AI APPLICATIONS IN DEFENCE SECTORS

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Abstract

The amount of data has been rapidly increasing recently, and this information is now identified as big data. Technological advances and transformations are increasing rapidly, and the different kinds of threats have also increased in different aspects, limiting human capacity for decision-making or making problem-solving insufficient. Therefore, by analyzing big data-based information with Artificial Intelligence (AI), it is possible to detect threats in advance, organize logistics, and run operations at different levels (air, land, naval, cyber, space). AI has a wide range of applications in the defence industry, from autonomous and semi-autonomous systems to cybersecurity, from logistics and maintenance processes to training, simulation, intelligence, and command and control activities. However, today, the concept of defence is not only limited to securing the military platforms, but also necessitates the holistic securing of critical infrastructures and civilians against asymmetric threats. In this context, AI-integrated digital twin technologies enable the real-time monitoring of transportation networks, energy and communication infrastructures, prediction of risks, and dynamic management of multi-layered defence scenarios. They offer a strategic capability that can complement missile and platform-based defence systems and function as a protective defence shield on different scales. Many countries, including the US, China, Russia etc., have been rapidly developing AI-based defence systems. Furthermore, AI has various applications in the field of military healthcare. In addition, uncertainties surrounding AI include the lack of a clearly defined legal framework regarding the application of autonomous defence systems, including issues such as accountability, compliance with national or international law, civil-military separation, and reduced human control on the systems. Ethical boundaries vary from country to country. However, it is predicted that in the coming years, AI applications in the defence industry will be further developed and applied in new defence applications. Türkiye's defence industry has a strong and developing ecosystem, primarily including the companies such as Aselsan, Turkish Aerospace, Havelsan, and Roketsan which are affiliated with the Turkish Armed Forces Strengthening Foundation. Additionally, other companies such as Baykar, TEI, STM, and MKE etc. have been implementing AI-based projects at various levels to meet the needs of the Turkish defence industry. Applications of AI in Türkiye's defence industry include autonomous systems, command and control systems, electronic warfare, cybersecurity, and intelligence analysis etc. Furthermore, the Presidency of the Republic of Türkiye, Secretariat of Defence Industries has numerous training programs, including those focusing on AI applications in defence.

Keywords

Artificial Intelligence, Defence Industry, Cybersecurity, Intelligence and Electronic Warfare, Defence Ecosystems

Introduction

Artificial intelligence (AI) has become the central topic of warfare technologies in recent years. A historical look at the use of AI in the warfare industry reveals how military operations have evolved. In recent years, AI has contributed as a groundbreaking technology in improving and transforming defence industry and military strategies, and today it is a technology applied in many fields. While traditional military logistics and decision-making applications are carried out using slow and manual methods, with AI, armies can perform faster, data-driven, and more effective operations (Rocket.Chat, 2024). For example, Alan Turing's work in cracking the Enigma codes laid the foundation of the use of AI in the military applications; the US Army's use of the DART system for logistics management in 1991 demonstrated the economic and operational impacts of AI (TE Connectivity, 2025).

The use of AI in the defence sector presents opportunities and risks (Geneva Centre for Security Sector Governance [DCAF], 2025). The application of AI in the defence industry has become a transformative force, and changes are ongoing (The global AI race and defence's new frontier, 2025). AI has become a strategic technology that both increases efficiency and improves/transforms applications related to military capabilities (The global AI race and defence's new frontier, 2025). In particular, AI has been an important developing technology in defence industries, as well as in many fields such as information technology, finance, education, and health. By obtaining and processing large amounts of data, AI in the defence industry increases operational efficiency, accelerates decision-making processes, and gains superiority against threats (DCAF, 2025).

Today, the amount of data is rapidly increasing, and information is now defined as big data. Technological developments and transformations are rapidly increasing, and the variety of threats has also increased in different dimensions, making the human capability for decision-making or problem-solving insufficient. Therefore, by analyzing big data with AI, it is possible to detect threats in advance, manage logistics, and coordinate operations at different levels (air, land, naval, cyber, space) (The global AI race and defence's new frontier, 2025). For example, with the Russo-Ukrainian war, it was seen that military interactions reached a critical level and modern warfare underwent a rapid transformation (Clapp, 2025). In this war, FPV drone applications were used effectively at many levels by both countries for different purposes. In this war, due to the active use of drones and the threats they pose, the use of helicopters in hot conflict zones has decreased significantly. This decrease has led to changes in war strategies.

Factors determining the lead in AI usage in defence sectors among the countries are technology readiness level (TRL), integration of AI with military doctrines, strategic independence, and ethics-management processes (The global AI race and defence's new frontier, 2025). In cyber defence processes, network traffic can be monitored in real time with AI, and threats can be detected and responded to instantly (DigitalDefynd, 2025). In addition, security and access control are strengthened with facial recognition and surveillance systems (DigitalDefynd, 2025). Furthermore, AI provides inventory optimization in logistics management, improves the performance of soldiers with realistic simulations in military training (DigitalDefynd, 2025). It offers tactical decision support on the battlefield, makes defence systems more effective and sustainable by analyzing missile threats, and provides instant translation in different languages in multinational operations, making communication more efficient (DigitalDefynd, 2025).

