The impact of new technologies on the development of operational capabilities of the armed forces

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***Abstract*— The aim of this paper is to analyze the impact of modern technologies on contemporary security and defense, with particular emphasis on the role of the European Union's defense industry and the use of unmanned aerial systems in military operations. The dynamic development of digital, information technology, telecommunications, and industrial technologies is profoundly transforming military structures, methods of conducting military operations, and strategic concepts on a global scale.The main research problem is to determine how new technologies are influencing the shape of modern armed forces and how they can enhance the defense capabilities and resilience of security structures in Europe. The research hypothesis assumes that the integration of innovative solutions—such as artificial intelligence, robotics, command automation, unmanned systems, and quantum technologies—is a key factor in enhancing the effectiveness of military operations and national security. The study utilizes qualitative and comparative analysis methods, including a review of scientific literature, NATO and EU strategic reports, and case studies of the use of modern technologies in military operations.The research results confirmed that new technologies significantly increase the precision, effectiveness, and speed of defense operations, with drones in particular playing a key role in reconnaissance, threat monitoring, and reducing human casualties. The final conclusion is that technological transformation in the military is the foundation of modern security. The development of technological innovations, while ensuring a legal, ethical, and organizational framework, is a prerequisite for building modern, integrated, and resilient armed forces in the European Union and globally.**

Keywords— unmanned systems, information warfare, new technologies

I. INTRODUCTION

The contemporary world is experiencing dynamic technological transformations that are fundamentally impacting all spheres of functioning of states and societies. Progress in fields such as artificial intelligence, robotics, quantum technologies, cybersecurity, nanotechnology, and Industry 4.0 is leading to profound economic, social, and political transformations. At the same time, these technologies are having a significant impact on security, defense, and the military, transforming both the nature of contemporary threats and the ways in which we respond to them. Modern technologies have become a dominant factor in determining the military potential of states and their position in the international system. Modern armed forces must operate in an environment where information, cyberspace, artificial intelligence, and operational automation are as crucial as traditional military components. Increasing digitization and the network-centric nature of the battlefield mean that technological superiority increasingly determines the outcome of armed conflicts. In this context, the role of the European Union is particularly important, as it strives to strengthen its strategic autonomy and defense capabilities through the development of a common security and defense policy and by supporting innovation in the defense industry. Programs such as the European Defense Fund and PESCO (Permanent Structured Cooperation) demonstrate the growing importance of industrial and technological integration within the Union, aimed at increasing the interoperability of the armed forces of Member States. The aim of this paper is to analyze the impact of modern technologies on military development and assess their importance for shaping defense capabilities within the European Union. The paper focuses on selected technological areas, such as artificial intelligence, autonomous systems, information technology, cybersecurity, and industrial defense production systems. The analysis encompasses both strategic and organizational aspects, as well as industrial ones, highlighting the links between technological innovations and the development of European defense capabilities.

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II. The role of digital technologies in shaping the modern security environment

The dynamic development of modern technologies, especially digital, information technology, and telecommunications, is one of the key factors influencing contemporary transformation processes in the security and defense spheres. Increasing digitization, automation, artificial intelligence, machine learning, robotics, the Internet of Things, and quantum technologies are not only changing the nature of the security environment but also redefining the conduct of military operations and the functioning of military institutions (T.R., Aleksandrowicz, 2016, p. 34).

Contemporary armed conflicts are increasingly taking the form of so-called new-generation wars, in which information, data, and the ability to rapidly process them play a decisive role. Information space, cyberspace, and the outer space domain are becoming equivalent to traditional battlefields—land, sea, and air. Consequently, a state's ability to ensure national security increasingly depends on the level of technological innovation and digital competence of its armed forces (W. Smolski, 2015, p. 67).

Modern technologies are also transforming organizational structures and the conduct of military operations. Network-centric concepts are being implemented, integrating reconnaissance, command, communications, and strike systems into a single, coherent information system. This type of integration enables rapid response, increases commanders' situational awareness, and allows for more precise use of force. At the same time, it necessitates the development of new forms of IT system security and critical infrastructure protection against cyberattacks (J. Wrona, 2020, p. 98).

Another important aspect of the transformation of armed forces is the growing importance of autonomous and semi-autonomous combat systems, including air, land, and sea drones. Their use in reconnaissance, logistics, and even direct combat support significantly changes existing concepts of military operations. In turn, the development of artificial intelligence technologies allows for the automation of decision-making processes, real-time data analysis, and command support, which can lead to increased operational effectiveness but also raises new ethical and legal challenges. The role of quantum technologies, 5G, cloud computing, and big data cannot be overlooked, as they create new opportunities for communication, information processing, and strategic data analysis. In the long term, these technologies could revolutionize not only the operation of armed forces but also the model of planning, training, and logistical support (T. Bąk, 2018, p. 13).

