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PKK's Drone Attacks within the Perspective of Learning Organisation and Türkiye's Counter Reaction

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Abstract

PKK's methods used in its terrorist attacks targeting Türkiye have been observed to transform over time. This transformation is influenced by other actors with whom it interacts in its environment and adopts their forms of action. When this interaction is considered from a theoretical perspective, it would be correct to describe the PKK as a "learning organisation". One of the concrete examples of the reflection of the interaction with different actors on the PKK is the organisation's tendency to use drones, largely influenced by ISIS. Records show that drones played an important role in the actions carried out by the organisation. On the other hand, the PKK's start of drone-based actions has resulted in Türkiye increasing its investments in anti-drone systems and using such solutions extensively. The current trend shows that Türkiye has developed and, in parallel with the dynamic structure of the threat, is going to place emphasis on hybrid solutions in the coming period.

Keywords:
Learning Organisation; Terrorism; PKK; Drone; Anti-Drone.

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The fight between Türkiye and the Kurdistan Workers' Party (PKK) terrorist organisation has been going on for nearly 40 years. It is clear that the PKK, which is considered a terrorist organisation by many states, as well as Türkiye, is one of the most dangerous organisations on both a regional and global scale. Undoubtedly, the PKK's military-technical capabilities have an undeniable role in defining it as such a dangerous organisation. The ability of the organisation to adapt to the changing structure of the combat environment is decisive in obtaining these capabilities. It is possible to see the traces of this change in the change in tactics, techniques and procedures applied by the organisation during the conflict process. For example, the organisation, which took good advantage of the authority gap in Iraq during the First Gulf War, increased both the number and destructiveness of its actions in Türkiye with the weapons and ammunition it seized. Similarly, the PKK, which entered into a fight against the Islamic State of Iraq and the Levant (ISIS) terrorist organisation, which emerged from the authority gap in Iraq, has achieved significant gains as a result of this interaction. It is possible to see the reflections of these gains in the PKK's emphasis on the use of remote-controlled mines and hand-made explosives in its actions, and in its practices during the conflict, known as Trench Operations in Türkiye, which includes combat in residential areas due to their physical and human conditions. Another outcome of the interaction with ISIS is the increase in the use of drones in recent years. So much so that the PKK, seeing the military potential of drones in its fight against ISIS, turned to this technology and began to use it widely in its actions in a short time.

The process described above is a clear indication that the PKK, as an organisation, has learned from the events unfolding around it and from other actors. It is accepted that the phenomenon of learning, which in its simplest form can be defined as a process that causes changes in behaviour, is valid for terrorist organisations as well as commercial organisations. At this point, it is certain that the PKK, which applies the knowledge it has acquired in the field, is also a learning organisation. On the other hand, the history of war is, in a sense, the history of precautions and countermeasures. Considering this fact, it is a natural course of action for Türkiye to take precautions against the increasing drone attacks of the PKK. As a matter of fact, Türkiye's practices in the field also coincide with this determination.

On the other hand, although the subject has received intense attention and discussion in the media, it has been assessed in the literature review that it has not received the value it deserves in the academic field. Based on this assessment, it is thought that a study that analyses PKK's drone attacks and Türkiye's search for precautions from a holistic perspective within the framework of the learning organisations approach will fill an important gap in the literature. However, it should be noted that the fact that PKK's drone capabilities specifically and Türkiye's countermeasures to them do not receive sufficient academic attention also poses a problem in terms of reference source supply. In addition, due to the nature of the subject, the content of the sources obtained from open sources is limited, and their confirmation is difficult.

This study reveals PKK's drone capabilities within the framework of the learning organisations approach and discusses Türkiye's search for precautions. In this context, firstly, the learning organisations approach was taken into consideration and its connection with terrorism and the PKK was examined. Subsequently, the PKK's current drone capabilities and the attacks it carried out in the field with these drones were examined. Finally, anti-drone systems in general and Türkiye's capabilities in this field were gone over carefully.

1. Learning Organisations, Terrorism and PKK

Acts of political violence, which can generally be described as terrorism, have become a significant threat in today's world. Almost every day, non-state groups in different countries commit acts of violence, many of which can be described as terrorism. The threat of such violence drives ongoing global military activities, and the need for countries to protect themselves against terrorist attacks is the main shaper of the domestic political agenda (Jackson et al. 2005, 2).

On the other hand, changing conditions bring to the fore the importance of terrorist groups' ability to change and adapt. Faced with a challenge to their operational capabilities, terrorist organisations transform the threat they may pose with a restructured form of attack. The ability of terrorist organisations to change their operations effectively over time is inherently linked to their ability to learn (Jackson et al. 2005, 2-3). For this reason, learning is an extremely vital issue for terrorist organisations, too.