Industry 5.0 technologies have radically updated defence technologies (Singh et al., 2025). Many capabilities in the defence industry have been improved with AI technologies such as machine learning, Internet of Things (IoT), big data analytics, real-time data analysis, augmented/virtual reality, threat detection, autonomous weapon systems, simulation-based military training, cyber defence, logistics optimization and improvement of maintenance processes etc. (Rocket.Chat, 2024; Singh et al., 2025). In addition, additive manufacturing methods (e.g., 3D printers) have been developed and are widely applied in the defence industry. In addition to these, it has been stated that defence capabilities have been improved with many critical and sensitive applications such as real-time intelligence, target detection, counter-drone systems, smart weapons, autonomous aerial, land, naval vehicles and monitoring of soldier health (Singh et al., 2025).

1. Artificial Intelligence Applications

AI can be used in defence industries such as autonomous weapon systems, unmanned vehicles, simulation and training environments, cyber defence and intelligence analysis. With these technologies, it can offer better awareness to the decision-maker and has the potential to reduce potential errors contributed by humans (DCAF, 2025). Anti-drone systems enhanced with computer vision, unmanned aerial, land, and naval vehicles, underwater robots, mines and very fast productions thanks to rapid prototyping with 3D printers increase operational efficiency (Singh et al., 2025).

Today, AI plays a critical role in threat detection. While analyzing radar and radio signals used to take a long time, nowadays, with AI systems, these signals can be detected and classified quickly (TE Connectivity, n.d.). For example, AI can predict the trajectory of ballistic missiles, which target they will reach, and how long it will take to reach it, thus enabling early intervention (TE Connectivity, n.d.). By solving

encrypted communications, it can provide valuable information about the enemy's correspondence and their plans/targets (TE Connectivity, n.d.). In addition, AI has an important place in the control of manned and unmanned vehicles. The coordinated operation of unmanned aerial, land, and naval vehicles in swarms is becoming standard in fighter jets, land vehicles, and naval platforms. In these systems, even if there are communication problems, national AI software is needed to prevent situations such as collisions or mission cancellations (TE Connectivity, n.d.).

AI has significantly accelerated data flow and analysis in intelligence gathering processes. Audio recordings can be transcribed and translated into another language in real time, enabling soldiers to make quick and accurate decisions based on factual information. AI has also made groundbreaking contributions in the field of education, enabling soldiers to prepare more effectively for operations they will encounter in the real warfare through combat simulations and continuously updated virtual trainings (TE Connectivity, n.d.).

AI systems have provided extensive improvements in integrated defence projects, for example, with the US-originated JADC2 program. This program aimed to integrate all military sensors/processes in aerial, land, naval, space, and cyber domains into a single AI-supported network. Thus, operational data can be shared instantly among all forces, and command and control processes can become much faster (TE Connectivity, n.d.). Large amounts of data are generated in electronic warfare and defence applications with the use of AI. However, very powerful embedded systems are needed for the processing of this data. Under warfare conditions, it is critical that these systems are robust, fast, and have high bandwidth (TE Connectivity, n.d.).

The 7 basic applications of AI in defence industry are given below (Rocket.Chat, 2024):

1. Autonomous weapon and vehicle systems: Unmanned aerial, land, or naval vehicles capable of performing their tasks and missions without human intervention/control, autonomous weapons, and swarm technologies, smart ammunition and guidance systems.
2. Cybersecurity: AI-based defence systems that can automatically analyze or detect and protect against attacks on internet networks.
3. Logistics optimization: Intelligent analysis tools that improve supply chain management and optimize resource utilization.
4. Training and simulation systems: Personalized training simulations that offer virtual combat scenarios for soldiers or include variable combat scenarios.

5. Electronic warfare and intelligence: Rapid detection and analysis of anomalies or threats through the analysis of big data, used in deciphering enemy communications.
6. Predictive maintenance: Reducing costs and time loss by identifying failure risks in military vehicles and equipment in advance, increasing sustainability.
7. Command and control systems: Joint operations management and real-time situation resolution processes that enable soldiers to make faster and more accurate decisions.

In this context, AI-integrated digital twin technologies stand out as a strategic capability, not only for monitoring critical infrastructure and urban systems, but also for integrating with defence platforms, command and control systems, and multi-layered security architectures. Digital twins represent the real-time status of military platforms, sensor networks, and energy and communication infrastructures in a virtual environment, enabling predictive maintenance, integrated security and defence management, and the simultaneous evaluation of emergency response scenarios. This approach ensures not only the protection of military assets but also the more effective, coordinated, and resilient execution of urban defence and attack/response mechanisms in warfare conditions.

In modern warfare environments, the disruption of electricity, energy, or communication infrastructures as a result of cyberattacks has serious and multifaceted impacts not only on defence systems but also on the civilians living in cities. Therefore, integrating vital systems such as drinking water networks, sewage systems, energy distribution networks, and transportation infrastructure into the defence architecture through AI-powered digital twins is very critical. Thanks to this integrated structure supported by cybersecurity measures, failures, attacks, or disruptions in infrastructure can be predicted in advance; and the resilience of cities can be improved by evaluating defence and civil crisis management scenarios together. Thus, AI supports not only the effectiveness of military operations but also the preservation of social continuity in wartime conditions.

