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Dear Readers,

We would like to present you with the second edition of our scientific and technical journal "Safety & Defense". We would also like to take this opportunity to point out that it is our constant desire to expand our group of readers, authors and reviewers. Thanks to you, Safety & Defense is gaining an increasingly important position among academic journals in which it is possible to publish the latest research findings in the field of broadly understood security. In addition, thanks to our readers, this journal received 20 points in the Ministry of Science and Higher Education's assessment. This motivates us to work even harder, which in effect will allow us to a greater extent contribute to the dynamic development of Safety & Defense in this calendar year.

In this edition of Safety & Defense, we present ten peer-reviewed articles that contain interesting research results concentrating on various areas of security. The conclusions and generalizations made by the authors in particular articles often indicate new aspects of security, and the series of theses that they have adopted can constitute a basis for implementing changes that should be made in security systems. This state of affairs should not surprise anyone who is well aware of the broad context of security including its complexity and interdisciplinarity. In this field, recent academic research findings suggest the need for abandoning old schemes and stereotypes that have often lost their validity as a result of the changes that have occurred in the security environment. In this respect, it should be noted that it is difficult to implement new concepts in the place of already proven solutions. This difficulty is also the result of the fact that, in relation to innovative solutions, in order to gain widespread acceptance and approval on the part of the academic community, time for substantial discussion and polemics is necessary. It is my hope that Safety & Defense will become a platform for discussion, in which the articles published will be given reliable assessments and academic verification, which will contribute to the dynamic development of Security Studies in the near future.

In this edition, we also present a variety of topics related to the field of security. One of them is human activity in outer space analyzed in terms of threats to national security. Undoubtedly, one of the main factors *contributing* to the rise of new threats are the concepts of militarizing outer space by means of creating very modern anti-satellite systems and hypersonic weapons. Moreover, ensuring the cybersecurity of satellite and communication systems operating in outer space is also essential. Technical activities must find their legitimacy in international law. This is also a key issue in space law, because there are still several contradictions and misunderstandings found in it.

The reflections on the need for standardizing the theoretical aspects of logistics with regards to the Air Force of the Armed Forces of Ukraine, which in accordance with the postulates found in the article, should take into consideration the current armament and organizational and task spectrum of the Air Force logistics, is no less interesting. This should be grounded in general laws and established coherent patterns (standards), global trends, principles, forms and methods of its realization, which have worked well in the armed forces of other states.

Another article presents considerations concentrated on the area of military leadership with a particular emphasis placed on related activities and undertakings in the context of effective tools for shaping interpersonal relations in the army. In this matter, there is no doubt that the essence of these activities is the appropriate and thoughtful selection and preparation of leaders for the needs of the armed forces. However, this requires identifying changes in the scope of leadership, which have occurred in the armed forces of several NATO member states.

The next article found in this edition of Safety & Defense focuses on the historical aspects of the development of nuclear weapons seen by many decision makers as a guarantor of safety and maintaining strategic balance. This causes that despite the several agreements signed banning the proliferation of nuclear weapons, many of the states that possess them in their nuclear arsenals are still conducting costly modernization and development programs. Such activities should urge the international community to reflect on the global threat that nuclear weapons could generate in a hypothetical armed conflict between states that have such weapons in their possession.

The next article makes reference to the technical aspects of the development of weapons using electromagnetic energy while indicating its advantages and disadvantages. A major part of these reflections consists of presenting a new design for the electromagnetic system which has been visualized in 3D with the use of a Maxwell interactive software package.

The next article published addresses the need for educating society about issues related to security. The topics presented undoubtedly play an essential role in every state that intends to build efficient security systems.

With reference to the subsequent reflections, it should be emphasized that they present research findings that assisted in determining the degree of reliability of the unmanned aerial vehicles used by the Armed Forces of the Republic of Poland. In this respect, we can familiarize ourselves with the results of empirical tests which indicate the various factors and elements, which to a great extent have a direct impact on decreasing the reliability of the UAVs used in the army.

The contents of the next article are dominated by the issue of military law in the legal system of the Republic of Poland, and includes a comparison of Polish provisions with the provisions in force in selected NATO member states. The research activities carried out constitute a strong foundation for making efforts to substantively systematize the provisions of military law. In this respect, it seems important to note that given the key role of the armed forces in times of peace, crisis and war, a set of legal norms determining the possibility of using the armed forces is one of the key elements that impact the efficiency of the entire national security system.

This edition of Safety & Defense concludes with a very interesting reflection, in which attention is drawn to the need for developing a security system for Polish soldiers including adopting rational procedures, whose implementation will allow their protection against dangerous tropical diseases. This is particularly important with regards to soldiers participating in expeditionary operations conducted abroad in difficult climatic conditions, which differ from European conditions in many ways. For this reason, biosecurity is also an important question along with medical, sanitary, hygienic and anti-epidemic safety.

We cordially invite you to read through the current issue.

Editor in Chief

Adam Radomski



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Space as a New Category of Threats to National Security

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Abstract

The scientific considerations presented in this paper concern threats to national security arising from the activity in outer space. The objective of this analysis is to identify these dangers and to propose solutions to minimize them.

The theoretical research methods employed in this study are: synthesis, analysis, abstracting and generalization.

In the course of the analysis, several modern threats were established, including anti-satellite and hypersonic weapons. Another important sphere discussed in the paper is the cyber security of satellite/communication devices and systems operating in space. With respect to satellite systems, the EA-18G Growler electronic warfare aircraft was presented as one of the concepts developed with the capability of disrupting their operation. The results from the conducted study emphasize the need to create a Space Domain Awareness (SDA) system, which is substantiated by the indication of natural threats that must be minimized, namely space debris, space weather and the possibility of collision with Near-Earth Objects.

The presented considerations are concluded by the analysis of the legislative state regarding space security, which in reality accentuate the incompatibility of the existing laws with the emerging threats, and other issues concerning space law.

Keywords: space, threats, state security, space law

1. Introduction

Space has always remained in the scope of military interest. Technical advancements and slowly accumulated experience have gradually allowed different actors to explore it so as to achieve various benefits or even military advantage. Similar trends are commonly observed at present. Space objects constructed nowadays surpass subsequent technological barriers: they fly higher and faster than ever before. As in the case with any technology subject to such dynamic progress, this also brings an equal share of new opportunities on the one hand, and threats on the other.

This study is devoted to the issue of space threats; therefore, it sets out to identify them and attempts to present a conceptual framework for their minimization. The specific question that drives the research is whether or not space is an environment the emergence of threats in which jeopardizes state security. In an attempt to verify this hypothesis,

theoretical research methods were employed, *i.e.* synthesis, analysis, abstraction and generalization.

2. Anti-satellite weapon

Anti-satellite weapon (ASAT) is a system of missiles capable of destroying targets in space. Typically, this is a kinetic weapon, *i.e.* a solution that destroys targets by transferring large amounts of kinetic energy through the shock of impact; the amount of released energy is typically regulated by the mass of the particular object, its velocity in motion and at impact. Usually, warfare devices of this class are equipped with a special design of exploding fragmentary warheads, nuclear warheads or propellant actuated devices of a specific cone and density of fire. Since they operate in outer space to a certain length, they are equipped with gas-dynamic control systems (*Ilustrowany leksykon lotniczy. Uzbrojenie*, 1991, p. 170).

The air-launched anti-satellite multistage missile, ASM-135 ASAT, is an example of the air-to-space anti-satellite weapon. The system targeted satellites in space in a range exceeding 560 km from the carrier. It was projected to high altitude by an air platform and fired upon reaching the specified ceiling, at which point its rocket engine was initiated. At the end of the 1980s, despite positive test results, further research on this type of weapon was abandoned, the major reason for it being the implementation and development of international legal regulations related to space exploration (Dougherty, 2010, p. 17).

In the face of the growing capabilities of the United States' network of military satellites, Russian armed forces have been making substantial investments in the development of anti-satellite weapons, which in the event of war, could deprive the US and its Western partners of a critical asset. Russia's air defense forces are set to induct the S-500 Prometheus surface-to-air missile system (SAM) into service by 2020. The platform, alongside its formidable anti-aircraft and anti-missile capabilities, is also able to deploy advanced 40N6 self-homing guided missiles designed to destroy low-orbit satellites, at real altitudes of 100km. The military has also invested heavily in the development of laser-equipped satellite hunting aircraft, making use of its A-60 Airborne Laser Laboratory to develop advanced strike capabilities to target satellites from within the atmosphere. Alongside these new platforms, Russia has also carried out six flight tests of a second anti-satellite missile system, known as A-235 PL19 Nudol, with the latest tests taking place at the end of March 2018. This came shortly after the system's fifth test in December 2017, which was also successful. Nudol is designed to operate from a mobile launch platform, with test launches having been carried out from a transporter erector launcher. Mobility is key to ensuring the missile's survivability in times of war. The platform's test in March represented its fourth successful flight test, and the missile is likely to enter service in the Russian armed forces in the near future. Deployment of the system near Moscow is scheduled for late 2018.

Russia's development of anti-satellite weapons systems has been met with much apprehension in the West, with Western militaries heavily reliant on satellite capabilities to engage in power projection operations abroad. In his 2018 Worldwide Threat Assessment, US Director of National Intelligence, Dan Coats, commented on these developments: "Both Russia and China continue to pursue anti-satellite (ASAT) weapons as a means to reduce US and allied military effectiveness. Russia and China aim to have non-destructive and destructive counterspace weapons available for use during a potential future conflict... We assess that, if a future conflict were to occur involving Russia or China, either country would justify attacks against US and allied satellites as necessary to offset any perceived US military advantage derived from military, civil, or commercial space systems." Echoing director Coats' words, US Defense Intelligence Agency Director, Lt. Gen. Robert Ashley, noted that Russia was set to "continue to pursue the development

of a full range of ground, air, or space-based anti-satellite weapons as a means to reduce US military effectiveness and control the escalation of conflict if deterrence fails" (*Russia Tests New Nudol Anti Satellite Missile System; Implications for the Future of Western Power Projection*, 2018).

3. Hypersonic weapon

At present, what is understood under the term **hypersonic weapon** is any combat aerial vehicle capable of developing hypersonic or high-hypersonic velocities, which is an advantage, increasing their chance of avoiding detection and tracking by the attacked party.

Currently, five countries are developing the technology in question. The USA has already launched several programs: Lockheed Martin SR-72, Boeing X-51 Waverider, Advanced Hypersonic Weapon (AHW), Hypersonic Technology Vehicle 2, HTV-3X and Boeing X-37B. France is developing the ASN4G cruise missile. The Russian Federation has three hypersonic objects in the pipeline: Avangard, AS-19 Koala air-to-surface missile and 3M22 Zircon anti-submarine hypersonic cruise missile, whereas India two – BrahMos-II and Shaurya. The People's Republic of China is developing a hypersonic glide vehicle (HGV) DF-ZF (Bielawski, 2019, p. 53). It ought to be remembered that these projects are at various stages of development – from initial concepts to actual tested designs; the latter category is represented by e.g. a Russian HGV Avangard, which is reported to have developed hypersonic and even high-hypersonic velocities in tests.

Modern hypersonic weapons are typically included in the Prompt Global Strike (PGS) system (Advanced Hypersonic Weapon (AHW) n.d.), whose primary objective is to demonstrate the capability to target and destroy any object on the globe in under an hour, compromising the attacked party's defensive capacity. Apart from AHWs, the PGS system includes: ICBM missiles launched from the surface or submarines; hypersonic cruise missiles launched from carriers (aircraft) or submarines (e.g. Boeing X-51 Waverider or AHW); kinetic weapon launched from in-orbit platforms.

With respect to the development of the defense capabilities of the Russian Federation, its new strategic system consists of six elements, hypersonic weapons being one (Trevithick, 2018). Other weapon systems essential to Russia's new military potential are: missiles equipped with nuclear warheads; an intercontinental ballistic missile, SS-28 Sarmat; an intercontinental unmanned autonomous nuclear submarine – Canyon/Status-6; hypersonic anti-submarine missile 3M22 Zircon – engaging targets on the water surface and submerged. Finally, the last element of the system is Avangard, mentioned in the preceding paragraph, and high-energy laser (HEL), used to target: unmanned aerial systems (including swarm formations), high-altitude aircrafts, elements of satellites and electronic warfare systems.

