INTRODUCTION OF VERSATILE UNMANNED AIRCRAFT SYSTEM: A COMBAT POWER MULTIPLIER FOR THE MACEDONIAN ARMY

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The latest events from the conflicts in Nagorno-Karabakh and Ukraine shifted the focus to the armed Unmanned Aircraft Systems employment in large-scale combat operations and shaped the perspectives for future war. Equipped with precision-guided ammunition, these armed Unmanned Aircraft Systems pushed forward the boundaries for their employment and changed the perception that Unmanned Aircraft Systems were solely Intelligence, Surveillance, and Reconnaissance assets. Armed Unmanned Aircraft Systems had a vital Close Air Support role by supporting the ground troops and conducting air interdiction missions on enemy Air Defense assets, artillery positions, command and control nodes, units in assembly areas, and logistic convoys that were moving from the rear area to the frontline. Armed Unmanned Aircraft Systems were also embedded with friendly artillery assets, thus providing precise target acquisition and accurate post-strike battle damage assessment. Macedonian Army will severely decrease its Close Air Support and air interdiction capabilities after retiring the Mi-24 combat helicopters in 2025. This study aims to develop a solution for a versatile armed Unmanned Aircraft System as a lucrative option for the Macedonian Army, which can be integrated into the ongoing modernization projects to multiply the overall armed force's capabilities, especially fires, intelligence, and command and control warfighting functions.

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ABSTRACT

INTRODUCTION OF VERSATILE UNMANNED AIRCRAFT SYSTEM: A COMBAT POWER MULTIPLIER FOR THE MACEDONIAN ARMY by Major Nikolcho Jovanov, 124 pages.

The latest events from the conflicts in Nagorno-Karabakh and Ukraine shifted the focus to the armed Unmanned Aircraft Systems employment in large-scale combat operations and shaped the perspectives for future war. Equipped with precision-guided ammunition, these armed Unmanned Aircraft Systems pushed forward the boundaries for their employment and changed the perception that Unmanned Aircraft Systems were solely Intelligence, Surveillance, and Reconnaissance assets.

Armed Unmanned Aircraft Systems had a vital Close Air Support role by supporting the ground troops and conducting air interdiction missions on enemy Air Defense assets, artillery positions, command and control nodes, units in assembly areas, and logistic convoys that were moving from the rear area to the frontline. Armed Unmanned Aircraft Systems were also embedded with friendly artillery assets, thus providing precise target acquisition and accurate post-strike battle damage assessment.

Macedonian Army will severely decrease its Close Air Support and air interdiction capabilities after retiring the Mi-24 combat helicopters in 2025. This study aims to develop a solution for a versatile armed Unmanned Aircraft System as a lucrative option for the Macedonian Army, which can be integrated into the ongoing modernization projects to multiply the overall armed force’s capabilities, especially fires, intelligence, and command and control warfighting functions.

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ACRONYMS

AF	Armed Forces
APCSM	Applied Professional Case Study Methodology
BDA	Battle Damage Assessment
BLOS	Beyond Line of Sight
BUQ	Basic UAS Qualification
C2	Command and Control
CAB	Combat Aviation Brigade
CAS	Close Air Support
C-BA	Capabilities-Based Assessment
CBRNE	Chemical, Biological, Radiological, Nuclear, High Yield Explosives
CDM	Chief Decision Maker
CJMQ	Combined/Joint Mission Qualification
CMC	Crisis Management Center
COMINT	Communications Intelligence
COMJAM	Communications Jamming
CRP	Communication Relay Package
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities, Policy
EA	Electronic Attack
ELINT	Electronic Intelligence
EW	Electronic Warfare
FAA	Functional Area Analysis
FMV	Full Motion Video

FNA	Functional Needs Analysis
FSA	Functional Solution Analysis
GCS	Ground Control Station
GMTI	Ground Moving Target Indicator
ISR	Intelligence, Surveillance, Reconnaissance
ISTAR	Intelligence, Surveillance, Target Acquisition, Reconnaissance
LOS	Line of Sight
LD	Laser Designator
LRF	Laser Range Finder
MALE	Medium Altitude Long Endurance
MOS	Military Occupational Specialty
MUM-T	Manned-Unmanned Teaming
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RPHO	Rescue and Protection Head Office
S&R	Search and Rescue
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communication
SIGINT	Signals Intelligence
TA	Target Acquisition
TOE	Table of Organization and Equipment
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
WFF	Warfighting Function

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CHAPTER 1

INTRODUCTION

Background

The latest events from the Nagorno-Karabakh conflict between Azerbaijan and Armenia and the conflict in the Donbas region between Russia and Ukraine shifted the focus to the armed drone employment in a large-scale combat operation and shaped the perspectives for future war. Equipped with precision-guided ammunition, these armed Unmanned Aircraft Systems (UAS) pushed forward the boundaries for their employment and changed the perception that they were solely Intelligence, Surveillance, and Reconnaissance (ISR) assets. Armed UASs had vital Close Air Support (CAS) role by supporting the ground troops and conducting air interdiction missions on enemy Air Defense (AD) assets, artillery positions, command and control (C2) nodes, units in assembly areas, and logistic convoys that were moving from the rear area to the frontline. These armed UAS were also embedded with friendly artillery assets, thus providing precise target acquisition (TA) and accurate post-strike battle damage assessment (BDA).

The United States (US) conducted its first recorded UAS strike on November 3, 2002, when a US Predator drone fired a Hellfire missile, killing six Al Qaeda operatives in Yemen (Rinehart 2016, ix). The US started the Global War on Terror campaign in 2001 with fewer than 50 drones, but since then, their number reached about 7500 in 2012 (Bergen and Rowland 2015, 300). The effectiveness of armed UAS employment was an indicator for other countries such as Israel, Turkey, Iran, China, Pakistan, and Russia to invest in either procuring or developing their systems. "By 2017, according to an estimate by the Center for New American Security, ninety countries had developed some kind of unarmed drone technology. Of these, thirty had programs for armed drones, but many more had the latent capabilities to do so" (Boyle 2020, 11).

The current security environment is unpredictable and is changing rapidly. Macedonia became a NATO member in 2020, but the country is still confronting a plethora of threats; conventional and hybrid. The possibility of conventional conflict is low but cannot be excluded. The strongest indicator is the current arms race in the region that increases the polarization of relations between the countries (MODRNM 2019, 5).

Modernization is currently an ongoing process in the Macedonian Army. It should increase Army's defense capabilities and interoperability with other NATO members in future deployments. *The Strategic Defense Review (SDR) 2018* and *The Long-Term Defense Capabilities Development Plan 2019-2028 (LTDCDP)* highlight the "Future Forces 2028" concept. The documents envision the dynamic acquisition of modern equipment by 2028 based on firm priorities (MODRNM 2019, 4). The modernization will improve the Armed Forces' capabilities through all warfighting functions. It envisions improving the command and control system, developing Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR), and Electronic Warfare (EW) capacities, developing indirect fire capabilities, improving aviation capabilities and capacities in support of ground forces, and developing and upgrading the active cyber defense system.

Problem Statement

The Long-Term Defense Capabilities Development Plan 2019-2028 affirms that Mi-24 combat helicopters will "remain in the Armed Forces (AF) structure until the expiration of their life cycle, by the end of 2025, without additional investments, except for the basic ongoing maintenance" (MODRNM 2019, 18). The Macedonian Army will severely decrease its combat power by losing the main CAS and air interdiction asset that it currently possesses. However, *The Long-Term Defense Capabilities Development Plan 2019-2028* does not provide a viable solution for maintaining the CAS and air interdiction capabilities after Mi-24's retirement in 2025. The *LTDCDP 2019-2028* precedes most of the latest conflicts and lacks implementation of the experiences from the modern battlefields such as Nagorno-Karabakh, Ukraine, Afghanistan, Syria, and Libya, where armed UAS were heavily used as CAS options and platforms for high precision fires. These lessons learned must be implemented in the ongoing modernization process.

Purpose of the Study

The purpose of this study is to develop a solution for a versatile armed UAS as a lucrative option for the Macedonian Army by analyzing the Organization and Materiel domains from the DOTMLPF-P framework. The introduction of a versatile UAS, with prolonged endurance and the ability to cover a wider area of operations, integrated with the other modernization programs, will enhance the overall force capabilities. Armed UAS can present an adequate replacement for the Mi-24 because they can simultaneously serve as a precision fire and ISR platform. On the other hand, they are challenging to locate and can destroy potential targets from a more extended range without exposing themselves to effective enemy counter-fire. The loss of a UAV is not equivalent to a loss of human life. Generally, UAS has a meager cost but can destroy an opponent's more expensive equipment such as tanks, air defense systems, and long-range artillery systems. They are simple to build, and the operators can be trained quickly.

The solution can be integrated into the ongoing modernization projects to multiply overall AF capabilities by:

1. Enabling aviation capabilities and capacities development in support of the land forces for CAS and air interdiction fires;
2. Providing ISR capabilities as intelligence support to the AF, which will be interoperable with NATO;
3. Enabling real-time situational awareness and providing an unhindered flow of information so the commanders can make sound and timely decisions;
4. Facilitating the targeting process by providing accurate target acquisition (TA) for potential targets and post-strike battle damage assessment (BDA); and
5. Providing electronic support, electronic protection, and electronic attack capabilities.

Research Questions

This research will answer the primary research question: How does integrating versatile UAS through the Materiel and Organizational domains of the DOTMLPF-P framework increase the combat power of the Macedonian Army?

Introducing a versatile UAS in the Macedonian Armed Forces will represent a prodigious combat multiplier through most warfighting functions. The primary research question should be supplemented with additional secondary research questions that will provide information on the adequate types of UAS and suitable UAS organizations. It should also provide a thorough and complete understanding of the factors that can lead to their viable and profitable integration with other modernization programs and existing weapon systems and integration in support of other governmental agencies during a crisis. The complementary secondary research questions are:

1. Which types of versatile, combat-proven UAS can effectively replace the Mi-24 as an air interdiction/ CAS asset by 2025?
2. What is a suitable solution for UAS unit organization in the Macedonian Army?
3. What other capabilities can versatile UAS provide to Macedonian Army?

Assumptions

UAS will increase its importance on future battlefields because of its versatility in supporting all warfighting functions. Besides precision strikes and ISR support, UAS provides TA and BDA to monitor the effects of fires by friendly aviation and indirect fire assets. They provide real-time situational awareness for the commander, thus hastening the decision-making process. The number of countries that will employ UAS in combat operations will be increasing. Many developing countries, unable to man aviation because of the high financial burden, rely on the UAS as an off-the-shelf air force. Macedonian authorities will perceive the benefits of acquiring versatile UAS that can be integrated with the modernization programs and can contribute to the overall combat readiness of the Armed Forces. That will lead to amendments to the *LTDCDP 2019-2028* and the "Future Forces 2028" concept.

Definition of Terms

Air Interdiction (AI): "Air operations conducted to divert, disrupt, delay, or destroy the enemy's military surface capabilities before it can be brought to bear effectively against friendly forces or to otherwise achieve objectives that are conducted at such distances from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required” (HQDA 2021, 1-3).

Battle Damage Assessment (BDA): “The estimate of damage composed of physical and functional damage assessment, as well as target system assessment, resulting from the application of lethal or nonlethal military force” (HQDA 2021, 1-10).

Close Air Support (CAS): “Air action against hostile targets which are in close proximity to friendly forces, and which require detailed integration of each air mission with the fire and movement of those forces” (NATO 2020, 26).

Electromagnetic Warfare (EW): “Military action involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy” (HQDA 2021, 1-35).

Intelligence, Surveillance, Reconnaissance (ISR): “An integrated operations and intelligence activity that synchronizes and integrates the planning and operation of sensors, assets, and processing, exploitation, and dissemination systems in direct support of current and future operations” (HQDA 2021, 1-54).

Target Acquisition (TA): “The detection, identification, and location of a target in sufficient detail to permit the effective employment of capabilities that create the required effects” (HQDA 2021, 1-99).

Unmanned Aircraft System (UAS): “That system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft” (HQDA 2021, 1-106).

Warfighting Function (WFF): "A group of tasks and systems united by a common purpose that commanders use to accomplish missions and training objectives" (HQDA 2019a, 5-2).

Scope

This research paper aims to provide recommendations for integrating a versatile UAS model that can increase the capabilities of the Macedonian Army across the warfighting functions of fires, intelligence, and C2 after retiring the Mi-24 in 2025. The DOTMLPF-P framework will provide solutions tailored to meet the essential requirements. The paper will focus on three areas: probable models of versatile UAS for adoption that own the desired air interdiction and CAS capabilities as an alternative to the Mi-24, possible UAS organization, what capabilities can UAS provide to improve fires, intelligence, and C2 warfighting functions, and the viability to support civil authorities.

The study focused on potential models manufactured by the United States, Israel, and Turkey. Secondly, it focused on a suitable, feasible, and acceptable UAS organization in the Macedonian Army. Furthermore, the study described the modes for employing the probable UAS to improve the C2 system, develop ISTAR and EW capacities, develop indirect fire capabilities, and improve aviation capabilities to support ground forces through their real-life employment. Lastly, it provided insights into their engagement in support of the other civil authorities, the Ministry of Interior, Rescue and Protection Head Office, and the Crisis Management Center.

Limitations and Delimitations

This subparagraph describes some of the limitations that influenced the quality of the paper. All the information presented in this research paper is unclassified and gathered by open source. A significant part of UAS characteristics is still confidential and constrained the in-depth exploration of the available sources. Available time was also a limiting factor in producing a comprehensive end-product.

This subparagraph describes the author's delimitations to focus on the most critical aspects of the research paper that relate to the defined problem and research questions. Focusing on the Organization and Materiel capabilities from the DOTMLPF-P framework and possible suitable UAS models narrowed the research scope and provided justifiable arguments and conclusions for UAS implementation and employment in the Macedonian Army. The study focused on UAS produced by the United States, Turkey, and Israel as models used by most NATO members. It would increase the interoperability of the Macedonian Army when participating in NATO-led operations by integrating with other alliance forces' assets and would decrease the logistical dependency on non-NATO or non-Western European countries. The analysis also excluded UAS that could not deliver lethal payloads (missiles) since the primary scope of the possible solution would be an alternative for the Mi-24 as a CAS and air interdiction asset. All UASs that were taken into consideration in the study were employed in actual combat operations. The main idea is to adopt a UAS that went through operational tests and evaluations to provide faster integration with other assets to increase combat power. UAS unit costs used in the analysis were from relevant sources published in different years, but they did not consider the yearly average inflation rate of the US dollar until today. Finally, the study analyzed how introducing UAS could improve only the intelligence, fires, and C2 warfighting functions to provide the Macedonian Army's broad spectrum of capabilities while conducting unified land operations.

Significance of the Study

The conflicts in the last decade gave publicity to the armed UAS and emphasized their importance in the new revolution of military affairs named "dronization of war" (Urcosta 2020a). The new technology was not exclusivity to the bigger and wealthier countries anymore. Some smaller and poorer countries recognized the benefit of introducing versatile UAS models as a lucrative option to increase their combat power across the warfighting functions. These countries saw combat UAS as "very cheap access to tactical aviation and precision-guided weapons, enabling them to destroy an opponent's much-costlier equipment such as tanks and air defense systems" (Dixon 2020). Latest conflicts emphasized the versatility of the UAS and its plethora of assigned roles: airstrikes to destroy enemy targets far beyond the Forward Edge of the Battle Area (FEBA), ISR mission to provide Critical Commander's Information Requirements (CCIRs), protection of forces by providing screen operations and support of precise indirect fire by providing accurate target acquisition and fire adjustment.

The Macedonian Army should thoroughly analyze lessons learned from previous conflicts, while the ongoing modernization is an excellent opportunity to implement them to prepare for the next-generation war. By adopting a new modular multipurpose UAS, the Army will receive strike assets to replace the obsolete Mi-24 combat helicopter, maintaining the CAS and air interdiction capabilities for ground forces. Additionally, it will extend the endurance of ISR missions, refine the TA and BDA before and after indirect fire employment, provide real-time C2 and accelerate the decision-making process and provide capabilities to disrupt enemy electronic systems and conduct offensive electronic actions. The research paper attempts to justify the purpose of a versatile UAS introduction in the Armed Forces and can serve as a guide for its integration through the DOTMLPF-P capabilities.

Pre-Research Position R1

Macedonian Army should analyze the experiences from the latest battlefields related to the UAS employment and their contribution to the overall success of achieving the operational and strategic end states. By revising the "Future Forces 2028" concept and including and integrating UAS in the modernization process, the Macedonian Army will sustain its CAS and air interdiction capabilities and enhance its overall combat power through most warfighting functions. The DOTMLPF-P framework is an adequate solution for developing the desired capability.

Summary

The UAS established their reputation as versatile assets that can significantly influence the outcome of a war. Their latest employments change the perception that UAS are high-technology equipment accessible only to the wealthier and more prominent countries.

> That a country such as Azerbaijan was able to effect precision strikes at operational depth—once thought to be the sole preserve of great powers—by using a range of relatively cheap tools to substitute for its lack of a robust air force is strategically noteworthy. In the future, Western forces should anticipate a robust, layered threat to the safety of their rear areas, even when facing sub-peer opponents (Watling and Kaushal 2020).

UAS users are increasing every day, especially among the smaller and poorer countries that see this technology as a cost-effective option to replace the expensive strike aircraft. Simultaneously, their flexibility provides diversity in their employment in additional missions such as ISR, adjustment to indirect artillery fire, real-time C2, and electronic warfare.

CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this study is to develop a solution for a versatile armed UAS as a lucrative option for the Macedonian Army by analyzing the Organization and Materiel domains from the DOTMLPF-P framework. This chapter provided information about the most significant literature used to answer the pre-formulated research questions:

1. How does integrating versatile UAS through the Materiel and Organizational domains of the DOTMLPF-P framework increase the combat power of the Macedonian Army? (Primary research question)
2. Which types of versatile, combat-proven UAS can effectively replace the Mi-24 as an air interdiction/CAS asset by 2025?
3. What is a suitable solution for UAS unit organization in the Macedonian Army?
4. What other capabilities can versatile UASs provide to Macedonian Army?

While conducting a literature review, it was very convenient to divide the sources of information by their different areas of research/study. For this research paper, the literature was divided into the following areas:

1. Macedonian national strategic documents;
2. Current Macedonian doctrine that relates to current UAS employment;
3. Army professional body of knowledge;
4. NATO, US, and UK doctrine for UAS employment;

5. Definition, classification, prospective models of UAS, and prospective UAS organization; and
6. Experiences from combat and non-combat employment of UAS worldwide.

The overall analysis of the literature review was based on open-sources analysis because a great deal of UAS characteristics were confidential and constrained for the public. Additionally, declassified information on UAS employment in combat operations was rare and hard to find.

Macedonian National Strategic Documents

Long Term Defence Capabilities Development Plan 2019-2028 and *Strategic Defence Review 2018* are national strategic documents that project and guide the development of the Macedonian Armed Forces. *Strategic Defence Review 2018* guides the future development and continued transformation of Macedonian defense to establish a modern and flexible Armed Forces through the "Future Forces 2028" concept, which can undertake mandated defense missions and positively contribute to NATO (MODRM 2018, 4). It has three parts: Contemporary Macedonian Defense, Future Macedonian Defense, and Strategic Defense Review Implementation and Defense. *Strategic Defence Review 2018* outlines that future AF should be capable of operating in different terrain and weather conditions and have the required firepower, intelligence, force protection, and effective command and control. At the same time, it states the list of the most immediate priorities for equipping, including the ISTAR capabilities.

Long Term Defence Capabilities Development Plan 2019-2028 is "the basic document that projects the development of defense and military capabilities of the Armed Forces (AF) and the Ministry of Defense (MOD) over ten years period" (MODRNM

2019, 2). The *Long Term Defence Capabilities Development Plan 2019-2028* portrays the vision for the change of the AF to "develop and maintain military capabilities to guide a wide range of armed conflict for the defense of the country, Alliance and Alliance's member states" (MODRNM 2019, 7). It also describes the goals for modernizing and equipping the AF and the MOD following the established priorities through different modernization programs to increase their effectiveness, efficiency, and interoperability with NATO allies. The *Long Term Defence Capabilities Development Plan 2019-2028* describes a detailed modernization and equipping plan through nine essential projects with the highest priority divided into three phases: the first period 2019-2024, the second period 2025-2028, and the third period after 2028. The estimated costs are calculated based on available data while preparing the document, and the projected overall amount is "$699 million, including customs and taxes" (MODRNM 2019, 41).

Current Macedonian Doctrine that Relates to UAS Employment

The Standard operating procedures (SOP) for employment of Unmanned Aerial Vehicles (UAV) from 2011 is the primary document in the Macedonian Army that incorporates the rules and procedures for UAV employment at the tactical level. It describes the limits for planning and execution of UAV missions to collect intelligence from the air. SOP defines the tactical UAV as a tool used to increase the ISTAR and BDA capacities, thus providing accurate and well-timed information for the commander. The document describes the UAVs solely as ISR assets assigned to accomplish the following tasks:

1. Conduct surveillance at Named Area of Interest (NAI) or Targeted Area of Interest (TAI);

2. Conduct route, area, and zone reconnaissance;
3. Support the intelligence gathering;
4. Maintain situational awareness;
5. Assist the TA and BDA;
6. Assist in area security operations; and
7. Assist in Combat Search and Rescue (CS&R).

The SOP also defines the employment of UAVs through the phases of planning, preparation, execution, and debriefing and describes their integration with other ISR assets. UAVs are vital assets when conducting Reconnaissance, Surveillance, and Target Acquisition (RSTA) to determine enemy disposition and strength and facilitate the commander's decision-making process by providing actual live video feeds or aerial photographs.

Army Professional Body of Knowledge

The Army's professional body of knowledge literature included all methods, concepts, processes, tools, and best practices from the Army profession, which generated a recommendation for improving Army capability (Long 2016). *How the Army Runs: A Senior Leader Reference Handbook, 2019-2020,* issued by the US Army War College, provided detailed insights on the Joint Capabilities Integration and Development System (JCIDS) and Capabilities-Based Assessment (C-BA) "to identify capability shortfalls or gaps, provide recommended doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy (DOTMLPF-P) solutions for required capabilities" (USAWC 2020, 3-1).

The Materiel solution closed the capability gap by acquiring a new asset or upgrading or modifying the existing one. The Organizational solution described the integration of the Materiel solution with the operators to accomplish the collective mission by supporting their "warfighting capabilities required to prevail in the future operational environment" (USAWC 2020, 3-10).

ATP 5-0.1 *Army Design Methodology* provided quality insights on the procedures necessary to detect and solve problems. It was a great tool to enhance a leader's abilities through critical and creative thinking because it "provided techniques for framing operational environments, framing problems, developing an operational approach, and reframing" (HQDA 2015, iii).

NATO, US, and UK Doctrine for UAS Employment

NATO standard ATP-3.3.8.1 *Minimum Training Requirements For Unmanned Aircraft Systems (UAS) Operators And Pilots,* edition B, version 1, codifies the

> basic UAS qualification and mission skills into standardized training sets. These minimum UAS qualification and employment skills are designed to standardize and streamline UAS training efforts for the NATO UAS community, thereby increasing efficiency, capabilities, and standardization of UAS operations for the combined/joint force commander (NATO 2019, 1-1).

The document defines NATO UAS classification based on the size, altitude, operational range, and level of the supporting commander and describes the difference between UAS operator and UAS pilot. It also outlines the qualifications and competencies that UAS operators/pilots should hold to operate UAS safely based on airspace regulations and designated missions while conducting NATO operations.

JDP 0-30.2, *Unmanned Aircraft Systems* "guides operational commanders and planning staff in understanding the terminology, tasking, and employment of the UK's

UAS" (UKMOD 2017, iii). The document recognizes the need for improving the current operational models of UAS used by the UK and predicts their future development path. The doctrine outlines the terminology and classification related to UAS, both UK and NATO. The UASs are divided into three classes based on their weight. The Army and Navy currently operate Class I and II systems (Watchkeeper, Desert Hawk III, Black Hornet, Scan Eagle) and prefer the term UAS, while the Air Force only operates Class III system (Reaper) and prefers the term Remotely Piloted Aircraft System (RPAS). NATO's definitions are similar, with one significant difference for RPAS related to pilot qualification.

JDP 0-30.2 recommends that intelligence specialists plan and integrate UASs for maximum exploitation. This standpoint will impose the logistic considerations while deploying UASs in the theater. The document also recognized the vulnerability of data link to the UAS and the importance of protecting the communications bandwidth from adversary action or accidental friendly interference (UKMOD 2017, 28).

The doctrine also gives a short description of the tactical and technical characteristics of the UASs used by UK AF. UASs are equipped with electro-optical and infrared (IR) sensors that provide tactical level video imagery during day or night. The laser module can find and designate targets, thus enhancing the TA process. Reaper is the only model that can be armed. No 13 Squadron operates it, and a complete system includes "four aircraft, two ground control stations, communication equipment and links, spares, and personnel from all three Services supported by contractor ground crew" (UKMOD 2017, 61).

Eyes of the Army: U.S. Army Roadmap for Unmanned Aircraft Systems 2010-2035 outlines how the US Army will develop, organize, and employ UAS from 2010 to 2035 across the unified land operations. It spans a 25-year period divided into three distinct periods: Near-term (2010-2015), Mid-term (2016-2025), and Long-term (2026-2035). Each period is analyzed through the developmental considerations using the DOTMLPF-P framework and the expected implementation plan (US Army UAS COE 2010, 2). It also provides a UAS description, definition, and a brief explanation of its components and UAS grouping, along with their capabilities and limitations.

The Roadmap also defines the missions that meet the warfighter's needs. It recognizes reconnaissance and surveillance as the number one mission for the UASs as specialized assets that provide intelligence for the commander. The UAS should also provide Chemical, Biological, Nuclear, and Chemical and High Yield Explosives (CBRNE) reconnaissance and Counter-Explosive Hazard capabilities. UAS should provide security operations by providing information about the threat and denying its ability to interdict friendly forces by direct fire.

The document also emphasizes the importance of UASs while conducting attacks in close combat, through interdiction or strike. Weaponized UAS should be integrated into the air/ground scheme of maneuver while supporting troops in close combat. Coupled with combat helicopters, it provides fires and non-lethal effects (primarily EW) or can conduct high payoff attack/strike operations (US Army UAS COE 2010, 3). Another aspect for improvement is the command, control, and communication support by enabling network connectivity among the weapon systems, sensors, soldiers, leaders, platforms, and command posts (CPs) at all echelons, no matter the terrain and the weather conditions (US Army UAS COE 2010, 4). *The Roadmap* also guides UAS employment in support of Warfighting functions.

The interim FM 3-04.155, *Army UAS Operations* provides detailed characteristics, capabilities, and limitations of UAS used by the US Army. It also describes the organization of different UAS types and their employment while conducting ISR missions, security operations, unmanned targeting, and various kinds of manned-unmanned team operations.

The document *RPA Vector: Vision and Enabling Concepts 2013–2038* defines the US Air Force's strategic vision for the future of Remotely Piloted Aircrafts (RPA) by outlining the concepts and capabilities needed over the next 25 years. The document emphasizes the importance of UAS across the range of military operations (ROMO), primarily while operating in Anti-Access Area Denial (A2/AD) environment.

RPA Vector defines the terminology and systems descriptions and divides UAS into five groups. Groups 1 through 3 are defined as Small UAS (SUAS), while groups 4 and 5 are classified as RPA. Many of the models can carry a lethal or nonlethal payload. The most significant differences are that RPA is complex and requires a rated pilot (11U or 18X), while SUAS is superficial, and its operator is not a rated pilot but functions as the pilot in command (PIC) and is responsible for the safe ground and flight operation of the Unmanned Aircraft and onboard systems (HQUSAF 2014, 13).

The document also described past UAS employment and gave a vision for their employment in the future, especially with providing protection, EW capabilities, suppression/destruction of enemy AD, C2, integrated ISR, CAS, search and rescue (S&R) missions, medical evacuation (MEDEVAC), and humanitarian assistance (HA).

RPA Vector defines the required capabilities over the twenty-five years by the DOTMLPF-P framework, where an increased number of milestones depicts solutions.

Definition, Classification, and Prospective Models of UAS and Prospective UAS Organization

In their book, *Drone Warfare*, John Kaag and Sarah Kreps define a drone, UAS, or RPA as any object that flies without an onboard pilot. Their classification depends on many parameters such as function, size, payload, geographical range, flight endurance, and altitude. Authors use the US Air Force system that classifies drones into five tiers, depending on their altitude and function. Another classification that the authors are using is according to the parameters of altitude and endurance, emphasizing the Medium Altitude High Endurance (MALE) drones that generally correspond to Tier 2. According to the authors, drones are very reliable and have a meager price than fighter jets, but they have two primary drawbacks: incapable of conducting air-to-air fights and vulnerable to jamming if the enemy has advanced technological capabilities to disrupt the drone's datalinks (Kaag and Kreps 2014, 25).

The book, *Drones and Targeted Killing in the Middle East and Africa, An Appraisal of American Counterterrorism Policy,* Christine Sixta Rinehart presents the prices for most types of UAS operated by the US Armed Forces. It also depicts the maintenance, asset utilization, and personal costs while operating a UAS. The book also gives additional details about the operators' training and the associated cost concerning achieving the training hallmarks for future UAS operators.

The vital differences in the technical characteristics of the Predator as the first-generation armed drone equipped with Hellfire missiles and the improvements in the

Reaper as a second-generation armed drone was depicted by Hugh Gusterson in his book, *Drone Remote Warfare Control*. The Reaper can fly twice as fast and twice as high as the Predator, and it is not limited to using only one type of missile.

In their article "Turkish UAV Capabilities as a New Competitor in the Market," Sinem Kahveciouglu and Hakan Oktal wrote about Turkey's proliferation of UAS models, especially the Anka model, compared to the US Predator and Israeli Heron. The conclusion is that Anka "will be able to execute not only the missions of intelligence, surveillance, target acquisation [*sic*], and reconnaissance (ISTAR) performed by Heron and Predator but also the mission of aerial strike performed by Predator" (Kahveciouglu and Oktal 2014, 185). Additional information about the Turkish models of UAS could also be found in Sibel Duz's publication *The Ascension of Turkey as a Drone Power: History*, *Strategy, and Geopolitical Implications*. The author depicted Turkey's progress in drone technology proliferation conducted in the last decade and provided an overview of the characteristics of the most famous Turkish designs, such as Bayraktar TB2 produced by Baykar Makina and Anka-S produced by TUSAŞ.

Jane's All the Worlds Aircraft Unmanned 2019-2020, edited by Martin Streetly and Akshara Parakala, is a prodigious compendium encompassing many UAS manufactured by different countries. It depicts the historical overview of their development and operational employment and provides a detailed overview of their technical characteristics.

Manufacturers' catalogs also supported the literature review because they provided information about the characteristics of different UAS and the types of payloads at their disposal, thus enhancing their versatility to conduct diverse missions.

The Unmanned Aircraft System Roadmap 2010-2035 and FM 3-04, *Army Aviation*, provide insights into the UAS MQ-1C Gray Eagle company organization as a part of the Combat Aviation Brigade (CAB). MQ-1C company consists of twelve UAS and four Ground Control Stations (GCS). Its organization includes company headquarters, a flight platoon, and a maintenance platoon (US Army UAS COE 2010, 97). The company provides support to the brigades as a division asset or can support the CAB through Man-Unmanned Teaming (MUM-T) in conducting: zone, route, and area reconnaissance, surveillance, attack, BDA, and C2 support (HQDA 2020a, 2-3).

Experiences from Combat and Non-Combat Employment of UAS Worldwide

In their article, "The Impact of the Nagorno-Karabakh Conflict in 2020 on the Perception of Combat Drones," authors Damir Ilic and Vladimir Tomasevic identified that number of countries that include combat UAS is increasing every day and that this proliferation is a result of UAS's low cost compared to their high efficiency. They presented a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) based on the combat UAS deployment on different battlefields worldwide over the last decade. The authors strongly support the thesis that the war in Nagorno Karabakh was a turning point for combat UAS employment. At the same time, lessons learned from this conflict will influence the employment of combat UAS in future conflicts. Mass employment of UAS in the Nagorno Karabakh conflict provided Azerbaijan opportunities to conduct UAS precise strikes independently or combined with other aircraft or artillery assets. Turkish Bayraktar TB2, combined with Israeli IAI Heron and Elbit Hermes 900, were the key combat UAS contributing to the conflict's outcome (Ilic and Tomashevic 2021).

In his research paper, “Unarmed and Dangerous: The Lethal Application of Non-Weaponized Drones,” Arthur Holland Michel described drones’ versatility in conducting different types of missions. The author provided vignettes and experience from actual operations conducted in Ukraine, Sahel, Syria, and Afghanistan. UAS provided buddy lasing for manned aircraft, assisted in TA, adjusted indirect fires, provided accurate BDA for the artillery, served as an airborne relay station to extend communications, or provided offensive electronic capabilities that would deny, degrade, disrupt, or destroy enemy electronic sources (Michel 2020).

Turkey began to project the new method of twenty-first-century warfare at the operational level while involved in conflicts in Syria and Libya. The employment of UAS in large-scale combat operations against peer adversaries differed from the previously known experiences—UAS were instruments of combat, deviating from the established practice that they were solely an ISR asset. The author, Ridvan Bari Urcosta, in his article “The Revolution of Drone Warfare, The Lessons from the Idlib De-Escalation Zone,” wrote about Turkish experiences while fighting the Syrian Army and forces loyal to Field Marshal Khalifa Haftar in Libya. According to high Turkish officials, tactical Bayraktar TB2 and multipurpose TAI Anka MALE UASs achieved tremendous results in destroying a significant number of high-value targets, including modern AD systems such as Pantsir S-1and Buk. Turkish forces also integrated electronic systems that allowed detection of Syrian Army location. Those locations were transmitted “to the TAI Anka UAS, which relayed data to the combat Bayraktar TB2s for target elimination” (Urcosta, 2020b, 52). UAS were also assigned *sniper* missions eliminating high-ranking Syrian officers (Urcosta 2020b, 54). The article ended with a detailed, in-depth analysis of operational advantages and limitations of UAS employment, based on the experiences gained on Syrian and Libyan battlefields.

Another source for understanding the importance of UAS employment was the paper, “Drones in Hybrid Warfare: Lessons from Current Battlefields,” by Frank Christian Sprengel. His paper analyzed the experiences of UAS employment in Ukraine, Syria, Libya, Yemen, and Nagorno Karabakh. The analysis demonstrated that UAS played a crucial role in these conflicts. All sides heavily relied on the UAS for ISR missions, close air support, target acquisition, and strikes on high-value enemy targets at the rear. Combined with electronic warfare measures, they also achieved significant results in destroying modern AD systems. The experiences from these conflicts also emphasized the value against efficiency ratio because “high-quality combat systems costing millions of euros could be rendered incapable of fighting or even completely destroyed with material costing only a few tens of thousands of euros” (Sprengel 2021, 24). In addition, high-resolution videos used for information operation broadcast showed the world “one’s own power and any powerlessness of the enemy” (Sprengel 2021, 24).