This holistic approach further highlights the importance of the Industry 5.0 perspective in the defence industry. Industry 5.0 goes beyond the automation and efficiency-focused structure of Industry 4.0, representing a transformation based on human-centered, resilient, and sustainable systems. In AI-supported defence applications, human-robot interaction strengthens cooperation between unmanned aerial vehicles, autonomous land and naval systems, and command and control centers; it increases the situational awareness of human decision-makers, ensuring more reliable and flexible operation of systems. In this context, Industry 5.0 provides a fundamental framework that enables the ethical, safe, and human-supervised use of

AI in the defence sector; it prepares the ground for the development of next-generation defence architectures that increase the military effectiveness of autonomous systems while keeping the human factor at the center of the system.

AI applications as a defence approach also play a critical role in military health and the protection of human lives in the conflict zones. AI-powered systems enable the development of software that can predict the risks of illness and injury by analyzing the physiological and biometric data of soldiers. Through medical decision support systems, data on illness, trauma, and injury are evaluated with early diagnosis algorithms, providing physicians with rapid and data-driven diagnostic and treatment recommendations. This approach provides a crucial capability that supports human intervention and reduces errors in time-critical situations in combat conditions.

In field operations, AI, integrated with digital twins and autonomous systems, is transforming management of wounded soldiers and emergency medical intervention processes. Emergency intervention can be provided to wounded soldiers via unmanned aerial vehicles and mobile autonomous platforms; necessary diagnostic and treatment equipment can be transported to the field; or physicians can remotely direct interventions through camera and sensor systems. Wearable sensors allow for continuous monitoring of numerous physiological parameters such as heart rate, oxygen levels, body temperature, and stress levels; this data is analyzed by AI algorithms to detect potential anomalies and health risks at an early stage.

However, AI-powered military healthcare applications are not limited to individual treatment processes but encompass a broader ecosystem including infection prediction and biosafety, psychological health and stress monitoring, medical logistics and resource optimization, telemedicine, and autonomous medical support. From an Industry 5.0 perspective, these applications are considered fundamental components of ethical and sustainable defence systems that prioritize human life. Thus, AI is becoming not only a technology that enhances operational effectiveness but also a holistic transformation tool aimed at protecting the health, safety, and long-term well-being of soldiers.

2. Applications of Artificial Intelligence in the Defence Industry in Countries Around the World

Among AI applications, intelligence gathering, autonomous systems, cybersecurity, and decision support mechanisms are widely used in modern warfare (Clapp, 2025). There is a rapidly growing global “AI weaponization process” in many countries such as the USA, China, and Russia etc. (Clapp, 2025). There is serious competition in AI investments in the defence sector, with the USA with its high-budget projects and

China with its big data infrastructure development. It is known that Russia and Israel are developing strategies to increase their AI systems, especially in autonomous systems (Republic of Türkiye Ministry of Industry and Technology & Republic of Türkiye Presidency Digital Transformation Office, 2021).

In the US, civilian technology companies are making significant investments in the defence sector. AI has become a decisive factor in the transformation of the US defence sector. Examples such as the OpenAI–Anduril collaboration are accelerating the transfer of advanced civilian AI systems to defence applications. Google, Amazon, Microsoft, Tencent, and many other technology companies can directly influence the implementation or operation of international security processes (Clapp, 2025). AI increases operational efficiency, shortens detection and decision-making times, and enhances the effectiveness of soldiers through simulations in many areas such as aviation (fighter jets, UAVs, drones), land vehicles, naval (ships, submarines, kamikaze ships, mines), and cyber defence (DigitalDefynd, 2025). Predictive maintenance can detect malfunctions in many aerial, land, and naval vehicles in advance, saving costs and time. In addition, dependence on human control in observation, target recognition, and support missions carried out with autonomous drones can be significantly reduced (DigitalDefynd, 2025).

AI applications in the defence industry in European Union (EU) countries have focused on strategic and technological independence issues. Particularly as a result of the Russo-Ukrainian War, the marginalization of European countries by the US and their criticism by the US regarding financial and other support to NATO created a need for EU countries to find solutions in their defence industry and AI applications. However, compared to the US and China, the R&D expenditures of EU countries in AI are quite limited (Clapp, 2025). To close this gap, many EU countries, especially France and Germany, are increasing their AI applications in the defence industry. France is working intensively on autonomous systems, big data, and supercomputers. Germany, on the other hand, has focused its AI applications on decision support and mission preparation (Clapp, 2025).

The global spread of AI in the defence industry presents a multi-layered competitive arena shaped by different strategies, threat perceptions, and industrial capacities, rather than a homogeneous development process among countries. Today, this transformation is considered a shift from a network-centric and “informed” warfare approach to an “intelligentized” warfare paradigm where machine cognition is decisive in decision-making, intelligence processing, logistical sustainability, and kinetic interaction processes. In this context, AI has become not only a force multiplier but also a strategic competency element aimed at providing cognitive superiority in the decision-making cycles of countries. The rapid growth of the global AI market for defence purposes clearly demonstrates that this technology plays a central role in military power projection.

