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Research Article

The Evolution of Unmanned Aerial Systems in 2024: Turkey's Export Leadership and Global Military Applications

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Abstract - Unmanned aerial vehicles (UAVs) and armed unmanned aerial vehicles (UCAVs) technologies have developed at a remarkable pace across the world in 2024. These developments had an impact not only in the military domain, but also in economic and strategic areas. The aim of this research is to reveal the significant changes in the field of UAVs and UCAVs during 2024 and their impact on the world.
This study goes beyond the technical focus of the existing literature and sheds light on multidimensional developments such as increased production, examples of use in wars and international cooperation. In this respect, it aims to make an original contribution by addressing the issue from a broader perspective. In the following sections of the study, Turkey's export successes achieved by Baykar are presented first, followed by an examination of how Ukraine has emphasized UAVs in its war strategy. New generation projects developed by Turkey, such as the Anka-3, are introduced, and finally, the partnership agreement with Italy within the scope of international cooperation is evaluated.

Keywords - Baykar, export, UAV, UCAV, Turkiye, Ukraine

I. INTRODUCTION

In today's world, unmanned aerial vehicles (UAVs) and armed unmanned aerial vehicles (UCAVs) have become important technologies that directly affect not only the battlefields but also the defense and foreign policy strategies of countries. The year 2024 was a turning point in terms of the production, use and international impact of these vehicles.

Although the history of UAVs dates back to the early 20th century, this technology has developed rapidly, especially in recent years, and has radically changed the defense approach of many countries. UCAVs, on the other hand, have become a serious alternative to conventional warfare methods with their ability to not only conduct reconnaissance and surveillance, but also to intervene directly against targets.

This study has been selected to better understand the rapid developments in the field of UAVs and UCAVs in 2024. Turkey's rise in global UAV/SUAV exports, Ukraine's turn to drone technologies in warfare, the emergence of new projects such as Anka-3, and cooperation with countries such as Italy make this period particularly important.

The contribution of the research is that it offers a broader perspective by addressing the issue not only as a technical innovation, but also in terms of international balances and economic impacts. Thus, both technological and geopolitical developments are evaluated as a whole.

II. Materials and Method

Research on UAV and UCAV technologies has increased significantly in recent years. A review of the literature on 2024 shows that developments in this field herald a new era in both military and strategic terms.

First of all, the $1.8 billion worth of UCAV exports realized by Baykar in 2024 made a great impression [1]. With this success, Turkey has become the leader in the global UCAV export market and has a global voice in the field of defense. In the report published by the US-based think tank CNAS, it was emphasized that Turkey's influence in the global UAV market is rapidly increasing [2].

The case of Ukraine is noteworthy in terms of showing the current state of drone use in warfare. According to the news shared by Anadolu Agency, Ukraine has reshaped its defense strategy with the goal of producing 1 million FPV drones per year by 2024[3]. This shows that conventional ammunition consumption has started to be replaced by low-cost drone technologies.

Another important development is the Anka-3 project developed by TAI. The stealth features of the Anka-3, its jet-powered structure and the test studies conducted within the scope of the "loyal wingman" concept have an important place in the literature [4].

Finally, as reported by Reuters news agency, Turkey's Baykar and Italy's Leonardo have signed an important cooperation agreement for the production of unmanned aerial vehicles in 2024[5]. This partnership aims to meet the growing demand for UAV technologies in the European defense market.

This study is based on directly accessed sources, and indirect quotations are used only for the limited purpose of providing supporting information. Sources are directly related to the topic and based on developments in 2024.

In this chapter, the unmanned aerial vehicles developed by Baykar Defence are examined and their technical specifications are analyzed comparatively. The selection of the vehicles was based on their operational capabilities, technical equipment and intended use in the field.

A. Bayraktar Mini UAV

Developed by Baykar Defence, Bayraktar Mini UAV is Turkey's first domestic and national micro-class unmanned aerial vehicle system. Designed for tactical level reconnaissance and surveillance missions, this system is especially effective in short-term missions such as difficult terrain conditions and urban operations. It offers a reliable solution in the field thanks to its lightweight structure, easy portability and fast installation advantages[6].

The technical specifications of the Bayraktar Mini UAV are presented in Table 1 and its visual appearance is presented in Figure 1.

Table 1. Technical specifications of Bayraktar Mini UAV

Feature	Description
Mission Objective:	Tactical reconnaissance, target detection and imaging in limited areas
Time in the Air:	About an hour
Range:	Up to 15 km (RF control range)
Takeoff / Landing:	Manual ejection - automatic parachute landing

Fig. 1 Image of Bayraktar Mini UAV

B. Bayraktar TB2

Bayraktar TB2 is a medium altitude - long endurance (MALE) class tactical unmanned aerial vehicle system developed by Baykar Defence. Turkey's first mass-produced armed unmanned aerial vehicle (UAV), the TB2 is capable of successfully performing both reconnaissance-surveillance and armed attack missions.

