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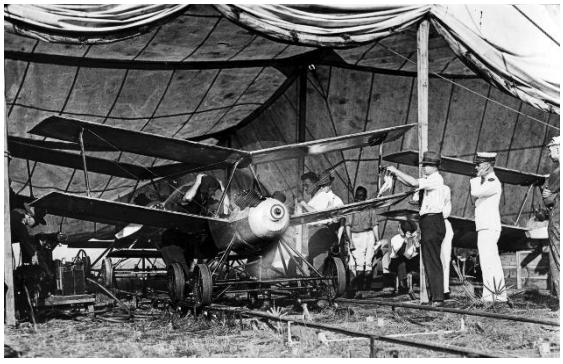
Abstract

This study examines the increasing use of drones in conflicts, focusing on their adoption by non-state actors, including terrorist organisations. It explores the historical development of drones, their applications in various sectors, and their accessibility in today's market. Through case studies in regions such as the Middle East, Russia-Ukraine, and India, the paper highlights the significant impact of drones in modern warfare. Additionally, it discusses counter-drone strategies and emphasises the need for a collaborative approach to address the evolving threat.

Introduction

On June 27, 2021, an Indian Air Force base in Jammu was targeted by two explosive-laden drones. One of the drones struck the roof of a building, causing minor damage, while the other detonated in an open area. These attacks did not result in any damage to critical military infrastructure or equipment, but they did manage to injure two Air Force personnel. Subsequent investigation revealed that the Pakistan-based terrorist organisation Lashkar-e-Taiba was responsible for this attack.[1] This incident was not the first instance of a terrorist organisation employing drones for such purposes. Over the past few years, there has been an observed proliferation of drones by various non-

state actors for a range of applications. Drones, also known as unmanned aerial vehicles (UAVs), are not a novel concept. They find application in fields such as filmography, agriculture, construction, delivery, military operations, and homeland security. In recent years, there has been a substantial surge in the global drone market across all these sectors. Advancements in additive manufacturing, machine learning, artificial intelligence, and electronic technologies have led to the increased sophistication of drones, coupled with a reduction in manufacturing costs, rendering them more accessible. The history of drones can be traced back to 1898 when Nikola Tesla developed the first radio-controlled boat.[2] This milestone laid the foundation for today's unmanned systems technology. The initial pilotless aerial vehicles were developed in Britain and the USA during the First World War, specifically between 1917 and 1918. The British pilotless aircraft was employed as an aerial target, while the American counterpart, known as the 'Kettering Bug,' was designed as an aerial torpedo equipped with an 82 kg explosive warhead. The Kettering Bug served as a precursor to modern cruise missiles and loitering munitions.



(Prototype of Kettering Bug (1918)- National Museum of the United States Air Force)

However, neither of these early drones was formally integrated into service. In 1935, Britain introduced a drone derived from the De Havilland Tiger Moth, named DH.82 Queen Bee, which saw service with both the British and American military for aerial target practice. The inaugural wartime use of drones took place during the Vietnam War, when the United States utilised them for reconnaissance missions over northern Vietnam and southern China. The specific drone employed was the Aerial-launched Ryan Model 147, a modified version of the Ryan Fire-Bee Jet-Propelled Aerial Target drone, which completed 20 reconnaissance flights in 1964. Throughout the course of the war, various iterations of drones were deployed by the US military.[3]

Modern Military Drones

The attitude towards Unmanned Aerial Vehicles (UAVs) underwent a significant shift after the Lebanon war in 1982. Prior to this event, UAVs were often viewed as unreliable and expensive gadgets. However, during the war, Israeli forces employed reconnaissance drones such as the Tadiran Mastiff and IAI Scout to pinpoint the locations of Syrian SA-6 Surface-to-Air Missile batteries in Operation Mole Cricket 19. This marked the inaugural use of UAVs in a military campaign focused on SEAD (Suppression of Enemy Air Defence), resulting in the destruction of a total of 19 SAM batteries.