Although there are many different definitions, learning is generally defined as "the process of acquiring knowledge through study" (Sun 2003, 154). Learning is also an expression used to describe the process that causes behavioural change. Hence, it is not possible to describe information that does not lead to a change in behaviour as learning. Although there may be many reasons that lead to changes in behaviour, it is desired that the changes that occur as a result of learning are natural, desirable and repeatable in different situations. From this perspective, it is possible to say that learning organisations are organisations that have the ability to change their behaviour (Demir 2008, 58-59). It can be said that learning organisations are organisations that undergo a process of acquiring new knowledge or technology that a group uses to make better strategic decisions, improve certain tactics and implementation skills, and increase the chances of success in their activities. In short, learning is change aimed at improving the performance of a group (Jackson et al. 2005, 9).

When explaining human behaviour, especially behaviour that violates social norms or laws, sociologists often resort to learning. In fact, learning is often reduced to specific theories that go by various names, such as differential association,

conditioning-reinforcement, or social learning. The most well-known of these types of works was carried out by Ronald L. Akers. Akers, who started by reformulating Sutherland's differential association principles within the framework of operant conditioning in the 1960s, further expanded his studies over the years and integrated them with the concepts of indirect, social, non-social and self-reinforcement and named them "Social Learning Theory". Akers's theory is one of the most frequently used theories in criminology and has been applied to a wide range of deviant and criminal behaviours (Akers and Jensen 2003, 1; Akers 1999, 59; Akins and Winfree 2017, 135; Martin 2017, 79). The basic assumption of Akers's theory is that social learning is the primary process that connects social structure to individual behaviour. Its basic proposition is that differences in social structure, culture and the positions of individuals and groups in the social system explain differences in crime rates, mainly through social learning variables. According to Akers, environments that produce deviance have an impact on individual behaviours through the operation of learning mechanisms (Akers 2009, 322).

Much of the existing literature on the learning organisation relates to private sector organisations. However, in recent years, it has been observed that criminal behaviour and terrorist organisations have also been subject to this theory (Garavan 1997, 18). Because, despite the fundamental differences between them, terrorist groups are also organisations. To be successful, they must change, and to change effectively, they must learn. Because they operate in highly volatile environments, it is essential for them to apply what they have learned at the institutional level to survive (Jackson et al. 2005, 9-10).

A terrorist group's ability to learn at the organisational level can make it both more effective and more capable of surviving in hostile environments. If a group can learn successfully, they can develop, improve, and use new weapons or tactics to change their abilities over time. It can improve the skills of its members so that they can better apply their existing weapons or tactics. It can collect and use the intelligence information needed to conduct its operations effectively. It can thwart countermeasures and increase its chances of surviving efforts to destroy it. It can preserve the abilities it has developed even if individual group members are lost (Jackson et al. 2005, 17-18).

Essentially, academic interest in learning about terrorist organisations has predictably increased following the September 11 attacks. At this point, it can be said that the studies largely focus on the Al Qaeda terrorist organisation, which is the perpetrator of this attack, and include issues such as the leadership structure of the terrorist organisation, tactical units, recruitment, training, vision, organisational identity, organisational design and action methods (Demir 2008, 62). On the other hand, it is certain that the PKK, whose official establishment dates back to 1978 and is one of the most dangerous terrorist organisations in its region, has been significantly affected by this global wave of terrorism led by Al Qaeda. In this regard, Özcan

pointed out three factors that ensure the survival of the PKK, which has existed for a long time. The first of these is external support and safe havens; secondly, there is a leadership that is compatible with the cultural norms of the society and the region, and lastly, the organisation's capacity to adapt to the political ecosystem, that is, being a learning organisation. As Özcan points out, the PKK, like all other terrorist organisations, is a "learning organisation" and generally manages to learn from what is happening around it (Özcan 2011).

2. PKK's Drone Capabilities and Attacks

2.1. A Look at PKK's Drone Capabilities

Although it is not reflected much in public opinion, the association of the PKK with drones is not a new phenomenon for the Turkish security bureaucracy. The terrorist named Serhat Taysi, a PKK member who went to the police station in Konya in 2007 and surrendered, shared in his statement that the organisation was trying to obtain drones and was preparing to take action against fixed and moving targets with them (Habertürk 2007). Although there is no record of the PKK taking action with such tools in those years. However, this statement shows that the organisation's interest in drones is not today's topic. The general trend on this issue is that the PKK's search for attacks using drones started in 2003-2004 (Erdem 2021).