The approaches of major military actors such as the US, China, and Russia clearly reflect this divergence. The US views AI as an infrastructure technology transforming the joint force structure and is institutionalizing it within the framework of Joint All-Domain Command and Control (JADC2) doctrine, which aims to integrate all sensors and platforms in aerial, land, naval, space, and cyber domains. China, on the other hand, uses civil-military fusion as a strategic leverage in line with its "smart warfare" doctrine and directly integrates commercial AI companies into its defence ecosystem. Russia's approach is shaped by a more centralized and state-controlled innovation model, focusing on developing asymmetric capabilities under economic and technological constraints. These three approaches demonstrate that AI is creating not only a technological but also an institutional and doctrinal transformation in the defence sector.

However, the global impact of AI in the defence industry is not limited to major powers. Medium-sized and regional actors are developing unique capabilities, particularly through unmanned systems, autonomy, and data-driven decision support mechanisms. The United Kingdom is positioning AI as the cognitive core of 6th-generation aerial platforms through alliance-based programs, while Türkiye has achieved a remarkable position in regional power projection with operationally proven AI-powered systems in unmanned aerial and naval platforms. These examples demonstrate that military superiority in the defence industry is increasingly defined by algorithmic capability, data architecture, and software integration capacity rather than the number of hardware platforms. Therefore, AI-based defence applications are creating a new power hierarchy on a global scale and necessitating long-term structural transformations in countries' defence strategies.

3. Artificial Intelligence and Robotic Systems

AI and robotic systems have evolved from being mere platform-based automation tools in the defence industry to becoming fundamental components of holistic defence architectures with decision-making, sensing, learning, and adaptation capabilities. This transformation has led to the evolution of unmanned aerial, land, and naval vehicles from remotely controlled systems to robotic structures capable of sensing environmental conditions, developing situational awareness, and performing tasks with limited or partial autonomy. Today, defence robots are considered not only physical task-performers but also cyber-physical systems supported by AI algorithms, generating data, and continuously learning from that data.

In modern defence environments, the effectiveness of robotic systems is defined not by the performance of individual platforms, but rather by the level of interaction these systems establish with other military elements, sensor networks, and command and control structures. AI-powered robots offer flexible and scalable solutions in complex

warfare thanks to swarm architectures, human-machine teams, and distributed task execution capabilities. In this context, robotic systems have become strategic elements that reduce the physical and cognitive risks to soldiers in areas such as reconnaissance and surveillance, target acquisition, logistics support, mine clearance, protection of critical infrastructure, and the execution of high-risk missions.

The impact of AI-integrated robotic systems on the defence industry is not limited to operational efficiency. These systems can also be integrated with digital twin technologies, enabling the creation of virtual representations of both physical platforms and mission environments. This allows the management of robotic component maintenance and repair processes using predictive approaches, and for the simulation of pre-mission and in-mission scenarios in real time, thereby reducing operational risks. Especially in conflict zones where logistics, communication, and infrastructure systems are damaged, AI-supported robotic systems can play critical roles in emergency response, reconnaissance, and civilian support activities.

In this context, the position of AI and robots in the defence industry is redefined from an Industry 5.0 perspective. Industry 5.0 represents an approach that places humans at the center of the system in defence applications, prioritizing resilience and ethical responsibility. In this context, AI-assisted robotic systems are considered not as replacements for human decision-makers, but as auxiliary elements that complement and strengthen human cognitive capacity. Human-robot interaction, especially in command and control processes, enables the development of more balanced, transparent, and reliable decision-making mechanisms in complex and uncertain combat environments.

In conclusion, AI and robots represent not only a technological advancement in the defence industry but also a multifaceted transformation encompassing doctrinal, ethical, and governance dimensions. Future defence architectures will be built on integrated structures where human, AI, and robotic systems work together, supported by digital twins, and based on resilience against multi-domain threats. This transformation clearly demonstrates that competitiveness in the defence industry will be shaped not by hardware but by algorithmic competence, system integration, and human-centered design capabilities.

4. Ethical Issues

In the application of AI in the defence industry, on soldiers, and in warfare, data confidentiality, the necessity of human oversight, and the determination of ethical and legal boundaries are of great importance. However, currently, there are no international regulations regarding the application of AI in the defence industry. For example, AI-based surveillance systems may lead to violations of the private lives,

human rights, or privacy of individuals/civilians (DCAF, 2025). The rapid application of AI on humans without completing control processes may lead to problems such as lack of transparency or unethical military practices (The global AI race and defence's new frontier, 2025). Therefore, it is important that the application of AI in the defence sector is developed in a verifiable manner and in accordance with international standards (The global AI race and defence's new frontier, 2025).

In the defence applications of autonomous systems, the legal framework regarding issues such as accountability, compliance with national or international law, civil-military separation, and reduced human oversight has not been clearly defined, and ethical boundaries vary from country to country. In particular, Lethal Autonomous Weapons Systems (LAWS) -i.e., systems that can make attack/kill decisions without human control and decision-making- are a major legal, ethical, and moral issue (Clapp, 2025). Although the EU Parliament supports the complete prohibition of this in military applications (Clapp, 2025), its applicability is almost nonexistent. In addition, autonomous weapon systems need to be resolved regarding issues such as data privacy and the necessity of human oversight (Rocket.Chat, 2024).