In the book, *Drones What Everyone Needs to Know*, Sarah E. Kreps defined the terms drone, UAS, or RPA by giving a brief overview of the historical genealogy of armed drones. Drone classification combines altitude, range, and endurance with three categories of drones; Mini, Tactical, and Strategic. The author also analyzed drones in combat in Pakistan, Yemen, and Somalia through the number of strikes and operations and fatality estimates. She also focused on the proliferation of drones per country. Another aspect of the author’s focus was drone technology in non-combat situations, which spans from security objectives such as humanitarian crisis prevention to immigration enforcement. In the US government, agencies use drones for their everyday work. Customs and Border Protection agency uses drones for border control. In local law enforcement, drones are used for functions similar to police helicopters, with a much lower expense than a fraction of operating a helicopter. Drones are also used at night for thermal imaging while searching for suspects, taking aerial photos of the scene of a crime or traffic accident, assessing a river's flooding, searching for missing persons, and investigating hazardous materials. Another non-military use of drones is aid and relief operations in protecting and researching wildlife, earthquakes, nuclear accidents, and wildfires (Kreps 2016, 106-117).

Summary

The literature review should provide enough relevant information essential to the study. It should demonstrate the writer's preparedness to continue the research and validate the overall importance of the topic. Literature division into six areas will facilitate the study and answer the primary and secondary research questions. This chapter focused on current Macedonian strategic documents that will lead to new military capabilities in the Macedonian Army over the next six years. It described the actual national doctrine and doctrines of NATO, the US, and the UK that relate to the definition and classification of UAS, their integration, and employment in the AF through the DOTMPLF-P concept. The Army professional body of knowledge literature provided the necessary methods, concepts, processes, tools, and best practices from the Army profession for further analysis. The literature review also provided information on the characteristics of possible UAS that the Macedonian Army should consider as potential CAS and air interdiction assets and possible types of organizations for their integration.

Finally, the chapter included the experiences and lessons learned from the modern battlefields that demonstrated the importance of UASs and their ability to influence the outcome of the conflict and their non-combat employment, demonstrating that UASs are adaptable and multifunctional.

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

This chapter will describe the methodology that will lead to a recommended solution for introducing versatile UAS in the Macedonian Army to the Chief Decision Maker (CDM). It starts with the Army Design Methodology (ADM) for applying critical and creative thinking to understand, visualize, and describe problems and approaches to solving them. Capability-based assessment (C-BA) will supplement ADM by providing adequate Functional Area Analysis (FAA) or *needs analysis*, Functional Needs Analysis (FNA) or *gaps analysis*, and Functional Solution Analysis (FSA) or *solution analysis*. Finally, the DOTMLPF-P framework will recommend Materiel and Organizational proposals to the CDM. The literature review provided information about the strategic needs for employment of UAS in the Macedonian Army, followed by characteristics of potential types of versatile UAS and approach to their integration into a suitable organization based on the doctrines of NATO, the US, and the UK. It also provided information on experiences from the modern battlefields that emphasized the significance of UAS and the advantage they had provided for the opponent that used them vigorously. Finally, operating a UAS in support of civil authorities illustrates their multifunctionality. The literature review provided answers to secondary research questions that facilitated answering the primary research question, focusing on the Materiel and Organization domains of the DOTMLPF-P framework.

Army Design Methodology (ADM)

The US Army doctrine defines ADM as "a methodology for applying critical and creative thinking to understand, visualize, and describe unfamiliar problems and approaches to solving them" (HQDA 2015, 1-3). The ADM is conceptual planning that provides solutions to complex and ambiguous situations. It includes the following steps:

1. Frame the operational environment by describing the current state and visualizing the future state;
2. Frame the problem by identifying the obstacles that prevent achieving the desired end state;
3. Develop an operational approach, a description of the broad actions and means to resolve the problem; and
4. Reframing, revisiting the understanding of the operational environment and the problem (HQDA 2015, 1-4, 1-5).

Capabilities-Based Assessment (C-BA)

As an integral part of the Joint Capabilities Integration and Development Systems (JCIDS), the C-BA identifies capability shortfalls or gaps, and provides recommended DOTMLPF-P solutions for the required capability (USAWC 2020, 3-1). It consists of three steps: FAA provides the framework to assess the required capabilities, FNA identifies any gaps between the current and programmed capabilities, and finally, FSA provides solutions or mitigations to the capabilities needs that arose from the FNA in terms of possible materiel or non-materiel approaches.

Method

The most appropriate method to answer primary and secondary research questions is the Applied Professional Case Study Method (APCSM). This qualitative research method applies best practices of the Army Professional Body of Knowledge (PBOK) by using appropriate professional models, concepts, processes, norms, and values to develop recommendations for improving Army warfighting capabilities and assist CDM in its decisions (Long 2016). This method is helpful when framing a problem, gathering data, analyzing the data collected, and providing recommendations and solutions based on analyzed data to the CDM. The method encompasses the desired level of critical and creative thinking that will create a final solution that will be suitable (achieve the desired effect), feasible (achieve the effect with means available), and acceptable (the cost should justify the effects). Figure 1 depicts the APCSM process and its components drawn from ADM and C-BA.

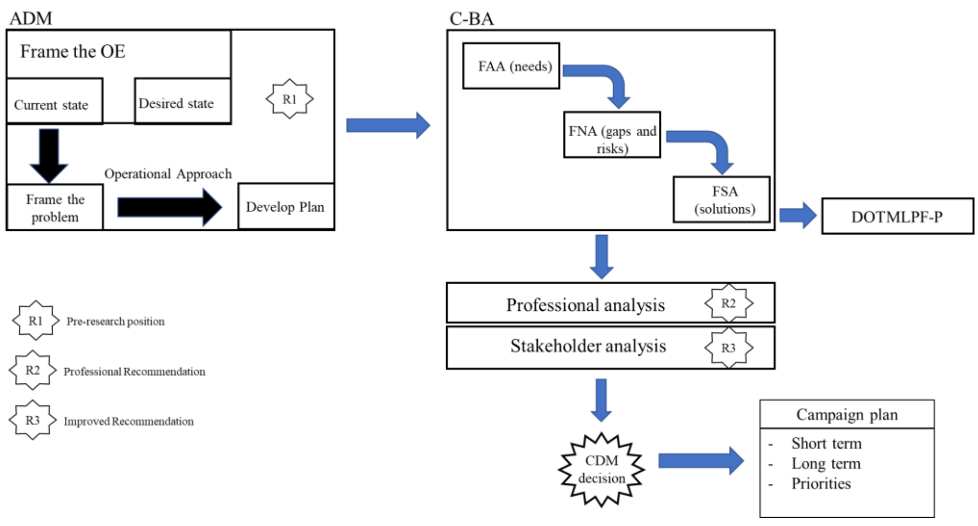

Figure 1. Long's Applied Professional Case Study Research Method

Source: Created by author using Long 2016.

The first step will include framing the problem by analyzing the current and the desired end state. ADM is an excellent tool for applying critical and creative thinking to understand, visualize, and describe complex problems and provide solutions. This step will include the pre-research position R1, which stems from the researcher's experience, initial insights, and professional judgment; the main goal is to list all the biases and assumptions transparently.

The second step is the C-BA process. It should augment the ADM by providing adequate needs, gaps, and solution analysis to achieve a suitable solution in the DOTMLPF-P domain (in this study, only Materiel and Organization will be used to provide solutions to the CDM).

The professional analysis will be the third step of the research methodology. It should provide feasibility based on the relevant criteria from the literature review and lead to a professional recommendation (R2).

The fourth step-stakeholder analysis, will provide acceptability from the stakeholder's perspective to the projected solutions. It will result in an updated recommendation (R3) that will encompass the improvements and adaptations from the previous R2 position for the CDM.

Step five starts after CDM approval, when a campaign plan is created. It should incorporate short-term and long-term actions in a gradation of priorities in terms of *must do*, *should do*, and *could do* (Long 2016).

Data Collection

The Applied Professional Case Study research method is a subclass of case study types, usually used in qualitative research methodology. It will provide "an empirical inquiry investigating a contemporary phenomenon within its real-life context" (Merriam 2009, 40). The selection of a multiple case studies approach provided additional data and emphasized the depth and breadth of the research.

Open-source literature was the primary foundation while conducting data collection. The research focused on specific facts, such as technical and tactical characteristics of certain models of armed UAS, existing UAS organizations, and experiences from combat and non-combat employment of armed UAS. The wide diversity of sources created sufficient data for later study and assured that the research questions were covered in detail. With well-defined evaluation criteria, the data analysis gained through the literature review would lead to suitable and coherent improved recommendation R2.

Data Analysis

Data analysis should provide an unbiased evaluation of the established criteria to evaluate the final solution and recommend the final proposal for CDM approval. Screening criteria suitable, feasible, and acceptable will ensure that the recommended solutions will solve the problem while developing clear evaluation criteria will augment selecting the best possible solution. The narrative form will be the dominant dimension in presenting the data analysis; however, the analysis will be complemented with additional tables and figures to visualize the process and facilitate the final CDM's decision.

Summary

The APCSM applied an adapted form of the Capabilities-Based Assessment (C-BA) process, used by the US Department of Defense to develop or improve new warfighting capabilities (Long 2016). First, ADM complemented with C-BA were the tools used to frame the problem and identify the capability gaps, steps that preceded the unbiased pre-research position R1. Second, the professional analysis was a product of the established relevant evaluation criteria and the literature review resulting in professional recommendation R2. Furthermore, incorporating important stakeholders' perspectives resulted in the updated recommendation R3, an amended solution proposed for CDM's approval. Finally, CDM approval resulted in a campaign plan which incorporated short-term and long-term actions with clear and distinct priorities during each action.

CHAPTER 4

ANALYSIS

Organization

The official national strategic documents, *Strategic Defence Review 2018,* and *Long Term Defence Capabilities Development Plan 2019-2028,* recommended the withdrawal of Mi-24 combat helicopters until the expiration of their life cycle by the end of 2025, thus severely decreasing the Army's combat power by losing the primary CAS and air interdiction asset. The *Long Term Defence Capabilities Development Plan 2019-2028* also emphasized modernizing and equipping the AF without providing an alternate solution for maintaining the CAS and air interdiction capabilities after Mi-24's retirement in 2025. Using the Applied Professional Case Study Method and the findings from the literature review, this chapter should answer the previously defined research questions and provide recommendations to the CDM on integrating a versatile UAS that can sustain the CAS and air interdiction capabilities and can increase the overall combat power of the Macedonian Army.

To understand the capability gap caused by Mi-24 withdrawal in 2025, this analysis will begin by providing an overview of the helicopter's characteristics and capabilities. Secondly, it will describe the definitions of UAS/RPAS and their categories and explain the significance and importance of integrating the UAS through the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. Third, it will provide information on the characteristics and capabilities of potential UAS. Fourth, it will describe the established evaluation criteria, analyze them through the lens of different stakeholders and weigh the criteria to provide a proposal for CDM approval.

These steps will answer the first secondary research question: Which types of versatile, combat-proven UAS can effectively replace the Mi-24 as an air interdiction/ CAS asset by 2025? The analysis of the MQ-1C Gray Eagle organization in a US Combat Aviation Brigade should provide insights for a suitable, acceptable, and feasible UAS organization at the lowest level in the Macedonian Army and answer the second secondary research question: What is a suitable solution for UAS unit organization in the Macedonian Army? Finally, the analysis will provide information on the possible integration of these versatile UAS with other assets to increase the overall combat power, based on the experience of their employment on the battlefields and the support of civil authorities worldwide. It will answer the third secondary research question: What other capabilities can versatile UASs provide to the Macedonian Army?

Mi-24 V (Hind-E) and Mi-24 K (Hind-G2)-the Pride of the Macedonian Air Wing

It has been more than twenty years since Mi-24V (Hind-E) was first introduced in the Macedonian Army. The first batch of ten Mi-24V gunships arrived in May 2001 (Malezanski 2010, 13), and an additional two Mi-24K (Hind-G2), used for photo-reconnaissance and Air Observation Post (AOP) tasks, arrived in December 2001 (VAYU Aerospace 2017).

Mi-24V is an attack helicopter designed to provide air interdiction/ CAS to the ground forces against armored targets and fortified objects and transportation of personnel. It is equipped with a revolving turret containing a four-barrel rotating 9A624 machine gun of 12.7 mm with 1470 rounds, four blocks of UB-32 (each with 32 pieces of S-5 missiles of 57 mm), four B-8V blocks for 20 rockets of S-8 type of 80 mm, different types of air bombs with maximum weight up to 1000kg (bombs can be 100, 200 and 500kg), and eight 9M 114 Shturm-V(NATO AT-6 Spiral) anti-tank guided missiles, fired from two cylindrical containers mounted at each wingtip (ARNM n.d.a). Figure 2 depicts a Mi-24 helicopter in action, demonstrating the diverse and prodigious payload it can deliver to destroy enemy targets.

The Mi-24K (Hind-G2) is the artillery fire-correction derivative that lacks guided weapons capability but is equipped with a powerful camera suitable for spotting targets on the battlefield. It "comprises the computer-controlled Ruta system with an under-nose Iris EO sight and radio datalink, while within the cabin, a large AFA-100 oblique photo camera is installed" (Mladenov 2010, 20, 21).

Figure 2. Macedonian Mi-24 Conducting Cannoning, Rocketing, and Bombing during Exercise at Krivolak Training Area

Source: ARNM 2015.

Mi-24V was the primary CAS asset for the Macedonian Army against the ethnic-Albanian rebels during the internal conflict in the country in 2001. A small part of these aircraft went through the process of modernization by the Israeli Elbit Systems under the *Alexander* project with an ultimate goal to increase their capability (by introducing the ANVIS/HUD-24 system, Trimble GPS, new self-defense aids, multifunctional displays for the COMPASS IV multi-sensor turret and head-mounted cueing system for both the turret and the YakB 12.7mm machine gun) and interoperability to NATO and International Civil Aviation Organization (ICAO) standards, particularly the navigation, communication, and identification system (Mladenov 2010, 25). Table 1 summarizes the primary tactical-technical data and capabilities of the Mi-24V helicopter.

Table 1. Tactical-Technical Data for Mi-24V (Hind-E)

Length	21.35 m
Height	5.47 m
Flight endurance	4 hours
Weight (empty)	8680 kg
Maximum take-off weight	12000 kg
Maximum speed	335 km/h
Ceiling	4500 m
Range	450km (1000km with external tanks)
Crew	3
Payload	2400 kg

Source: Created by author using ARNM n.d.a; Ministry of Defense & Armed Forces of the Czech Republic n.d.

Definition of UAS

The US doctrine defined the UAS as "a system whose components include the necessary equipment, network, and personnel to control an unmanned aircraft" (HQDA

2021, 1-106). The definition used by NATO is very similar. It defined UAS as "a system whose components include the unmanned aircraft, the supporting network, and all equipment and personnel necessary to control the unmanned aircraft" (NATO 2020, 133). Human involvement is the focus of UAS's employment in both definitions. *Eyes of the Army U.S. Army Roadmap for Unmanned Aircraft Systems 2010-2035* stated that each "UAS is comprised of an unmanned aircraft (UA), payload, human operator, control element, display, communication architecture, life cycle logistics, and the supported Soldier" (US Army UAS COE 2010, 1). The *Roadmap 2010-2035* also described each component separately:

Unmanned aircraft. Fixed or rotary-wing aircraft capable of flight without an onboard crew that also includes the integrated equipment needed for flight (propulsion, avionics, fuel, navigation, and data links).

Mission packages. Equipment carried on a UAS configured to accomplish a specific mission. Typical payloads include:

1. Different types of sensors (electro-optical (EO), infrared (IR), synthetic aperture radar (SAR), Ground Moving Target Indication (GMTI), signals intelligence (SIGINT), electronic attack (EA), Full Motion Video (FMV), and still frame imagery). Their advantages and disadvantages are depicted in Table 2,

Table 2. Advantages and Disadvantages of Different Types of Sensors	
Advantages	Disadvantages
Electro-optical (EO)	
Affords a familiar view of a scene	Employment of camouflage and concealment techniques can deceive the sensor
Offers system resolution unachievable in other optical systems or in thermal images and radars	Restricted by weather conditions; visible light cannot penetrate clouds or fog
Preferred for detailed analysis and measurement	Restricted by terrain and vegetation
Can provide 3D imaging for better analysis	Limited to lighted areas during the night
Infrared (IR)	
A passive sensor, impossible to jam	Not as effective during thermal crossover (1 to 1.5 hours after sunrise or sunset)
Offers camouflage penetration	Tactical platforms threatened by threat air defenses
Provides a good resolution. Night imaging capability	Bad weather degrades the quality
Synthetic Aperture Radar (SAR)	
Near continuous situational awareness even in adverse weather	No video capability. Not supported by One System Remote Video Terminal (OSRVT)
Detailed imaging of a large area.	Extensive processing and distribution bandwidth
Photographic-like images	Image latency based on resolution
Ground Moving Target Indicator (GMTI)	
Provides increased UA survivability through increased stand-off ranges	Additional processing may be required. Will miss stationary targets

Source: JUAS-COE 2010, 4, 5.

2. Communications payloads that extend voice and data transmissions via the UAS,

3. Weapons payloads that include lethal (missiles and bombs) and nonlethal systems to incapacitate people, damage or destroy property or render sources nonfunctional or unavailable, and
4. Cargo, internal or external to the UA (supplies, personnel, or equipment).

Human element. Human interface to operate UAS throughout the mission.