On the other hand, although its history dates back to the early 2000s, it can be said that what created real awareness about drone technologies for the PKK was the Syrian branch of the organisation, the Democratic Union Party (PYD), observing ISIS's ability to use such tools effectively. Namely, Türkiye has gained serious momentum in the field of defence industry and with this; Developing Unmanned Aerial Vehicle (UAV) capabilities, increasing close air support platforms in terms of quantity and quality, ending foreign dependency on ammunition, building new fortified police stations, and starting to carry out the fight against terrorism entirely by professional units have greatly limited the PKK's capacity to take action (Kasapoğlu and Kırdemir 2019, 3). The organisation, which suffered a high number of militant losses as a result of the domestic and cross-border military operations carried out by the Turkish Armed Forces (TAF) and whose mobility in rural areas came to a halt, turned to drones, which it sees as a relatively risk-free and cost-effective means of action, as a way out. In this context, PKK's attacks using drones began to appear in the Turkish media for the first time in 2016 (Şafak 2016). It was after 2018 that the attacks intensified and became systematic. The attacks carried out in different parts of Şırnak on 10 November 2018, which coincided with the 80th anniversary of Atatürk's death, can be considered a milestone in this respect (Habertürk 2018).

Drones used by the PKK are divided into two types: rotary-wing, multicopter type and fixed-wing, glider type. First of all, it should be noted that these vehicles have completely different flight mechanics and operational planning requirements due to

their designs. Analyses based on open-source intelligence data in the organisation's inventory reveal that there are DJI Phantom, DJI Mavic and DJI Matrice 600 model rotary-wing and RQ-20 Puma, X-UAV Talon model fixed-wing drones (Kasapoğlu and Ülgen 2021, 29-30). Except for the RQ-20 Puma, which was developed for the United States (US) Army, all of the models listed are of Chinese origin and are platforms designed primarily for civil/commercial use. As the X-UAV Talon example shows, it is possible to purchase such platforms from electronic commerce sites without any restrictions and at very reasonable prices, such as approximately 400 dollars (RCDrone 2024). Naturally, these drones sold online do not contain payloads such as weapons or explosives (Sims 2018, 97). However, these platforms can be made suitable for use in terrorist acts by integrating subsystems, which can be easily obtained commercially from all over the world, under limited workshop conditions and without the need for very high technical expertise (Mevlütoğlu 2018). In this context, it is noteworthy that a study conducted at Louisiana State University revealed that a "handmade" drone, which has a payload capacity of approximately 3 kg and can stay in the air for up to 10 minutes, can be produced at a cost of less than $ 2,500 using completely off-the-shelf commercial products (Price 2018, 2). Undoubtedly, the PKK also benefits from these opportunities. Additionally, it should be noted that the organisation receives information, training and logistical support from some non-state actors and foreign intelligence services in the region, which are covered in detail in the first section.

It is noteworthy that in the early periods when the PKK started its drone-based actions, it used rotary-wing, relatively simple models, but in the following period, it also turned to fixed-wing platforms that offer higher payload capacity and range values (Kasapoğlu and Kırdemir 2019, 3). Another notable trend in this field is the use of platforms that do not require remote control and that fly autonomously according to preloaded coordinates of the target for navigation purposes. It is stated that jammers, which interrupt/confuse the data connection between the remote control unit and the drone, are largely ineffective against these platforms, which are observed to use the multi-channel and frequency hopping capable Global Navigation Satellite System (GNSS) technology (Aksan, Sevin and Karaahmetoğlu 2021).

PKK uses drones in general; they are used for reconnaissance-surveillance, target determination and attack purposes. While reconnaissance-surveillance flights are mostly carried out for intelligence gathering, damage assessment and video recording for propaganda purposes, flights for target determination are carried out to direct explosive-laden vehicles to the desired point and to arrange mortar and rocket fire. Vehicles preferred for attack flights are used to release free-falling ammunition to the target with a hand-made release mechanism from a certain altitude, or to dive into the target and destroy it with an explosive carried in the role of a direct hit (kamikaze) drone. It is observed that ammunition such as modified rifle grenades, mortar bullets, rockets or grenades, which fall into the improvised explosive (IED) category, are mostly used in drone attacks. For example, it is a common practice to

attach wings on the back of badminton balls to 40 mm rifle grenades to ensure a more stable fall and increase the hit rate on the target (Cancian 2021).

The recorded attacks show that the organisation targets public buildings and commemorative events, as well as military units and bases (Doğan and Küçük 2021, 7). When the timing of the actions taken against the specified targets is examined, it immediately draws attention that the organisation is seeking to launch simultaneous attacks at different points (Şen 2018). There is also data that the "saturation attack" tactic, which is based on saturating the air defence system and neutralising it, was tried (TRT Haber 2021). It seems that the attacks carried out so far have been somehow foiled by the security forces or have resulted without causing serious casualties. However, the positivity of the balance sheet should not be interpreted as the threat being at a low level. On the contrary, the PKK attaches great importance to improving its capacity regarding aerial platforms in general and drone technologies in particular. Murat Karayılan, the head of the PKK's military wing, People's Defence Forces (HPG), declared 2018 as the "year of aviation" for the organisation, which is a clear indication of the importance given to drones and the intention to take action with these tools (Bural 2021). As emphasised above, when discussing the use of GNSS-based drones, the PKK is seeking to access solutions that can bypass anti-drone systems. The threat from drones will inevitably increase in parallel with the new capabilities to be obtained in this field. When performing a threat analysis, it should be taken into consideration that these tools can be used for critical infrastructures in addition to the existing target scale.