The introduction of an Integrated Data-Link system, real-time high-resolution video coverage, and extended operational endurance rendered these drones more capable than their predecessors. These enhanced capabilities caught the attention of the US military, leading to the establishment of the RQ-2 Pioneer drone programme. This initiative, a collaborative effort between the American AAI Corporation and Israeli Aerospace Industries, was designed for surveillance and reconnaissance purposes and served as a foundational element for contemporary US military drone initiatives.

(United States Navy RQ-2 Pioneer UAV)

From July 1986 onwards, the US Navy began receiving these drones for deployment on the USS Iowa. Additionally, three systems were allocated to US Marines, where they were operationally utilised on LHA-class vessels and within various land-based units. These drones saw action in diverse theatres, including the Persian Gulf, Bosnia, Yugoslavia, Somalia, and Iraq.[4] During this same period, countries like Iran and Russia initiated their own drone programmes. The Mohajer-1 became the first drone to be integrated into the Iranian military's service during the Iran-Iraq war in 1986. Meanwhile, Russia commenced production of the Yakovlev Pchela-T1. Both of these drones were employed for Surveillance and Reconnaissance missions.

Armed Drones and War on Terror

After the successful demonstration of their utility in the Gulf War, global militaries invested extensively in the domestic development of combat UAVs, with the United States leading the way. The US Combat Drone programme commenced in 1988 when Leading Systems Inc. (Karem Aircrafts) initiated the development of the Gnat-750 UAV, which served as the precursor to the MQ-1 Predator. This marked the inception of the first dedicated attack UAV, derived from their earlier Amber UAV developed under DARPA's TEAL RAIN project in 1986. [5][6] The Predator programme initially began as a reconnaissance initiative. However, in February 2000, the UASF equipped the RQ-1 Predator with laser-guided Hellfire missiles to evaluate its combat capabilities. This transformation solidified the Predator's status as the world's first Dedicated Unmanned Aerial Vehicle.

Before the Predator, Iran had already started equipping its Mohajer-1 UAV with RPGs during the Iran-Iraq war. This UAV was capable of carrying six RPG rounds, though it remains unclear whether Iran carried out drone attacks during the conflict.[7][8] The first use of an armed drone occurred during World War II when four American TDR-1 drones, each armed with a 2,000-pound bomb, flew 55 miles to Bougainville on September 27, 1944, to attack an anti-aircraft battery established by the Japanese on a beached merchant vessel. One of the TDR-1s was lost at sea, and a second crashed 30 yards astern of the gun emplacement, but the bomb failed to detonate.[9]

(A TDR-1 being prepared for a mission on Mbanika Island, in the Solomons. Note the TV camera in the nose.)

Following the devastating attack on September 11, 2001, the Bush administration launched the 'Global War on Terror'. Over the course of this 19-year campaign, the

United States and other NATO countries conducted anti-terror military operations in Afghanistan, Pakistan, and MENA countries such as Yemen, Syria, Iraq, and Libya. On October 27, 2001, the USA carried out the first anti-terror drone strike in Kandahar, Afghanistan, resulting in the killing of Muhammad Atef, al Qaeda's military commander, marking the first UCAV strike of the modern era. The US military also began using the MQ-9 Reaper UCAV alongside the Predator after 2007. The Reaper stands as one of the most advanced operational drones of the current era, succeeding the MQ-1 with advanced datalink, satellite communication, targeting systems, extended endurance, and a higher service ceiling. It was later adopted by major NATO and non-NATO allied nations.

(A MQ-9A Reaper in Afghanistan, 2007)

During the campaign period, the CIA and US military conducted more than 4100 drone strikes, with 2243 of them carried out within the first two years of the Trump Administration, surpassing the total conducted over the eight years of the Obama administrations. From January 2002 to January 2019, more than 8,858 individuals were killed in these strikes, including over 910 civilians.[10] Numerous prominent leaders of terrorist organisations, such as Ayman al-Zawahiri of Al-Qaeda, Ahmed Abde Godane of Al-Shabaab, Abu Bakr al-Baghdadi of the Islamic State, Commander of the Iranian Quds Force, Qasem Soleimani, and many other top-tier leaders from the CIA kill list were targeted.