Technology-wise, hypersonic weapons are highly advanced objects. In order to develop high velocity, they are equipped with hypersonic ramjet engines, such as the Turbine Based Combined Cycle (TBCC) propulsion system

(Walker, 2008, p. 1). In brief, this technology ensures a horizontal takeoff and landing utilizing a jet engine, which operates up to a speed of 4 Ma. Upon reaching the specified velocity, the turbine-based engine's flow channel is mechanically shut off and the ramjet/scramjet engine takes over (Gretatrix, 2012, p. 1068). When the speed falls below 4 Ma, the inlet opens and the turbine propulsion engine works until the object lands on the landing site.

Hypersonic speeds entail highly elevated temperatures. The issue is resolved by the use of high-strength, low-mass, thermally durable structural materials, such as Q-fibers (Walker, 2008, pp. 2–3). These come as cuboid plates of ultrapure amorphous silica fibers, filled with air (94% by volume). They increase the thermal strength of the objects for temperatures amounting to 1357°C (Lee, 1992, p. 114). The solution is applied on surfaces under the heaviest thermal loading, the bottom surfaces of wings and fuselage, vertical fins, the leading edges of wings and vertical fins, the nose cone and the section in the region of the main propulsion system.

Along with high speeds, the issue of immediate and precise positioning emerges. Modern satellite navigation systems, including Differential Global Positioning System (DGPS), enable locating objects with increased accuracy (Grantz, 2011, p. 4). DGPS owes its high precision of exact object position indication to the differential technique. The technique involves the use of corrections transmitted by reference stations, whose position is precisely determined and known. The said reference station of DGPS system consists of: a GPS receiver, a data processing system that determines corrections and supplies navigation data, and a correction data transmitter (El-Naggar, 2015, pp. 1127–1128).

Hypersonic missile warheads may carry a conventional, thermonuclear or nuclear payload of relatively high TNT equivalence factor. In this respect, the ASMP-A hypersonic missile carries a TN81 thermonuclear warhead with a TNT equivalence factor of 300 kt, while the payload transported by Russian Avangard is known to have an equivalent blast yield of 2 Mt.

Although hypersonic missiles are to an extent protected from attacks by the sheer velocity of flight, in order to increase their safety, anti-interference systems are employed, such as the anti-jamming protector technology. The protected object is coated with partially radio-wave absorbent paint that distracts the signal from the radiolocation station (Lardier and Barensky, 2018, p. 25). Alternatively, hypersonic missiles protection can be provided by means of plasma stealth technology. The surface of the missile is covered with a plasma cloud, *i.e.* ionized gas emitted from the apparatus located at the front part of the missile. The special properties of the plasma layer allow it to deflect or absorb the electromagnetic signal discharged from radiolocation stations (Singh, Antony and Jha, 2016, pp. 10–11). This solution is believed to significantly reduce the danger of radar recognition, thus concealing the object it camouflages (Kumar and Vadera, 2017, p. 532).

The list of protective measures must not omit an essential aspect – the cyber security of hypersonic missiles. Currently, two major types of threats are recognized, jamming and

spoofing. In response to these threats, the US Armed Forces have designed a special Selective Availability Anti-spoofing Module (SAASM). Since 2006, the GPS encryption module has been installed in all military GPS receivers. This device provides greater signal accuracy in the event of GPS interference. Furthermore, in an emergency both the American and European modules are capable of disabling civilian satellite navigation signal so that the only remaining signal is reserved for authorized users. In effect, should an armed conflict or other threat emerge, only state services and the army will have permission to access GPS based on these systems.

With respect to economic viability, hypersonic weapon designs must be developed under the cost-effectiveness constraint, *i.e.* their high operational effectiveness must ensure the best use of the resources. With a view to guaranteeing that the future hypersonic measures conform to the cost-effectiveness criterion, they ought to be developed with the following factors in mind (Chansoria, 2008, p. 202): implementation of new technologies; application of the assumptions of R&D (research and development) concept; dividends in terms of such factors as: speed, reliability, capability and operability – including downtime; ease of operation; reducing collateral damage; reducing the fear of escalation beyond the acceptable threshold level, as well as compatibility with various platforms (carriers). Additional requirements include: extended shelf life, the capability for incorporation as part of a network-centric battle, as well as the capability to engage multiple targets with salvo feature.

4. Cyber threats in space

The space environment is categorized as an electronic environment (Bielawski and Grenda, 2019, p. 15), and as such, it is susceptible to cyber threats. In particular, these are navigational and telecommunications satellite systems that are believed to be the most vulnerable objects of cyber-attacks in space. The attacks could be performed by means of jamming or spoofing, described in the preceding section of this paper.

The EA-18G Growler air platform is an interesting technical concept employing jamming and spoofing techniques against space objects. Jamming targets in space is analogous to the engagement of airborne objects with the use of an ASAT missile launched from an aircraft.

The EA-18G Growler aircraft is an important platform in electronic warfare. It is equipped with special payload – jamming pods, which, as in the case of conventional weapons, are attached to the under-wing pylons. One of the systems that may be carried by EA-18G is AN/ALQ-218, supplied by Northrop Grumman. It is a Tactical Jamming System (TJS) applicable at the beginning of the radio-electronic reconnaissance. It is, namely, responsible for detecting the enemy infrastructure and weapons – the technical devices (*e.g.* radar stations), anti-aircraft defense (*e.g.* SAM guided missiles) or command and communication stations. It guarantees preliminary verification of the correlation between the pre-anticipated Electronic Order of Battle (EOB) and the factual current

state of events. What is understood under EOB is a set of generated assumptions that require verification *e.g.* identification of signals intelligence (SIGINT) transmitters, which constitute potential destruction targets, pinpointing their geographical location or determining their range of mobility, identification of their signal source (whether emitted by telecommunication or radiolocation devices) and, if possible, determining their broader role in the organizations of enemy forces. This *modus operandi* of AN/ALQ-218 facilitates the decision-making process, inasmuch as it enables decisions that are more accurate and reduces the commanders or personnel reaction time, thus contributing to the successful completion of the mission – jamming technical devices of hostile forces. The intelligent operation system of this jamming pod provides constant updates on SIGINT transmitter data should the opponent decide to modify their tactic with respect to Electronic Order of Battle parameters.

The jammer consists of two independent groups of receivers, primary and auxiliary. The primary receiver group consists of four channelized and four cued receivers, which operate in tandem to provide immediate signal acquisition, accurate parameter measurement, immediate updates and precision geolocation, employing geolocation techniques by means of GPS tracking, or the IP address of a given device. In turn, the auxiliary receiver group provides an extended range of frequencies, substitutes the primary receiver in long-term measurements, helps in the recognition of intra-pulse modulation and updating estimates for geolocation. The AN/ALQ-218 engages a unique combination of short, medium and long baseline interferometer techniques, *i.e.* a device responsible for measuring the interference (overlap) of electromagnetic waves, with a patented passive algorithm to provide geolocation of emitters for cueing jammers and other built-in equipment such as electro-optical sensors, IR technology and on-board radar stations (Keller, 2018).

5. Space Domain Awareness

Space Domain Awareness (SDA) is a fundamental concept, essential for virtually any involvement in space-related activities (including reaction, adaptation or prevention), which is based on the knowledge of the Space Environment (SE), its current state, anticipation of its development and knowledge about the operational environment on which these activities depend, including terrestrial and space facilities (*Joint Publication 3–14. Space Operations*, 2018).

The purpose of the SDA system is to provide in-depth characteristics as required of the space situation in both the terrestrial and the space domain. The capabilities of the SDA system are subordinate to the interdisciplinary integration of data derived from multiple sources, *e.g.* space observation, data storage, handling, analysis and processing, monitoring changes in the space environment, collecting data on the capabilities of one's own and allied space systems and their assessment, evaluation of the readiness of one's own systems, foreign and international systems, analysis of space in a broad sense.

The development of Space Awareness System responds to the emergence of phenomena that can be grouped into three categories: the presence of space debris of man-made objects, *e.g.* remains of exploded or destroyed satellites, spent rocket stages or rocket nose cones orbiting the earth, which constitute a source of potential danger for future space operations and earth-bound objects (*i.e.* Space Surveillance and Tracking – SST), natural phenomena caused by solar activity or other space objects (*i.e.* Space Weather – SWE) and the possibility of earth colliding with natural space objects, such as asteroids or near-earth comets.

The rising number of in-orbit satellites along with technological advancements leading to their astounding miniaturization significantly increase the danger of collisions within the earth's orbit. Therefore, there is a clear and growing need for more extensive and detailed information on the location of all objects orbiting the earth. In addition, analysts agree that the appearance of large constellations (from several hundred to several thousand satellites) is bound to rapidly increase the risk of such events. Being fully aware of the consequences of the described developments, the United Nations also recognizes this risk and has already taken action, which resulted in the introduction of guidelines devised with the objective of maintaining sustainable long-term access to space (COPUOS). These guidelines are addressed to states and international organizations, also to promote methods and techniques for the improvement of accuracy of space objects orbiting the Earth.

Many countries have begun to recognize that space weather and related phenomena exert a great impact on societies, human life and the economy of states, and thus they should be regarded as of considerable importance to space use. To further substantiate the assumption, we may refer to an example from the UK, where in the 2011 British National Risk Register, which outlines key civil emergencies from various spheres, severe space weather phenomena were included among newly assessed risks. Furthermore, in 2015, both the UK and the USA introduced governmental space weather programs, namely, the former – Space Weather Preparedness Strategy, while the latter National Space Weather Strategy. The documents introduce action plans, which aim to promote space weather awareness with the end purpose of ensuring national readiness in the face of future space weather events. Other European countries have begun to develop their own national regulations on space weather.

Another type of threat involves Near-Earth Objects (NEO) and possible collisions of these objects with earth. The most recent spectacular and well-documented example of the NEO's entry into the earth's atmosphere took place on 15 February 2015, near Chelyabinsk, Russia. The shockwave on the impact of the meteor caused damage to the Earth's surface and wounds in approximately 1,200 people (Zuluaga and Ferrin, 2013). That event was a harsh reminder of this type of threat, which may occur with higher frequency and could bring about catastrophic effects.

The awareness of the space domain and the ability to predict events originating from and associated with it has

become increasingly urgent in recent years. Various studies show that the risks in question may generate substantial costs to ESA or EU member states, estimated at ca. EUR 2.6 billion should they not begin to counteract threats resulting from the space-weather-related phenomena alone. Secondly, the risks associated with the impacts of NEOs into the Earth's surface may involve the costs of EUR 2.23 billion (in the case of a 50-meter space object), EUR 42.8 billion in the case of a 140-meter object or even EUR 3.25 trillion in the case of an object as large as 1 km. The analyses furthermore indicate that present European observation and tracking systems (derived from individual national systems) are certainly inferior to American programs, which is why partner cooperation with the USA in this respect is yet impossible. Considering space weather, a recent study conducted in the US has indicated that power outages that may occur as a result of the Solar Storm could affect up to 66% of the US population. In monetary terms, the economic losses involved are likely to match USD 41.5 billion per day. However, considering the losses caused by disruptions in international supply chains, they could increase to an additional USD 7 billion (Chimicz, 2018, pp. 133–146).

6. Legal aspects of space security and space safety

An American lawyer, Andrew G. Haley, was the first to have postulated the need to codify space law as a set of rules transcending the existing international legal relations. He considered a "metalaw" as an alternative to the former approaches rooted in the geocentric space (cosmic) law. From the legal standpoint, the premier flight of an Earth satellite over the territories of several countries was to be carried out according to the principle of airspace sovereignty of states. The concepts of international law regulating spaceflight at that point had yet to be exhaustively defined. Although the international community was exhibiting the readiness to systematize the legal status of flights at high altitudes, these attempts were impeded by several unresolved issues, namely, the lack of a defined upper limit of airspace, the principle of innocent passage or the consent to flights of rocket propulsion devices in foreign airspace. The next step towards space law was the acceptance of the innocent passage of space objects, which, however, did not deprive states of the right to respond to an emerging threat to their own territory. What is more, the affirmation of this law was not to be understood as a case against the accepted and implemented international aviation law. The reaction of the international environment has begun to set the direction for the development of space regulations. According to the UN, the idea of differentiating space regulations and not integrating them with the law of airspace played a significant role in space legislation (Polkowska, 2011, p. 64). Since 1957, the expansion of space has begun to gain momentum, which resulted in the establishment of organizations whose activity was confined to space aspects, as in the case of the International Astronautical Federation. Regular work on the creation of space regulations began in 1958, which was when the United Nations Committee on the Peaceful Uses of Outer

Space (COPUOS) was established by the UN General Assembly. That event was the milestone in the integration and consolidation of legislative work in the context of the international space law (Polkowska, 2011, p. 67).