Finally, the intensification of the PKK's actions with drones indicates that a certain capacity has been developed in terms of pilot training and subsystem supply chain. As a matter of fact, it is stated that the organisation, which wants to improve its capacity to take action with aircraft, established a "drone academy" in Mahmur Camp, which is under its control in the north of Iraq, and turned it into a production centre (Orakoğlu 2021). The PKK's unit responsible for drone activities is known as the Delal Amed Air Defence Force. The unit, named after Hülya Eroğlu, codenamed Delal Amed, a member of the PKK Five Executive Council, who was in the red category on the list of wanted terrorists of the Ministry of Internal Affairs and was neutralised in an operation carried out in the Şırnak Bestler Dereler Region on November 2, 2017, monitors the drone actions carried out by the organisation (Bural 2021).

2.2. PKK's Drone Attacks Targeting Türkiye

It is known that the PKK has used various types of drones in its actions targeting Türkiye since 2016. For this reason, it is possible to say that the drone threat to Türkiye is increasing day by day. In this context, it is extremely important to discuss the prominent drone attacks carried out by the PKK against Türkiye, both within the country and in its immediate surroundings, in terms of revealing the dimensions of this threat.

The organisation appears to have gained expertise in the use of weaponised commercial unmanned aerial vehicles, especially with the help of its Syrian sister organisation, the People's Defence Units (YPG). In 2016, Türkiye seized two RQ-20 drones from the PKK, allegedly taken from northern Syria. According to Turkish experts, the PKK started using drones in its operations in 2016. The first attack in this context took place in Hakkari on October 12, 2016. A hand grenade-trapped drone used by the PKK was shot down while trying to land on a military unit. It was also claimed that attacks were carried out against Turkish bases in Iraq in 2017 with armed drones (En Son Haber 2016; Zwijnenburg 2023, 17). In 2017, two more attacks carried out by the terrorist organisation using drones were recorded. Regarding the first of these, in the statement made by the Ministry of Internal Affairs: "On Wednesday, August 30, 2017, in the Hakkari-Şemdinli District, Derecik Town, Biz Tepe Base area, as a result of the fire opened by the elements carrying out an operation in the field, a drone (6 propellers, capable of releasing explosive materials with a spring system, 130 cm between two wings) belonging to the terrorist organisation, coming from Iraqi territory and considered to be preparing for an attack, was hit." (Ministry of Internal Affairs 2017a) In the second one, it was reported that a drone loaded with grenade launcher ammunition was seized in the Doğu Beyazıt district of Ağrı on November 12, 2017 (Erdem 2021).

The number of attacks recorded in 2018 was three. In this context, on November 10, 2018, the terrorist organisation targeted the November 10 ceremonies in Şırnak and attacked ten different points, including the governor's office, with drones carrying C-3 and C-4 explosives (Yeni Şafak 2019). Regarding another attack, according to the information made on the official Twitter account of the General Staff, on May 3, 2018, the drone belonging to the terrorists approaching the Güven Base Region in Zap in the north of Iraq from the south was shot down with anti-drone weapons and neutralised (Anadolu Ajansı 2018).

There were six attacks recorded in 2019. In the first of these, an attack was carried out on Ercüment Turkmen Barracks in Silopi on February 24, 2019, with drones loaded with 60 mm mortar bullets. It was stated that a large-scale investigation was initiated regarding the attack, which reportedly resulted in no loss of life (Yeni Şafak 2019). In the second one, it was announced that twelve attacks carried out by the terrorist organisation YPG/PKK with drones launched from the east of the Euphrates in two consecutive weeks in March 2019 were prevented by the Turkish Armed Forces. It was announced that the targets of these attacks, which were carried out with drones targeting domestic base areas and directed from terrorist bases deep in Syria, were the Turkish Armed Forces elements in Şırnak's Silopi, Gaziantep's İslahiye, Şanlıurfa's Suruç and Birecik districts. It was reported that all of the attacks were prevented by the security forces with anti-drone weapons and various weapon systems, and there were no casualties (Özer 2019). In the third attack, it was announced that the IED-laden drone belonging to PKK terrorists, located in the Dilucu Customs Directorate area, which is the Nakhchivan border gate, was detected and neutralised

by the Aselsan Milkar 5S anti-drone system. The incident took place on June 21, 2019, around 12.30, at the Dilucu Border Gate in the Martyr Bülent Aydın Border Team Patrol Command's responsibility area of the Aralık district. It was stated that the explosive-laden drone, which was determined to be sent by PKK terrorists, was detected and neutralised by the Aselsan Milkar 5S anti-drone system located in the Dilucu region under the responsibility of the 5th Border Regiment Command (Aydın 2019). Another attack in 2019 took place in Batman on December 4, 2019. The bomb-laden drone, which took off from the village of Muzen in the town of Amude in Syria, targeted the section where the oil boilers were located at the Tüpraş Oil Refinery, and the disaster was averted when the bomb drone exploded 5 meters behind. It was claimed that the fingerprints of Syrian PKK/PYD terrorists were found on the drone (B. Doğan 2022).