With more than 200+ thousand flight hours of operational experience, the TB2 is actively operating not only in Turkey but also in other countries, and stands out as a game-changer in modern battlefields. The system is equipped with electro-optical sensors, laser targeting, image processing and autonomous flight capabilities[7].

The technical specifications of Bayraktar TB2 are given in Table 2, while its visual appearance is shown in Figure 2.

Table 2. Bayraktar TB2 technical specifications

Feature	Description
Mission Objective	Reconnaissance, surveillance, armed attack
Time in the Air	27+ hours
Range	150+ km (LOS), more (SATCOM ops)
Maximum Take-off Weight	700 kg
Payload Capacity	150 kg
Weapon Integration	MAM-L, MAM-C, Roketsan munitions
Takeoff / Landing	Automatic over the runway
Engine	Internal combustion, single propeller
Flight Control System	Triple redundant autopilot / GPS-INS supported
Camera System	EO/IR, laser marker
Ground Control Station	Modular, mobile or fixed platforms

Fig. 2 Bayraktar TB2 visual

C. Bayraktar TB3

Bayraktar TB3 is the first Turkish-made attack-class unmanned aerial vehicle (UCAV) system developed by Baykar Defence, capable of landing and taking off and landing on short-runway naval platforms such as aircraft carriers. It is especially designed to be integrated into flying ship platforms such as TCG Anadolu. With this feature, it has a foldable wing structure and can operate in limited areas with high performance.

Bayraktar TB3 has been developed for reconnaissance, surveillance, target detection and armed operations, and can perform beyond line of sight (BVLOS) missions thanks to satellite control (SATCOM) support. In this respect, it is a more advanced system compared to the classic TB2[8].

The technical specifications of Bayraktar TB3 are presented in Table 3, while its visual appearance is presented in Figure 3.

Table 3. Bayraktar TB3 technical specifications

Feature	Description
Mission Objective	Reconnaissance, surveillance, armed attack
Time in the Air	24+ hours
Range	Beyond line-of-sight mission with SATCOM
Maximum Take-off Weight	1450 kg
Payload Capacity	280 kg
Wing Structure	Foldable, ship platform compatible
Landing/Departure	Autonomous over runway ship
Flight Control System	Triple redundant autopilot / GPS-INS supported
Weapon Integration	MAM-L, MAM-T, laser guided missiles
Camera System	EO/IR sensor + laser pointer
Satellite Communication	Yes (SATCOM)

Fig. 3 Bayraktar TB3 visual

D. Bayraktar Akinci

Bayraktar Akıncı is one of Turkey's most advanced unmanned aerial platforms in the attack unmanned aerial vehicle (UAV) class, developed by Baykar Defence. Akıncı, which attracts attention with its high altitude, long endurance and heavy payload carrying capacity, has the capability to perform missions at both strategic and tactical levels.

Akıncı is equipped with many high technologies such as indigenous artificial intelligence algorithms, multi-weapon integration, AESA radar, air-to-air munitions, SESP, EO/IR systems, SATCOM, electronic warfare and air defense interceptor systems. In this respect, it is capable of sharing the missions of manned combat aircraft[9].

Technical specifications of Bayraktar Akıncı are presented in Table 4 and its visual appearance is presented in Figure 4.

Table 4. Bayraktar Akıncı technical specifications

Feature	Description
Mission Objective	Strategic offense, reconnaissance, electronic warfare
Time in the Air	24+ hours
Maximum Take-off Weight	6,000 kg
Payload Capacity	1,500 kg
Wing Span	20 m
Engine Options	2×450 hp / 2×750 hp / 2×950 hp
Service Altitude	40,000 ft (12,192 m)
Weapon Integration	MAM-L/C/T, HGK, KGK, SOM, Bozdoğan, Gökdoğan
Radar System	AESA radar
Satellite Communication	SATCOM)
Camera and Sensor Systems	EO/IR, SAR, laser pointer
Flight Control System	Redundant autopilot + artificial intelligence

Fig. 4 Bayraktar Akıncı visual

E. Bayraktar UAV (Vertical Take-off and Landing UAV)

The Bayraktar UAV is a hybrid class unmanned aerial vehicle developed by Baykar Defence with vertical take-off and landing (VTOL) capability. It prevents fixed-wing UAVs from needing a runway to take off and enables them to operate in narrow areas and runway-free environments.

The UCAV has four electric vertical take-off and landing engines and one fixed-wing flight engine. During the mission, it takes off vertically, then switches to fixed wing mode and continues its flight efficiently. At the end of the mission, it switches back to vertical mode and lands safely. Thanks to this structure, both long-term mission execution at high altitude and ease of mobile use are provided[10].

The technical specifications of Bayraktar IWHA are given in Table 5 and its visual appearance in Figure 5.