Another notable date for the evolution of space law was 1963 – the year when the General Assembly adopted the Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space. That resolution laid the foundation for the 1967 Outer Space Treaty. Since then, a series of legal regulations concerning the use of space have been introduced. Prior to focusing on the treaties, described below, let us consider the basic terminology associated with this area. The term is derived from English, and its semantic range encompasses numerous aspects of space flight, *i.e.* according to geographical, technical and pragmatic/functional indicators. The primary issue with respect to the geographical area is the delimitation of the border between airspace and outer space. The lack of international agreement on the issue has resulted in the emergence of three premises for the determination of the course of this border (Berezowski, 1964, p. 5). The first perspective on delimitation was closely associated with scientific and technical assumptions. The second concept assumed the demarcation of a categorical or conventional border of outer space. According to the third idea, the border was to follow from the functionality criterion. Eventually, after it had caused considerable confusion on the international arena, it was agreed that the airspace/outer space border would be set at the altitudes from approximately under one hundred to one hundred fifty kilometers above Earth. Over the course of the evolution in space technology, which has resulted in expanding our capabilities and enabled the projection of space devices at much lower altitudes, the boundary of outer space has come under modification. The terminological gap has become even more evident given the fact that the most essential documents regarding airspace and outer space, *i.e.* the 1944 Chicago Convention and the 1967 Outer Space Treaty, fail to clarify the concepts explaining the spatial spheres or the regulations that would enable their separation. The technical face of space law considered the aspects of both spacecraft, which operate as space objects and aircraft. In its current understanding, space law regulates the activity and uses of space, which are subject to international regulations, contained in five treaties prepared under the supervision of the United Nations (Polkowska, 2011, p. 71).

The intensification of space activities has brought the issue of space security to public attention. This conclusion is in a way a direct repetition of J.L. Pelton's views, for whom "space safety" is the protection of human existence and the entire space equipment and systems during a space expedition, regardless of whether the mission is manned or unmanned. This term encompasses all aspects of spaceflight, from the launch of a space object, through its on-orbit operation to the re-entry and return to Earth (Allahdadi, Rongier and Wilde, 2013, p. 5).

The wide spectrum of aspects that come into space safety required establishing specialized organs and space

agencies. One such organization is the International Association for the Advancement of Space Safety, whose goals are: to develop space safety model, to refine regulations and laws relevant for space policy and to ensure that aid provisions for space mission safety emergencies are respected and implemented. On the other hand, another important term “space security” considers the use of space systems or defense facilities and methods for protecting space infrastructure against natural or human threat. This concept additionally incorporates the aspect concerned with the defense of human existence and the terrestrial ecosystem against the dangers arising from space. Therefore, from this perspective, it was of utmost importance to prepare international regulations so as to grant permission for modern military formations to penetrate space on missions that could also include space military operations.

To this day, 72 space agencies have been established worldwide, 14 states have obtained autonomous spacecraft launch systems and 60 states have placed their satellites in the Earth's orbit (OSCAR, 2019). It should be noted that the involvement of the private sector is on constant rise; as a result, it is slowly becoming the leader in space activities (telecommunications, internet and tourist weather services).

7. Conclusions

The purpose of the scientific considerations presented here was to approach space from the viewpoint of threats that may occur or originate therein. This investigation has identified space threats and presented the conceptual framework for minimizing these types of hazards. As a result, the working hypothesis, assuming that space is an environment, the emergence of threats in which jeopardizes state security, has been confirmed.

Primary modern threats determined in the study were anti-satellite (ASAT) and hypersonic weapons. These means of combat are certain to be developed further, particularly given that they have been incorporated as important elements of modern military systems: Prompt Global Strike (PGS) and the new strategic system of the Russian Federation. These modern weapons have been shown to use ramjet/scramjet engines, light construction materials of superb mechanical and thermal strength, highly accurate positioning systems as well as anti-jamming and anti-spoofing systems against radar recognition.

Cyber threat is another danger of concern to objects located in space. The solution that could ensure safety in face of cyber-attacks is the EA-18G Growler aircraft, equipped with an AN/ALQ-218 jamming pod. Since it is capable of reaching high ceiling altitudes, it could serve as a defense measure against enemy interference or engage enemy satellites by means of jamming and spoofing systems.

In order to counter the mounting natural hazards in space such as: space debris, space weather and collisions with Near-Earth Objects (asteroids, comets), there is a substantiated need to develop and implement a space domain awareness program. While various examples were given to support

this claim, it is the economic aspect – the outlays to be incurred in the event of natural hazards – that emphasizes the urgent need for these problems to be addressed.

Despite several attempts having been taken to codify space law since 1957, the process is riddled with problems. To this day, for instance, the border between airspace and outer space has not been pinpointed. Furthermore, the dynamic development of space technologies implies the demand for an adaptation of international laws to modern reality – the militarization of space and the rise of the private sector in space environment. Therefore, the legal aspects relating to threats will be developed in further studies.

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Nuclear weapons in an international security environment

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Abstract

Nuclear weapons are a historically acknowledged factor of security development and maintenance of the strategical balance. Therefore, in spite of programs preventing its proliferation, most states having such weapons modernize and develop their nuclear arsenals, perceiving it as a sign of power and a guarantee of security. The methodology employed in this article critical analysis and synthesis of reliable sources from the scope of the area of research. The nature of the article is explanatory with elements of inference. This paper presents an evaluation of circumstances inducing a state to possess nuclear weapons, in consideration of both the positive and negative consequences of their possession. In the author's view, studying this article should at least evoke a reflection on the development of nuclear weapons as a means of forming modern relations of security.

Keywords: nuclear weapons, legal restrictions of nuclear weapon use, modernization of the nuclear arsenal

1. Introduction

Although 70 years have passed since the first use of nuclear weapons, irrespective of the tragic consequences of this occurrence, they continue to play an important role in global politics. Moreover, there is a large group of states aspiring to possess them. North Korea – an insignificant totalitarian regime until quite recently – has become a political entity remaining in the center of attention of world powers: the United States, the Russian Federation, China, Japan and South Korea, because of its possession of a nuclear weapon. Although this state does not have much to offer, it drives a hard bargain. Its only expectations concern the price that the world is ready to pay for its denuclearization. The expectations are high. North Korea expects the lifting of political and economic sanctions and, consequently, the coverage of all costs of social and political-economic transformation of the state. In the hands of North Korea's leader, the nuclear weapon is the only bargaining tool, but a very strong one.

It is a kind of "trump card" about which partners may not know everything, but with which they have to reckon. Is it not an enticing prospect for other quarrelsome states? Iran perceives nuclear technology issues in a similar way, presenting a new attitude in this matter [1,2]. Today nobody doubts the fact that the possession of a nuclear weapon is a guarantee of security. It does not matter whether these guarantees may sometimes be "fragile". Here I will refer to the denuclearization of Ukraine. For the return of nuclear arsenals developed in the territory of Ukraine to the Russian Federation, the Budapest Memorandum having the force of a treaty was signed. It was supposed to guarantee the sovereignty and territorial integrity of Ukraine. It is worth noticing that in 2014, after its annexation of the Crimea, Russia refused consultation in this matter, and the signatories to the treaty did not show the determination expected by the Ukrainian party in spite of appeals by the Ukrainian Parliament. Thus, we can ask a question: what has been left of international guarantees?

Sadly, not much; the only available option is to make diplomatic attempts, but do they matter at all in the face of a real threat of using nuclear weapons being at the disposal of the endangered state? It is difficult to estimate what actions Russia would dare to undertake against Ukraine if it realized that its neighbor has a nuclear potential and is also driven to despair with the existing threat to its sovereignty. Only political speculations remain – there are no other examples indicating the conditions of possession and voluntary disposal of nuclear weapons and the impact of this act on further policy. However, the cases of North Korea and Iran are different from the situation of Ukraine, so there is no basis for considering them jointly.

The aim of this work is to analyze political and military relations with regard to nuclear weapons. In the course of studying materials, the author observed already at the beginning of the analysis that nuclear weapons have been an essential element of adopted policy, a component of military doctrines and strategies and, most of all, a strategic element of deterrence. Therefore, the natural consequence of the author's reflections was the adoption of selected research issues, including:

- 1) What is the place and role of nuclear weapons in doctrines of “nuclear” states?
- 2) How are nuclear weapons perceived in NATO's strategic conceptions?
- 3) What are international legal restrictions with regard to the use of nuclear weapons?
- 4) What nuclear weapon powers and devices are at the disposal of NATO states?
- 5) What role do nuclear weapons play in the doctrine of the Russian Federation?
- 6) Why do nuclear weapons remain so “attractive” that various states conduct research on their construction and development?

2. Nuclear policy in relations of international security

At the NATO summit in Prague in 2009, the President of the United States of America made this significant statement: “...we will reduce the role of nuclear weapons in our national security strategy, and urge others to do the same” (Zarychta S., 2016) [3]. The aim of these words was to suggest that the period of the perception of security in terms of possession of nuclear weapons was coming to an end. As one could assume, the world without nuclear weapons is a world free of all kinds of dangers arising from their very existence. When making this historical declaration, President Barack Obama may have had doubts about its likelihood himself, adding immediately that the implementation of this vision might take a few decades, but it is feasible. Unfortunately, this vision was an illusion – or maybe only a PR trick of the newly elected president aspiring for a Peace Nobel Prize?

The most important actors having nuclear weapons – mainly the Russian Federation, to which this statement primarily referred – treated it as an act of political naivety used against the new president as well as the United States. Ten

years have passed, and little has changed in the nuclear policy of NATO, the United States and the Russian Federation. As during the Cold War period, it is again used as a political deterrent and for the reinforcement of diplomatic efforts in international relations. Is a new arms race beginning to form? Probably yes – at least many military analysts think so. This is confirmed by the unilateral suspension of the INF treaty by the United States since February 2nd, 2019; as a consequence, Russia did the same. This means the beginning of the end of the treaty establishing the international control of the proliferation of nuclear weapons deployed on intermediate-range ballistic missiles (500–5,500 km) in Europe [4].

In his address to both houses of the Russian parliament in January 2018, Vladimir Putin used the words that leave no doubt any more: “Russia has started an active phase of testing a new intercontinental Sarmat ballistic rocket [5]. The new missile is to replace Voivode – currently the most powerful Russian intercontinental ballistic missile.” Putin stated that Russia would take further steps in response to the growth of the American anti-rocket defense system. This did not escape the attention of NATO's leaders. At his meeting with the President of Poland Andrzej Duda, Jens Stoltenberg stated that Russia is ready and wants to use force to change borders within Europe. In the arms race that has already started, Russia seems to be winning. In response to any kind of presence – even a symbolic one – of NATO forces in Baltic states and Central & Eastern Europe, Russia builds strike forces close to the external borders of the Alliance. In spite of the apparent political dialogue (John Kerry's talks with Sergei Lavrov and Vladimir Putin), security relations have not been so tense since the mid-1980s. In the military rhetoric of the Russian Federation, the NATO states and the United States have become a “very probable opponent”. It seemed that after the Cuban crisis in 1962, when the real threat of a nuclear conflict existed, the world came to its senses and that ‘nuclear states are not at war with one another’. Did that really happen? No. The nuclear threat is still very real. Having joined a group of states with a nuclear potential, North Korea does not intend to resign from exposing its power due to the possession of nuclear weapons. As the leader of North Korea, Kim Dzong Un, has recently remarked that his state will use nuclear weapons against the United States (or any other enemy) only for the defense of its own territory [6]. Thus, contrary to what President Obama envisaged a few years ago, the world without nuclear weapons does not exist.