So, eight attacks of the terrorist organisation were recorded in 2020, when the attacks increasingly intensified. In this context, the Ministry of National Defence (MSB) announced that PKK terrorists attempted to attack the base area in northern Iraq with two drones on August 20, 2020, and the aircraft in question were shot down. In the statement made by A Haber correspondent regarding the incident, it was said: "The attack attempt was intended to be carried out against Turkish troops in the Şeladize town of Northern Iraq at around 07:00 in the morning. The terrorist organisation PKK attacked with a drone but was unsuccessful. There was no loss of life in the attack attempt with a drone. It was destroyed in the air." Stating that the drones destroyed in the air fell in various areas in the region, the reporter added that the PKK's attack was repelled thanks to the signal jamming system (Takvim 2020).

On the other hand, it was determined that there were twelve attacks recorded in 2021, when the trend of drone attacks increased. In the first of these, the Ministry of National Defence announced that a drone used by terrorists to attack Turkish Armed Forces elements was destroyed on May 11, 2021, during the ongoing Claw-Lightning and Claw-Lightning operations in the north of Iraq. In the statement, it was noted that the soldiers, who were carrying out search and scanning activities in the Metina region where the Claw Lightning operation was held, noticed a drone coming towards them and opened fire with machine guns, and it was shot down before it could reach its target (NTV 2021a). Regarding another attack, Diyarbakır Governorship reported that an attempt was made to attack the 8th Main Jet Base Command with drones. In the statement made by the Governorship, it was stated that an attempt was made to attack Diyarbakır 8th Main Jet Base Command with drones at around 00.30 on May 18, 2021, and that the drone used in the attack was shot down and there were no casualties at the base. Regarding the issue, the Minister of Internal Affairs at the time, Süleyman Soylu, also made a statement: "An attempt was made to attack a military facility in Diyarbakır with two drones, the drones were neutralised and there were no casualties." he said (Euronews 2021). On the other hand, it was announced that a similar attack attempt occurred in Batman and Şırnak provinces on May 21, 2021, just three days after the attack attempt against Diyarbakır

2nd Air Force Command. Members of the terrorist organisation PKK attempted to attack Batman Airport Command with three and Şırnak 23rd Gendarmerie Border Division Command with two explosive-laden drones. As the security forces noticed the situation, the drones were shot down in the air (Kaçar 2021). Regarding another attack attempt, in the statement made by the Ministry of National Defence, it was stated that on May 25, 2021, PKK terrorists attempted to attack with a base drone in the Euphrates Shield region, the aircraft in question was shot down, and in the operation carried out at the point where the plane took off, a PKK/YPG terrorist was neutralized (NTV 2021b).

By 2022, it was announced that the terrorist organisation PKK started to target base areas with explosive-laden drones in response to the Claw-Lock operation launched by the Turkish Armed Forces in the north of Iraq. In this context, on May 9, 2022, the PKK tried to attack the base areas of the Turkish Armed Forces with drones. The explosive-laden drone approaching the base areas was detected, taken under fire and shot down. On May 5, it was announced that the terrorist organisation PKK tried to attack the base areas with an explosive-laden drone and that the attack attempt was prevented by members of the Turkish Armed Forces (CNN 2022). In another attack attempt in 2022, it was reported that the Turkish Armed Forces' Bamerne base in Duhok was attacked with drones. It was announced that an attack was carried out with two drones on the Turkish Armed Forces' military base in Bamerne in the morning hours of July 22, there was no loss of life due to the attack, one of the drones was shot down by fire from the base, and the other fell by itself. Although no one claimed responsibility for the attack, it is thought to have been carried out by the PKK (Cumhuriyet 2022).

On the other hand, it was reported that PKK's bomb drones were shot down in the Claw-Lock Operation region on September 11, 2023. It was stated that PKK terrorists, for whom the USA gave drone training, attempted to attack four hills in the Claw-Lock Operation region with nine bomb-laden drones, and these drones were shot down with IHASAVAR and anti-aircraft guns. It was announced that the drones in question took off from PKK camps in the southeast of Metina (Star 2023).

3. Anti-Drone Systems and Türkiye

3.1. Overview of Anti-Drone Systems

It can be said that until recently, the capabilities of terrorist organisations regarding aircraft were limited, but cheap and easily accessible civilian drone technology has changed this situation (Chaves and Swed 2020, 31). Terrorist organisations seeking sensational action have discovered the potential of drones and started to use them widely. Nowadays, many terrorist organisations operating in different regions of the world, such as the Middle East, Africa, South America and Southeast Asia have such vehicles in their inventories (Bergen, Salyk-Virk and Sterman 2020). Due to the

ease of procurement, no change in the picture is expected, at least for the foreseeable future, and this shows the need to take precautions and the importance of using anti-drone systems.