The US government also faced public backlash due to civilian casualties resulting from collateral damage during drone strikes. Studies have shown that domestic US public support for lethal drone operations is high, but it significantly declines when individuals are informed of civilian casualties. Research has also demonstrated that individuals' support for lethal drone operations is influenced by the potential for mission failure, American military casualties, and foreign civilian casualties. Notably, foreign civilian

casualties have a more substantial negative impact on public attitudes than American military casualties.[11]

Civilian Drones and The Global Market

In recent years, there has been a rapid surge of interest in drones within the civilian market due to their wide range of applications. It is projected that by 2030, the global drone market will reach a value of $91.3 billion USD, which includes the defence segment.[12] Factors such as accessibility, remote operability, ease of use, technological advancements, cost-effectiveness,[13] and reduced size have contributed to their popularity among diverse user groups. The major civilian industries driving the drone market today are Survey and Inspection, Agriculture, Entertainment, Mapping, and Logistics. Additionally, Non-Military government agencies are increasingly adopting drones for various purposes.

Currently, the Defence sector holds the largest market share in the drone industry, followed by Enterprise, Consumer, and Logistics segments. According to a report by 1Lattice, it is anticipated that the Enterprise segment will surpass the Defence segment by 2027, accounting for 41% of the market value.[14] When examining market share by manufacturer, the Chinese drone manufacturer DJI is the dominant player, commanding over 70% of the global drone market share.[15]

Loitering Munitions and Small drones in Battle field

In the 2020 Nagorno-Karabakh war, Armenia suffered a humiliating defeat against Azerbaijan. The key factor in Azerbaijan's victory was the deployment of Turkish-made TB-2 UCAVs against Armenian ground troops and armoured vehicles. Consequently, Turkish drone manufacturer Bayraktar received orders for TB-2 drones from numerous nations. However, it was another drone that enabled the TB-2 to execute ground strikes safely on the battlefield. This drone is the IAI Harop, an Anti-Radiation loitering munition drone developed to target Surface-to-Air missile radars. The use of the Harop in SEAD operations against Armenian SAM batteries paved the way for TB-2 strikes against ground targets. This marked the first instance of extensive use of loitering munition in a major war. Loitering munitions, also known as kamikaze drones or suicide drones, carry warheads and impact their targets. They present a cost-effective solution for precision strikes against small strategic targets such as armoured vehicles, troop

carriers, ground radars, and other military installations. Due to their cost-effectiveness, many militaries have begun acquiring loitering munitions from domestic or foreign sources.

In the ongoing Russia-Ukraine war, Russia has employed Iranian-made Shahed-136 and domestically produced Zala Lancet loitering munition against Ukrainian military installations and vehicles. In response, the Ukrainian military has acquired American Switchblade and Polish Warmate loitering munitions. All of these loitering munitions are capable of carrying conventional strikes, unlike the Harop which is specifically designed for SEAD operations. Ukraine has also utilised the Bayraktar TB-2 Drone UCAV for ground strikes, but it has begun to lose its effectiveness over the past few months due to the sophisticated Russian surface-to-air defence system. One of the major challenges Russia has faced is small drones equipped with munitions targeting Russian armoured systems and ground troops. Ukraine has employed DJI Mavic and FPV drones loaded with explosives to target Russian troops and armoured columns. Videos have emerged on the internet showing Ukrainian drones dropping munitions on Russian troops positioned in trenches, and FPV drones equipped with explosives striking Russian tanks and armoured fighting vehicles.[16][17][18] Now, Russian forces have also begun using FPV drones to carry out attacks against Ukrainian tanks.[19] These makeshift solutions are comparatively more cost-effective than conventional loitering munitions. Presently, many countries around the globe are either in the process of developing or have already developed loitering munitions, with some opting for these makeshift solutions as well.