Ethical responsibilities regarding the use of AI in the health field, the uncertainty of who or what will be held responsible in case of erroneous decisions, patient data confidentiality and clinical validation requirements, and the establishment of an ethical and legal infrastructure to provide solutions to these important issues are necessary (Golec et al., 2025). In conclusion, although AI has potential in the health services of soldiers, regulations should be made for safe and responsible use/application (Golec et al., 2025).

According to the US Department of Defence's act in 2023, when making a decision about the action of autonomous weapons systems, the final decision must be made by a human, and with this approach, human control must be maintained in the lethal attack/use of force by AI (TE Connectivity, n.d.). In this regard, China proposes the application of flexible rules that are not binding, while Russia is opposed to binding prohibitions (Clapp, 2025). Although the UN and NATO are working to create frameworks/decisions for the responsible use of autonomous systems, there is no universally accepted consensus (Clapp, 2025).

5. Disadvantages of Artificial Intelligence

Although AI has serious potential in the defence industry, it also carries risks. Due to lack of transparency or deficiencies in software algorithms, AI systems can be manipulated by cyberattacks and counterattacks etc. Deep-fake content and automated disinformation tools can jeopardize military communication processes and the security of civil society (DCAF, 2025).

The use of AI makes it difficult to prevent human-caused interventions in the defence sector, thus avoiding negative impacts on civilians. Non-transparent algorithms can make accountability difficult, prevent timely action on illegal processes, and weaken the intervention of soldiers in decision-making matters (DCAF, 2025). To mitigate these risks, defence institutions need to establish strong oversight mechanisms and processes in accordance with legal infrastructure (DCAF, 2025).

6. The Future of Artificial Intelligence

In the coming years, it is predicted that the applications of AI in the defence industry will extend and be applied in newer areas. The role of AI technologies in big data and autonomous warfare systems is increasing. AI has become an important tool for the effectiveness of the armies nowadays (TE Connectivity, n.d.).

Transparency should be increased, especially regarding to software and legal processes in the use of AI, the performance and security/trust/control levels of the systems should be checked regularly, independent controls should be conducted, and the collaborations of universities and high-tech companies should be strengthened in basic R&D, prototype R&D and product development processes. In this way, AI technologies/systems/applications can increase the effectiveness of armies and soldiers on the battlefield (Geneva Centre for Security Sector Governance [DCAF], 2025). In the field of defence, countries' with AI and its know-how will be the main role-players in military superiority in the future (The global AI race and defence's new frontier, 2025).

Areas where AI will have a major impact on defence applications by 2030 include predictive decision support systems, autonomous systems/platforms (swarm drones, autonomous systems), dynamic resource management, and advanced logistics applications (The global AI race and defence's new frontier, 2025). For example, swarm drones are being extensively used by both countries in the Russo-Ukrainian War. AI-supported decision-making mechanisms will enable more effective execution in terms of speed, accuracy, and flexibility in operations, providing operational agility and precision, as well as ensuring the safety of soldiers (The global AI race and defence's new frontier, 2025).

Furthermore, the sustainability of AI applications in the defence industry is of great importance. It is predicted that maintaining secure communication, 5G drone networks, and improving maintenance processes with augmented reality will become increasingly important (Singh et al., 2025).

It is important to create a common ecosystem that will enable faster cooperation between the Ministry of Defence and the private sector in countries. Thus, the aim should be to evaluate the suitability of AI projects to the military requirements of the relevant country before commercialization and to accelerate innovation/basic

R&D/prototyping/product development processes (Gaskins, n.d.). In this way, AI will be much more decisive in future wars/conflicts. In this regard, countries need a comprehensive structural integration of AI processes into their own applications to transform their own defence industry (Gaskins, n.d.). For example, Germany has declared the “2027+ Vision” to develop these processes and has set targets for the increasing application of AI-based defence strategies in the country (The global AI race and defence's new frontier, 2025). This vision foresees developments in AI applications in terms of compatibility with NATO/EU processes, the development of university/industry collaborations related to basic R&D/innovation ecosystems, and the implementation of management systems related to ethical/legal processes (The global AI race and defence's new frontier, 2025).

The future of AI in the defence industry is evolving from task-specific "narrow AI" applications to autonomous agents (agentic AI) capable of breaking down high-level objectives into sub-tasks and executing these tasks without human intervention. This transformation is expected to be decisive in cyber defence, logistics management, intelligence processing, and operational planning processes between 2025 and 2035. Unlike classical decision support tools, AI systems offer structures that continuously collect data, adapt to environmental conditions, and perform dynamic task prioritization. However, this increased capability also brings new risk areas, particularly in terms of the supervision, responsibility sharing, and legal framework of autonomous agents operating on armed or decentralized networks.

Another trend in defence technologies during this period is biologically based computing approaches and edge AI architectures. Since fuel constraints and communication interruptions pose a significant problem, especially in unmanned aerial vehicles, missile systems, and swarm platforms, processors that mimic the working principles of the human brain are becoming a strategic priority in defence R&D. These architectures offer real-time detection and decision-making capabilities even under electronic warfare or in communication-disrupted environments, thanks to their low latency and ultra-low power consumption. In parallel, cognitive electronic warfare approaches are moving beyond systems based on classical threat libraries, making it possible to develop AI-powered solutions that can learn unknown radar and communication signals during a mission and generate countermeasures instantly.