Anti-drone systems mean fixed or mobile solutions that detect and neutralise drones by working in coordination with various components (Zmysłowski, Skokowski and Kelner 2023, 459). Although they have the same meaning, definitions such as drone countermeasure systems are also made for such solutions in the literature. In fact, from a doctrinal perspective, anti-drone systems are also included in the low-altitude air defence systems layer, and their design architectures are similar to other air defence systems. As a matter of fact, like all air defence systems, these systems consist of three main components: sensor, command-control and weapon (Meteksan 2020). On the other hand, traditional air defence systems are optimised for the detection, tracking and destruction of large and fast platforms such as aircraft, helicopters and cruise missiles. Technically, it is not possible for these systems to be effective under all conditions against small and slow-flying drones at very low altitudes (Michel 2019, 2). As a result, it can be said that anti-drone technology was developed by taking into account the disadvantages of existing air defence systems, which are inadequate against the increasingly widespread drone threat, and the main distinction between these systems is made based on their potential targets.

Anti-drone systems are divided into three types: land-based, hand-held and UAV-based (Business Research Insights 2024). No matter what category they fall into, these systems neutralise threatening drones; it takes place within a kill-chain, which is listed as detection, diagnosis, tracking and response (4T). In the destruction-chain in question, radar, radio frequency (RF) analyser, electro-optical/infrared camera and acoustic sensor systems are used for detection, diagnosis and tracking stages. There are also solutions where these systems are integrated with each other (Michel 2019, 3). In the reaction phase, which is the last link of the destruction-chain, hybrid systems in which physical-destruction (hard-kill), functional-destruction (soft-kill) or both are used come into play. In this context, in physical-destruction systems, the target is neutralised using kinetic ammunition, while in functional-destruction systems, the target is neutralised by non-kinetic electronic warfare applications (Eshel 2017). Physical-destruction systems include weapons, lasers and networks; RF jamming, GNSS jamming and deception are examples of functional-destruction systems. On the other hand, in some scenarios, such as RF jamming being ineffective against autonomous drones, it is not possible to obtain definitive results by using a single system. Therefore, when taking precautions, such scenarios should be taken into consideration (Sütçüoğlu and Alay 2019, 6-7).

From a military geography perspective, the places where anti-drones are used can be basically divided into two: residential areas and rural areas. First of all, it should be underlined that the areas where it is more difficult to develop countermeasures are the residential ones. Factors such as the presence of multi-storey buildings

with different architectural designs, the intensity of air traffic, the high level of electromagnetic pollution and the abundance of unwanted echoes make it difficult to detect small-sized drones in residential areas (Robin Radar Systems 2021). By taking off from any point in a residential environment with a rotary-wing drone, it is possible to attack targets such as public buildings, general law enforcement stations and meeting places. Unlike in rural areas, what complicates the equation here is the difficulty of creating a destruction chain. The number of potential targets that need to be protected is very high (Doğan and Küçük 2021, 20). Even if anti-drone solutions are deployed sufficiently, none of the detection systems, from radars to acoustic sensors and optical/thermal cameras, work at full capacity in the residential environment, resulting in a shortening of the reaction time and an increased risk of secondary damage (Deschenes 2019, 51). It should also be noted that the risk of collateral damage is a factor that limits the use of solutions based on physical destruction, especially within densely populated civilian settlements.

Regardless of whether they are inside or outside residential areas, vehicles and critical infrastructures in sectors such as transportation and energy are among the high-value targets for drone attacks. For example, passenger aircraft are extremely vulnerable to drone attacks, especially during the take-off/climb and approach/landing phases of the flight. Although manufacturers design aeroplanes to be resistant to bird strikes, there are no tests for a drone entering the engine or hitting the cockpit windshield (Paganini 2016). In this context, it should be noted that tests conducted at the Impact Resistance Laboratory of the University of Dayton Research Institute revealed that even collisions with mini-class drones weighing a few kilograms can cause serious structural damage to passenger aircraft. Moreover, drones that did not carry explosives were used in the tests in question, and the damage was caused entirely by kinetic energy. It is obvious that the threat posed by a drone modified to carry explosives will be much higher. Another example that can be given in this context is refineries. Their vital importance for the maintenance of economic activities and the possibility that interruptions in production processes may have devastating consequences make refineries among high-value targets (Fortem Technologies 2024). The drone attacks that targeted Saudi Aramco's Abqaiq refinery and Hurays oil field on September 14, 2019, causing Saudi Arabia's oil exports to decrease by approximately 60% and causing the Brent oil price to increase by more than 10%, reveal the extent of the threat (The Economist 2019).