Proliferation of Dones by Non-State Actors

While the accessibility of drones has become a boon for humanity, many terrorist organisations have started equipping themselves with these machines. These organisations employ drones for purposes such as smuggling drugs and arms, conducting surveillance, attacking military forces and critical infrastructure, and executing chemical, biological, and radioactive attacks. The technology they have access to cannot surpass the technology employed by military forces. However, with the support of state governments, they can carry out attacks with significant damage. These terrorist organisations utilize commercially available off-the-shelf systems or assemble completely knocked-down units themselves. These systems include multi-

copters and small fixed-wing UAVs. In his 2002 testimony to the US Senate Governmental Affairs Committee's Subcommittee on International Security, Proliferation, and Federal Services, Christopher Bolkcom identified seven features that make RPAs attractive to terrorist groups: (1) low acquisition costs; (2) a variety of purchasing pathways; (3) potential for high accuracy; (4) operational flexibility; (5) high likelihood of air-defence penetration; (6) high survivability pre-launch; and finally (7) low levels of infrastructure needed to support their deployment.[20] From the Iran-Iraq war to the Israel-Gaza conflict, the Middle East has remained a hot spot for conflicts for many decades. However, in the last two decades, terrorist organisations in this region have witnessed a proliferation of drones. On October 2, 2016, ISIS carried out an attack, killing two Kurdish peshmerga soldiers and injuring two French soldiers who were investigating a crashed drone laden with explosives.[21] ISIS had been using drones for surveillance purposes and to record videos of suicide attacks carried out by their personnel. However, it was the first time they used a drone for an attack. It's worth noting that this was not a drone attack in the sense that the drone was not used to drop explosives or strike a target. The actual use of a drone for an attack by ISIS occurred in February 2017 agains t the Iraqi Army campaign in Mosul.[22]

(*Bomb (in red) dropped from an ISIS armed drone on an Iraqi army vehicle in the west Mosul neighbourhood of Al-Maamoun (the photo was released by ISIS's Nineveh Province on a file sharing website, February 25, 2017)*

The organisation had an extensive supply chain network based in the UK, Spain, Denmark, and Bangladesh, run by two brothers, Siful Haque Sujan and Ataul Haque Sujan, under the guise of IT firms. The Turkish firm Profesyoneller Elektronik was also involved in this network, supplying drone components worth $500,000.[23] ISIS also had an institutional drone training programme for flying and weaponizing the drones. [24]

(ISIS Terrorists drone training)

After this attack, ISIS carried out many major attacks in Iraq and Syria using drones. Between February 2017 and March 2017, ISIS conducted more than 81 drone strikes, resulting in 39 deaths and 103 injuries. They also targeted six military vehicles during these attacks. The main drones used by ISIS for these attacks were the DJI Phantom, a quadcopter manufactured by the world's largest drone company, DJI, and the Skywalker X-8, a fixed-wing drone.

(Commercial drone modified for projectile drop capability by islamic state Terrorist [25])

(ISIS Terrorist with Skywalker X-8 UAV Citation [26])

Later in 2017, as ISIS started losing power in the region, their drone capability also began to decline. However, ISIS was not the only terrorist organisation to use drones for attacks. Organisations like Hamas, Lashkar-e-Taiba, Houthis, and Hezbollah also carried out major attacks against state military forces. Unlike ISIS, Houthis, Hamas, and Hezbollah organisations have the technical support of state governments like Iran,

Syria, and Lebanon. On September 24, 2019, Houthi loitering munition and cruise missiles struck Saudi Aramco oil facilities in Abqaiq and Khurais, causing significant damage worth more than millions of dollars. The drones used in these attacks closely resemble the Iranian-made Shahed series loitering munition. This was a major attack on infrastructure using drones by terrorist organisations.