An assumption was made that the security environment in Europe and around the world underwent serious modification after the end of World War II, becoming divided into two opposite political-military blocs that used their nuclear potential for deterrence and for exerting a political impact on each other. As a consequence of this, nuclear weapons began to be perceived as an effective guarantee of security. The weapons that additionally increase the importance of a state on the international arena constitute a sort of insurance policy in case of an higher threat, particularly for states with an average or small military potential. This is how North Korea treats nuclear weapons (‘others have to reckon with me while

I have them'). Therefore, there is still little progress in nuclear disarmament issues. Apart from the failure to "stop" the process itself, we can also observe the expansion of nuclear potentials, particularly in Asian states. For this reason, the remaining challenge is to suppress the proliferation of mass destruction weapons and nuclear terrorism and to guide the nuclear deterrence strategy towards challenges and threats, including asymmetric and hybrid actions.

3. Legal conditions of the use of nuclear weapons

As has already been noticed, nuclear weapons are a guarantee of security; and, on the one hand, an indicator of the position of a state on the international arena, while on the other hand, a serious threat to security. How can we reconcile these confrontational theses? What is bigger: the threat, or the sense of security? The world came to know the consequences of the use of nuclear weapons after the United States had launched attacks on two Japanese cities: Hiroshima and Nagasaki in 1945. These accidents did not stop the nuclearization of the world; just the opposite, they stimulated this process, leading to a global arms race in this field. This is reflected by the number of states in possession of nuclear weapons; there are also many states whose ambition or even dream is to have their own nuclear weapons. The nuclear non-proliferation policy proves ineffective, too. North Korea has acquired such weapons in the eyes of the global public opinion, thereby permanently destabilizing the strategic situation in the Far East region. In the light of international law, the activity of states in the field of nuclear weapons should mainly consist in:

- maintaining the permanent supervision of the nuclear arsenal being kept, without the right to transfer weapons or devices used for their production;
- monitoring nuclear policy, e.g., by restricting attempts of non-nuclear states to acquire nuclear weapons;
- undertaking negotiations with a view to limiting the nuclear arms race until total disarmament under international control;
- producing nuclear energy only for peace purposes.

The proliferation of nuclear weapons is theoretically favored by the existing international legal state. There are no legal limitations imposed on the research, development or modernization of nuclear warheads being held. In general, the nuclear non-proliferation treaty divides states into two groups: nuclear and non-nuclear states. This allows policy-makers to employ the idea that there is a certain group of privileged states – "nuclear" states – that possess nuclear weapons lawfully and the remaining states that do not have such weapons. Is it the right distinction? No – it would be more appropriate to divide states according to their technological capacities. Otherwise, according to the aforementioned treaty, only the USA, Russia, Great Britain, France and China would be lawful nuclear powers. States like India, Pakistan or Israel would not be among them, because they are not a party to the adopted Treaty; the same goes for states such as North Korea (which withdrew in 2003) and South Africa,

which acceded to the treaty in 1992 and destroyed its nuclear arsenals (Bryła J., 2006). Nuclearly subthreshold countries, if such a term can be used, include the states standing at the border of nuclear technologies opening the road to their production. These states include Argentina, Australia, Belgium, Brazil, Germany, Italy, Japan, Netherlands, New Zealand, Sweden, Switzerland, Taiwan, and many other states, such as Algeria or South Korea.

In the course of further reflections on the legality of possession of nuclear weapons, it would be possible to conclude that since the aforementioned states hold their nuclear weapons lawfully, why would they not be entitled to use them in certain situations? This type of rhetoric is used, for example, in the defensive doctrine of the Russian Federation, which reserves the right to use nuclear weapons in the case of a threat to its national interests. This gives rise to the question: what circumstances could allow the Russian Federation to use nuclear weapons? There is an ongoing dispute in this field on the basis of doctrines of international law. This issue is settled to a certain extent by an opinion issued by the International Court of Justice (ICJ) [7] in 1996 in connection with a question asked by the General Assembly of the United Nations: Is the threat or use of nuclear weapons in any circumstance permitted under international law? The ICJ replied that there was no clear prohibition or norm in international law that would allow or strictly ban the use of nuclear weapons or a threat of such use. Opposite views on that subject were presented, for example, by Professor Remigiusz Bierzanek, who argued that since the possibilities of using suffocating or similar gases are forbidden, this very fact is a sufficient basis for assuming that it would be unreasonable to think that each new weapon will be prohibited only when a special convention is concluded (Bierzanek R., 1982). This matter had also been examined by the United Nations General Assembly, which even adopted the relevant resolution 1653/XVI questioning the legality of the use of nuclear weapons in 1961. However, it was not adopted unanimously. The main nuclear states, such as France, Great Britain and the United States, voted against it (Góralczyk W. Sawicki S., 2009). This gave rise to the legal situation of substantive indeterminacy. Thus, it is assumed that, in the light of the ICJ's opinion, every use of nuclear weapons, or only a threat of using them, will be prohibited if the following rules are violated:

- 1) the principle of humanitarianism resulting from the 4th Hague Convention of 1907 – it must be followed by all fighting parties under the law;
- 2) combating only against the enemy's armed forces so that the effects of the use of nuclear weapons would not be harmful to civilians;
- 3) the complete prohibition to attack undefended or non-military objects; this is required under Article 27 of the Hague Convention imposing the obligation to save, as far as possible, temples, hospitals, schools, etc., which is difficult when nuclear weapons are used (Journal of Laws, 1927);
- 4) using combat measures causing the excessive suffering of population is not allowed, and the use of nuclear weapons certainly leads to such consequences;

- 5) the consequences of the war must not affect neutral states, and nuclear weapons do not guarantee that the consequences of their use will not affect states that are not engaged in the conflict;
- 6) the principle of proportionality that applies in the decision-making process, including the choice of objects in compliance with the principle “human cost – military effect”;
- 7) the obligation to refrain from the use of threat or force against the territorial whole or independence of any state (Journal of Laws, 1947.23.90).

The first six principles were derived directly from the international humanitarian law of armed conflicts, which means that they apply to all parties to the conflict. Nevertheless, there may be a factual state that will “justify”, or rather constitute an extraordinary circumstance, e.g., a threat to the existence of the state concerned that will force them by means of circumstances to exercise the right to self-defense using all available means, theoretically going “as far as” the use of nuclear weapons. It is worth adding that the right to self-defense arises directly from Article 51 of the Charter of the United Nations, which applies both to individual and collective self-defense. This provision allows or rather enables the defense of a state not having nuclear weapons by states that have such weapons. These are the premises on which NATO’s nuclear policy is based.

4. Nuclear weapons vs. the sense of collective security

Nuclear weapons have exerted a huge impact on the character of international relations. Firstly, they brought World War II in Asia to an end; secondly, they guaranteed security to Western European states during the Cold War period. This is why so many states have attempted to possess them, perceiving their arsenal as a cheap military means – cheaper than the expansion of conventional forces, to obtain a comparable level of deterrence and the potential consequences of destruction.

During World War II, both Nazi Germany and the United States did intensive research on the construction of a nuclear bomb. There was a peculiar race against time that led the United States to construct the world’s first nuclear bomb under the Manhattan program. It was successfully tested on July 16th, 1945, but used against Japan shortly afterwards on August 6th, when Hiroshima was bombed; three days later, on August 9th, the same happened to Nagasaki. One can wonder whether two attacks were necessary, whether these attacks had a military character, or rather they were a political demonstration of power aimed at intimidating the Soviet Union. We can also speculate what would have happened if the Germans had been the first to build a nuclear weapon? Obviously, we can assume with a high degree of likelihood that they would have used this weapon against the allies or the USSR in the last phase of the war. The only open question would be the choice of attack targets that would produce a comparable or certainly even bigger shock that would force the allies to negotiate.

The nuclear bombs dropped on Japanese cities confirmed their destructive power. Thus, they became an object of desire, which triggered a series of nuclear programs in various states. The most advanced party in this race was the Soviet Union, which carried out the first successful nuclear test in 1949. In this way, it became the second nuclear state in the world. The “nuclear states’ club” was joined by Great Britain in 1952 and by France in 1960. In 1964, China joined this group. In the course of further work on the development of nuclear weapons, a thermonuclear (hydrogen) weapon was designed in 1952; subsequently, a neutron weapon was constructed in 1962. Thus, the nuclear industry started in full swing. Attempts were made to reduce the weight and dimension of nuclear bombs so that they could be carried by strategic bomber aircraft. Intensive work was conducted to miniaturize nuclear warheads so that they could be mounted in ballistic missiles, mines and crumps. This process was never stopped.

5. NATO’s nuclear policy

The arms race that started in the 1960s was one of the main elements of the Cold War. Armament programs were developed with a view to the production of intercontinental missiles, land-based and marine-based ballistic missiles and tactical missiles. Also, the deployment of American tactical nuclear weapons in Europe started. These actions were aimed at the potential use of nuclear weapons during a subsequent global conflict, if any. Nuclear weapons were also supposed to improve the security of the United States and NATO’s allied countries.

The huge destructive power of nuclear weapons and the rapid development of war technology led to changes in the military strategy, tactics and organization of forces. Views of the character of the future war changed essentially, too. It is, however, worth noticing that the growing popularity of nuclear weapons did not suppress the role of land troops and conventional weapons. There were opinions that nuclear weapons themselves might not decide the course of war themselves. At the end of the day, it was assumed that conventional armed forces were necessary to vanquish the enemy completely and to gain control of its territory. Therefore, nuclear weapons were perceived only in combination with the use of conventional forces (air, marine and land forces).

In the 1960s, the “balance of fear” arose between the USA and the USSR, based on the balanced nuclear potential, which meant that nuclear weapons became the main means of deterrence. The negative consequence of this balance was the continuous arms race, which led to the development of new forces and means within the scope of new strategic conceptions being introduced. Obviously, nuclear weapons and means of carrying them played a fundamental role. This was reflected by the formulation of the deterrence strategy, which was based on simple principles that made it necessary to create an appropriate nuclear arsenal that would be equal to or preferably stronger than the enemy’s potential. The nuclear arsenal of a state did not only reinforce

its position as a superpower on the international arena and create a security policy, but could also destroy the enemy with its nuclear strength. During that period, military strategists realized that the advantage in having nuclear weapons was slowly losing its importance and that the United States' advantage in this respect and in the maintenance of international security would decrease because the USSR slowly but effectively balanced its potential with the USA's nuclear potential. Nuclear weapons were believed to be a necessary element of levelling the advantage of the Warsaw Pact in conventional armed forces and types of armament.

The 1970s brought a temporary detente in relations between the USA and the USSR, which resulted in an attempt to build means of trust aimed at creating an effective international security system. In 1968, the Nuclear Non-Proliferation Treaty (NPT) was signed, being a milestone in building mutual trust and obliging signatory states to refrain from transferring nuclear weapons and from helping other states to obtain them. In the subsequent years, bilateral talks were continued, resulting in the conclusion of important international treaties concerning the control, restriction and reduction of strategic armaments. The Conference on Security and Co-operation in Europe in 1973 and the adoption of the Helsinki Final Act on August 1st, 1975 were the signs of this detente.

As a result of the disintegration of the bipolar system, the likelihood of a large-scale military conflict with the use of nuclear weapons decreased considerably at the beginning of the 1990s. However, the states did not resign from the expansion of their nuclear arsenals. After the end of the Cold War, the role of nuclear weapons as a means of deterrence ceased to match the new reality. Previously, both the United States and the USSR had treated nuclear weapons as a special opportunity to gain global dominance. The United States also perceived nuclear weapons as a counterbalance for Soviet conventional forces deployed in Eastern European countries and as a means of suppressing its expansionist plans. Over many years, the security and war strategy of Western states was based mainly on the deterring role of nuclear weapons and the possibility of using them. However, it was assumed that every attempt to use nuclear weapons would immediately result in retaliatory action. It would lead to a total unlimited long-term nuclear war that, apart from terrible destructions on both sides of the conflict, would bring annihilation to millions of lives. Of course, there was a question who would win this war? The winner's losses in the nuclear war might prove so huge that the benefits of this victory would be questionable. It was asked whether the use of nuclear weapons was the only means of achieving the goal, because none of the goals of the war seemed important enough to risk the destruction of the population and the ruin of one's own country.