3.2. Türkiye's Anti-Drone Capabilities

The start of drone-based actions, performed by terrorist organisations such as the PKK and ISIS, has led Türkiye to focus on developing countermeasures, and has also resulted in the widespread use of anti-drone technologies in the field. In this context, in parallel with the increase in the drone threat, it can be noticed that original solutions are rapidly developed by Turkish defence industry companies and offered to the service of the Turkish Armed Forces and general law enforcement forces. It is considered that anti-drone systems, which are gradually entering the inventory, are

distributed according to the threat level and, accordingly, priority is given to military bases and troops in the field, which are of critical importance in the fight against terrorism. It should also be emphasised that these systems are used to protect critical infrastructures, public buildings, assembly areas and government officials.

It seems that the solutions put into service in the first place are systems that fall into the functional-destruction category and generally use the RF jamming method. However, after a while, the dynamic nature of the threat caused systems that only affect the RF spectrum to become insufficient, resulting in the need to take additional measures. In this regard, the provision of systems that jam GNSS signals or conduct deception attacks to mislead previously entered navigation coordinates can be considered as measures developed based on the change in threat parameters. A similar evaluation can be made for the inventory of physical-destruction systems that use kinetic ammunition. Due to its advantages, it has been observed that the supply trend in recent years has shifted towards solutions that use different prevention methods together.

There is no inventory list shared with the public by official authorities regarding the anti-drone systems used by Turkish security forces. Despite this, it was possible to conduct an inventory study by analysing both the news reported in the media at various times and the statements made by authorised individuals or manufacturing companies. Anti-drone systems found to be used by the Turkish Armed Forces and general law enforcement forces will need to be mentioned further on. It should be noted in advance that there may be systems that are not included in the study because this situation could not be detected even though they are in active use. Likewise, it should be noted that systems that are known to have been developed by Turkish companies, but whose entry into the inventory cannot be confirmed at this stage, and jammers designed to neutralise threats such as IEDs are also excluded from the scope.

The first of the anti-drones in the inventory of Turkish security forces is Aselsan's İHASAVAR system. Standing out with its cost-effectiveness, İHASAVAR has a compact design architecture that can be used by a single soldier, and is basically a gun-type anti-drone system consisting of a backpack and a handheld rifle-like directional antenna equipment. It is stated that İHASAVAR, with an output power of 50 watts, can mix all RF and GNSS-based navigation, data and image transmission frequencies simultaneously (Mehmet 2018). The effective range of İHASAVAR is between 2 and 3 km. The system, which allows the targeted drone to land at its location by cutting off its data connection, can broadcast uninterruptedly for at least 1.5 hours thanks to its rechargeable high-capacity Li-Ion batteries (Haber 2018). Delivery of İHASAVAR to Turkish security forces started in November 2017. There is information in open sources that nearly 1,000 systems were in service at home and abroad as of April 2020 (TR Military News 2020).

Another anti-drone system developed by Aselsan and included in the inventory of Turkish security forces is IHTAR. IHTAR, which has fixed and mobile versions that can be integrated on vehicles and provides uninterrupted 360-degree coverage 24 hours a day in all weather conditions, has a design suitable for the protection of base areas, critical facilities and crowded organisations in urban and rural environments. The basic components of IHTAR consist of ACAR radar, HSY electro-optical system, GERGEDAN jamming/blinding system and command-control system. Additionally, it is possible to integrate different sensors and physical destruction systems into the standard configuration (Aselsan 2022a). IHTAR, which is used to protect critical facilities such as the Presidential Complex, Akkuyu nuclear power plant and TÜPRAŞ refineries in Türkiye, was exported to TRNC, Kyrgyzstan, Niger and Angola as stated (Mehmet 2023).

One of the systems developed by Aselsan against the drone threat is the ŞAHİN 40mm Physical Destruction System. Integrated on a towed trailer with easy deployment and installation features, ŞAHİN performs automatic target detection and tracking with its advanced electro-optical cameras mounted on a stabilised turret and destroys threatening drones with its 40mm MK19 Mod3 Bomb Launcher gun. ŞAHİN's effective range is 700 m, and its ammunition capacity is 64 units. In order to increase the hit rate, ATOM 40mm High Speed Smart Grenade Launcher Ammunition, based on time programmed fuse technology, is used in ŞAHİN (Aselsan 2022b).

Another anti-drone system used by Turkish security forces is Roketsan's ALKA Directed Energy Weapon System. ALKA, a hybrid system, draws attention with its two-layered defence architecture in which functional-destruction and physical-destruction methods are used together. In this architecture, threats detected and tracked by radar and electro-optical systems are first tried to be prevented with an electromagnetic jamming weapon, and if this is not sufficient, a laser weapon is activated. ALKA, whose laser weapon has an effective destruction range of 750 m, can prevent swarm attacks regardless of the number of targets, thanks to the lack of ammunition restrictions. ALKA, which offers lower shooting costs compared to conventional methods, has fixed and mobile versions (Roketsan 2022). A report in the Western media stated that ALKA was deployed in Libya and shot down a Chinese-made Wing Loong II type unmanned aerial vehicle belonging to the United Arab Emirates on August 4, 2019. It should be underlined that the engagement in question was recorded as the first use of a laser weapon in real combat conditions (Timokhin 2019).