The future of AI in the defence industry is not only limited to software and algorithms, but also extends to areas such as hypersonic threats, materials science, and military health. Faced with the unpredictable maneuverability of hypersonic weapons, real-time trajectory prediction using deep learning-based hybrid models is becoming a fundamental element of next-generation defence systems. Furthermore, generative AI approaches enable the design of next-generation armor and protective materials at the microstructural level, contributing to the development of lighter, more durable, and environmentally friendly defence materials. Similarly, in scenarios where

medical evacuation options are limited in conflict zones, AI-powered autonomous medical intervention systems play a critical role in protecting military health. These developments demonstrate that the future of AI in the defence industry will be shaped not only by military superiority but also by the protection of human life and sustainability.

7. Literature About Artificial Intelligence in the Defence Industry by Country

Table 1 shows the number of articles published by the top 10 countries between years 1981 and 2025 using the Scopus database and the criteria "Article title, Abstract, Keywords" for the keywords of "Artificial Intelligence Defence". While the USA was the country with the most publications on this topic between 1981 and 2019, China and then India showed a significant improvement in their publication numbers after 2020. When these publications were evaluated for 2-different time periods of between 1981-2019 and 2020-2025 by country, it is predicted that China and also India will see even more increases in their publication numbers on this topic in the near future.

Table 1

Number of Articles Published by the Top 10 Countries in the Scopus Database for the Keywords "Artificial Intelligence Defence" Based on the "Article Title, Abstract, Keywords" Search Criteria (1981–2025)

Years	Total Publication	USA	China	India	UK	Australia	Italy	Canada	Saudi Arabia	Germany	France	Other Countries
1981 - 1990	107	**36**	1		6			1			1	62
1991 - 1995	101	**60**	1	1	6	5		5			1	22
2001 - 2005	155	**59**	8	2	13	9	3	3		4	3	51
2006 - 2010	245	**67**	50	10	14	16	6	13		6	9	54
2011 - 2015	374	**101**	70	20	19	13	11	19	4	12	8	97
2016 - 2017	278	**76**	45	36	18	9	11	5	1	9	8	60
2018 - 2019	379	**120**	83	33	20	12	19	5	3	15	15	54
2020 - 2021	690	152	**209**	67	52	21	21	14	11	19	15	109
2022	417	**106**	**106**	57	25	20	8	11	11	14	5	54
2023	598	126	**153**	90	41	18	13	14	21	22	13	87
2024	1011	196	189	**227**	55	43	25	18	31	15	28	184
2025	1421	239	**315**	309	70	52	37	45	66	25	22	241
Total	5776	1338	1230	852	339	218	154	153	148	141	128	1075

An examination of the literature related to the term "Artificial Intelligence Defence" reveals that while the US led before 2019 in terms of number of publications, publications of China and India have increased in recent 5-years. Israel and Russia are absent from the top 10 publication rankings, suggesting they are focusing on prototype or system/subsystem development stages within the TRL7-9 range rather than making publications in this area. In Russia, publications in national state or defence journals are considered to be active at a certain level, rather than submissions to international journals. Among the four European countries in the top 10 (UK, Italy, Germany, and France), the UK has the most publications, while France has the fewest.

According to Table 2, when looking at the number of articles from the USA, China, and India, the USA published more articles than the other two countries until 2019. However, from 2020 onwards, first China, and then from 2024 onwards India, have shown a significant increase in the number of articles compared to the US.

Table 2

Number of Articles Published by the United States, China, and India in the Scopus Database Based on the "Article Title, Abstract, Keywords" Search Criteria (1981–2025

Years	USA	%	China	%	India	%	Total Publication
1981 - 1990	**36**	97.3	1	2.7		0.0	37
1991 - 1995	**60**	96.8	1	1.6	1	1.6	62
2001 - 2005	**59**	85.5	8	11.6	2	2.9	69
2006 - 2010	**67**	52.8	50	39.4	10	7.9	127
2011 - 2015	**101**	52.9	70	36.6	20	10.5	191
2016 - 2017	**76**	48.4	45	28.7	36	22.9	157
2018 - 2019	**120**	50.8	83	35.2	33	14.0	236
2020 - 2021	152	35.5	**209**	48.8	67	15.7	428
2022	**106**	39.4	**106**	39.4	57	21.2	269
2023	126	34.1	**153**	41.5	90	24.4	369
2024	196	32.0	189	30.9	**227**	37.1	612
2025	239	27.7	**315**	36.5	309	35.8	863
Total	1338	39.1	1230	36.0	852	24.9	3420

Table 3 presents publication numbers for Türkiye's neighbors, some Middle East countries, and some countries related to Türkiye. It is noteworthy that Saudi Arabia has the highest number of publications, while Israel has the lowest. Russia ranks 6th among the 10 countries in terms of publications. Furthermore, it is assessed that countries with low publication rankings, such as Israel, despite having intensive

technological/industrial work in AI, may not publish their basic R&D studies as articles. In Türkiye, the number of publications related to AI research is increasing through joint publications of universities and defence industry firms (especially in autonomy and image processing).