(On the right, a wreckage of a drone recovered from the Aramco Attack site; on the left, drones displayed by Houthis.)

In the same year, Houthis conducted a drone attack during the Saudi Coalition Parade on January 10, 2019, when a drone exploded over the parade, killing six.[27] They also use Qasef-1, which closely resembles the Iranian Ababil-2 and Samad Series loitering munition. In January 2022, Houthis targeted three oil tankers and an extension of the airport in Abu Dhabi, resulting in three deaths. Hezbollah, a terrorist organisation based in Lebanon, also uses some similar drones to those used by Houthis. In fact, while writing this paper, Hezbollah conducted a loitering munition strike using the Shahed-136 loitering munition on the IDF position in Shebaa Farm, northern Israel. The video of the attack surfaced on Twitter.[28] On May 16, 2023, the Middle East Media Research Institute posted a video on Twitter showcasing a Large-Scale Offensive Drill in Southern Yemen by Houthi Forces, simulating attacks on Israeli and American positions using infantry, artillery, tanks, rockets, multicopter drones with munitions. During that drill, Houthis demonstrated swarm capability for an offensive role, indicating that many terrorist organisations are shifting towards hybrid warfare rather than conventional warfare, which is alarming for militaries around the world.[29]

(Houthis showcasing drone swarm capability in south Yamen.)

HAMAS, a non-state organisation based in the Gaza Strip near Israel, also possesses loitering munition capability like Houthis and Hezbollah. One of their drones closely resembles the Iranian Sarir H-110 UAVs.

(Hamas UCAV, which looks like Iranian Sarir H-110 [30])

The conflict between Israel and Hezbollah and Hamas has been ongoing for over a decade, but the use of drones against the IDF started in 2004, predating the ISIS drone programme. Since then, the IDF has been able to shoot down many drones operated by Hezbollah and Hamas. However, these organisations are still able to carry out drone incursions due to constant state support from Iran, Lebanon, and Syria. In the ongoing Israel-Gaza conflict, Hamas released a video in which they targeted the Israeli Merkava tank with a PG-7VR HEAT Anti-Tank round grenade attached to the DJI Matrice 600 Pro drone. The maximum payload capacity of the Matrice is 6Kg, allowing it to easily carry two PG-7VR/L rounds, which are sufficient to take out any tank.[31]

(Hamas Terrorist attaching PG-7L Anti-Tank round to DJI Matrice600 pro Drone)

(PG-7VR Round being dropped from drone on IDF Merkava Tank)

Additionally, Hamas showcased their homegrown loitering munitions like Zouari, named after a Tunisian aerospace engineer who was working for Hamas and was later assassinated, and Shihab.

(Hamas Terrorists with Zouari Loitering Munition)

Like the Middle East, India is also facing a serious terrorism problem due to state-sponsored terrorism. As mentioned in the introduction, the attack on the Jammu airbase was the first of its kind in India. Additionally, India is grappling with drug and weapon smuggling by drones in the Punjab region. In 2022, the Border Security Force was able to shoot down 23 drones. There were 10 incidents of intrusion between March 19 and April 25, 2023, of which BSF was able to take down only one.[32] From May 20 to June 12, BSF shot down 10 drones. Most of these drones were either hexacopters made for agricultural purposes or DJI-made Matrice 300RTK.[33] According to the New America Foundation, 23 terrorist organisations around the globe possess drone capabilities (including non-lethal drones), of which five organisations have military-grade drones.[34]

In addition to incidents involving groups carrying out attacks, there were also cases where individuals were involved in drone terrorism activities by providing support to non-state actors or planning attacks. In September 2011, a 26-year-old physics graduate and model hobbyist from Massachusetts was arrested in an FBI undercover

operation and accused of planning to build small, explosive-laden drones to attack the Pentagon and the Capitol. [35] Another incident occurred in September 2023 when a Birmingham University PhD student was found guilty of using a 3D printer at home to build a kamikaze drone designed to deliver an explosive warhead or chemical weapon for Islamic State (IS) terrorists.[36] These individual incidents are difficult to detect without the right human intelligence, which can lead to catastrophic events. The use of drones by terrorist organisations poses a significant threat to global security. From ISIS in the Middle East to groups like Houthis, Hezbollah, and Hamas, these organisations have demonstrated their ability to employ drones for surveillance, reconnaissance, and even deadly attacks. With state support, their capabilities are amplified, making it crucial for governments and militaries worldwide to address this evolving challenge.