Table 5. Technical specifications of Bayraktar (DIHA)

Feature	Description
Mission Objective	Reconnaissance, surveillance, target detection
Takeoff / Landing	Vertical (VTOL)
Time in the Air	12 hours
Range	150 km (Line of Sight)
Wing Span	5 m
Propulsion System	1 fixed wing engine + 4 VTOL engines
Payload	Electro-optical and infrared camera
Flight Mode	Autonomous / semi-autonomous
Body Structure	Composite material
Ground Control System	Portable GCS

Fig. 5 Bayraktar (DIHA) image

III. RESULTS AND DISCUSSION

According to the research, UAV and UCAV technologies have shown a significant development worldwide as of 2024. In particular, Turkey has gained a serious leadership in this field with Baykar's $1.8 billion UAV exports and has become an important player in the global market. This shows that Turkey has achieved independence in UAV and UCAV technologies through domestic production and reduced its foreign dependence. According to the CNAS report, Turkey's success not only contributes to the military, but also to the economy [11]. Table 6 provides a technical comparison of the analyzed models.

Table 6. Technical Comparison

Features	**Mini UAV**	**TB2**	**TB3**	**Akin**	**DİHA**
Mission Objective	Reconnaissance, surveillance	Reconnaissance, UCAV	Sea platform UCAV	Strategic UAV	VTOL reconnaissance-surveillance
Time in the Air	1 hour	27 hours	24 hours	24 hours	12 hours
Max. Take-off Weight	4.5 kg	700 kg	1450 kg	6000 kg	Unknown (50+ kg)
Payload Capacity	Less (1 kg)	150 kg	280 kg	1500 kg	EO/IR camera system
Meniz (LOS/SATCOM)	5 km (LOS)	150+ km (LOS)	SATCOM supported	SATCOM supported	150 km (LOS)
Landing / Takeoff Type	Hand throw / parachute	Automatic on the runway	Aircraft carrier / runway	Automatic on the runway	Vertical (VTOL)
Engine Type	Electric	Internal combustion	Internal combustion	Dual engines (450-950 hp)	Hybrid (1+4 engines)
Satellite Communication	No	Optional	Yes (SATCOM)	Yes (SATCOM)	No
Weapon Carrying Capability	No	MAM-L/C	MAM-L/T etc.	MAM-L/C, SOM, Bozdogan	None
Camera Systems	EO/IR	EO/IR + laser	EO/IR + laser	EO/IR, SAR, AESA	EO/IR
Featured Feature	Micro-sized, silent	Strategic reconnaissance / UCAV	Foldable wing / ship compatible	Artificial intelligence, heavy load	Vertical take-off advantage

Ukraine's goal of producing 1 million FPV (First-Person View) drones by 2024 is indicative of changes in warfare technology. Ukraine's new strategy reveals that traditional methods of warfare are being replaced

by drones that can be produced more cost-effectively and quickly. However, the fact that these FPV drones are generally used for short-range and high-precision attacks suggests that they offer a more limited range of use compared to the long-range and autonomous capabilities of UCAVs. In this respect, both technologies serve different war doctrines.

New generation projects such as the Anka-3 prove that UCAVs are capable of not only reconnaissance and observation, but also direct combat missions. The Anka-3's stealth capability and jet engine are specifically designed to provide superiority against advanced air defense systems. This means that in the future, UAV/UCAV technologies can be used not only as unmanned aerial vehicles, but also as unmanned combat aircraft.

Another important finding during the research is the increase in international cooperation. In particular, the agreement between Baykar and Italy's Leonardo company shows that UAV and UCAV technologies have become a strategic tool not only for local defense industries, but also for global military alliances. Such collaborations are likely to further popularize UAV and UCAV technologies.

The findings of the study are in line with the literature reviews and data from reliable sources. The validity of the results obtained is based on the fact that they are based on current and direct sources. These results indicate that combat technologies will further diversify in the future and the use of UAVs/UAS will continue to increase.

Overall, the research findings reveal that UAV and UCAV technologies will play an important role in shaping modern war doctrines and international relations. In particular, the rapid production and low-cost advantages of FPV drones signal the beginning of a new era in war strategies. The development of these technologies is likely to lead to significant changes not only in the military field, but also in economic and strategic terms.

IV. CONCLUSION

The results obtained in this study show that by 2024, developments in UAV and UCAV technologies are progressing very rapidly. In particular, Turkey's $1.8 billion worth of UCAV exports through Baykar proves that Turkey has gained an important place in this field worldwide. This shows that Turkey is becoming more independent in the defense industry with domestic production.

Ukraine's 2024 production target of 1 million FPV drones demonstrates how drone technologies are taking modern warfare to a new level. This shows that drones that can be produced at lower cost and faster speeds will play an important role in future warfare strategies. In addition, advanced UCAVs such as the Anka-3 will continue to play an important role in providing air superiority in warfare.

It seems certain that UAV and UCAV technologies will play a greater role in future war doctrines. These technologies are likely to create a major transformation in both military and strategic terms.

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