. The proposed changes are designed to address the unique requirements of UAS as a specific airspace user, and the feasibility of implementing these modifications is estimated to be within the range of 0 to 6 months. The rank assigned to this proposal is 6, indicating its relative importance and impact on the existing framework.

The medium-term package of measures has been designed to enhance capabilities through training, organisational rules, and supporting infrastructure. R04 operationalises the "Train as you fight" principle by systematically removing barriers to training in airspace, the electromagnetic spectrum (EMS) and training areas through controlled access and coordination within a framework that is doctrinally defined (Impact 5; Feasibility 3; 6–18 months; Rank 3). R05 establishes the framework for scalable production and maintenance of instructors/experts, and subsequent certification of operators under training conditions (impact 5; feasibility 3; 6–18 months; rank 4). R06 establishes a tolerance for training losses and makes adjustments to the record-keeping rules, with the aim of treating certain components of sUAS as consumables (impact 4; feasibility 3; 6–18 months; rank 7). R08 is a system that facilitates the integration of modular components within the airframe, sensor, and payload, thereby ensuring the expeditious restoration of functionality following losses and the seamless adaptation of configurations without the necessity for protracted cycles. This innovation is designated as impact 4, feasibility 3, with a projected timeframe of 6–18 months and a rank of 8. R09 differentiates between two categories of components: those that are centrally procured/managed (for example, GCS, selected communication components) and those that are consumable (airframes/payloads). The former category is assigned an impact of 4, a feasibility rating of 3, a timeframe of 6–18 months, and a rank of 9. R10 proposes the implementation of digital tools for the purpose of recording qualifications, flights, and logistical status. Furthermore, it establishes the mandatory documentation necessary for ensuring safe operations (impact 4; feasibility 3; 6–18 months; rank 10).

The long-term program measures devised for this purpose focus on enhancing interference resilience and ensuring the interoperability of data and interfaces. R07 has been demonstrated to enhance the resilience of sUAS communication and navigation against EW and NAVWAR through materials, design, and systems. This includes a reduction in dependence on single-band data links and GNSS via redundancy and solution diversification (impact 5; feasibility 2; 18+ months; rank 5). The R11 standardises key interfaces between the ground control segment (UCS), the platform, and the connection to C4ISR as a prerequisite for interoperability (impact 4; feasibility 2; 18+ months; rank 11). R12 implements an interoperable LOS datalink and standardised ISR data formats/metadata for the purpose of facilitating coalition usability and rapid sharing of ISR products (impact 4; feasibility 2; 18+ months; rank 12).

4. Conclusions

The methodological combination of SLR, qualitative content analysis coded into the DOTMLPF-I framework, prioritisation of measures, and targeted expert validation is relevant for sUAS implementation in the tactical units of the CAF. It enables transparent conversion of heterogeneous open-source findings into traceable “evidence-based statements” and actionable recommendations across DOTMLPF-I and improves practicality through expert verification. With rapidly evolving sUAS TTPs and C-UAS/EW/NAVWAR countermeasures, this structured approach supports priority steps beyond equipment procurement by addressing systemic capability dependencies.

However, application highlighted limitations. In the SLR, the diversity of sources requires assessing content, context, and temporal relevance, including occasionally incompatible conceptual frameworks. Translating findings into uniform “evidence statements” and measures is another weakness: synthesis risks loss of meaning and interpretive distortion, affecting DOTMLPF-I coding and prioritisation. Therefore, a carefully assembled expert team is pivotal to validate relevance and credibility and refine terminology where statements are strong yet unsuitable for military practice or doctrinal language. Expert validation aims to reach consensus on final formulations. Robustness depends on disciplined synthesis and expert input that minimises bias and increases implementation value.

Based on the SLR and subsequent synthesis, a core set of evidence-based statements was created and refined by experts, delineating opportunities and challenges for sUAS use and implementation within tactical units of the CAF, and the need to sustain adaptation against adversarial C-UAS/EW/NAVWAR measures. From these statements, practice-based measures were formulated and prioritised across the DOTMLPF-I domains. The resulting framework covers formal definitions and anchoring mechanisms, standardisation through continuously updated, validated, and securely shared SOPs/TTPs, organisational and personnel support, and standardised linkages of sUAS outputs to ISR and FSC, including integration into targeting, roles, and responsibilities. It also addresses scalable “train as you fight” training through systematic management of training capacities, airspace, and activities in the EMS, as well as materiel and system requirements for combat effectiveness in an EW/NAVWAR environment, emphasising redundancy and diversification of communications and navigation. The framework further includes infrastructure and logistical dimensions (recovery/attrition) and interoperability requirements to ensure real-time delivery of ISR data from platforms to users and higher-level ISR systems. Overall, the consolidated measures provide a realistic implementation path toward sustainable sUAS use at the tactical level of the CAF, maximising operational benefits while managing risks and mitigating C-UAS effects and enemy interference with the EMS and navigation.

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