Control element. It encompasses several mission aspects, including C2, mission planning, take-off and landing, unmanned aircraft control, payload control, weapons control, and communications. The control element is usually located at the GCS and can be a laptop computer, a kit mounted on a vehicle/aircraft, or located in a larger fixed facility.

Display. Include GCS display systems, handheld displays, remote viewing display systems, and other manned cockpit displays.

Communication Architecture. It consists of hardware and software to exchange data and voice communications between the unmanned aircraft, control element, and the Soldier, usually by Line of Sight (LOS) or Beyond Line of Sight (BLOS) data transmission and reception.

Lifecycle logistics. It represents the dedicated logistical support, including the equipment to deploy, transport, launch, recover, enable communications, and sustain the UAS. Smaller UAS have relatively few support requirements, while larger and more complex UAS usually require more significant support.

NATO doctrine determined the term remotely piloted aircraft (RPA) as “an unmanned aircraft that is controlled from a remote pilot station by a pilot who has been trained and certified to the same standards as a pilot of a manned aircraft” (NATO 2020, 110). Personnel with “Basic UAS Qualification (BUQ) levels I and II are generally termed *UAS operators*, whereas those trained to BUQ levels III and IV are generally termed *UAS pilots*, as these latter training levels are considered equivalent to manned aircraft” (NATO 2019, 1-2). The US Air Force distinguished between the terms Small UAS (SUAS) and RPA based on the level of operator’s expertise and the system’s categorization. “SUAS operators (SUAS-O) are not rated pilots, but function as the pilots in command (PIC) and are responsible for the safe ground and flight operation of the UA and onboard systems” (HQUSAF 2014, 13). On the other hand, “RPA requires rated pilots (Air Force Specialty Code (AFSC) 11U or 18X) along with the sensors operator or system operator, a ground control station (GCS) and squadron operations center (SOC), associated manpower and support systems, and communication infrastructure to perform the mission and intelligence integration” (HQUSAF 2014, 13). RPA also refers to UAS categories IV and V, while categories I to III are considered SUAS.

Categories of UAS

Literature generally differentiated the UAS by several parameters, including function, size, payload, geographical range, flight endurance, and altitude. *The Eyes of the Army U.S. Army Roadmap for Unmanned Aircraft Systems 2010-2035* described five groups of UAS categorization shown in Table 3 based on the following attributes: weight, altitude, and speed without considering the tasking authority, echelon of C2, or payloads.

Table 3. UAS Current Systems

UAS Category	Max Gross Takeoff Weight	Normal Operating Altitude (Ft)	Airspeed	Current Army UAS in operation
Group 1	< 20 pounds	< 1200 above ground level (AGL)	< 100 knots	RQ-11B Raven
Group 2	21-55 pounds	< 3500 AGL	< 250 knots	No system
Group 3	<1320 pounds	< 18000 mean see level (MSL)		RQ-7B Shadow
Group 4	>1320 pounds		Any airspeed	MQ-5C, MQ-1C
Group 5		> 18000 MSL		No system

Source: US Army UAS COE 2010, 12.

Group 1 UAS are small, lightweight, man-portable, hand-launched systems with modular payloads such as EO, IR, and SAR, usually capable of ISR tasks to provide situational awareness at battalion-level and below. They have a small logistical footprint but have to operate within the operator's LOS at low altitudes for a short duration.

Group 2 UAS are medium-sized systems found at brigade level or lower ISR and TA requirements. They are usually catapult-launched and do not require an improved runway. Their payload includes EO/IR sensors and a laser range-finder/designator (LRF/D). Group 2 UAS has greater endurance than Group 1 UAS, and their increased power allows the employment of more sophisticated sensors with better visual acuity and resolution. These systems have a medium logistical footprint with more unit resources for transport and sustainment. The Scan Eagle used by the US Air Force represents this category.

Group 3 UAS are robust systems that operate at medium altitudes with medium to long-range endurance. Their payload is versatile and usually includes EO/IR sensors, LRF/D, SAR, moving target indicator, SIGINT, communications relay, and explosive hazards or CBRN detection. Some types can carry different precision-guided weapon systems, decreasing their endurance but increasing their overall logistical footprint. Also, Group 3 UAS usually does not require an improved runway for their employment.

Group 4 UAS are large systems that operate at medium to high altitudes and have extended endurance. They have a versatile payload that includes EO/IR sensors, lasers, radars, an automated identification system (AIS), SIGINT, communications relay, and weapons. Since they have greater power than the previous three groups, their munition payload is larger without significantly decreasing overall endurance. They require runways for launch and recovery and have a massive logistical footprint similar to manned aircraft. Their employment demands severe airspace measures and requirements, and because of their extensive range, Group 4 UAS depends on satellite communication links to achieve BLOS control of the unmanned aircraft.

Group 5 UAS are the largest systems capable of operating in medium to high altitude environments and have the greatest range and endurance while covering a much larger area than any other category of UAS. Their payloads include EO/IR sensors, lasers, radars, AIS, SIGINT, communications relay, and weapons. They also require improved areas for launch and recovery and have a massive logistical footprint similar to manned aircraft. Their employment demands severe airspace measures and requirements, and because of their extensive range, Group 5 UAS depends on satellite communication links to achieve BLOS control of the unmanned aircraft. MQ-9 Reaper and RQ-4 Global Hawk used by the US Air Force are the most prominent representatives of this category.

NATO classification system relies on weight as the crucial parameter to determine the category of UAS. Figure 3 depicts the UAS growth in size, range, and altitude based on the UAS's progression from Class 1 to Class 3. The higher the UAS's class, the more complex the UAS is.

NATO UAS CLASSIFICATION

Class	Category	Normal Employment	Normal Operating Altitude	Normal Mission Radius	Primary Supported Commander	Example Platform
Class III (> 600 kg)	Strike/ Combat *	Strategic/ National	Up to 65,000 ft MSL	Unlimited (BLOS)	Theatre	Reaper
	HALE	Strategic/ National	Up to 65,000 ft MSL	Unlimited (BLOS)	Theatre	Global Hawk
	MALE	Operational/ Theatre	Up to 45,000 ft MSL	Unlimited (BLOS)	JTF	Heron
Class II (150 kg - 600 kg)	Tactical	Tactical Formation	Up to 18,000 ft AGL	200 km (LOS)	Division, Brigade	Watchkeeper
Class I (< 150 kg)	Small (>15 kg)	Tactical Unit	Up to 5,000 ft AGL	50 km (LOS)	Battalion, Regiment	Scan Eagle
	Mini (<15 kg)	Tactical Sub-unit (manual or hand launch)	Up to 3,000 ft AGL	Up to 25 km (LOS)	Company, Platoon, Squad	Skylark
	Micro ** (<66 J)	Tactical Sub-unit (manual or hand launch)	Up to 200 ft AGL	Up to 5 km (LOS)	Platoon, Squad	Black Widow

Figure 3. NATO UAS Classification

Source: NATO 2019, 2-2.

Strengths, Weaknesses, Opportunities, Threats (SWOT) Analysis of Combat UAS

The following SWOT analysis presents the advantages and disadvantages of combat UAS compared to manned aircraft and their employment on the modern battlefields, especially in the conflicts in the last decade. Figure 4 unifies the strengths, weaknesses, opportunities, and threats that the UAS operator should consider for a successful UAS employment.

Strengths	Weaknesses
1. Suitable for dull, dirty, and dangerous tasks 2. Longer flight endurance 3. Low-level flight 4. No pilot onboard, no risk for crew 5. Fast responsiveness in targeting cycle 6. Versatile payloads enable different missions 7. Low procurement and operational cost 8. Low operational and maintenance costs 9. Low training cost	1. Limited capability in adverse weather conditions 2. Smaller payload compared to manned aircrafts 3. Datalinks prone to jamming 4. Slow target 5. Vulnerable to network-centric, layered air defense 6. Restricted operations in civilian airspace 7. Moral, legal and ethical employment of UAS
Opportunities	**Threats**
1. Increase in future UAS proliferation 2. It can be used as a propaganda weapon 3. Integration with other lethal and non-lethal assets 4. Support other governmental agencies 5. A simpler system with easy and simple maintenance 6. Easily accessible components on the market	1. Possibility of civilian casualties 2. Threatening the civilian air traffic 3. High possibility of accident/lose 4. Bandwidth requirement

Figure 4. SWOT Analysis of Combat UAS

Source: Created by author using Ilic and Tomashevic 2021.

Strengths

UAS operates in *dull, dirty, and dangerous tasks*, thus minimizing the risk to the aircrew. It can fly at extremely low altitudes and has a longer sustained presence over a potential target than manned aircraft. UAS also allows fast responsiveness, decreasing the *find-fix-finish loop* during the targeting cycle. It has minor acquisition and operational costs compared to modern aircraft. The versatile payload provides flexibility while executing different missions, ranging from ISR, strike, EW, target acquisition, resupply, counter-improvised explosive device (C-IED) protection to combat search and rescue (CS&R).

Weaknesses

UAS has limited capability during adverse weather conditions (heavy rain, fog, strong wind) and a smaller payload than manned aircraft (missiles, sensors). It is not capable of air-to-air combat, its datalinks are prone to jamming, and potential employment is restricted, mainly while operating in civilian airspace. UAS is a very slow target and is vulnerable to modern, network-centric, layered air defense.

Opportunities

The proliferation of UAS will increase in the future, having more countries capable of producing UAS from commercially available components from various manufacturers worldwide. The latest conflicts have shown that combat UAS "can also be a powerful weapon of propaganda" (Ilic and Tomashevic 2021, 17). UAS integration with manned aircraft and long-range artillery systems enhanced strike capabilities and provided accurate BDA. UAS also provided offensive EW capabilities against enemy C2 systems and radars.

Threats

Despite its modern and high-quality sensors that can monitor the situation on the ground, UAS employment in the past often resulted in civilian casualties (Ilic and

Tomashevic 2021, 17). Without proper coordination, UAS can interfere with civilian air traffic and become a threat primarily when operating near civilian airports.

Prospective Types of Combat-Proven UAS

Mi-24 is a versatile helicopter that provides CAS by destroying enemy armor and fortified objects at the FEBA, conducting air interdiction missions in the friendly force's deep area, reconnaissance and surveillance of NAIs, observation, and adjustment of friendly indirect fires, and transport of personnel. When considering the possible type of UAS seen as the replacement of the Mi-24V combat helicopter, the primary focus will be on CAS and air interdiction capacities as its primary roles and capabilities.

The further analysis will exclude the categories/classes of UAS used solely as ISR assets (Class I and Class II according to NATO classification or Groups 1, 2, and 3 according to the US classification). It will focus on the assets whose primary capability is to deliver lethal projectiles (Class III according to NATO classification and Group 4 and 5 according to the US classification).

US Models

The United States is still the leading nation in UAS proliferation nowadays. The weaponization of the existing unmanned aircraft vehicles was a logical step between the previous mission to collect and record data and the later mission to deliver lethal payloads. The most prominent models with strike capability are the MQ-1C Gray Eagle used by the U.S Army and MQ-9 Reaper used by the US Air Force.

The MQ-1C Gray Eagle

The MQ-1C Gray Eagle illustrated in Figure 5 “is a multi-mission, multi-payload system whose primary mission is to provide UAS support to division combat aviation, fires, and battlefield surveillance brigades, BCTs, and other Army and joint force units. It is capable of long endurance, near real-time reconnaissance, and precision attack” (HQDA 2020a, 5-5).

Figure 5. General Atomics MQ-1C Gray Eagle

Source: General Atomics Aeronautical n.d.a.

The MQ-1C Gray Eagle “can be outfitted with the AGM-114 Hellfire missile for attacking selected targets. The MQ-1C uses a laser range-finder and a laser designator, which is used to determine the range to the target and to designate targets for delivery of laser-guided munitions. Four missiles are carried in the attack configuration, and two are carried in the reconnaissance/attack configuration” (HQDA 2020a, 5-7). Gray Eagle can be equipped with an electronic warfare pod that provides two capabilities: the ability to conduct an electronic attack or jamming and electronic support capability that facilitates SIGINT (Pomerleau 2019). Table 4 summarizes the primary tactical and technical data of the MQ-1C Gray Eagle UAS and underlines the vast capabilities it can bring in combat.

Table 4. MQ-1C Gray Eagle Unmanned Aircraft Characteristics

Fuselage Length	29 feet (8.83m)
Height	9 feet 8 inches (2.94m)
Main Wing Span	56. 3 feet (17.14m)
Endurance	25 hours without armament
Propulsion	Heavy fuel engine (1. 7 or 2. 0 liter)
Maximum Gross Take-Off Weight	1. 7L 3,200 pounds (1451 kg) /2. 0L 3,600 pounds (1633 kg)
Maximum Altitude	25,000 feet (7620 m) above mean sea level
Runaway Requirement	4500 feet (1372 m) at 9000 feet (2743 m) density altitude; hard surface only
Cruise Airspeed	80 knots (148.2 km/h)
Max Continuous Airspeed	167 knots (309.2 km/h)
Payload capacity	1,075 pounds (488 kg)
Armament	4 Hellfire missiles
Sensors/Payloads	EO, IR, laser pointer, laser range-finder, laser designator, laser spot tracker, SAR, GMTI
Datalink Equipment	Ku-Band satellite communication (SATCOM), LOS tactical common data link (TCDL)
Additional Capabilities	communication relay, FMV, Remote Video Terminal (RVT), COMINT, ELINT, COMJAM

Source: Created by author using HQDA 2020a, 5-6; General Atomics Aeronautical n.d.a; BAE Systems 2015; JUAS-COE 2010, 102.
NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

The MQ-1C has a per-unit cost of about $18.2 million (SecDef/CFO 2020, 1-5). "Its expansive mission set includes wide-area Intelligence Surveillance and

Reconnaissance (ISR), convoy protection, Improvised Explosive Device (IED) detection and defeat, close air support, communications relay, and weapons delivery missions" (General Atomics Aeronautical n.d.a).

MQ-9 Reaper

MQ-9 Reaper, illustrated in Figure 6, is used as an intelligence collection asset and a high-precision missile delivery platform. "It provides a unique capability to perform strike, coordination, and reconnaissance against high-value, fleeting, and time-sensitive targets. Reapers can also perform the following missions and tasks: intelligence, surveillance and reconnaissance, close air support, combat search and rescue, precision strike, buddy-lase, convoy and raid overwatch, route clearance, target development, and terminal air guidance" (USAF 2021).

Figure 6. General Atomics MQ-9 Reaper

Source: USAF 2021.

“A fully operational system consists of sensor/weapon-equipped aircraft, a ground control station, Predator Primary Satellite Link, and spare equipment, along with operations and maintenance crews for deployed 24-hour missions” (USAF 2021). “The MQ-9 baseline system carries the Multi-Spectral Targeting System (MTS-B) that integrates an infrared sensor, color, monochrome daylight TV camera, shortwave infrared camera, laser designator, and laser illuminator. The full-motion video from each imaging sensor can be viewed as separate video streams or fused” (USAF 2021). MQ-9 can be equipped with an electronic attack jamming pod produced by Northrop Grumman (Carey 2013).

“The laser range-finder/designator precisely designates targets for employing laser-guided munitions, such as the Guided Bomb Unit-12 Paveway II. The Reaper is also equipped with a synthetic aperture radar and can employ up to eight laser-guided AGM-114 Hellfire missiles” (USAF 2021). The crew consists of a rated pilot to control the aircraft and command the mission and an enlisted aircrew member to operate sensors and guide weapons. MQ-9 Reaper has a per-unit cost of about $32.5 million (SecDef/CFO 2020, 1-6). Table 5 summarizes the primary tactical and technical data of the MQ-9 Reaper UAS and its capabilities to conduct various missions.

Table 5. MQ-9 Reaper Unmanned Aircraft Characteristics	
Length	36 feet (11m)
Height	12.5 feet (3.8 m)
Wing Span	66 feet (20.1 m)
Endurance	27 hours clean configuration 16-20 hours with max payload
Range	1150 miles (1850.7 km)
Maximum take-off weight	10,500 pounds (4760 kg)
Weight (empty)	4,900 pounds (2,223 kilograms)
Maximum Altitude	50,000 feet (15,240 m) above mean sea level
Launch method	runway, hard surface only
Cruise Airspeed	200 knots (370.4 km/h)
Dash Airspeed	240 knots (444.5 km/h)
Payload capacity	3750 pounds (1701 kg)
Armament	Combination of AGM-114 Hellfire missiles, GBU-12 Paveway II, GBU-38 Joint Direct Attack Munitions, GBU-49 Enhanced Paveway II, and GBU-54 Laser Joint Direct Attack Munitions
Sensors/Payloads	EO, IR, laser range-finder, laser designator, Lynx multi-mode radar (SAR, GMTI, Maritime Wide Area Search (MWAS)
Datalink Equipment	Ku-Band BLOS/SATCOM data link control, C-Band LOS data link control
Additional Capabilities	FMV, Remote Video Terminal (RVT), ELINT, COMINT, communication relay, COMJAM

Source: Created by author using JUAS-COE 2010, 107; General Atomics Aeronautical n.d.b; Streetly and Parakala 2019, 288; USAF 2021.
NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

Turkey's Models

Turkey is another major player that significantly influenced the proliferation of armed drones in the last couple of years. "The tactical effectiveness, strength, and survivability of Turkey's UAVs in Syria, Iraq, Libya, and the southeast of Turkey have enabled Turkey's products to be labeled as "combat proven" and have given Turkey a highly prestigious reputation in the worldwide drone market" (Duz 2020, 8). Turkish UAS also significantly influenced the outcome of the Nagorno-Karabakh conflict while successfully suppressing enemy air defense assets and destroying enemy armor units. They have definitively proved themselves as versatile, reliable, and cost-effective assets compared to other UAS platforms that exist on the market today.