Countering Drone Terrorism

Countering small drones presents a challenge. Because of their small size, detecting them on radar is tricky. Currently, there are many Counter-UAV systems available on the market to safeguard important infrastructure and military facilities. Additionally, there are national laws and regulations in place to ensure that civilian drones cannot be used for harmful purposes.

According to the UN guide for safeguarding vulnerable targets from terrorist attacks involving unmanned aerial vehicles (UAVs), there are some important points that nations must follow. [37]

All stakeholders have important roles to play in mitigating the drone terrorist threat. Governments should develop counter-drone strategies and regulations, support operators of vulnerable targets, and leverage drones to enhance security. Law enforcement can help secure targets, investigate incidents, and disrupt drone supply networks. Private-sector actors can make drones more secure and help detect threats.

Key recommendations include:

• Governments should develop whole-of-government counter-drone strategies and regulations in consultation with stakeholders.

• Operators of vulnerable targets should integrate drone threats into security plans, select appropriate detection and mitigation options, and partner with law enforcement.

• Law enforcement can support target operators, employ counter-drone technologies, and investigate drone-related incidents and networks.

• Manufacturers can install features like geofencing and transmit drone identification information to make drones more secure.
• Retailers and vendors can conduct due diligence on customers and provide security-related information.
• Users should comply with drone laws and take cybersecurity precautions to reduce the risk of drone hijacking.

Counter-drone systems are broadly classified into two categories: Soft Kill Systems and Hard Kill Systems. Soft Kill Systems employ non-lethal methods to neutralise drones. This involves the jamming of GPS or communication signals received by the drone, typically achieved through the use of RF-based jammers. Additionally, devices such as Leather Dazzlers and Net Guns fall under this category. The former works by suppressing the functionality of optical sensors through disability glare. In contrast, Hard Kill Systems rely on kinetic strikes to disable drones. This is accomplished through the deployment of anti-air guns, direct energy weapons, man-portable air defence systems, and micro anti-air missiles.

While Soft Kill Systems can cover a wide area, their effectiveness diminishes when a drone operates at an extended distance from the anti-drone system within the coverage area. This vulnerability arises from the limitations of the system's jamming capability. Drone operators can further exploit this by employing techniques such as GPS spoofing and Frequency Hopping to deceive the system. Additionally, the use of Swarm Drones has the potential to overwhelm both types of systems. Although an Anti-Aircraft Gun equipped with Air-burst fragmentation rounds can address swarm drones to some extent, it may not suffice against a large-scale attack. Considering the economic aspect, it is imperative that the operational cost of a Counter-Drone System remains significantly lower than that of the adversary's drone fleet.

In summary, the choice of an appropriate counter-drone system necessitates careful consideration of its capabilities, limitations, and economic viability. Both Soft Kill and Hard Kill Systems have their respective strengths and weaknesses, which must be evaluated in light of the specific operational requirements and budget constraints. This ensures the most effective defence against hostile drone threats while maintaining fiscal prudence.

Conclusion

In conclusion, this research highlights the growing influence of drones in contemporary conflicts, particularly their adoption by non-state actors for various purposes. The case studies illustrate the dynamic nature of warfare and the challenges posed by drone-centric tactics. Effective counter-drone measures are crucial for safeguarding critical targets, and a balanced approach is needed to ensure accessibility and cost-effectiveness. This summary provides a foundational understanding of the evolving threat of drone terrorism, serving as a starting point for further exploration in this field.

DISCLAIMER

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