Another anti-drone used by the Turkish security forces is the İLTER Drone Detection and Blocking System developed by Boğaziçi Defence Technologies. Essentially, İLTER is the general name of an anti-drone product family that includes various RF and radar-based systems. All systems in this family have

fully automatic target detection and prevention features. Another common feature of the systems in the product family is 24-hour uninterrupted operation and 360-degree protection against multiple drone attacks (Boğaziçi Savunma Teknolojileri 2024). It is stated in open sources that the number of ILTERs delivered to the Turkish security forces as of October 2020 is approximately 350 (Yıldırım 2020). It is known that İLTER, which has a localisation rate of over 90 per cent, has been exported to more than 10 countries with its successful performance in the field (TRT Haber 2023).

Another anti-drone system in the inventory of the Turkish Armed Forces and the General Directorate of Security (EGM) is Harp Arge's DRONE SAVAR. DRONE SAVAR, which is stated to be the first solution in its category developed and produced in Türkiye, is a gun-type anti-drone system that can be used by a single soldier. In general, DRONE SAVAR consists of a backpack carrying electronic systems and batteries, and a rifle-like antenna equipment with a foldable stock and grip for ease of transportation. It is an important advantage that DRONE SAVAR, which has a battery life of 1.5 hours and provides ease of use with its lightness, has Picatinny rails that enable the mounting of different accessories. Azerbaijan is among the known users of DRONE SAVAR (Yıldırım 2017).

One of the anti-drone systems included in the inventory of the Turkish Armed Forces is KALKA, developed by the National Defence. KALKA, which has fixed and mobile versions and can be used in manual or automatic mode according to the operator's preference, provides protection in a circular area of approximately 3 km, depending on geographical conditions. KALKA consists of a detector that acts as a sensor by detecting the RF communication between the approaching drone and the control centre, and a jamming system that ensures functional destruction. KALKA's first export customer was a Russian private sector company that placed an order to protect its own facilities (Haber Aero 2020).

Three different weapon types of anti-drone systems developed by the National Defence have also entered the inventory of the Turkish Armed Forces. In this context, the first of the systems actively used in the field is; it is İHAMIX, with 21 watts of output power. The effective range of İHAMIX, which weighs 4.5 kg and has an operating time of 60-80 minutes, is 1,000-1,500 m. The Picatinny rails on it make it possible to mount various optical sights on the İHAMIX. The output power of another system, İHAMINI, is 15 watts. The effective range of İHAMİNİ, which weighs 3 kg and has an operating time of 60-80 minutes, is 700-1,000 m. İHATİM, which is the smallest of the weapon-type anti-drone systems produced by the National Defence, has an output power of 6 watts. The effective range of İHATİM, which weighs 2.5 kg and has an operating time of 60-80 minutes, is 300-500 m.

Conclusion

There is no doubt that the PKK is a learning organisation, constantly updating and improving its methods in terrorist acts. It is possible to see the traces of this in the use of drones in the actions taken in recent years, so much so that, in its fight against ISIS in Iraq and Syria, the PKK discovered the potential of drones in an asymmetric combat environment and quickly copied it. As a matter of fact, it is possible to evaluate the increase in the use of drones in their actions after 2016 within this framework.

The PKK's focus on drone-related actions has caused Türkiye, which already has a certain knowledge in anti-drone technologies, to further accelerate its work in this field. Essentially, the process progresses in a spiral of precautions and countermeasures. Namely, while the systems used by the Turkish security forces in the first place were systems that fell into the functional-destruction category and generally used the RF jamming method, the dynamic nature of the threat caused them to become insufficient after a whileand, as a solution, the supply of systems that scrambled GNSS signals or devices that carry out deception attacks to mislead previously entered navigation coordinates has come to the fore. Moreover, the dynamic nature of the threat has led to the inclusion of physical-destruction systems using kinetic ammunition into the inventory after a while, and it is possible to say that, due to their advantages, the supply trend in recent years has shifted towards hybrid solutions that use different prevention methods together.

Undoubtedly, it is important to have advanced anti-drone systems in the inventory in combating the drone threat and studies in this field need to continue. On the other hand, it is not possible to combat the increasing drone threat with purely military-technical solutions, and this does not coincide with the realities of the battlefield. It is also essential to take additional measures against the drone threat posed by the PKK and similar organisations. At this point, it is considered to be of critical importance to cut the organisation's supply chains and destroy the training and production-modification infrastructure.

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