Table 3

Number of Articles Published by Türkiye and Selected Countries in the Scopus Database for the Keywords "Artificial Intelligence Defence" Based on the "Article Title, Abstract, Keywords" Search Criteria (1986–2025)

Years	Saudi Arabia	Turkiye	UAE	Greece	Jordan	Russia	Iraq	Iran	Egypt	Israel
1986 - 1995										**1**
1996 - 2005										**2**
2006 - 2010		1		1	1			**2**		**2**
2011 - 2015	4	4	1	**5**		3		2	1	
2016 - 2017	1	**3**		1		2		1		2
2018 - 2019	3	**5**	2	3		4	1	1	1	4
2020 - 2021	**11**	4	4	**11**	3	9	3	5	1	2
2022	**11**	6	6	5	2	2	2	2	1	2
2023	**21**	10	8	6	5	8	8	5	3	1
2024	**31**	26	19	8	14	10	16	5	13	2
2025	**66**	34	47	16	30	11	18	11	13	10
Total:	148	93	87	56	55	49	48	34	33	28

8. Applications of Artificial Intelligence in the Defence Industry in Türkiye

AI applications in Türkiye's defence industry encompass unmanned aerial, land, and naval autonomous systems/vehicles, target detection and recognition systems, intelligence-surveillance-reconnaissance, and electronic warfare activities. Furthermore, AI's ability to enable soldiers to make rapid and accurate situational assessments in decision support systems increases operational effectiveness in the field. In Türkiye, AI is increasingly being integrated into digital health infrastructure within health units and force commands to improve military health and the conditions of active personnel in the field.

AI applications in the defence industry include a wide variety of applications such as UAVs, ballistic missile navigation, autonomous vehicles, land systems, naval systems, and submarine systems. The development of a national AI system (such as ChatGPT, DeepSeek, Gemini, etc.) by Türkiye is significant in terms of creating Türkiye's language model. AI models are being applied to transform unmanned autonomous aerial, land, and naval systems into self-thinking systems. The application of AI in the defence industry began with processes such as machine learning, data analysis, and big data.

In the field of defence industry, as a result of minimizing or completely eliminating the human factor in AI applications, potential anomalies regarding the reliability of the relevant technology or data should be identified in advance, and alternatives should be developed to solve these problems.

The defence industry in Türkiye has a strong and developing ecosystem, primarily with companies such as Aselsan, Turkish Aerospace, Havelsan, and Roketsan, which are affiliated with the Turkish Armed Forces Strengthening Foundation. In addition, Baykar, TEİ, STM, MKE, etc. are working in various applications related to the needs of the Turkish defence industry. Furthermore, a "Process Management and Artificial Intelligence Applications Branch Directorate" has been established within the Ministry of National Defence (Republic of Türkiye Ministry of Industry and Technology & Republic of Türkiye Presidency Digital Transformation Office, 2021).

In recent years, as AI has been applied in many sectors (e.g., agriculture, energy, finance, health, etc.), its contribution to the defence industry has been increasing. There are many projects at the TRL 1-9 level in Türkiye's defence industry applications. This encompasses current needs (TRL 7-9) and the prediction of future areas of study (TRL 1-6). Current applications of AI in Türkiye's defence industry include autonomous systems, command and control systems, electronic warfare, cybersecurity, and intelligence analysis. At the R&D level, there are studies in machine learning, prediction and data analytics, and computer vision (Republic of Türkiye Ministry of Industry and Technology & Republic of Türkiye Presidency Digital Transformation Office, 2021). The areas where AI is heavily used in Türkiye's defence industry are given in Table 4.

Table 4

Main AI Activities and Related Application Areas in Türkiye's Defence Operations

Main Field of Activity	**Application Areas**	**Purpose**
Autonomous Systems	Unmanned aerial vehicles (UAV / UCAV)	Target detection, route optimization, and identification of friendly and hostile units
	Unmanned ground vehicles (UGV)	Obstacle avoidance, situational awareness, and autonomous patrol operations
	Unmanned surface and naval vehicles (USV)	Autonomous navigation, maritime surveillance, reconnaissance, and tracking
Image and Signal Processing	Satellite and drone imagery	Automated target recognition and geospatial analysis
	Radar signal processing	Enemy detection, signal filtering, and noise reduction
	Thermal and night vision systems	Object detection and classification under low visibility conditions
Decision Support Systems	Threat prioritization	Ranking and assessment of threats using battlefield data
	Strategy recommendation systems	Decision support for operational and tactical planning
	Predictive analytics	Forecasting enemy movement and operational outcomes from large-scale data
Cybersecurity	Network traffic analysis	Detection of abnormal or malicious network behavior
	Automated intrusion detection and response	Real-time cyber defence and attack mitigation
	Malware analysis	Prevention of system infiltration and compromise
Smart Ammunition and Guidance Systems	Visual target recognition	Precision targeting and engagement accuracy
	Adaptive trajectory control	Real-time guidance based on target movement
	Mission-based self-neutralization	Controlled termination after mission completion
Training and Simulation Systems	Enemy behavior modeling	Realistic adversary behavior simulation
	Adaptive scenario generation	Dynamic training environments responding to soldier actions
	AI-supported VR training environments	Immersive and data-driven military education
Electronic Warfare and Intelligence	Signal recognition and classification	Identification and interpretation of electromagnetic signals
	Jammer system optimization	Adaptive electronic attack and countermeasure efficiency
	Automated intelligence analysis	Rapid processing and synthesis of intelligence data
Swarm Technologies	Cooperative task allocation	Distributed task sharing among autonomous units
	Dynamic routing and coordination	Real-time path planning and formation control
	Fault tolerance and reconfiguration	Adaptation to loss or failure of swarm elements