III. Breakthrough technologies and defense capabilities in the European Union

Since the beginning of the 21st century, the development of new defense technologies has not been a priority in the European Union. The civilian market has primarily been interested in implementing technological innovations. This state of affairs stemmed from an incomplete and imprecise assessment of military threats on the continent and the exploitation of the existing peace. This was also influenced by the new trend of dual-use technologies intertwining between the civilian and defense markets. Civilian technologies became the driving force of progress, and the arms industry benefited from their further military applications (J. Solarz, 2009, p. 35).

Only in the second decade did some revival occur. Thanks to the European Commission's "Preparatory Action Plan 2017-2020" (PDA 2017-20), five research projects were launched, focusing on the use of artificial intelligence in explosive detection, autonomous positioning, navigation, long-range strikes, and enhancing individual combat capability. The small scope of the projects and modest financial outlays (€7.5 million) did not raise hopes for spectacular success. Furthermore, organizational solutions in project management, based on the dominant role of start-ups and small and medium-sized enterprises, which had proven effective for many years in implementing innovations in the civilian market, failed in the case of defense technologies (P. Śledź, 2020, p. 16).

Despite this, the EU continues to strive to strengthen the European defense technological and industrial base, strengthen cooperation within the common defense market, and increase member states' involvement in new initiatives that ensure greater synergy between the civilian, defense, and space sectors, emphasizing that technologies remain the main driving force of competitiveness and innovation. The starting point for defining priorities and determining the main development directions for promising technologies is the EU's defense and security capabilities (K. Nastaj-Sałek, 2023, p. 149).

The identified technologies are the result of a detailed assessment of short-, medium-, and long-term capability gap and needs analysis. The scope of future capabilities is developed using various types of input, taking into account military capability shortfalls within the Common Security and Defense Policy, long-term capability and technology trends, Member States' defense plans, and lessons learned from ongoing missions and operations (K. Kowalczewska, 2021, p. 14).

The setting of technological development priorities is based on the Capability Development Plan (CDP), which is the main reference point for defence planning in the EU and all European defence-related initiatives, such as the Coordinated Annual Review on Defence (CARD), Permanent Structured Cooperation (PESCO), the European Defence Fund (EDF) and any future EU defence support tools (D. Barton, J. Woetzel, J. Seong, Q. Tian 2017, p. 147).

IV. The importance of drones for defense and security

Unmanned aerial systems (UAS) are currently one of the most important elements of modern armed forces and a key factor influencing national and international security. Their dynamic development in recent years has revolutionized the conduct of military operations and significantly changed the

strategy for planning and implementing military operations. Drones enable the implementation of tasks previously difficult or impossible for manned combat assets, while simultaneously minimizing the risk to soldiers' lives. As a result, they have become not only a tool for increasing the effectiveness of military operations but also a crucial element of national security policy (M. Adamski, 2015, p. 56).

The importance of drones in defense lies primarily in their ability to provide more comprehensive situational awareness on the battlefield. In an era of asymmetric, hybrid, and information-based conflicts, the ability to conduct continuous reconnaissance and monitor operational areas is crucial for making accurate strategic and tactical decisions. Drones equipped with optoelectronic cameras, infrared sensors, synthetic aperture radars (SAR), and satellite communications systems provide real-time data, enabling rapid situational assessment and threat response. In this way, they become an integral element of the command and control system (C4ISR), which underpins the functioning of modern armies (N. Świętochowski, 2018, p. 167).

At the same time, unmanned aerial systems significantly increase the precision of combat operations. The use of drones equipped with intelligent guidance systems enables precise attacks on specific targets with minimal risk of collateral damage. This allows for more selective military operations, which has not only military but also political and ethical implications. Reducing civilian casualties and limiting damage to civilian infrastructure translates into greater public acceptance of military operations, especially in the context of international operations and stabilization missions (K. Cyrkun, N. Czarnota, 2019, pp. 99-101).

Another dimension of drones' importance is their impact on the operational and logistical effectiveness of armed forces. Unmanned platforms can be used to transport supplies, evacuate the wounded, and deliver ammunition or equipment to hard-to-reach areas. In this way, they support traditional logistics and increase the mobility of units operating in the field. Transport drones, although still in the development phase, are becoming an increasingly important element of so-called future logistics, the goal of which is to quickly and flexibly respond to the dynamically changing needs of the battlefield (A. Kołodziejczyk, 2018, p. 78).