<u>Bayraktar TB2</u>

Bayraktar TB2, produced by Baykar Teknoloji, is a Medium Altitude Long Endurance (MALE) tactical UAS capable of conducting ISR and armed attack missions. "The system consists of Bayraktar TB2 Armed / UAV Platform, Ground Control Station, Ground Data Terminal, Remote Display Terminal, Advanced Base with Generator and Trailer modules" (Baykar Technology n.d.b). The components of the Bayraktar TB2 system are illustrated in Figure 7.

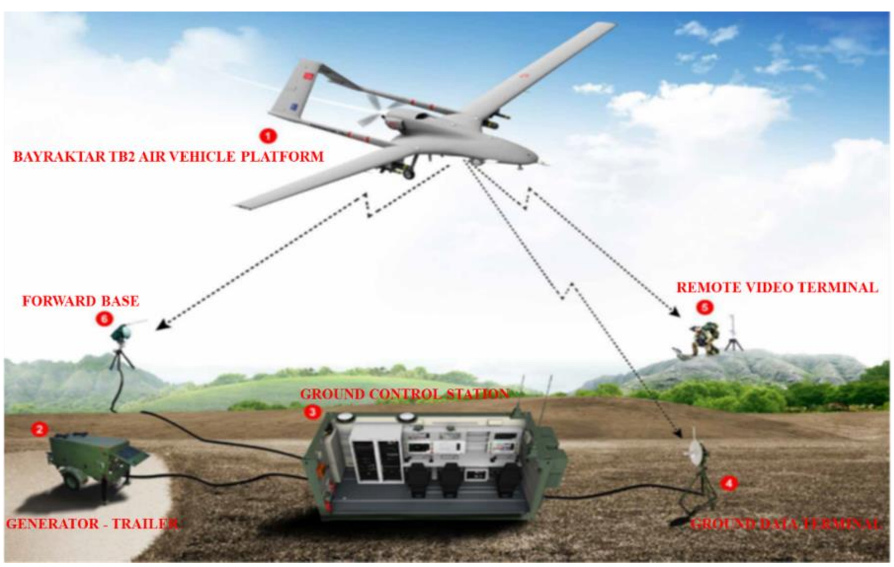

Figure 7. Baykar Bayraktar TB2 UAS

Source: Baykar Technology n.d.a, 8.

The Bayraktar TB2 payload can incorporate EO and IR camera modules, laser pointers, designators, range-finders, and Multipurpose Active Electronically Scanned Array (AESA) radar (Baykar Technology n.d.b). Its guidance and control features include a fully automatic flight system and automatic take-off/landing/taxi/parking. Bayraktar TB2 needs a hard surface runway to conduct conventional wheeled take-off and landing (Streetly and Parakala 2019, 222). The Bayraktar TB2 can deliver up to 4 smart munitions designated MAM-L and MAM-C produced by Roketsan, capable of destroying armor targets and enemy personnel at a maximum range of 8 km. It can also conduct precise TA using the onboard laser designator. The price of Bayraktar TB2 is $3 million (Karataş 2020, 56). Table 6 summarizes the primary tactical and technical data of the Bayraktar TB2 UAS and underlines the available capabilities while conducting different missions.

Table 6. Bayraktar TB2 Unmanned Aircraft Characteristics

Length	6.5 m
Height	2.2 m
Wing Span	12 m
Endurance	27 hours
Range	150 km
Weight (empty)	650 kilograms
Maximum Altitude	25,000 feet (7,620 m) above mean sea level
Operational altitude	22,500 feet (6,860 m) above mean sea level
Launch method	Automatic, runway
Cruise Airspeed	70 knots (130 km/h)
Dash Airspeed	120 knots (222 km/h)
Payload capacity	150 kg
Armament	4x MAM-C or MAM-L Roketsan missiles
Sensors/Payloads	EO, IR, laser range-finder, laser designator, laser pointer, SAR, Moving Target Indicator (MTI)
Datalink Equipment	C-Band and UHF antenna system
Additional Capabilities	ELINT, COMINT, RVT, FMV

Source: Created by author using Baykar Technology n.d.a; Baykar Technology n.d.b; Meteksan Defence 2021; Streetly and Parakala 2019.
NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

The signal intelligence system BSI-101 "is a high-performance radio receiver that can be used for airborne monitoring and surveillance of the RF spectrum. Based on a software-defined radio architecture, BSI-101 can be customized for the specific needs of ELINT and COMINT systems" (Baykar Technology n.d.a, 16).

TAI Anka

Anka UAS, illustrated in Figure 8, is an advanced MALE tactical UAS capable of conducting day and night, all-weather ISR, target detection, and armed attack missions. It also has autonomous flight capability, including automatic take-off and landing system

(ATOLS). Produced by Turkish Aerospace Industries (TAI), the UAS went through a couple of modernizations from its prototype introduced in 2010 (Anka Block A, Block B, and Block S, the last incorporating secure communication and "wide-band satellite communication up to 20Mbs" (TAI n.d.b).

Figure 8. TAI Anka

Source: TAI n.d.a.

Anka has different types of payloads, such as the Aselsan ASELFLIR 300T EO/IR imager (Block A and B) or the Aselsan Common Aperture Targeting System (CATS) for Anka-S, X-band Aselsan SAR for Anka Block B with ground moving target indicator and strip map/spot SAR operating modes, automatic antenna for positioning/stabilization, onboard recording capability and provision for SIGINT and communications relay equipment. Anka-B can carry up to four missiles (Streetly and Parakala 2019, 224). According to the manufacturer, these missiles include laser-guided rockets, anti-tank missiles, or precision-guided bombs. The UAS can conduct Electronic

Support Measures (ESM), Electronic Attack (EA), and COMJAM (TAI n.d.b). Table 7 summarizes Anka's tactical and technical data and the different types of payloads and sensors it can employ.

Table 7. Anka Unmanned Aircraft Characteristics

Length	8.6 m
Height	3.25 m
Wing Span	17.5 m
Endurance	30+ hours
Range	250 km (BLOS); 1000 km (SATCOM)
Weight (empty)	2,270 pounds (1,030 kg)
Maximum take-off weight	1,700 kg
Maximum Altitude	30,000 feet (9,144 m) above mean sea level (MSL)
Operational altitude	18,000-23,00 feet (5,486m- 7,010 m) above MSL
Launch method	runway, hard surface only
Cruise Airspeed	88 knots (163 km/h)
Dash Airspeed	140 knots (259 km/h)
Payload capacity	350+ kg
Armament	4x munitions (precision-guided bombs, laser-guided rockets, or anti-tank missiles)
Sensors/Payloads	EO, IR, laser range-finder, laser designator, laser pointer, Inverse SAR, GMTI
Datalink Equipment	Wideband SATCOM for BLOS communication, VHF/UHF antenna for LOS communication
Additional Capabilities	VHF/UHF radio relay, wide-area surveillance camera, COMINT, ELINT, RVT, FMV

Source: Created by author using TAI n.d.a; TAI n.d.b; Streetly and Parakala 2019, 224. NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

Anka UAS comprises "three AVs; a truck-mounted ground control station (GCS); an encrypted portable video terminal; a trailer-mounted power generator; an all-weather, radar-based ATOLS (with digital GPS back-up), and a truck-mounted image exploitation system" (Streetly and Parakala 2019, 224). It needs a hard surface runway of about 1500 meters for a conventional wheeled take-off and landing. The estimated cost for the Anka UAS unit is around $8 million (Tawil 2020).

Israel's Models

Besides the United States, Israel is the country that has the most extended history in developing, manufacturing, and operating armed and unarmed UAS. Israel used UAS as ISR assets during the Yom Kippur War in 1973 and Bekka Valey operations in 1982 but has also undertaken targeted killing campaigns since the second intifada (Skinner 2019, 9). Israel plays a major part in UAS proliferation nowadays. The fact that from seventy-nine countries operating UAS, thirty-nine countries use at least one drone from Israel (Gettinger 2019, ix) demonstrates the Israeli UAS program's quality and reliability. The most prevalent long-endurance models capable of carrying missiles are Elbit Systems' Hermes 450 and Hermes 900 and IAI's Heron TP.

Hermes 450

Hermes 450, illustrated in Figure 9, is a multi-role, long-endurance tactical UAS produced by Elbit Systems. It has different types of non-lethal payloads, including EO/IR laser, SAR/GMTI, maritime patrol radar (MPR), large area scanners, hyperspectral sensors, and communication jamming/EW/electronic intelligence (ELINT) equipment (Streetly and Parakala 2019, 109). Hermes 450 can carry four Rafael Spike anti-tank guided missiles (RUSI n.d.).

Figure 9. Elbit Hermes 450

Source: Elbit Systems n.d.a.

A Hermes 450 unit consists of four to six UAVs with a GCS, common for all Hermes UAS platforms, which provides in-flight payload control. GCS includes two Ground Data Terminals (GDT), a remote video terminal, and a flight line tester/loader. Hermes 450 has an automatic wheeled take-off or a catapult launch with the Robonic MC 2055L launcher and automatic wheeled recovery with an arrester cable (Streetly and Parakala 2019, 109). It uses an "advanced data link that supports LOS radio frequency communication up to 30 km" (Elbit Systems of America n.d.). The estimated cost for Hermes 450 unit is around $2 million (Flesher, Oni, and Aaron 2011, 24). Table 8 summarizes the primary tactical and technical data of the Hermes 450 UAS and its different types of sensors and payloads to support various operations.

Table 8. Hermes 450 Unmanned Aircraft Characteristics	
Length	5.7 m
Height	2.37 m
Wing Span	10.5 m
Endurance	17 hours
Range	250 km
Weight (empty)	200 kg
Maximum take-off weight	550 kg
Maximum Altitude	18,000 feet (5,486 m) above mean sea level
Launch method	Automatic wheeled or with a catapult, 350 m
Cruise Airspeed	70 knots (130 km/h)
Dash Airspeed	95 knots (176 km/h)
Payload capacity	180 kg
Armament	4x Rafael Spike anti-tank missiles
Sensors/Payloads	EO, IR, laser range-finder, laser designator, SAR, GMTI
Datalink Equipment	Radiofrequency for LOS communication in C-band datalink
Additional Capabilities	ELINT, COMJAM, COMINT, wide-area surveillance camera, communication relay, RVT, FMV

Source: Created by author using Elbit Systems n.d.a; Streetly and Parakala 2019, 109; Daly and Streetly 2008, 95; Stolley 2012, 8; Drwiega 2020, 16.
NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

Hermes 900

Hermes 900, produced by Elbit Systems, is a MALE UAS primarily capable of performing persistent ISTAR missions. "The system employs standard and long-range EO/IR/laser, SAR / GMTI & MPR, COMINT/Direction Finding (DF), COMINT Global System for Mobiles (GSM), COMMJAM, ELINT, EW, hyperspectral systems, large area scanning systems, and wide-area persistent surveillance" (Elbit Systems n.d.b). Hermes 900 can carry four Rafael Spike anti-tank guided missiles (RUSI n.d.). Figure 10 represents an illustration of a flying Hermes 900 UAS.

Figure 10. Elbit Hermes 900

Source: Elbit Systems n.d.b.

Hermes 900 guidance and control features comprise a line of sight (LOS) or SATCOM data links and a GCS equipped with two GDTs capable of simultaneously controlling two UAVs and a remote video terminal. It needs a hard surface runway to conduct conventional wheeled take-off and landing (Streetly and Parakala 2019, 111). The cost of a Hermes 900 UAS ranges from $18-30 million, depending on its configuration (Dombe 2021). Table 9 summarizes the primary tactical and technical data of the Hermes 900 UAS and highlights its abilities to support different missions.

Table 9. Hermes 900 Unmanned Aircraft Characteristics	
Length	8.3 m
Wing Span	15 m
Endurance	36 hours
Range	2500 km
Maximum take-off weight	1,180 kg
Maximum Altitude	30,000 feet (9,144 m) above mean sea level
Launch method	runway, hard surface only
Cruise Airspeed	60 knots (111 km/h)
Dash Airspeed	119 knots (220 km/h)
Payload capacity	350 kg
Armament	4x Rafael Spike anti-tank missiles
Sensors/Payloads	EO, IR, laser range-finder, laser designator, Inverted SAR, GMTI
Datalink Equipment	SATCOM and LOS data link
Additional Capabilities	ELINT, COMJAM, COMINT/DF/GSM, wide-area surveillance camera, communication relay, RVT, FMV

Source: Created by author using Elbit Systems n.d.b; Elbit Systems 2016; Stolley 2012, 8; and Drwiega 2020, 16.
NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

Heron TP

Heron TP, illustrated in Figure 11, is a MALE UAS produced by Israel Aerospace Industries (IAI) intended to perform a variety of strategic missions, “including intelligence gathering, surveillance, target acquisition, and reconnaissance, using various payloads, with a high level of reliability” (IAI n.d.). It also can carry Rafael Spike anti-tank missiles (RUSI n.d.).

Figure 11. IAI Heron-TP

Source: IAI n.d.

According to the manufacturer, Heron TP has a variety of payloads, including EO/IR imagers, LRF/LD, SAR, maritime patrol radars, SIGINT electronic support, and electronic intelligence equipment. Heron TP guidance and control systems include multiple lines of sight datalinks, SATCOM datalinks, and modular GCS. It also has automatic wheeled take-off and landing. (Streetly and Parakala 2019, 121). The estimated cost for a Heron TP unit is around $35 million (Flesher, Oni, and Aaron 2011, 24). Table 10 summarizes the primary tactical and technical data of the Hermes TP UAS along with its additional capabilities and payloads.

Table 10. Heron TP Unmanned Aircraft Characteristics	
Length	14 m
Wing Span	26 m
Endurance	35 hours
Range	1000+ km (BLOS)
Maximum take-off weight	5,670 kg
Maximum Altitude	45,000 feet (13,716 m) above mean sea level
Launch method	runway, hard surface only
Dash Airspeed	220 knots (407.4 km/h)
Payload capacity	2,700 kg
Armament	4x Rafael Spike or Hellfire anti-tank missiles
Sensors/Payloads	EO, IR, laser range-finder, laser designator, Inverted SAR, GMTI,
Datalink Equipment	SATCOM and direct LOS data link
Additional Capabilities	ELINT, COMINT/HF/VHF/UHF/DF, wide-area surveillance camera, communication relay, FMV, RVT, COMJAM

Source: Created by author using IAI n.d.; Vayu Aerospace 2017; Stolley 2012, 8; Streetly and Parakala 2019, 121.
NOTE: The conversion from imperial into metric values is calculated using Metric Conversions 2018.

Updated Individual Recommendation R2

Before defining the individual recommendation (R2) to the CDM, we must develop criteria to formulate and evaluate possible solutions. FM 6-0, *Commander Staff Organization and Operations*, March 2014 defines two types of criteria: screening and evaluation.

According to FM 6-0, *Commander Staff Organization and Operations*, screening criteria ensure solutions can solve the problem. Screening criteria define the limits of an acceptable solution and usually are tested by asking five questions:

1. Is it suitable? —Does it solve the problem, and is it legal and ethical?
2. Is it feasible? —Does it fit within available resources?

3. Is it acceptable? —Is it worth the cost or risk?
4. Is it distinguishable? —Does it differ significantly from other solutions?
5. Is it complete? —Does it contain the critical aspects of solving the problem from start to finish?

According to FM 6-0, *Commander Staff Organization and Operations*, evaluation criteria measure the relative effectiveness and efficiency of the proposed solutions. Well-defined evaluation criteria have five elements:

1. Short title- criterion name,
2. Definition- a clear description of the evaluated feature,
3. Unit of measure- a standard element used to quantify the criterion,
4. Benchmark- a value that defines the desired state for a solution in terms of a particular criterion,
5. Formula- an expression of how changes in the value of the criterion affect the desirability of the possible solution.

When considering the best possible solution for a UAS, we will use the evaluation criteria described in Table 11.

Table 11. Evaluation Criteria for Updated Individual Recommendation R2 and Improved Recommendation R3

Title	Definition	Measure	Benchmark	Formula
Procurement cost	The maximum budget for a UAS procurement	United States Dollars (USD)	35 million USD	<1 UAS unit procurement is disadvantage; >=1 UAS unit procurement is advantage; more is better
Endurance	The time a UAS can continuously fly without refueling	Hours	16 hours	<16 hours is a disadvantage; >=16 hours is an advantage; longer is better
Versatility	Adaptability to different functions and missions	Number of payloads that affect the overall combat power by WFF	6 different types of primary payloads	<6 primary payloads is a disadvantage; >=6 primary payloads is an advantage; more is better
Payload capacity	The weight a UAS can carry (sensors, cameras, and missiles)	kilograms	150 kilograms	<150 kg is a disadvantage; >=150 kg is an advantage; more is better

Source: Created by author.

Procurement cost is the maximum value of money paid for a single UAS unit, and it has a significant influence when considering the possible solution. Small armies seek the best cost-effective solution because they have small and limited defense budgets. The procurement cost benchmark of $35 million is based on the Heron-TP price as the highest price of a single UAS analyzed in this research. The higher number of UAS is an advantage because it will provide redundancy for continuous UAS employment in case of UAS loss, thus avoiding the risk of mission failure.

Endurance is the amount of time that the UAS can fly without refueling. It allows a prolonged time of operation over a designated target. Compared to manned aircraft, most of the UASs analyzed in the research paper have prolonged endurance that enables uninterrupted mission accomplishment. Since the potential UAS would operate at the division level and higher, it should provide long-duration general support and direct support at the tactical and operational level for a minimum of sixteen hours (US Army UAS COE 2010, 1).