6. Resources and modernization of nuclear weapons

The countries that have nuclear weapons are intensively modernizing their arsenals. In the current geopolitical reality, it is difficult to imagine the possibility of their reduction. In

other words, the vision of the world without nuclear weapons is practically vanishing. The success of the 1990s – the time of successful implementation of disarmament programs of the United States and Russia that led to the reduction of the number of strategic warheads (Start I and II) and the tactical reduction of nuclear weapons in Europe – is unlikely to occur again. These actions encompassed also French and British nuclear potentials. After the collapse of the Soviet Union, Ukraine, Belarus and Kazakhstan voluntarily resigned from the possession of nuclear weapons. South Africa's nuclear program came to an end, too, and the nuclear potential was liquidated.

We can assume that the successful disarmament gave a significant impulse to American and Russian leaders to formulate political declarations on the possibility of withdrawing nuclear weapons completely as a thing of the past – a sort of relic left after the Cold War period that did not match the contemporary geopolitical reality. Successful disarmaments took place in Europe. On the other hand, a nuclear arms race began in the Far East in 1998. In 2003, North Korea withdrew from the nuclear non-proliferation treaty. At the same time, Iran continued its work on nuclear weapons, too. This made it difficult to work on global disarmament. The United States was not blameless, either – in 2001, it unilaterally withdrew from the treaty on the limitation of antiballistic systems. During this politically difficult time, a vision of the world without nuclear weapons appeared. It was presented by Barack Obama first in Berlin in July 2008, and then in Prague in April 2009 during the celebration of the 60th anniversary of NATO. It is estimated that these plans were one of the main reasons for which Barack Obama, already as President of the USA, received a Peace Nobel Prize. This changed his negotiating position and helped finalize talks concerning the New Start treaty concluded with Russia in Prague in April 2010. The treaty limited the number of strategic nuclear warheads to 1,550 on each side. That was generally the end of successful disarmament actions. The negotiations concerning the reduction of tactical missiles were not even undertaken. The main reason was the lack of interest on the part of Russia. In spite of Russia's reserved reaction to further nuclear disarmament, the United States independently withdrew Tomahawk missiles armed with nuclear warheads from service, thus depriving its navy of tactical nuclear weapons. The President of the United States unilaterally announced the further reduction of the number of strategic warheads to 1,000–1,100 by 2023. These plans were confirmed in the Nuclear Weapons Employment Strategy prepared in 2013. What has been left of it? Not much. All states having nuclear weapons at their disposal invest in their modernization and the modernization of means of their delivery. None of the nuclear powers, excluding the United States, is announcing the reduction of these weapons.

The advanced plans of the expansion of the United States' nuclear potential encompass the air force in the first place. A new LRS-B (Long Range Strategic Bomber) is going to be put into service around 2024; in further years, it will successively replace B-52H and B-1B models. Altogether, the

introduction of around 80–100 aircrafts is planned [8]. The new machines can optionally be unmanned. This may stir a discussion on the possibility of arming unmanned aircraft with nuclear weapons. The Americans are also conducting studies on a new category of ballistic missiles. The new missiles would enter into service in stationary and mobile versions (intended, among others, for submarines) at the end of the third decade. The plans include also the expansion of ballistic missile defense, because the existing system is not capable of resisting an all-out nuclear attack, which the American government openly admits.

The United States' nuclear disarmament policy is confronted with growing nuclear weapon expenses in China and, primarily, the Russian Federation, whose armament budget is approaching 14% of the GNP. In this situation, the USA is not likely to make another disarmament step. According to the arrangements of the New Start treaty, the United States will reduce its potential to the assumed level of 1,550 warheads by 2018. The experts say that, as a consequence of this, the United States has lost their advantage in the number of strategic nuclear warheads being held for the first time in many years. Russia's arsenal has been a few times bigger than the American one for a long time. The American arsenal consists mainly of B-61 nuclear aircraft missiles modernized to the standard of a precision missile. Thus, the United States focuses on quality rather than quantity. Fifth-generation combat aircrafts (F-35) designed with the use of stealth technology are being prepared for the role of carrier vehicles; it is assumed that they would be ready to carry out nuclear strikes around 2024. The modernized B-61 missiles will also probably be made available to the European members of NATO under the Nuclear Sharing program.

Intensive armaments are also carried on by the Russian Federation, which plans to restore the production of Tu-160 strategic bombers in a new version; it has also started work on a new PAK-DA bomber that will be equipped with cruise missiles with hypersonic propulsion. The modernization of missile forces is in progress. New RS-24 Jars and RS-26 Rubezh systems are being entered into service. At the same time, work is continued on a new heavy RS-28 Sarmat missile weighing over 100 tons [12]. The new missile that will enter into service in the third decade of the 21st century will be capable of carrying up to 15 warheads and flying over the South Pole, thus making it possible to attack the USA from the direction at which it does not have elaborate missile defense systems at its disposal. After 2030, the Russian Navy is planning to enter into service fifth-generation submarines armed with RSM-26 Bulava missiles (the marine version of Topol-M missiles).

Russia does not neglect tactical nuclear weapons, either. It does not even hesitate to violate the INF Treaty of 1987 on the Elimination of Intermediate-Range and Shorter-Range Missiles [9]. Russia does this by deploying Kalibr-NK cruise missiles in the Kaliningrad region and the Caspian Sea region with a reach exceeding even 2,500 km and Iskander-K missiles with a R-500 cruise missile with a range of around 2,000 km. Apart from Kalibr-NK missiles capable of carrying

nuclear weapons that were used during the Syrian War, the Russian Navy is also working on P-900 Alfa anti-ship missiles. The container version of these missiles that can be deployed, e.g., on civil ships is being tested. If these plans are confirmed, that would be a real curiosity. At that moment, it seems that we should begin to wonder whether Russian tactical nuclear weapons are merely a scarecrow or a real threat to NATO?

Similar plans are being made by the People's Republic of China, which has the world's third nuclear arsenal at its disposal. The only difference is that the modernization of China's nuclear potential is conducted in a more secret way. The most important Chinese development program is DF-41 ballistic missiles with a range of around 15,000 km. They are armed with a thermonuclear warhead with a power of 1 Mt or up to 10 MIRV (Multiple Independently Targetable Reentry Vehicle) warheads, or independently targetable warheads with an adjustable explosion power ranging from 20 to 250 kt. The Chinese air force plans to enter into service a new-generation Xian H-20 strategic bomber around 2025. According to unconfirmed available information, it can be an equivalent of the American B-2 vehicle. The navy is also being modernized; in the next few years, it plans to introduce second-generation ballistic missiles with a range up to 8,000 km capable of carrying a single nuclear warhead or 3-4 MIRV warheads. New submarines to be introduced will be equipped with eight missiles of this kind. China is also working on new-generation missiles for land troops. They are to be characterized by lower radar cross-section and a range of up to 4,000 km.

Table 1. Nuclear potential of various states around the world (as on July 2017)

No.	State	First test	Deployed warheads*	Other warheads**	Total
1.	USA	1945	1800	5000	6800
2.	Russian Federation	1949	1950	5050	7000
3.	United Kingdom	1952	120	95	215
4.	France	1960	280	20	300
5.	China	1964		270	270
6.	India	1974		120–130	120–130
7.	Pakistan	1998		130–140	130–140
8.	Israel			80	80
9.	North Korea	2006		10–20	10–20
Total			4150	10785	14935

* Deployed warheads are those mounted on missiles or located in bases of operational forces.

** Other warheads are those being stored, withdrawn or awaiting disassembly.

Source: own work based on SIPRI Fact Sheet, *Trends in world nuclear forces, 2017* [13].

In a group of states having nuclear capacities, it is worth focusing on North Korea, which is working very intensively on intermediate-range and long-range ballistic missiles. The technology of construction of intermediate-range ballistic missile is probably based on missiles using the Soviet technology of the 1960s that are capable of hitting targets at a distance of up to 4,000 km.

According to the propaganda of Kim Dzong Un's regime, this country already has the missiles capable of hitting targets in the USA. This does not seem very probable, at least for the time being, but after the successful tests of Hawasong 15 missiles in 2017, this vision may soon prove quite real [10]. Can further nuclear powers arise? If North Korea can, others can do the same, too. Therefore, we can assume with full certainty that the group of nine existing nuclear powers will soon increase.

In 2015, the international community managed to conclude a nuclear treaty with Iran, which agreed to suspend its nuclear weapon construction program in return for the annulment of sanctions. For the time being, we do not see any other countries that would intend to develop nuclear technology at all costs. It must be noticed, however, that this is a consequence of political actions rather than technological barriers. For many countries, such as Germany, Japan, South Korea or Australia, building their own nuclear bomb is a question of maybe a few months, should they desire to have one. Therefore, the illusion of the world without nuclear weapons still remains an illusion (Nuclear forces – table).

7. Polish nuclear experiences

Poland has never pursued any deliberate independent nuclear policy. Our interest in nuclear weapons was a consequence of international alliances. In the second part of the 1950s, the Soviet Union made the results of ongoing nuclear research available to Poland. At a scientific conference held in the Academy of the General Staff of the Polish Armed Forces in November 1954, the commanding staff of the armed forces, including the military air force, was informed about plans to equip NATO's air force with nuclear weapons, which seemed to require the air force of the Warsaw Pact to have such weapons, too. This is how our national experience with nuclear weapons began. The need to adapt military aircraft to the possibility of equipping them with nuclear weapons resulted in a change of requirements for bomber aircraft, indicating that their adaptation to the role of "nuclear weapon carriers" will require the capacity to operate at a height of over 12,000 m and that they should have the biggest possible range and the capacity to operate in weather conditions of any kind. Therefore, new aircraft designs were necessary.

The first aircraft of the Polish military air force with a capacity to carry a nuclear bomb was Ilyushin Il-28 – a subsonic turbojet-powered bomber delivered to Poland in 1952. This aircraft, along with MiG-15 turbojet-powered fighters delivered at the same time, can be regarded as "the first major technical revolution". It is worth adding that Il-28 was quite a modern bomber at that time – it could take a bomb weighing

between 1,000 kg and 3,000 kg (with a limited quantity of carried fuel). The most important combat load for this aircraft was nuclear bombs, commonly called special bombs. A typical nuclear bomb for this aircraft was a RDS-4 Tatyana bomb with a power of 30 kt and a weight of 1,200 kg (Suvorov W., 2013).

Tatyana was a standard special bomb of the Soviet air force. In the 1950s, it was produced in a quantity of maximum 20 pcs per annum. This bomb was suspended on a special reinforcement beam in the bomb bay in the fuselage of the Il-28 aircraft. The bomb was dropped from a horizontal flight. Bomb drop training was conducted using the IAB-3000 (Imitacjonnaja Awiacjonnaja Bomba) imitation device, which could be used for training ground handling personnel and flying personnel. The explosion of the imitation device perfectly resembled the explosion of a nuclear bomb, imitating also a kind of "nuclear mushroom cloud". The tactic of nuclear bomb drop training was interesting. As Jakub Marszałkiewicz indicates, the Soviet tactic of using Il-28 bombers was implemented in theory for the Polish air force, too (Marszałkiewicz J., 2016). The special bomb carrier was protected by an Il-28 aircraft squadron force, mainly for the purpose of hiding it in a group of aircraft, and by a force of 4–6 electronic warfare aircraft and, as far as possible, also by fighter cover aircraft.

Altogether, a combat formation flew over its own territory at a height of 10,000 m, mainly due to the lower consumption of fuel. The flight profile provided above was still maintained over the territory of Poland, up to the borders of detection of the enemy's advanced radar stations. At this border, the formation "went" downwards, theoretically under the zone of detection of NATO radar stations, performing masking manoeuvres – primarily the repeated separation of the striking group and the departure of a part of the force in the eastern direction. This would suggest a change of plans, i.e., the "pacification" of the enemy's air defense. Similar manoeuvres were used for crossing the borders of development of the enemy's air defense means, mainly Nike Hercules and Hawk missiles. After crossing the air defense borders, the carrier aircraft, using a profile flight below 1,000 m, approached the target; in the final stretch, it rapidly gained height, adjusted navigation and bombing data and dropped the special bomb.