The role of drones in the strategic and deterrent spheres cannot be overlooked. Contemporary conflicts increasingly revolve around information and technology, and possessing modern unmanned systems is a measure of a state's military and technological potential. Drones can be used not only for direct combat operations but also as a tool for demonstrating power and maintaining strategic balance. In this context, developing national capabilities in the design, production, and integration of UAV systems is becoming a crucial element of defense policy and one of the pillars of technological sovereignty (D. Prokopowicz, 2023, p. 9).

In the international security sphere, drones present both new opportunities and challenges. On the one hand, they contribute to the effectiveness of peacekeeping missions, border patrols, and crisis response, but on the other, they generate the risk of escalating tensions, especially in situations where the drone is used autonomously or outside the operator's control. Their availability on the international market and increasingly lower production costs are leading to the proliferation of this technology, including among states with limited military capabilities and non-state actors. This phenomenon poses significant challenges to global security, as drones can be used for terrorist activities, sabotage of critical infrastructure, or attacks on civilian targets (N. Świętochowski, 2018, p. 154).

From the European Union's perspective, the development of drone technologies is an important element in building common defense capabilities and technological independence. The European Defence Fund (EDF) and initiatives within the Permanent Structured Cooperation (PESCO) support the development and integration of unmanned systems, both in terms of research and industrial production. Cooperation between member states in this area aims not only to increase the interoperability of armed forces but also to create a European technological ecosystem capable of competing with powers such as the United States, China, and Israel. Incorporating drones into common EU defense strategies is consistent with the pursuit of European strategic autonomy and resilience to security threats (P. Śledź, 2020, p. 11).

V. CONCLUSIONS

The contemporary world is undergoing an intense technological transformation, which increasingly determines the functioning of states, economies, and security systems. Progress in areas such as artificial intelligence, automation, cybersecurity, quantum technologies, and the development of unmanned aerial, land, and naval systems is transforming not only the face of modern armed forces but also the nature of armed conflicts themselves. Technology is becoming a key strategic resource, comparable to military or economic potential, and technological superiority increasingly determines the operational effectiveness and international standing of states. The analysis conducted in this paper suggests that the development of modern technologies is the foundation of contemporary defense and security. These changes are manifesting themselves in both organizational and operational spheres. Armed forces are adapting to new battlefield conditions, utilizing digital, information, and communication technologies to increase operational precision, shorten response times, and minimize losses. The introduction of autonomous and robotic systems, in turn, is transforming command structures and logistics and requires the development of new doctrines and operational procedures. A particular example of a technology that has had the greatest impact on military operations in recent years are drones – unmanned aerial systems. Their versatility, ability to operate in diverse environments, and relatively low operating costs make them an indispensable element of modern armed forces. Drones contribute to increased situational awareness, operational effectiveness, and the safety of military personnel. They also constitute a strategic tool, enabling the execution of high-risk

missions without directly endangering the lives of soldiers. At the same time, their development generates new challenges – from cyber threats, through legal and ethical issues, to the risk of uncontrolled spread of this technology.

Equally important is the political and industrial dimension of military technology development. In the context of the European Union, technological innovation is one of the pillars of building common defense capabilities and striving for strategic autonomy. Programs such as the European Defence Fund (EDF) and Permanent Structured Cooperation (PESCO) play a key role in integrating the industrial and technological potential of member states. These programs facilitate the creation of joint research and development projects, strengthen cooperation between the arms industry and the scientific sector, and unify technological standards within the European security system. The long-term effect of these efforts is to increase the EU's self-sufficiency in defense and enhance its resilience to external threats.

The analysis undertaken in this work confirmed the research hypothesis that modern technologies are a key factor in strengthening defense capabilities, operational effectiveness, and the resilience of security structures. Their importance is not limited to the technical aspect – it is also a political, strategic, and civilizational issue. Implementing technological innovations in the military requires the simultaneous development of human resources competencies, a legal framework, and responsible control mechanisms that ensure the safe and ethical use of technological potential. Over the coming decades, the development of military technologies will progress towards increasing automation, network-centricity, and system integration. New forms of human-machine interaction will emerge, and the boundary between civilian and military technology will become increasingly blurred. In this context, a key challenge for states and international organizations, such as the European Union, will be maintaining a balance between innovation and security, between technological progress and controlling its consequences.

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