Versatility is the ability to provide multi-role and multi-purpose UAS that can conduct different missions. The ability to carry different types of payloads broadens the spectrum for diverse UAS employments. To increase the fires, intelligence, and C2 WFF, UAS should have a minimum of six primary payloads, including the ability to deliver lethal projectiles (missiles, guided/unguided bombs). Secondary payloads augment the primary. They are required but not mandatory. Table 12 shows the primary and secondary payloads that support these WFFs. Their combination will enhance the overall versatility and maximize UAS employment to conduct different types of missions based on the fires, intelligence, and C2 WFF.

Table 12. Types of Payloads to Support Different WFF

WFF Payloads	Fires	C2	Intelligence
Primary	1. Missiles	2. RVT/FMV	3. EO 4. IR 5. LRF/LD 6. SAR/GMTI
Secondary	Electronic Attack	Communication Relay Package	COMINT/ELINT

Source: Created by author.

Payload capacity is the maximum amount of weight that a UAS can carry. UAS has modular payloads that can be mounted depending on the mission, thus supporting all levels of operations. A general rule of thumb says that a bigger payload capacity enables greater UAS versatility when conducting a single task. The desired minimum payload capacity is a UAS's ability to carry its primary sensor payloads (EO, IR, SAR, and GMTI) and a certain number of missiles. Since the Bayraktar TB2 has the lowest payload capacity compared to the rest of the analyzed UAS but meets the previously described criteria, the payload's benchmark is set at a hundred and fifty kilograms.

The individual recommendation for the potential UAS to replace the Mi-24 was based on the pre-described evaluation criteria. The primary factor was the procurement cost for a single UAS unit. The best solution should encompass significantly lower acquisition costs which provide the most substantial payload, emphasizing the redundancy in UAS employment, thus providing continuous operations if UAS are lost due to malfunction or enemy action. Since Mi-24's primary mission is CAS and air interdiction to destroy enemy personnel and equipment, payload capacity will be paramount. Second, it should also provide a broad spectrum of payloads that increases its versatility and has sufficient endurance to enable prolonged operations over a designated area. Table 13 summarizes the essential data for each UAS based on the established evaluation criteria.

Table 13. Comparison of UAS Based on the Evaluation Criteria

UAS Model	Cost	Endurance	Versatility	Payload Capacity
MQ-1C Gray Eagle	$18.2 M	25 hrs	14 functions	488 kg
MQ-9 Reaper	$32.5 M	27+ hrs	13 functions	1701 kg
Bayraktar TB2	$3 M	27 hrs	11 functions	150 kg
Anka	$8 M	30+ hrs	13 functions	350 kg
Hermes 450	$2 M	17 hrs	13 functions	180 kg
Hermes 900	$18-30 M	36 hrs	13 functions	350 kg
Heron-TP	$35 M	35 hrs	13 functions	2700 kg

Source: Created by author.

Stakeholder Analysis

The stakeholder analysis has "to indicate whose interests should be considered when making a decision and why these interests are taken into account" (Crosby 1991,1). The key stakeholders within the Ministry of Defense/Macedonian Army can positively or negatively affect the effort to introduce combat UAS as a CAS alternative after the retirement of the Mi-24 helicopter and their integration with the other modernization programs to increase the overall combat power of the Army. These stakeholders include the Finance Department (MOD)/J-8 (Army General Staff), J-3 (Army General Staff), and the commander of the unit where the UAS will be assigned.

Finance Department (MOD)/J-8 (Army General Staff)

The Finance Department (FD) "performs budgeting and budget analysis, determines and adopts the financial plan of the MOD, executes the financial resources specified by the MOD budget and the financial plan. FD analyzes the financial resources and budgeting in the MOD and proposes possible solutions for overcoming any potential problems" (MODRNM n.d.). On the other hand, J-8 as a section of the General Staff (GS) is responsible for the "financial resources planning for current and future force requirements according to the Army structure plan and handling the finances within the Army" (ARNM n.d.c).

From the Department of Finance/J-8 point of view, the best procurement solution will be the one that is the most cost-effective. The primary focus will be the cost of the UAS, followed by its flexibility to conduct different types of missions. Table 14 summarizes the analysis for the best possible solution based on the two most important evaluation criteria from the FD/J-8's perspective.

Table 14. FD/J-8 Stakeholder Analysis

UAS Model	Unit cost	Number of units per $35M	Versatility per unit	Number of functions per $35M
MQ-1C Gray Eagle	$18.2 M	1.92	14 functions	26.92
MQ-9 Reaper	$32.5 M	1.08	13 functions	14
Bayraktar TB2	$3 M	11.67	11 functions	128.33
Anka	$8 M	4.38	13 functions	56.88
Hermes 450	$2 M	17.5	13 functions	227.5
Hermes 900	$18-30 M	1.94	13 functions	25.28
Heron-TP	$35 M	1	13 functions	13

Source: Created by author.

When assessing the best possible solution from the FD/J-8 point of view, the number of units for a budget of $35M (pre-established benchmark) and the number of functions derived from the total number of units were the most critical evaluations criteria. The number of units per benchmark was calculated by dividing the benchmark by the procurement cost of each UAS unit. The number of functions was calculated by multiplying the number of functions per unit and the total number of units within the available budget.

J-3 Combat Readiness and Operations (Army General Staff)

J-3 is responsible for monitoring, controlling, and assessing Army's combat readiness. Its most essential tasks include organizing and monitoring the application of measures for the Army commands and units' readiness and organizing and coordinating operations, either domestic or abroad. J-3 coordinates and manages operations to support the Ministry of Interior (MOI), state institutions, local community units, non-governmental institutions, and citizens in crises (ARNM n.d.b).

From the J-3 point of view, the best solution would be the UAS which could provide multiple options when conducting a broad spectrum of missions such as reconnaissance, surveillance, attack, security, C2, and fires. The primary focus would be the versatility of the UAS, followed by its endurance to conduct different types of missions for a prolonged period. Table 15 summarizes the analysis for the best possible solution based on the two most important evaluation criteria from the J-3's perspective.

Table 15. J-3 Stakeholder Analysis					
UAS Model	Number of units per $35M	Endurance	Operational hours per $ 35M	Versatility per unit	Number of functions per $35M
MQ-1C Gray Eagle	1.92	25 hrs	48.08	14 functions	26.92
MQ-9 Reaper	1.08	27+ hrs	29.08	13 functions	14
Bayraktar TB2	11.67	27 hrs	315	11 functions	128.33
Anka	4.38	30+ hrs	131.25	13 functions	56.88
Hermes 450	17.5	17 hrs	297.5	13 functions	227.5
Hermes 900	1.94	36 hrs	70	13 functions	25.28
Heron-TP	1	35 hrs	35	13 functions	13

Source: Created by author.

The operational hours by pre-defined benchmarks were calculated by multiplying the endurance per single UAS and the total number of units within the available budget, while the number of functions was calculated by multiplying the number of functions per unit and the number of units within the available budget.

From an operational point of view, besides providing extended reconnaissance operations, "lessons learned in Iraq and Afghanistan by the US military validated the need for long endurance platforms that remain on station with precision strike capabilities, thereby reducing collateral damage and facilitating time-sensitive targeting of high-value targets" (US Army UAS COE 2010, 6).

UAS Unit Commander

UAS unit commander is the single person responsible for accomplishing the unit's mission and mission essential task list. UAS unit commander must be tactically and technically proficient in planning, preparing, and executing UAS sustained operations, especially in contested A2/AD environments. Table 16 summarizes the analysis for the best possible solution based on the two most important evaluation criteria from the UAS commander's perspective.

Table 16. UAS Unit Commander Stakeholder Analysis

UAS Model	Number of units per $35M	Endurance	Operational hours per $ 35M	Payload capacity per unit	Total payload per $35M
MQ-1C Gray Eagle	1.92	25 hrs	48.08	488 kg	938.46 kg
MQ-9 Reaper	1.08	27+ hrs	29.08	1701 kg	1831.9 kg
Bayraktar TB2	11.67	27 hrs	315	150 kg	1750 kg
Anka	4.38	30+ hrs	131.25	350 kg	1531.3 kg
Hermes 450	17.5	17 hrs	297.5	180 kg	3150 kg
Hermes 900	1.94	36 hrs	70	350 kg	680.56 kg
Heron-TP	1	35 hrs	35	2700 kg	2700 kg

Source: Created by author.

From the UAS unit commander's point of view, the primary focus would be the payload of the UAS which enables the capacity to utilize a variety of lethal (missiles, guided/unguided rockets, or bombs) and non-lethal payloads (different sensors) in a single mission, followed by its endurance to conduct various types of assignments for a prolonged period. The operational hours by pre-defined benchmarks were calculated by multiplying the endurance per single UAS and the total number of units within the available budget, whereas the total payload capacity was calculated by multiplying the payload of a single UAS and the number of UAS units within the available budget.

<u>Improved Recommendation (R3)</u>

Improved recommendation (R3) encompasses an updated set of recommendations that demonstrate improvements and adaptations of the R2 position as a result of looking at R2 through the eyes of the various stakeholders (Long 2016). Table 17 incorporates all UAS models analyzed in the research paper concerning established evaluation criteria. It depicts the overall number of UAS, operational hours, payload, and functions and undoubtedly demonstrates that UAS with a lower cost, such as Hermes 450 and Bayraktar TB2, is a better option for procurement compared to more expensive models such as Heron-TP or MQ-9 Reaper regarding the pre-established benchmark for procurement cost of $35 million. The higher number of low-cost UAS provides more operational time, functions, payload, and redundancy, thus improving the chance of accomplishing the mission should other UAS become compromised or lost during operation.

Table 17. Combined Stakeholder Analysis

UAS Model	Number of units per $35M	Operational hours per $ 35M	Total payload per $35M	Number of functions per $35M
MQ-1C Gray Eagle	1.92	48.08	938.46 kg	26.92
MQ-9 Reaper	1.08	29.08	1831.9 kg	14
Bayraktar TB2	11.67	315	1750 kg	128.33
Anka	4.38	131.25	1531.3 kg	56.88
Hermes 450	17.5	297.5	3150 kg	227.5
Hermes 900	1.94	70	680.56 kg	25.28
Heron-TP	1	35	2700 kg	13

Source: Created by author.

As mentioned earlier, the improved recommendation R3, which combines conclusions from the updated individual recommendation R2 and stakeholders’ analysis, provides the most acceptable, suitable, and feasible solution to the CDM. The most crucial step before providing recommendations to the CDM is defining the weights for the evaluation criteria because it establishes the relative importance of each criterion concerning the others. This weighting should reflect the judgment of the CDM or acknowledged expert as closely as possible (HQDA 2020b, 35).

Before assigning weights, all UAS should be ranked based on the pre-defined evaluation criteria. The best solution in each evaluation criteria (highest rank) is the UAS with the smallest number. The ranking is then multiplied by the respective weight, and each UAS is assigned points concerning a specific evaluation criterion. The total number of points is calculated by adding the specific evaluation criterion points. Table 18 provides information on the improved recommendation R3 to the CDM, where the lowest total score is the preferred solution for a possible UAS.

Table 18. Improved Recommendation to the CDM

UAS Model	Cost (weight 4)		Endurance (weight 1)		Payload capacity (weight 3)		Versatility (weight 2)		Total
	Rank	Points	Rank	Points	Rank	Points	Rank	Points	
MQ-1C Gray Eagle	5	20	5	5	6	18	4	8	51
MQ-9 Reaper	6	24	7	7	3	9	6	12	52
Bayraktar TB2	2	8	1	1	4	12	2	4	25
Anka	3	12	3	3	5	15	3	6	36
Hermes 450	1	4	2	2	1	3	1	2	11
Hermes 900	4	16	4	4	7	21	5	10	51
Heron-TP	7	28	6	6	2	6	7	14	54

Source: Created by author.

It undeniably confirms that pre-established criteria rank Israeli Hermes 450 as the best option for UAS procurement, followed by Turkish Bayraktar TB2 and Anka. Once approved by the CDM, the improved recommendation results in a campaign plan of short-term and long-term actions with clear priorities in each action.

Prospective Type of a UAS Organization

While conducting the research, open-source information limited the possibility of analyzing various UAS organizations in multiple Armies. The follow-on analysis primarily relied on the MQ-1C Gray Eagle organization in the US Army since US Army doctrine was the only type of open-source that provided effective and dependable approaches for a potential UAS organization in the Macedonian Army.

MQ-1C Gray Eagle company is organic to the Combat Aviation Brigade (CAB), and it consists of twelve MQ-1C UAVs. "It provides multi-mission UAS tactical capability to the divisional brigades according to the division commander's priorities, which include the following tasks: surveillance, reconnaissance (zone, route, and area), attack, BDA, and command and control support" (HQDA 2020a, 2-3). The company can also support the CAB, mainly by conducting MUM-T with combat or reconnaissance helicopters. "When supporting the CAB, the Gray Eagle company or subordinate elements conduct the following tasks: reconnaissance (zone, route, and area), attack, BDA, and command and control support" (HQDA 2020a, 2-3). Figure 12 portrays the subunits, number of personnel and the required variety of specialties within the MQ-1C Gray Eagle company.

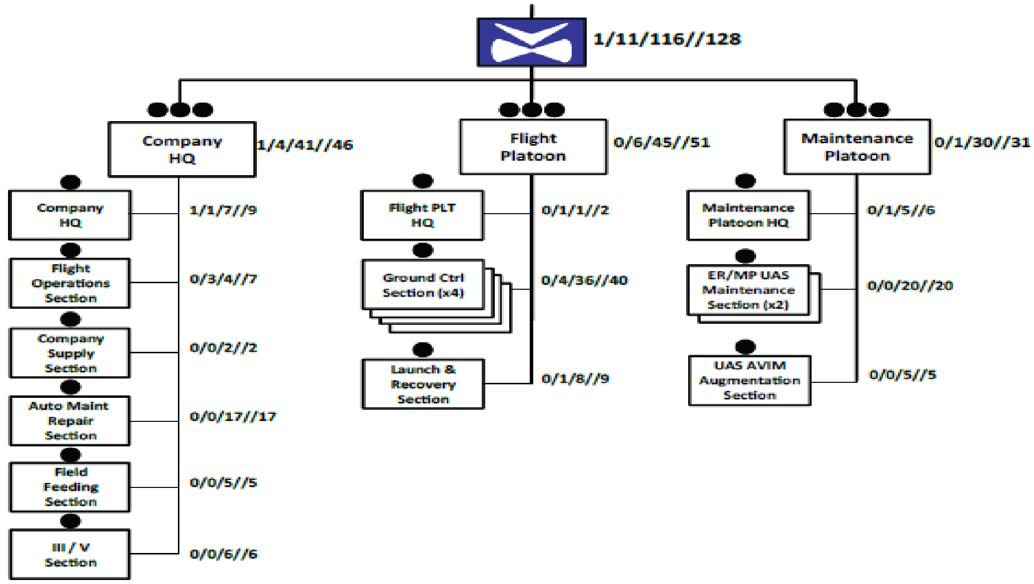

Figure 12. MQ-1C Gray Eagle Company Organization

Source: US Army UAS COE 2010, 97.

MQ-1C platoons consist of "four unmanned aircraft, two Universal Ground Control Stations, seven Ground Data Terminals, one Mobile Ground Control Station, one Satellite Ground Data Terminal, an automated takeoff and landing system, Light Medium Tactical Vehicles (LMTV), and other ground support equipment" (USAASC n.d.). The company consists of 128 soldiers and incorporates an additional headquarters and an organic maintenance platoon with distinctive specialty teams to assist C2 and sustainment while conducting UAS operations.

UAS Company Force Integration Functional Area (FIFA) Analysis

General Staff J-5 section (Military Planning and Force Structure) is the primary proponent responsible for developing the Army's force structure. The Force Integration Functional Area (FIFA) analysis ensures a suitable, feasible, and acceptable

Organizational solution from the DOTMLPF-P domains. To be suitable, the proposed organizational design must accomplish the Army's mission and comply with the Chief of the General Staff's guidance. To be feasible, the proposed organization must be capable to achieve its mission with the resources available. To be acceptable, the capability's advantages acquired through the organizational design must justify the increased cost in required resources (USAWC 2020, 3-19).

The first requirement for conducting a successful FIFA analysis is creating a draft Table of Organization and Equipment (TOE), which provides "a standard method for documenting the Army's organizational structure. A TOE prescribes the doctrinal mission, required structure, and mission essential wartime manpower and equipment requirements for several levels of organizational options for a particular type unit" (USAWC 2020, 3-20). The potential TOE will depend primarily on the Materiel solution selected and the likely mission and mission essential tasks list assigned to the UAS organization.

Structuring

Macedonian Army has not had any experience integrating armed UAS so far. The Mi-24 retirement in 2025 will abolish the existing combat helicopter flight, thus decreasing the capabilities of the helicopter squadron and the Air Wing in general. Introducing a new UAS unit will fill this gap because it will maintain the air interdiction and CAS proficiencies and supplement additional capabilities such as ISR, TA, BDA, C2, and EW. The probable organization should have a headquarters element, flight element, maintenance element, support element, and appropriate support infrastructure. The new UAS unit should remain part of the Macedonian Air Wing, subordinated directly to the

Air Wing Commander, thus enabling effective and efficient C2 while supporting the division-level Operations Command's (OC) mission.