After the drop, the aircraft returned and, lowering its flight, flew away from the bombing place. In order to increase the range of impact, "refueling" airports were created in Poland and East Germany. The theoretical use of these airports was to ensure a broader range of combat impact up to the borders of the English Channel. However, the chances of crews' return after completing a special mission were slight. Therefore, the selection of personnel for these tasks was very careful; preferred candidates were single officers who did not have a family abroad and, primarily, ideologically committed persons – fervent party members. In subsequent years, along with deliveries of successive new aircraft, the training system with special bomb imitation devices (IAB-500) covered a majority of air regiment personnel who systematically performed special drops at Polish and Soviet firing grounds.

In the 1960s, the Air Force Institute of Technology in Warsaw designed a Polish nuclear bomb imitation device

in co-operation with domestic research centers, particularly with the Military Institute of Engineering Technology from Wrocław. The body of the imitation device was made of epoxide laminate, whereas the detonation load was made of 200 kg of TNT and 500 kg of soot. Like the Tatiana special bomb, the imitation device was suspended in the bomb bay of the Il-28 aircraft. The first exercise drops from an Il-28 aircraft were performed in the Bay of Puck. Grzegorz Skowroński indicates that on the day of these tests, in spite of maintaining full secrecy, the beaches were filled with crowds of curious people who somehow gained knowledge about the drop of a “nuclear bomb”. Interestingly, there were no protests – nobody was afraid of destructive agents. The only intriguing fact was how quickly the news about one of the biggest military secrets of that time reached society (Skowroński G., 2004). It is also worth stressing that all successive models of modern combat aircraft were adapted to the carriage of nuclear weapons. This referred to MiG-21, Su-7, Su-20, Su-22, MiG-23, Su-22 and theoretically MiG-29 aircraft. The Russians tried to persuade Poles into buying intermediate-range bombers – Tu-16 Tupolev vehicles, but these purchases never materialized due to the costs of purchase and future operation. In the 1960s, R-70 and R-300 tactical and operational missiles adapted to the carriage of nuclear weapons were purchased.

In Soviet bases located in Poland, at least 300 special bombs and missiles with nuclear warheads were kept until the 1990s. These weapons were withdrawn in 1989, at the stage of the Round Table negotiations. The problems of storage of nuclear weapons in Poland are described in various sources – among others, by Tadeusz Szulc (Szulc T., Nicpoń K., 2007). In the Cold War period, according to the strategy of the Warsaw Pact, nuclear weapons were used mainly as a means of fire impact for fighting against mobile targets, primarily march columns of armored troops and enemy forces in the grouping areas, as well as command posts, communication centers, airports, landing grounds, etc. The primary target of a nuclear air attack was to be a tank battalion column (losses of 60–70%, i.e., 2/3 of existing forces). For the destruction of such a target, the use of a bomb with a power of around 50 kt was planned. Nuclear weapons served also as a means of increasing the pace of operation. The use of nuclear weapons theoretically allowed troops to develop an offensive operation, for example in the north-coastal direction, to a depth of 500–600 km, in a stretch of 200–250 km, while maintaining the offensive pace of 60–80 km per day. The spatial breadth and pace of the operation performed with the use of classic warfare agents was twice as small.

Currently, the Polish Armed Forces do not pursue an active nuclear policy, although it is said or rather speculated that Poland might return to the game under the Nuclear Sharing program. According to the data of Defence24.pl, five NATO states made an active use of this program in 2015, including: Italy, Turkey, Germany, Belgium and Netherlands, equipped with F-16 and Tornado nuclear bomb carrier aircraft. These vehicles are adapted to the carriage of American special B61 air bombs. In the future, F-35 aircraft should also be adapted

to this role, and Poland may be their beneficiary, too. The idea of incorporating Poland into this program is a consequence of the growing threat from the Russian Federation. Therefore, if Poland joined the Nuclear Sharing program, this would mean a rapid growth of security for us, which is also organizationally parallel to the planned withdrawal of Germany from this agreement, mainly due to the withdrawal of Tornado IDS aircraft and the lack of plans to adapt Eurofighter vehicles to the new role. The potential change of policy towards Poland may also be probable thanks to improving political relations with the United States and the stable and expanding engagement of the United States in Poland and in the Central & Eastern European region in general.

It is also worth noting another fact, which is well known: the Polish nuclear program was started as early as the 1970s, during Edward Gierek's rule. Was it real? It is difficult to tell – there are many doubts about this, and many people treat this as a sort of sensation that causes a more or less heated discussion in the media, particularly the local ones. The leading person in the nuclear weapon acquisition program was Brigadier General Professor Sylwester Kaliski (1925–1978) – the commander-rector of the Military University of Technology, a graduate of the Faculty of Civil Engineering of the Gdańsk University of Technology. In 1973, he performed a controlled thermonuclear microsynthesis, obtaining the plasma temperature of 10 million degrees (the “Focus” experiment). The official goal of this research was to create a source of cheap, pure and practically inexhaustible energy. The first theoretical publications on that subject were published in 1969; later, after 1975, results of the research were kept secret. These results aroused huge interest among the political authorities of the People's Republic of Poland, including Edward Gierek himself. It is supposed that he had certain hopes for the creation of a Polish nuclear bomb, which could improve the position of Poland in relation to the USSR within the Eastern Bloc, as this had allowed France to obtain large political and military independence of the USA in the past (Wetoszka A., Truskowski A., 2017). The mysterious death of Professor Kaliski in 1978 put an end to the Polish nuclear program. According to some opinions, this was an assassination, with secret service officers of the USSR, the People's Republic of Poland and many Western states being mentioned as its potential perpetrators. It is believed that the possession of its own nuclear technology, let alone a bomb, by Poland, was not in the interest of the Soviets nor the West.

8. Conclusion

The performed analyses show that nuclear weapons have been and still are an important means of deterrence. The construction of the nuclear weapon revolutionized the rules and methods of warfare. Its use had an impact on the contents of doctrines and concepts of use of armed forces and ensured the continuous development of the structures and equipment of armed forces. Because of their destructive force, nuclear weapons play the main role in the deterrence policy and are the primary means of maintaining security. In the Cold War

period, they were an important element of the strategy of the balance of powers of NATO and the Warsaw Pact, using the “doctrine of fear”. The fear of the consequences of their comprehensive use ensured the stability of the bipolar system of powers for many decades. The signed treaties and disarmament agreements were a step forward aimed at increasing public security in the context of global challenges and preventing the proliferation of nuclear weapons. However, these actions were not fully effective, as politicians and experts realize more and more frequently today. There is no tendency to resign from nuclear weapons in the modern world. Quite the opposite – there are states that almost dream of acquiring such weapons. In spite of ongoing negotiations on the subject of arms reduction, the biggest challenge for the modern world is still nuclear terrorism and the proliferation of mass destruction weapons, including nuclear weapons. Also, there is no significant difference in the doctrinal perception of nuclear weapons among “nuclear states”, which suggests that nuclear weapons are an equally important element of security for the United States and for the Russian Federation. The examples presented in this work indicate clearly that, contrary to what may seem, nuclear weapons are not entirely unfamiliar to Poland. In the era of the People’s Republic of Poland, the armed forces had access to nuclear weapons and were systematically trained in this field under alliance agreements. During Edward Gierek’s rule in the 1970s, Poland pursued also its own secret program of acquisition of nuclear energy for military purposes in order to increase Poland’s independence on the international arena. Currently, Poland is not pursuing any armament program connected with nuclear weapons. Polish crews are not trained in this respect. However, it is still theoretically possible for Poland to participate in NATO’s Nuclear Sharing program, if such a need arises.

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Linear electromagnetic accelerator

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Abstract

Over time, the weapons have been based on mechanical energy (bows, catapults) and chemical energy (guns, missiles), however, at the moment, more and more weapons are designed using electromagnetic energy (railgun, coilgun). The focus of this paper is to obtain the desired muzzle velocities of a projectile according to the existent current. In the first part of the paper, the railgun and coilgun design are presented along with their most important advantages. Based on these observations, a new design of an electromagnetic launch system is presented. Next, Maxwell interactive software package was used that applies the finite element method (FEM) to analyze and solve 3D electromagnetic field problems in order to analyze the variation of acceleration force, speed in time. All simulation data shows that this design has a great potential, because of the adaptability to different applications.

Keywords: electromagnetic energy, coilgun, projectile, launch system, simulation

1. Introduction

Nowadays, directed energy weapons (DEWs) are nothing new to mankind. They were discovered a long time ago when the famous Greek Archimedes allegedly used polished parabolic mirrors to direct sunlight on the sails of Roman ships while defending the city of Syracuse in order to destroy enemy ships with fire. The device made by Archimedes was used to focus sunlight into approaching ships using mirrors acting collectively as a parabolic reflector, causing them to catch fire.

The US Department of Defense (DOD) defines, in *Electronic Warfare*, a directed-energy weapon as "an umbrella term covering technologies that produce a beam of concentrated electromagnetic energy or atomic or subatomic particles". DEWs are a part of an electronic attack, along with High Power Microwave, Electromagnetic Pulse and Radio

Frequency having an important role in the combined operations and destruction of the enemy by combined kinetic and electromagnetic attacks. Also, they use non-kinetic directed energy, which is used as a direct means to incapacitate, injure, kill people, or to incapacitate, degrade, damage or destroy objects.

While DEWs offer a variety of advantages over conventional kinetic weapons including precision, low cost per shot, and scalable effects, there are also some basic constraints, such as beam attenuation, limited range, and an inability to be employed against targets outside the line of sight, which must to be resolved in order to make these weapons effective across the entire spectrum of combat operations.

A representative example which belongs to the directed energy weapons category is the electromagnetic cannon. Electromagnetic cannons use electricity to accelerate the

projectile and thus eliminates the danger of explosion of the powder that propels conventional projectiles. Since the fastest and less expensive way to increase the firing range is the speed of the projectile, the electromagnetic cannon is the best choice. With the speed of the projectile, a series of advantages are obtained, such as reducing the flight time to the target and increasing the impact energy, which makes the presence of an explosive load in the projectile unnecessary.

At the time, different designs of electromagnetic cannon were studied: railgun and coilgun.

The most advanced of all projectile acceleration systems using electromagnetic forces is the railgun which can exploit the high kinetic energy stored in the projectile for extremely lethal effects. The name railgun comes from the fact that the system consists of two electrical conductors that also have a guiding role. These two electric conductors are rigidly fixed at a constant distance from each other. The railgun function has an incredibly powerful electric circuit formed by these two rails, which is closed by a mobile conductor that can move along them. This conductor can be the projectile itself or an armature that pushes the projectile.

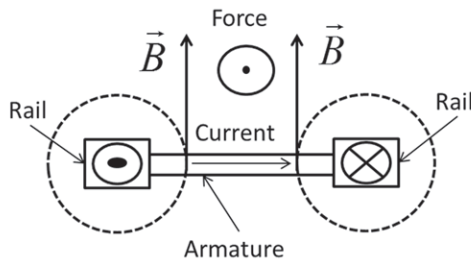


Fig. 1. Railgun

Because this design uses only straight conductors, the value of magnetic gradient inductance is very low. The only way to obtain a high value of force is to increase the current I which flows through conductors.

The combination between this simple design and very high currents creates the condition to obtain a great Lorentz force on armature.

$$\vec{F} = I \cdot \vec{l} \times \vec{B} \quad (1)$$

The advantages of this design are:

- the magnetic flux density is perpendicular on armature;
- the current on armature I also create the magnetic field around rails.

Even the magnetic field created by rails is not so strong compared with a magnetic field created by a coil, the armature touches the rails and use the magnetic field created very efficiently.

This great advantage comes also with a significant disadvantage of this design: sliding contacts between armature and rails at very high current. For this reason, the rails are damaged after few shots.

Another system that uses electromagnetic energy to accelerate the projectile is the coilgun system. This system is

composed of a coil powered by a very high current pulse, of the order of thousands or tens of thousands of amps, in order to create a strong magnetic field using only a fraction of current and avoiding sliding contact, and a projectile. Although the technology of this system dates to 1930, when Northrup professor at Princeton University built the first projectile accelerator at very high speeds, for the moment, the railgun system remains in the spotlight.