Within the Presidency of the Republic of Türkiye, Secretariat of Defence Industries, basic R&D, Prototype R&D and Product Development projects related to the applications of AI technologies in the defence industry have been funded (Republic of Türkiye Ministry of Industry and Technology & Republic of Türkiye Presidency Digital Transformation Office, 2021). Some of these projects are listed as follows: Deep Learning Big Data Analysis Platform, Development of Global Positioning System Independent Autonomous Navigation, Classification and Identification of Surface Targets Detected by Radar, Autonomous Exploration, Guidance and Navigation with Collaborative Robots, AI-Powered Commander Assistant that Develops Movement Pattern, AI-Supported Fire Control and Autonomous Driving for Land Vehicles, AI-Based Vulnerability Detection and Prevention in Software Defined Networks and Global Vulnerability Analysis projects (Republic of Türkiye Ministry of Industry and Technology & Republic of Türkiye Presidency Digital Transformation Office, 2021).

Among the capabilities that AI has brought to the defence industry, it is used as a decision support mechanism in Command and Control systems. Furthermore, it is used in anomaly detection in image processing or cybersecurity, in detecting and preventing attacks before they cause damage, and in accelerating business processes. In UAVs, AI is utilized in situations where the UAV needs to determine its status and store it in its memory to make decisions. In logistics operations, it is used for various activities related to preventive maintenance. In autonomous systems, AI is used in swarm technologies for the coordinated movement of multiple autonomous systems/vehicles and their behavior according to the mission. Additionally, studies are being conducted in Türkiye on how unmanned aerial, land, and or autonomous vehicles can communicate with each other and behave in swarms, and on the development of new warfare scenarios. In these areas, NATO published an AI Strategy in 2021. It has been suggested that all member countries be responsible for implementing six articles: 1) Lawfulness, 2) Responsibility and Accountability, 3) Explainability and Traceability, 4) Reliability, 5) Governability and 6) Bias Mitigation (NATO, 2024). Türkiye participates in the working groups established by NATO on these issues. Workshops, conferences and panels on these issues are also held in Türkiye.

The Secretatiat of Defence Industries coordinates various clustering structures (e.g., AI capability clusters) in the field of AI. These clusters comprise numerous industrial firms, SMEs, universities, and user organizations (requesting authorities). Furthermore, within the scope of the Secretariat of Defence Industries, the Defence Industries Academy (https://www.ssa.gov.tr/) provides training, including AI applications in defence. The Defence Industries Academy runs programs related to AI such as the Electronic Warfare School, Artificial Intelligence School, and Cybersecurity School (https://www.ssa.gov.tr/programlar).

The Artificial Intelligence Academic Thesis Program (ATP) was launched in the 2025-2026 period in cooperation with the Council of Higher Education (YÖK) and Secretariat of Defence Industries (SSB) (The Council of Higher Education, 2025). In addition, major defence industry organizations in Türkiye such as Aselsan, Baykar, Havelsan, Roketsan, Turkish Aerospace etc. have postgraduate programs with Gazi University, Gebze Technical University, Hacettepe University, ITU, ODTU, etc. universities.

9. Conclusion and Recommendations

This study demonstrates that the role of artificial intelligence in the defence industry has gone beyond being merely a technology that automates specific tasks, leading to a holistic redefinition of military capabilities. Autonomous agents, biologically based computational approaches, information-based electronic warfare, and generative technologies are impacting all layers of the defence architecture, from decision-making processes and logistical sustainability to platform design and soldier health. This transformation is shifting defence power towards a structure measured not only by the number of systems/vehicles or ammunition capacity, but also by algorithmic competence, data architecture, and system integration capabilities.

Türkiye holds a strategic position in this transformation thanks to its defence industry ecosystem, operational experience in unmanned systems, and developing academic-industry collaborations. However, to transform this potential into a sustainable advantage, AI applications need to be addressed not as fragmented projects, but within the framework of a shared vision and a long-term roadmap. Strengthening institutional coordination towards AI in the defence industry, clarifying R&D priorities, and ensuring interoperability between different platforms are among the key elements that will determine Türkiye's competitiveness.

At the policy level, Türkiye primarily needs to strengthen a continuous and competent management mechanism that coordinates AI studies for defence purposes. This structure should accelerate the flow of information between the public sector, industry, and academia, prevent duplicate investments in critical technologies, and ensure focus on priority areas. Simultaneously, human resource development should be considered a strategic priority; engineering education, military training, and ethics-management dimensions should be considered together. Designing AI systems in a transparent and reliable manner that does not exclude human oversight is critical for operational success and international legitimacy.

In conclusion, AI-based defence technologies should be considered not only an area of technological development for Türkiye, but also a fundamental component of strategic autonomy, deterrence, and long-term security policies. By adopting a human-centered and sustainable approach supported by feasible policies, Türkiye will be able to occupy an innovative and effective position in the defence architecture of the 2030s.

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