Manning

UAS unit will be "properly manned by assigning all authorized personnel by grade and skill" (USAWC 2020, 3-19). The unit will require a certain number of officers, non-commissioned officers (NCOs), and professional soldiers with specific Military Occupational Specialties (MOS). The requirement to train the UAS operators/ pilots to the highest Basic UAS Qualification (BUQ) and Combined/Joint Mission Qualification (CJMQ) levels (NATO 2019, 3-1, 4-1) will impose the need to implement new MOSs for the personnel in the unit similar to pilots with qualifications "11U or 18X according to the US Air Force Specialty Code" (HQUSAF 2014, 13). It can be achieved in one of the following ways: retrain the existing Mi-24 pilots, support, and maintenance personnel for the new MOS without changing the total number of personnel, or plan for additional personnel to be trained, thus increasing the total number of personnel in the Air Wing.

Equipping

The complete equipping of the unit includes unmanned vehicles and the different supporting equipment such as ground control stations, ground data terminals, satellite terminals, automated takeoff and landing systems, tactical vehicles, spare parts, and maintenance equipment and tools.

Training

Training for the UAS personnel will be paramount since they need special technical skills and knowledge. Initially, for part of the key personnel, training should be provided by the equipment manufacturer and included in the acquisition plan. The UAS pilots will undergo BUQ and CJMQ training following the requirements described in the ATP-3.3.8.1, *Minimum Training Requirements For Unmanned Aircraft Systems (UAS) Operators And Pilots.* For instance, BUQ Level IV qualification requires the UAS pilot to achieve the knowledge and skills required to operate under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) in all airspace (NATO 2019, 3-1, 4-1).

On the other hand, CJMQ Level C requires the UAS pilot training in operational-level ISR support missions and missions that involve the employment of lethal payloads while supporting a strategic-level commander with fires (NATO 2019, 4-1). Support and maintenance personnel will also undergo specialty training to achieve the desired proficiency in their field of expertise. The Training and Doctrine Command (TRADOC) should publish proper tactical and technical manuals for UAS employment and maintenance and individual and collective training standards supporting the unit's mission and mission-essential tasks list (METL). TRADOC should also design institutional training level courses for all MOS incorporated in the new organization. The introduction of training devices such as training simulators will provide battle-focused training and improve overall MOS performance.

Sustaining

The higher headquarter of the UAS unit should plan for additional spare parts, supplies, facilities, and non-combat personnel to sustain UASs. The support and maintenance units should be manned, sustained, stationed, equipped, trained, and funded to support the UAS organization by conducting essential and low-level technical maintenance (USAWC 2020, 3-20). A supporting logistics echelon from the headquarters one and two levels up will provide a higher level of maintenance.

Funding

UAS unit should have identified, programmed, and resourced funds that support unit's operations, maintenance, sustainment, stationing, transportation, and facility construction and renovation (USAWC 2020, 3-20). The UAS's operation costs will include the UAS acquisition costs and the operational life-cycle for a specific period. With the retirement of the Mi-24 combat flight, the overall funding in the defense budget should not sustain radical changes since the new UAS unit will replace the existing combat helicopter flight.

Deploying

The potential UAS unit should maintain high combat readiness level by proper manning, equipping, training, sustaining, funding, and stationing its operational and maintenance units to support the operational or strategic commander in accomplishing its mission.

Stationing/Facilities

The current combat helicopter flight has enough stationing facilities and supporting infrastructure to accommodate the potential UAS unit without degrading personnel life, safety, or environmental standards (USAWC 2020, 3-20). The current location offers adequate hard surface runways to support UAS takeoff and landing.

Readiness

The UAS unit should achieve tactical readiness to conduct its primary or assigned mission. Unit readiness should be measured based on the Unit Status Report (USR) parameters for equipment and supply, manning, and training.

UAS Support to Warfighting Functions

Integrating UAS with the ongoing modernization programs would enhance the Army's capabilities through most warfighting functions. *The Unmanned Aircraft System Roadmap 2010-2035* provides the following examples of how a UAS can contribute to an increase in warfighting functions:

Movement and maneuver. "The movement and maneuver warfighting function is the related tasks and systems that move and employ forces to achieve a position of relative advantage over the enemy and other threats" (HQDA 2019a, 5-3). Armed or unarmed UAS would be employed in conjunction with ground and air systems to achieve a position of advantage at a place and time chosen by the commander.

Intelligence. "The intelligence warfighting function is the related tasks and systems that facilitate understanding the enemy, terrain, weather, civil considerations, and other significant aspects of the operational environment" (HQDA 2019a, 5-4). UAS equipped with various mission payloads could support most of the commander's intelligence-gathering requirements defined during the mission planning.

Fires. "The fires warfighting function is the related tasks and systems that create and converge effects in all domains against the adversary or enemy to enable operations across the range of military operations" (HQDA 2019a, 5-4). UAS is capable of delivering lethal and non-lethal payloads. "UAS can shorten the sensor-to-shooter response time by performing aided target recognition, tracking, laser-designating targets, and providing BDA" (US Army UAS COE 2010, 21). It can facilitate the call for fire procedure and assist in adjusting mortars or artillery indirect fires. When armed, UAS can provide lethal effects. On the other hand, UAS with EW payload can provide non-lethal effects such as electronic attacks (jamming), electronic protection, or electronic warfare support.

Protection. "The protection warfighting function is the related tasks and systems that preserve the force so the commander can apply maximum combat power to accomplish the mission" (HQDA 2019a, 5-6). UAS can enhance the protection by providing "early warning, target tracking, and reconnaissance of designated NAIs" (US Army UAS COE 2010, 21). It is suitable for protecting fixed bases and installations, convoys, or troop movement. Some payloads provide Chemical, Biological, Radiological, and Nuclear (CBRN) reconnaissance in affected areas.

Sustainment. "The sustainment warfighting function is the related tasks and systems that provide support and services to ensure freedom of action, extended operational reach, and prolonged endurance" (HQDA 2019a, 5-5). Future UAS models will enhance sustainment by providing supply and medical evacuation of casualties.

Command and control. "The command and control warfighting function is the related tasks and a system that enable commanders to synchronize and converge all elements of combat power" (HQDA 2019a, 5-3). UAS equipped with communication relay payload and RVT, FMV, and SAR/GMTI sensors can facilitate the C2 warfighting function by providing real-time decision-making to improve the command of forces, control the operations, and improve the situational awareness of the commanders.

Most of the UAS taken into consideration in this research paper can increase most warfighting functions. Their modularity and ability to accept different payload types provide versatility while conducting various missions. The research delimitation focused on fires, intelligence, and C2 warfighting functions and whether the procurement of a versatile UAS could increase these capabilities. Table 19 illustrates the ability of the analyzed UAS to support the desired WFFs concerning the different payloads they possess.

Table 19. UAS Support to WFF by Payloads

UAS Model	Fires		Intelligence					C2	
	Missiles	EA	EO	IR	LRF/LD	SAR/GMTI	COMINT/ELINT	CRP	RVT/FMV
MQ-1C Gray Eagle	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bayraktar TB2	✓		✓	✓	✓	✓	✓		✓
Anka	✓		✓	✓	✓	✓	✓	✓	✓
Hermes 450	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hermes 900	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heron-TP	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: Created by author.

By analyzing data in Table 19, it can be concluded that most of the UAS considered in the research have payloads that support fires, intelligence, and C2 WFF. Turkish Bayraktar TB2 is missing an electronic attack payload and communication relay package, while Anka is missing electronic attack capability. Even though specific open sources confirm that the Turkish Defense Industries Presidency (SSB) kicked off the Stand-Off-Jammer/Remote Jammer (SOJ) project to equip Turkish UAS models with EA capabilities (Daily Sabah, 2021), Baykar and TAI, up until now, did not confirm these capabilities for their respective UAS models.

Intelligence, Surveillance, and Reconnaissance (ISR)

ISR is the core contribution that a UAS brings to operations by facilitating understanding of the operational environment and answering CCIRs. It is "an activity that synchronizes and integrates the planning and operation of sensors, assets, and processing, exploitation, and dissemination systems in direct support of current and future operations" (JUAS-COE 2010, 9). The wide variety of sensor payloads, such as EO/IR cameras, SAR and GMTI radars, LRFs, LDs, and SIGINT (COMINT, ELINT, or both), enable the execution of different ISR missions.

UAS can provide a situational understanding of the terrain (obstacles, key terrain), the enemy (disposition, strength, location of high payoff targets (HPTs), possible courses of action), civilian considerations, and other aspects of the operational environment for the commander. Their high endurance enables wide-area coverage and identifies and tracks potential targets for an extended time. During the Nagorno Karabakh conflict in 2020, Azerbaijani UAS managed to find and track enemy high-value targets far beyond the front line. The location of these targets was reported, and most of them were targeted either by aerial strikes or indirect fires.

Target Acquisition (TA) and Battle Damage Assessment (BDA)

UAS facilitates the targeting process by its ability to conduct TA and BDA. UAS detects targets with FMV, GMTI, Wide-Area Motion Imagery (WAMI), and SIGINT sensors. After target detection, UAS pinpoints the location by lasing the target with LD/LRF and provides the target's coordinates to the unit that will conduct the indirect fire task, air interdiction, or CAS. The UAS's endurance is critical since it provides a more prolonged *fixation* on the target. Afterward, the same UAS could provide imagery or live video feed to the firing unit to evaluate the level of damage that the target has sustained. The sensor type, camera fidelity, and zoom quality will determine the level of success when conducting TA/BDA. The US military has excellent experience using UAS for lasing since their Predators and Reapers have lased for different aircraft types while conducting air interdiction. The French Air Force has also employed Reapers to lase for Mirage strike aircraft and Tiger HAD helicopters in Operation Barkhane, counter-terrorism operations in the Sahel region in Africa (Michel 2020, 6).

The concept of integrating the UAS with the manned ground or aerial platforms is known as manned-unmanned teaming (MUM-T). It allows maximum utilization of each platform's strengths and capabilities since the manned aircraft pilot receives information directly from the UAS. US Army is teaming its MC-1C Gray Eagle with AH-64E Apache helicopter gunship. One or more UAS transmit live video and data to the Apache pilots, who can see the target well in advance before arriving at their attack location or provide the ability to attack the target beyond their visual range (Michel 2020, 19).

UAS assist indirect fire units by detecting targets, providing fire adjustments, thus replacing the standard forward observers on the ground, and conducting assessment after firing. UAS can detect targets in low visibility conditions (night, obscuration) and provide fire adjustment on distant targets, primarily while operating in a dangerous environment. They also speed up the fire adjustment process because their software calculates the necessary corrections between the initial indirect fire impact point and the target (Michel 2020, 16). According to Dr. Can Kasapoglu, recent experiences from Syria showed that the Russian and Turkish military mastered the *drone-artillery complexes*—an integration of the artillery assets and UAS in a combined fight. While conducting Operation Spring Shield in early 2020, Turkey's military "used its drones to execute ISTAR missions for the 155mm-class Firtina howitzer and multiple-launch rocket systems. Furthermore, the Turkish drones were also used for battle damage assessment duties to monitor the effects of the artillery and rocket salvos" (Kasapoglu 2020).

During the Nagorno Karabakh conflict in 2020, Azerbaijani UAS located the Armenian positions and provided accurate TA and BDA to the indirect fire assets (conventional artillery, multiple-launch rocket systems, LORA ballistic missiles), "turning these cheap conventional capabilities that lack guidance into deadly long-range fires systems" (Watling and Kaushal 2020). The outcome was destroying over a hundred Armenian T72 main battle tanks of different production years.

The Russian military also integrated UAS with indirect fire assets in Ukraine to detect targets and adjust indirect fires. Their integration is very advanced because the experiences in Ukraine showed that since a Russian UAS locates a Ukrainian position, the soldiers have ten to fifteen minutes to abandon it before the position is hit by precise indirect fire (AWG 2016, 23). In July 2014, during the battle of Zelenopillya, "a single Russian artillery fire mission destroyed two Ukrainian mechanized battalions in a matter of minutes” (O’Connor 2019, 69). In August 2014, indirect fires adjusted by Russian Orlan-10 and Forpost UASs destroyed an entire column of the Ukrainian 92nd Separate Mechanized Brigade (Cranny-Evans, Cazalet and Foss 2018).

Air Interdiction and CAS

UAS conduct air interdiction “to divert, disrupt, delay, or destroy the enemy’s military surface capabilities before it can be brought to bear effectively against friendly forces, or to otherwise achieve objectives that are conducted at such distances from friendly forces that detailed integration of each air mission with the fire and movement of friendly forces is not required” (HQDA 2021, 1-3). Combat UAS is equipped with different types of missiles or guided bombs that can destroy high-payoff preplanned or time-sensitive targets such as enemy armor, artillery, air defense assets, and C2 and logistic nodes. The commander has a near-real-time situational understanding of the battlefield based on the real-time video or imagery provided by the UAS. It facilitates decision-making and abbreviates the targeting cycle.

Once more, during the Nagorno Karabakh conflict in 2020, the Azerbaijanis focused their efforts on Armenia’s second echelon forces and lines of communication, causing Armenians to lose a significant number of tanks, armored vehicles, artillery systems, and even four sophisticated S-300 air defense systems (Sprengel 2021, 23).

Armed UAS can also conduct close air support (CAS) missions to support friendly forces by engaging targets in their close proximity. The Joint Terminal Attack Controller (JTAC) locates targets, guides the aircraft onto the intended target, and gives verbal corrections to follow-on aircraft for weapons impact onto a target. The JTAC can use the UAS’s laser target designator to guide laser-guided munitions from other strike aircraft onto targets. "If the unmanned aircraft is armed, it can be used to locate targets and engage with its own weapons payload" (HQDA 2006, 5-25). Figure 13 illustrates the essential C2 infrastructure when conducting CAS and air interdiction missions in support of commanders at the tactical level. It undeniably shows that human involvement is vital to the decision-making loop.

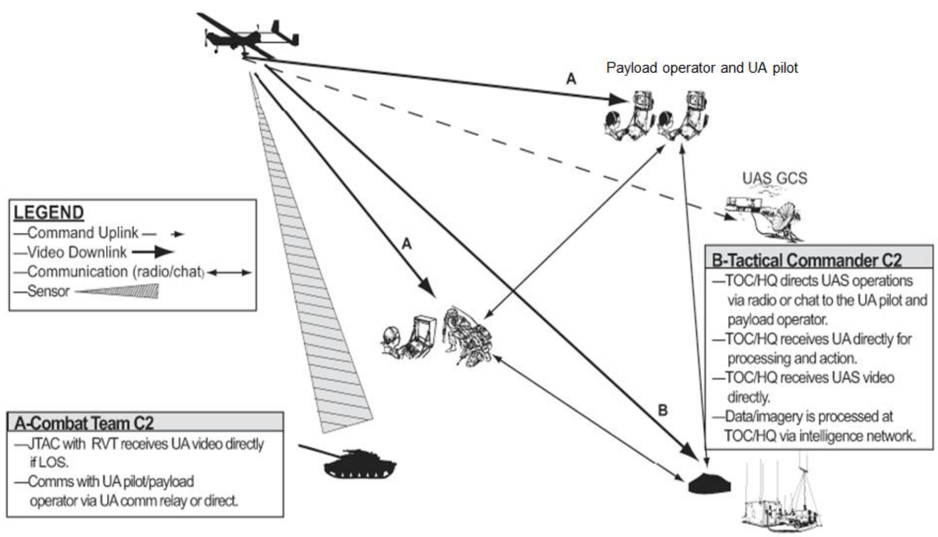

Figure 13. UAS C2 Infrastructure when Conducting CAS/Air Interdiction

Source: JUAS-COE 2010, 51.

Electronic Warfare

UAS is equipped with multifunctional EW sensors that provide ground units with an electronic attack, electronic protection, and electronic warfare support capabilities. The EA's capability to provide electromagnetic, direct energy, or antiradiation weapons enable attacks on personnel, facilities, or equipment with the intent of their degradation, neutralization, or destruction. These types of UAS should be capable of long-endurance missions and carry small, low-cost electronic attack payloads (HQUSAF 2014, 51).

Electronic protection's main task is to prevent or reduce the enemy's use of the electromagnetic spectrum and protect friendly personnel, facilities, and equipment to protect against degradation, neutralization, or destruction of friendly combat capability. UAS "should be equipped to search, intercept, rapidly identify threats, and locate sources of radiated electromagnetic energy" (HQUSAF 2014, 51).

Electronic warfare support (EWS) includes actions to search for, intercept, identify, and locate sources of intentional and unintentional radiated electromagnetic energy sources for immediate threat recognition, targeting, planning, and conduct of future operations (HQDA 2019b, 1-1).

Turkish military achieved visible results in Syria by integrating EW systems with UAS. They listened to Syrian communications and determined their locations that relayed the grid locations to the Anka UAS, which relayed data to the Bayraktar TB2 UAS for targeting. On the other hand, they also evaded Syrian countermeasures and destroyed three sophisticated Pantsir-S1 air-defense systems by applying electronic jamming. (Urcosta 2020b, 52,53).

Russian military uses the Leer-3 system, consisting of two Orlan-10 UASs and a ground station. The system can jam cellular networks or send fake messages up to sixty kilometers. In Ukraine, Russians used the system by sending text messages to Ukrainian troops that looked like they came from their fellow comrades, encouraging them to flee the ranks because their commanders had abandoned them and their forces were suffering heavy losses nearby (Associated Press 2017).

Command and Control

UAS can provide situational awareness for the commanders that will facilitate their decision-making because of different sensors such as CRP, RVT, and FMV. RVT and FMV sensors can enable real-time decision-making, while the communication payloads can primarily provide “airborne relay over rugged, mountainous, or urban terrain, where other communications options are limited or to decrease the dependence on satellite connectivity. On the battlefield, RPA will provide a persistent long-range communications relay or act as a gateway manager of multiple communications to enhance C2 connectivity and span of control” (HQUSAF 2014, 52). UAS will facilitate the communications between the commanders and subordinate units, supporting one or multiple waveforms. This communication relay package (CRP) should be compatible with the ground C2 platforms to enhance interoperability. It “operates in the UHF/VHF bands, supporting a variety of frequencies and waveforms, including the Single-Channel Ground-Air Radio System (SINCGARS), extending the range between users for voice and data communications, including chat text, instant messaging, and imagery” (Defense Update 2010).