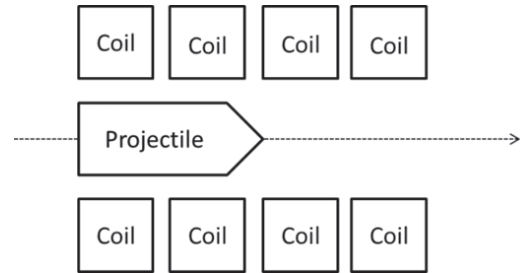


Fig. 2. Coilgun

In order to reduce the value of current I , the rails can be replaced by coils. By using coils, we can obtain the same value of magnetic flux density created by the rails with a lower amount of currents. The current inside the armature can be obtained by using induction instead of sliding contacts.

The axial component of magnetic flux density inside coil creates the induced current inside projectile, which interact with radial component of magnetic flux density.

The induced current depends on rate of change of the axial magnetic flux density and the radial magnetic flux density depends on the amount of magnetic flux. The magnetic flux is created by the coil and is the only one which induces the current in projectile, providing simultaneously the radial magnetic field on the induced current.

It is difficult to control with a coil both the rate of change of the axial magnetic flux density and the radial magnetic flux density. Also, it is difficult to control the phase of induced current in projectile and the phase of the radial magnetic flux density.

Compared with railgun, the coilgun creates a strong magnetic field using only a fraction of current and avoiding sliding contacts. The coilgun design is also much more complex than railgun, because the position of projectile must be synchronized with powered coils.

In order to increase the radial magnetic flux density and to decrease the current inside the coil a design with magnetic circuit made by ferromagnetic materials was proposed.

The magnetic circuit also creates a zone where the magnetic field is radial on conductor, in our case, a ring. The E shaped design use the soft magnetic materials and use the Lorentz force to accelerate projectiles, but that design does not allow controlling the difference of phase between induced current in projectile and the phase of the radial magnetic flux density.

$$\vec{F} = I \cdot \vec{l} \times \vec{B} \quad (2)$$

In order to create a great electromagnetic launch systems (EMLS) design, we should preserve the advantages of the railgun design and avoid high currents to obtain the desired force.

The induction coilgun design presented in Fig. 3 is important for our study, because the projectile is not located inside a gun barrel like in a railgun and the classical coilgun, but is located outside the acceleration system. Because we use electromagnetic energy to accelerate the projectile, we do not need a barrel like guns which use chemical energy. This is a very important remark.

If possible, the EMLS should be simple as a railgun and efficient as a coilgun. A design which respects all these conditions is presented in the following chapter.

Before the presentation of a new electromagnetic launch system, we will analyze again the equation of Lorentz force (3).

In order to obtain maximum force, the angle must be $\alpha = 90^\circ$.

The value of current I can be easily increased as we saw in railgun design. The magnetic field density B can be easily created using a pair of coils with magnetic core.

The next element is l (length of conductor inside magnetic field) and apparently its value cannot be modified, but if we use more wires (let's say N turns), like in a coil, we can easily increase the value of force by N times.

If we manage to increase the number of conductors inside the magnetic field by N times, we can increase the total force acting on armature by N times. This is an easy way to increase the force. This number depends by the size of wire and the space volume where the magnetic field is strong enough to create a useful Lorentz force. The Lorentz force became:

$$\vec{F} = I \cdot N \cdot \vec{l} \times \vec{B} \quad (3)$$

2. Linear electromagnetic accelerator

In this paper, we present the theoretical results obtained during a project aimed to explore the new ways to accelerate a mass using electromagnetic energy. The objective of the project is to accelerate a projectile with a mass of 1 kg from zero to 3000 m/s using 5 meters of acceleration length. According with this objective, the kinetic energy of the projectile is:

$$E_k = \frac{1}{2}mv^2 = 0.5 \cdot 1 \cdot 9 \cdot 10^6 = 4.5 \cdot 10^6 J \quad (4)$$

If we assume the initial speed is zero and the acceleration force acting on the projectile is constant, then the value of the force is:

$$L = E_k = F \cdot d \quad (5)$$

$$F = \frac{E_k}{d} = \frac{4.5 \cdot 10^6}{5} = 900 kN \quad (6)$$

Our design consists of a static part which is made by a pair of coils similarly as in Fig. 3. The coils are square

with the outer length calculated at a dimension of 180 mm and the inner length calculated at a dimension of 100 mm. The number of turns N depends by the size of wire. We are looking for a copper wire able to sustain a fusing current calculated per Onderdonk for 32ms up to 1000 amperes. From the table with American wire gauges, we find AWG 19 with a 0.912 mm diameter. At this dimension of wire, we can accommodate $N = 4000$ turns in the rectangle cross section area obtained from calculations. Since only a single pair of coils is not enough to accelerate the projectile, we will use many pairs which form stages of acceleration. For our simulation we used four stages of acceleration. The length of each stage is calculated at a dimension of 100 mm. These acceleration coils provide the current intensity I and the length l of conductor inside the magnetic field presented in Equation 3. Because the number of conductors is equal with the number of turns N , the Lorentz force will be multiplied by N .

Each coil on stage produces an acceleration force so that the total net force on each stage is multiplied by 2.

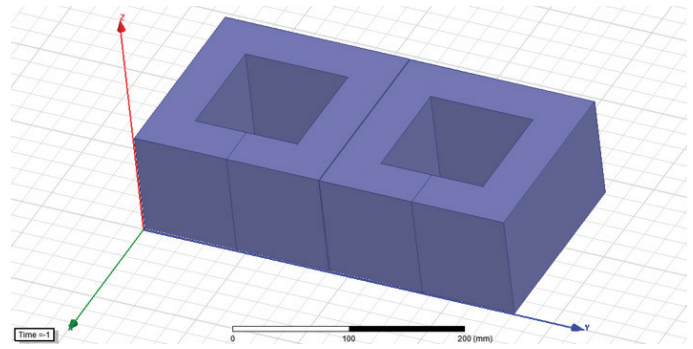


Fig. 3. Static coils for acceleration path

In Fig. 4 we present the two coils made to produce the magnetic Field B required by the Lorentz force. These 2 coils are in front of the acceleration stator. The coils are square with the outer length calculated at a dimension of 180 mm and the inner length calculated at a dimension of 100 mm. The number of turns N is 1600. The length of the coils in axe x direction is 40 mm. These two coils are the moving parts. The magnetic field produced by moving coils and the intensity of the current in static coils create an acceleration force in positive z direction.

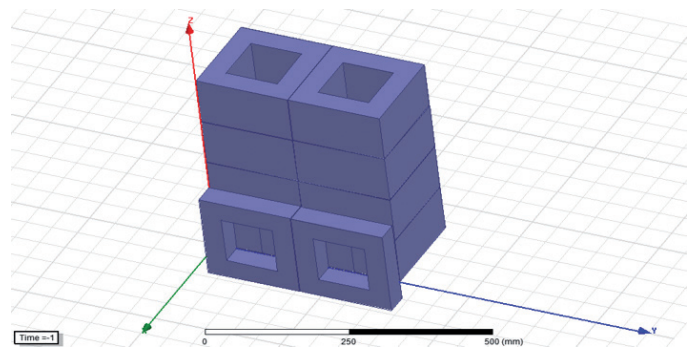


Fig. 4. Moving coils in front of acceleration stages

In order to increase the efficiency of the system, we also created a magnetic circuit made by electromagnetic steel. The shape and position of this core is presented in Fig. 5.

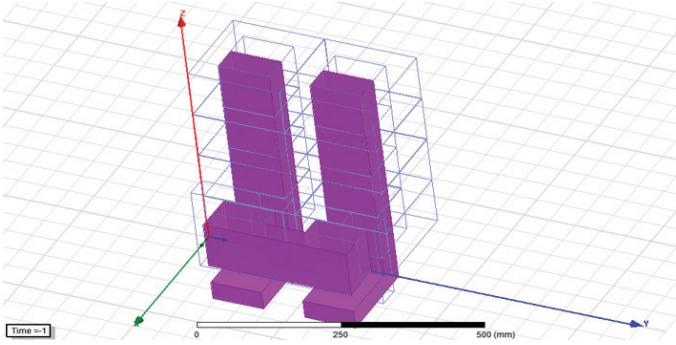


Fig. 5. The magnetic core

The entire design is presented in Fig. 6. The number of acceleration stages can be increased according to need. For our simulations, we used only four stages. We used the same amount of currents to power all of the coils. Because we have moving coils, we can power these coils using moving contacts. This approach is possible because the maximum current used is 1000 A. The acceleration Lorentz force is:

$$F = 2 \cdot I \cdot N \cdot l \cdot B \quad (7)$$

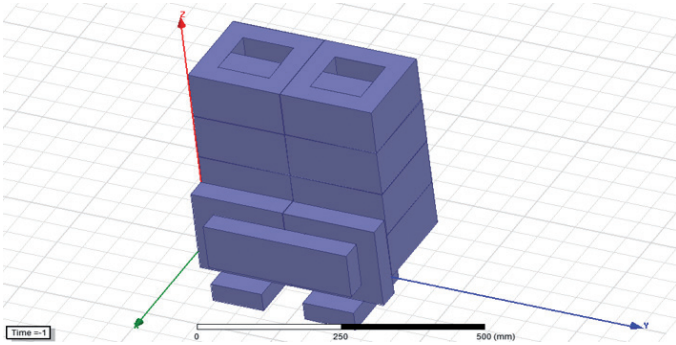


Fig. 6. New EMLS design

3. Simulations

For simulations, we chose the Maxwell interactive software package that uses the finite element method (FEM) to analyze and solve 3D electromagnetic field problems. First, we built the simulation model with the same dimensions as we used to calculate the theoretical values of current intensity I , acceleration force F , and muzzle velocity v . Because the acceleration length is 5 m and our simulations are for only 0.1 m, the value of velocity, we expect from the simulation is 60 m/s.

$$E_k = \frac{1}{2}mv^2 = 0.5 \cdot 1 \cdot 3600 = 1.8 \text{ kJ} \quad (8)$$

$$F = \frac{E_k}{d} = \frac{1800}{0.1} = 18 \text{ kN} \quad (9)$$

According to theoretical calculus, we need a constant force of 18 kN to accelerate a mass of 1 kg from 0 m/s to 60 m/s on a length of 0.1 m. This length is the length of an acceleration stage. We obtained from the simulation the necessary value of current intensity to achieve a speed of 60 m/s is 80 amperes.

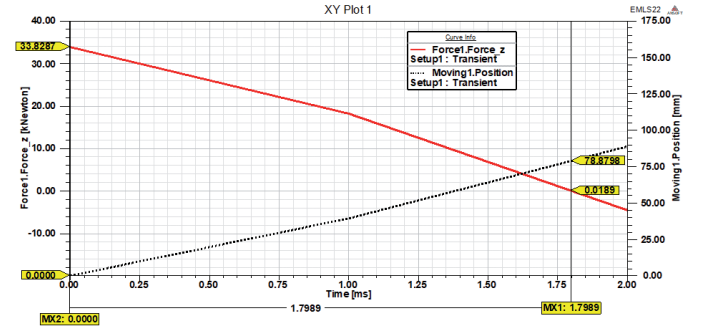


Fig. 7 Variation of acceleration force in time

In Fig. 7, the variation of acceleration Lorentz force in time is displayed with continuous line. As we expected, the force is not constant as in our theoretical calculus. The position of mobile coils in time is displayed with dots. The value of force decreases from 33 kN to 0 N when the mobile coils reach the point of 78 mm. For this simulation, we do not power the stages 2, 3 and 4.

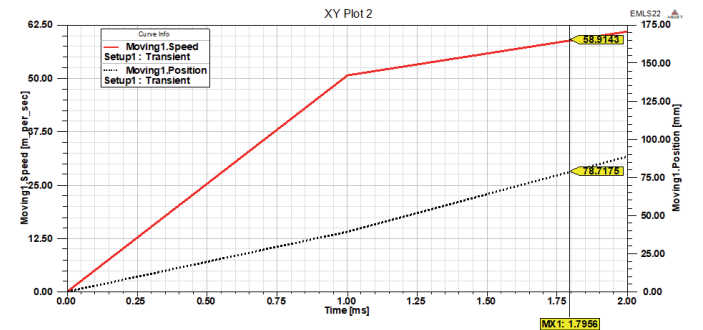


Fig. 8 Variation of speed in time

In Fig. 8, the variation of speed in time is displayed with the continuous line. At the end of first stage after 0.078 m the velocities of mobile coils achieve the value of 58.91 m/s. The position of mobile coils in time is displayed with dots.