UAS Support to Civil Authorities in Crisis

UAS is a suitable asset that can operate in a *dull, dirty, and dangerous* environment while minimizing the risk for the pilot in both combat and non-combat missions. The National Defense Law allows the Army to support the civil authorities in crisis, emergencies, or war. The Army can support the Ministry of Interior (MOI) when the overall security of the state is endangered, and MOI is not capable of handling the crisis. It can also support the Rescue and Protection Head Office and Crisis Management

Center in crises and emergencies such as natural disasters, dangerous material incidents, and search and rescue tasks.

UAS in Support of MOI

UAS can assist MOI in tracking suspects, terrorist and criminal groups or conducting border patrolling. Long-endurance UAS can *fix* the target for a prolonged period and provide information on its activities, enabling real-time situational awareness for the decision-maker at a smaller cost than a manned aircraft. It can also assist in target identification and confirming whether they are armed or not. The suspect, terrorist or criminal group is unaware that it has been under surveillance because of the UAS's high operational altitude and concealed noise, thus affording flexible opportunities to capture or eliminate the threat by conducting raids, ambushes, or hasty checkpoints.

Another practical application for UAS employment in crisis is assisting the border police units while conducting border security and providing information on illegal trespassers or smugglers. Figure 14 illustrates the role of the UAS as a part of an integrated border security system.

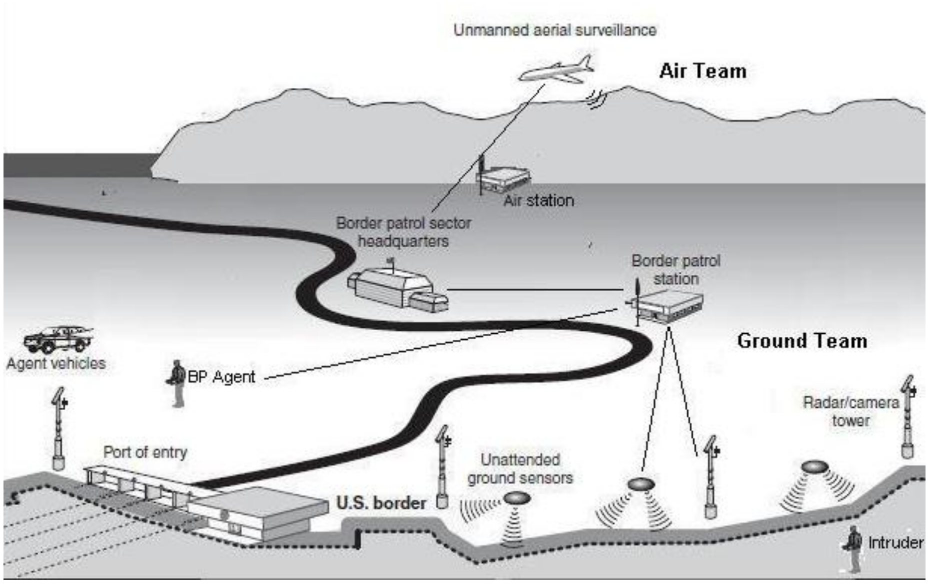

Figure 14. Border Security System

Source: Flesher, Oni, and Aaron 2011, 3.

A border security system is an integrated system consisting of aerial and ground assets linked together. The UAS will conduct surveillance in a specific area and transmit the information to the ground base. The integration will effectively detect and track potential targets while maintaining low operational costs (Flesher, Oni, and Aaron 2011, 3). The US Border and Customs service is the second-larger user of UAS outside the US Department of Defense. Most of their UAS overwatch the US-Mexican border, especially in severely restricted areas that limit movement or dangerous areas where human presence is risky (Kreps 2016, 107).

UAS in Support of Rescue and Protection Head Office (RPHO) and Crisis Management Center (CMC)

UASs can operate in areas affected by natural disasters (earthquakes, floods, wildfires) by surveying the disaster sites and people who need help. During the 7.8

magnitude earthquake in Nepal in 2015, UAS provided surveillance from sites inaccessible to humans in normal circumstances. Most of the trapped personnel were located by UAS's thermal cameras faster and easier. UAS also used aerial mapping for the earthquake-stricken area, provided photos, and directed assistance to those areas (Kreps 2016, 116).

UAS can provide information to the RPHO and CMC for incident awareness and assessment, search and rescue, communications, CBRNE, or logistical sustainment in the affected area regarding the level of destruction to the critical infrastructure and facilities that present hazards to the population (US Army UAS COE 2010, 29). UAS equipped with special CBRNE detection equipment can conduct reconnaissance in the affected area while transmitting full-motion video to the previously established Emergency Operations Center (EOC). The same UAS can facilitate communications by serving as a relay station, thus connecting the EOC with the other elements participating in the operation. The integration of a UAS while conducting civil support operations during a possible bio-hazard incident is depicted in Figure 15.

Figure 15. UAS in Support of Civil Authorities in Emergency

Source: US Army UAS COE 2010, 30.

Since UAS is capable of loitering over the target for a prolonged period, it can also provide real-time situational awareness and enable the C2. During the Fukushima nuclear incident in 2011, UAS measured the radiation level, thus preventing individuals from being exposed to the dangerous radiation.

Another application for UAS employment without endangering human lives is fighting wildfires. Wildfires start very fast and can affect a larger area in a short time. UAS are suitable to provide information for wildfires on highly restrictive terrain, pinpointing the hotspots of the fire and guiding water drops from the flying boat amphibious airplanes to achieve effective results. The California National Guard had used drones in 2013 to do infrared mapping of the Yosemite National Park fire. During the 2015 wildfire at Olympic National Park, the National Park Service employed UAS to provide information about the fire, determine the critical hotspots, and guide the water drops. UAS's cameras can scan large areas and automatically detect potential fire from a long distance (Kreps 2016, 116). It also provides continuous surveillance and real-time video delivery to ensure better coordination on the ground among different agencies involved in the operation.

UAS can assist civil authorities when conducting search and rescue, especially in inaccessible, mountainous terrain that limits movement and radio and GSM communication. Its high-resolution cameras and long endurance determine the precise location for possible search and rescue operations (downed aircraft, lost hikers, personnel in dangerous regions affected by a natural disaster) and cover a larger area for a prolonged time. Turkish Bayraktar TB2 had successful search and rescue operations when a UAS operated by the Turkish gendarmerie assisted in rescuing a tourist lost in a ski resort in northwestern Turkey. TB2 located the person and sent accurate coordinates to the Turkish Disaster and Management Authorities and gendarmerie to rescue the tourist (Balcikoca 2022).

Summary and Conclusion

Chapter 4 provided a thorough and systematic analysis based on the gathered data and chosen research method to give an articulate and comprehensive recommendation to the CDM while answering the primary and secondary research questions. The analysis began by providing an overview of Mi-24's characteristics and capabilities, describing the definitions and categories of UAS/RPAS, conducting a UAS SWOT analysis, and providing information on the characteristics and capabilities of potential UAS. It also analyzed the MQ-1C Gray Eagle organization to provide insights for a suitable, acceptable, and feasible UAS organization at the lowest level in the Macedonian Army. Lastly, the analysis displayed approaches for possible integration of versatile UAS to increase the overall combat power, based on the experience of their employment on the battlefields worldwide and the support of civil authorities in different situations. Chapter 5 will use the improved recommendation R3 as a starting point for creating a campaign plan, which incorporates short-term and long-term actions defined by clear priorities.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the findings derived from the data analysis conducted in the previous chapter. The answers to the research questions should be the foundation for a solid implementation plan for the R3 position proposed to the CDM. The plan should define a clear time frame and priorities. The chapter should also provide information on possible research questions that would facilitate future research and personal lessons learned, which contributed to the author's reflective learning (Long 2016).

Research Recapitulation

The purpose of the study was to lay out an acceptable, suitable, and feasible Materiel and Organizational solution for a versatile UAS to increase the combat power of the Macedonian Army. The literature generated enough findings that drove the analysis, which answered the research questions and created an adequate commendation to the CDM based on the professional recommendation R2 and the improved stakeholder recommendation R3. The research analysis was divided into three parts, and each part answered a specific research question.

Part one of the research began by providing information on the Mi-24 characteristics and capabilities as a starting point in determining the desired capabilities of a potential UAS that can primarily serve as a CAS and air interdiction asset. The definitions of UAS/RPAS gave an overview of the differences between the levels of expertise that the UAS operator should possess to operate a complex UAS. At the same time, the categories of UASs laid out an outline of the payload types and their maximum endurance, which enabled conducting versatile missions for a prolonged period. The information on tactical and technical capabilities of the most well-known combat-proven UAS systems produced by the United States, Turkey, and Israel, facilitated the development of the most critical evaluation criteria, which measured the relative effectiveness and efficiency of the proposed solution seen through the lens of different stakeholders.

Part two of the research analyzed the organization of an MQ-1C Gray Eagle company in a US Combat Aviation Brigade. It studied the UAS company's structure and determined the necessity of defining a suitable organization at the lowest level possible. On the other hand, it emphasized the versatility of this organization based on the additional supporting equipment such as different types of ground control stations, satellite terminals, tactical vehicles, or takeoff and landing systems that enable successful UAS operations. The potential UAS unit should plan for sufficient maintenance subunits to extend the unit's operational reach and endurance.

Finally, part three of the research described the integration of UAS into different types of missions and their impact on increasing the combat power of the Macedonian Army, focusing on the fires, intelligence, and C2 warfighting functions. It also provided thoughtful insights on UAS employment in supporting different governmental agencies and organizations. It created two additional benefits: assisting law enforcement agencies in building a more secure environment and assisting civil authorities in crisis and natural disasters.

Recommendations

The accepted improved recommendation R3 by the CDM would become the starting point for creating and implementing the campaign plan, which encompassed short-term and long-term actions, along with clear priorities in each action. Based on the established evaluation criteria and defined weights for each criterion, R3 defined the answer to the best possible Materiel solution of a potential armed UAS for the Macedonian Army, providing a partial answer to the primary research question How does integrating versatile UAS through the Materiel and Organizational domains of the DOTMLPF-P framework increase the combat power of the Macedonian Army?

The FIFA analysis based on the Gray Eagle company provided insights for possible suitable, acceptable, and feasible organizational solution for a future UAS organization in the Macedonian Army. This organization will significantly depend on the selected Materiel solution, incorporating a headquarters element, flight element, maintenance element, support element, and appropriate support infrastructure.

Proposed Action

Table 20 summarizes the proposed actions based on the priorities to implement the accepted improved recommendation R3. It describes the near-term (1-2 years) and the long-term plan (3-5 years), which relate to the Materiel and Organizational solution for UAS introduction in the Macedonian AF. Since the anticipated retirement of Mi-24 helicopters in 2025 will generate serious capability gaps, especially in air interdiction and the CAS domain, the development of capability requirements in the emergent threat timeline will be paramount. The emergent timeline “identifies needs that represent potential mission failures if not satisfied by a rapidly acquired capability solution" (USAWC 2020, 10-5).

Table 20. Campaign Plan

Solution	Priority	Near-term plan (1-2 years)	Long-term plan (3-5 years)
Materiel	Must do	- Update the "Future Forces 2028" concept. - Conduct detailed UAS procurement analysis and allocate funds.	- UAS introduced in operational employment.
	Should do	-Prepare project proposal to the Logistics Department/MOD.	- All additional equipment and special tools related to the UAS procured.
	Could do	-Initiate the acquisition process to fill in the capability gap.	- Technical and training manuals are available. - Training devices are acquired together with the UAS.
Organization	Must do	-Approve the Army's updated TOE.	- Operational, support, and maintenance sub-organizations are fully functional and operable.
	Should do	-Define TOE for the potential UAS organization.	- Establish a training center for UAS MOS individual and collective training.
	Could do	-Study potential UAS organizations based on the Materiel solution.	- Plan for specialized level 2 and 3 maintenance units.

Source: Created by author.

Suggestions for Future Research

The research paper focused on providing Materiel and Organizational solutions for UAS integration in the Macedonian Army to improve combat power through fires, intelligence, and C2 WFF. The research limitations and delimitations described in Chapter 1 constrained comprehensive research and provided ground for additional work and analysis in the future. Some of the potential areas for further study will be providing solutions for a UAS integration through the rest of the DOTMLPF-P domains, primarily Doctrine and Training. They both logically build upon the Materiel and Organizational domains to provide a complete solution integration based on the identified capability gaps.

Doctrine and Training domains are closely connected to the operational employment of UAS since they provide guidance and skills to plan, prepare, execute, and assess operations. The Macedonian Army does not have a doctrine for armed UAS employment, which imposes the need for different doctrinal field manuals, training publications, and appropriate technical manuals based on the lessons learned from the employment of the selected model of UAS. The doctrine should encompass the integration of the UAS employment on the battlefield with other systems, especially when providing lethal or non-lethal fires, intelligence, or support of the C2. Combined with Training, it should produce tactically and technically proficient personnel capable of supporting different missions.

Training should be focused on the essential MOS skills necessary to operate and support the UAS during their lifecycle. All personnel should obtain the required qualifications to ensure that they are trained and capable of conducting the desired missions, thus leading to the overall unit’s mission and essential task list accomplishment. Macedonian Army TRADOC should support the training by issuing proper tactical and technical manuals for UAS employment and maintenance and individual and collective training standards. Designing institutional training courses for all MOS, including training simulators, will enhance realism and improve overall training performance.

Another potential area of future study which may provide more research fidelity is to incorporate additional parameters, such as UAS system cost, possible warranty packages by the manufacturer, and UAS operational life cycle cost. Open-source information could not provide that analysis, but a deeper study in the future will eventually lead to approved access to this information, preferably by the UAS manufacturer, and produce more accurate screening and evaluation criteria for a possible Materiel solution. The likely drawback of the study is the possibility to limit its availability to a broader audience since most of the information can be under a non-disclosure agreement with the UAS manufacturer.

Personal Lessons Learned

The necessity to procure and integrate UAS in the Macedonian Army arose recently, with primary drivers being Macedonian strategic documents that relate to the force modernization and experiences from the latest battlefields. The problem had not been studied earlier, so the research demanded a thorough and detailed analysis that could be a starting point in a potential acquisition process. The research provided valuable experience for the author because it incorporated best practices of the Army Professional Body of Knowledge by using appropriate professional concepts, techniques, frameworks, and methods to develop recommendations for the eventual CDM's decision that generated a solution to an identified capability gap. It imposed the need to synthesize the knowledge gained during different Command and General Staff Officer Course curriculum modules into an articulated and quality research study. Working on the research paper also provided valuable insights into the research process and its phases, improved the author's ability to analyze or synthesize data into useful information and enhanced his writing skills. Finally, the application of critical thinking throughout the research process resulted in unbiased research that was more clear, more accurate, and more relevant because the author implemented intellectual standards of clarity, accuracy, precision, relevance, depth, breadth, and logic (Elder and Paul 2013, 35).

Conclusion

The latest experiences from the modern battlefields proved that UAS is a new revolution in military affairs (RMA) that can be employed in the wide range of the conflict continuum. The UAS represents a lucrative option for an asset that can support a plethora of missions ranging from TA, air interdiction, CAS, indirect fire adjustment, BDA, C2, conducting screen, convoy and base protection, and CBRNE reconnaissance. Their procurement and operational costs are much lower than appropriate manned aircraft platforms, making them a preferable solution for countries with limited defense budgets.

The research study can serve as a framework to provide Materiel and Organizational solution for UAS integration in the Macedonian Army. The main goals are the preservation of air interdiction and CAS capabilities after the Mi-24 helicopter retirement in 2025 and increasing additional capabilities, primarily through fires, intelligence, and C2 WFF, to increase the overall combat power of the Macedonian Army in accomplishing its constitutional mission and tasks.

GLOSSARY

Line of sight. “The unobstructed path from a Soldier’s weapon, weapon sight, electronic sending and receiving antennas, or piece of reconnaissance equipment from one point to another” (HQDA 2021, 1-62).

Mission package. “Equipment carried on a UAS configured to accomplish a specific mission” (US Army UAS COE 2010, 8).

Remotely piloted aircraft. “An unmanned aircraft that is controlled from a remote pilot station by a pilot who has been trained and certified to the same standards as a pilot of a manned aircraft” (NATO 2020, 110).

Reconnaissance. “A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an adversary or to obtain data concerning the meteorological, hydrographical or geographic characteristics of a particular area” (NATO 2020, 108).

Sensor operator. “The person who controls the payloads or sensors onboard an RPA but does not command and control the aircraft” (HQUSAF 2014, 99).

Strike. “An attack which is intended to inflict damage on, seize, or destroy an objective” (NATO 2020, 123).

Surveillance. “The systematic observation across all domains, places, persons or objects by visual, electronic, photographic or other means” (NATO 2020, 124).

Targeting. “The process of selecting and prioritizing targets and matching the appropriate response to them, taking into account operational requirements and capabilities” (NATO 2020, 127).

Unmanned aircraft system control station. “A facility or device from which the UAS is controlled and/or monitored for all phases of flight” (NATO 2019, LEX-3).

Unmanned aircraft system operator. “The individual responsible for controlling an unmanned aircraft system” (NATO 2019, LEX-3).

Unmanned aircraft system pilot. “An unmanned aircraft system operator who has been trained and certified to the equivalent standards as a pilot of a manned aircraft” (NATO 2019, LEX-3).

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