According to the results from this simulation, we can predict that the system is able to accelerate a mass of 1 kg from 0 to 3000 m/s on 5m length of acceleration using only 80 amperes current.

4. Conclusion

In this paper, we proved theoretically by means of simulation the possibility of obtaining the desired muzzle velocities of a projectile using a current of 80 A.

The great advantage of this design is its adaptability to different applications. If we need to increase the acceleration

force, we can increase the current up to 1000A, but also, we can increase the number of systems. According to the simulation results, this design can be easily used to accelerate projectiles up to 3000 m/s. This system can be an electromagnetic catapult or a coilgun.

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On Security Education in Poland. The Essence and Content of the Subject of Education

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Abstract

The purpose of this article is to highlight the essence and content of teaching this subject, which was introduced in Polish schools on 1 September 2009. To achieve this goal, the importance of education and, specifically, security education is discussed. The essence of security education is then presented, and it replacing the currently implemented defense adaptation is explained. Subsequently, the educational content of security education was discussed. The aim of the study was based on theoretical research methods such as analysis, synthesis, comparison, and inference.

The conclusion encourages further reflection on this subject because education is an important area for ensuring security; hence, education in security from pre-school education to adult education can be found in Polish education.

The tendency toward change testifies to broader cognitive perspectives, especially in the area of personnel and structural security of individuals and social groups. It also testifies to the understanding of the essence and importance of education itself.

Keywords: education, security, security education, civil defense course

1. Introduction

The need for security has always accompanied humankind. Earlier, security referred primarily to the capability to counter external threats, which generally were associated with military activities. However, the modern-day development of civilization and the resulting new challenges have seen the meaning of security broaden and not only associated with armed forces (Pieczywok 2011, p. 466, Wiśniewski 2011, 2017, Drabik 2018, Waever 2008). Today, “one can assume that it is the primary, existential and supreme value and need of every human being, conditioning the survival and development of the individual and social groups. In order to strengthen the sense of security, people unite (associate) and establish the state as the highest organizational form, guaranteeing safety” (Skrabacz 2012, p. 26).

Because of changes in all areas of human life, the subject of security has assumed a new meaning. In the 21st century, the capability to deal with multifarious threats that do not have the nature of classical external threats is much more substantial (Bachmann 2012, Millet and Perez 2005). In addition, the development of science, technology, civilization and industry has meant an increase in the number of factors directly threatening human health and life. Moreover, the progressing deterioration of the natural environment has generated serious ecological threats (Siegel 2015). Developing skills to deal with these changeable conditions has recently become a major task for authorities, national security institutions, the education system, and individual citizens too (Pieczywok 2011, pp. 466–467).

This article looks at issues related to security education with regard to safety as a significant human, universal, humanistic, and educational value. The purpose of this article is to highlight the essence and content of teaching this subject, which was introduced in Polish schools on 1 September 2009. The aim of the study was based on theoretical research methods, such as analysis, synthesis, comparison, and inference. To achieve this goal, the importance of education and education for security is discussed. The essence of education for security is then presented, and it replacing the currently implemented defense adaptation is explained. Subsequently, the educational content of education for security is discussed. The analysis carried out in this way allowed conclusions to be reached in summary.

2. Education and security education – understanding of concepts

Security – understood as a state of peace, certainty, freedom from threats, fear of attack – is the supreme need and value of human social groups, as well as the most important goal of existence. The essence here is not only survival, integrity or independence, but also the security of development, which is to ensure protection and enrich the identity of individuals and of the nation (Pokruszyński 2010, p. 6, Wodak 2009).

The opportunity for shaping a sense of security lies in education. It is one of the basic ways of shaping human security because it affects its attitudes, values, messages, and skills that are necessary for preventing and dealing with threats and removing their consequences (Pieczywok 2012, p. 65).

Education is all interactions that serve to form (change, develop) human life abilities. The total impact means both institutional and individual, conscious and unconscious impacts, etc. These impacts may be systematic, unsystematic, contingent, planned, etc. Systematic and planned educational activities take place, for example, at school. Non-systematic and contingent activities occur in peer interactions, among other things, and are hidden in the messages of culture, e.g., works of literature. Human life abilities may refer to many areas of its functioning: intellectual, emotional, interpersonal, motivational, physical, etc. (Rubacha 2005, p. 25).

Education is carried out through the educational system and it consists of two basic processes: education and training. In the history of thought about upbringing, there were pedagogues, such as Georg Kerschensteiner, Sergiusz Hessen, and Antoni Bolesław Dobrowolski, who identified upbringing with education. Another position was equally popular – represented by Heliodor Muszyński and Krzysztof Sośncki, for instance, which consists in a radical separation of education from upbringing. Contemporary theory is increasingly moving away from the position that places an equal sign between upbringing and education (*ibidem*).

Education is deliberately organized social activity based on an educational relationship between a ward and an educator, whose aim is to induce intentional changes in the personality of a ward (Okoń 2004, p. 25). These changes include the following dimensions:

- cognitive-instrumental, associated with the cognition of reality and the ability to influence it;
- emotional and motivational, consisting in shaping the attitude of an individual to the world and people, their attitudes and beliefs, the hierarchy of values, and purpose of life (*ibidem*).

In other words, education is the purposeful influence of mature people, or educators, mainly on children and adolescents, or foster children, in order to cultivate specific concepts, feelings, attitudes and aspirations in them. Hence, the educational activity includes caring, providing entertainment and culture, physical, mental, moral, aesthetic, social, and ideological education, along with teaching, training, and preparing the ward for performing various tasks. The educational activity is socially organized and takes place through and within the framework of the life of particular social groups that act as educational institutions, such as family, school, youth organizations, workplaces, theatres, and museums (Kunowski 1993, p.19). Education is, therefore, a conscious and deliberate pedagogical action aimed at achieving relatively constant effects (developmental changes) in a juvenile's personality (Rubacha 2005, p. 26).

On the other hand, the term education can be understood as a system of activities aimed at making the learner aware of the world, preparing themselves to change the world, and shaping their own personality. It is primarily a process leading to education and one that applies to the entire human personality. Education is a system of actions aimed at enabling a learning unit or a set of individuals to enable:

- learning about the world that nature has created and what we owe to culture, including science, art, and technology;
- preparing to change the world by developing physical and mental qualifications, abilities and talents, interests and passions, needs and self-education skills;
- shaping individual personality by developing creative attitudes and personal relation to moral, social, cognitive, artistic, and religious values (Okoń 2004, p. 200).

The process of education, the subject of which is a given to an individual or a group, can be organized by institutions, mainly by a school, university, and family, by various institutions, workplaces, and individuals, especially teachers. It can also be taken by the individual or group spontaneously when it takes the form of self-education or self-reliance. On the other hand, the process of upbringing is conducted by people and institutions responsible for education, such as parents, teachers, schools, social, cultural, and religious organizations (Okoń 2004, p. 200).

Security education is, therefore, the process of educating the human being, and hence educating him/her in order to ensure his/her sense of security. According to the definition, security education is proposed by Bogdan Rudnicki (1994, p. 62) to be all educational processes aimed at preparing young people and adults to act in situations threatening the existence of people and the functioning of the state.

In turn, following Ryszard Stępień (1999, p. 11), it can be stated that security education is a definite didactic-educational system of the family, school, army, mass media, youth

organizations and associations, workplaces as well as state and local government institutions focused on shaping the system of values, dissemination of messages and shaping of skills important for ensuring national security. In terms of subject, education for security concerns three basic dimensions (Kitler 2006, p. 16):

- the security of a person (individual) equipped with a system of social values and norms that are specific to them, which also apply to their imperatives related to individual security;
- the security of a group of people who want to feel safe in different social (interpersonal) situations;
- legal formalized security, state, and international structures, such as the municipality, powiat (county), state, or group of countries which, due to their territorial scope, are respectively local, national, and international security.

Summing up the theoretical considerations concerning the essence and areas of meaning of the term security education, it can be concluded that it is a continuous process encompassing a series of activities, including (Pieczywok 2012, p. 67):

- transferring knowledge about the occurrence of threats;
- shaping “safe” behavior and attitudes;
- motivating actions to ensure safety;
- dissemination of necessary knowledge and skills in the field of countering threats;
- raising awareness of the scale and type of needs in difficult situations;
- developing a sense of responsibility for taking specific actions;
- developing appropriate habits (behavior) in emergencies;
- caring for values in relation to human life and health.

On the other hand, from the point of view of practical needs, education for security fulfills the following functions (ibidem):

- implementation – education for security adapts people to social and professional life as well as skillful team activities;
- corrective – education for security makes it possible to correct attitudes and behavior in accordance with accepted social requirements and norms;
- socialization – education for security shapes and improves prosocial values, attitudes, and behavior;
- stimulative – education for security aims to develop the habit of optimal involvement in the implementation of various projects, effectively eliminating threats;
- personality-generating – education for security manifests itself in the continuous development and improvement of personal and professional qualities related to the development of personality and improvement of skills related to safety in the professional work of a given individual.

Security education is an important element in the process of shaping security in general (Igbuzor 2011). If the creation of desirable conditions of survival and development (certainty of life) of a human being meets the stipulations of the definition of security, then education for safety is one of the methods (methods) of this creation.

3. The essence of security education

Having in mind mentioned above premises Keeping the above in mind and, consequently, the need to reevaluate the content of school instruction – omitting areas that are less important and detailed, with the focus on areas that are most important for security – the Ministry of National Education, in agreement with the Ministry of National Defense, introduced a new subject – education for security in the core curriculum of the lower and upper secondary schools (changing the previous one – civil defense course). The main core of the subject is a comprehensive approach to security issues with the focus of educational activities on the issues of threats to peace e.g. armed conflict (Żakowska 2018, pp. 219–247), as well as types of behavior in crisis situations at any place and time (Hargreaves 2003, Urych 2013, p. 385). “Security education in dangerous times” (Pieczywok 2018, pp. 7–22) is very necessary for contemporary school (Drabik 2018, pp. 23–37). In these classes, topics are discussed that relate to current problems disrupting various dimensions of state security, such as migration (Domalewska 2018, Domalewska and Żakowska 2019, pp. 3–14) and health security threats (Urych 2013, pp. 384–407).

The concept of education for security emerged in the process of research on the security system of the Republic of Poland, conducted at the National Defense Academy¹ in the years 1993–1995 (Stępień 1994). In those years, there were significant changes in the interpretation of defense education of society as traditionally viewed, which made it possible to replace it with the term education for safety. This term has an extensive range of content because it is associated with patriotic, civic, moral, and defense education. As a component of education, it aims to direct and consolidate these educational efforts that foster the formation of patriotic and defensive attitudes. Education for safety is associated, in particular, with politics, the education system, the state, power, and the whole system of its exercise, and its issues are essential for the whole of society as well as for individual units (Stępień 1999).

It is worth mentioning that the subject of education for security, which was introduced in the Polish education system on September 1, 2009, completely replaced the subject that had been previously implemented, namely the civil defense course. It is possible to understand this date as preparing society, with particular reference to the education system of secondary school children, to perform humane tasks in order to minimize results and the liquidation of effects of breakdown, disasters, natural disasters and warfare (Siuda and Zaczek-Zaczyński, 1994, pp. 98–99).

The essence of this was mainly issues in the field of self-defense in the event of an outbreak of war and the principles of operation of nuclear weapons, content related to self-defense, sanitary training, and preparation for the performance

¹ Based on Article. 3. the Act of May 20, 2016, on the establishment of the War Studies University on May 30, 2016, the National Defence University in Warsaw was abolished on October 1, 2016. The War Studies University was created (Journal of Laws of 2016, item 906).

of basic military service. Students also acquired basic team skills for peace, danger, and war. They also shaped ideological and patriotic attitudes. Post-secondary school students were prepared for the roles of junior commanders in self-defense formations and learned about the tasks of third-party workplaces. During the summer, school students participated in obligatory military and defense preparation camps, where they expanded the theoretical knowledge acquired during the implementation of the subject curriculum and acquired and perfected practical skills.

Numerous changes to the youth defense preparation programs were carried out in 1971, 1974, 1982, 1986, and 1989. The amendments aimed at streamlining the programs by issues and content useful in modern society, e.g., increasing the number of hours of sanitary training. Since 1987, changes have been introduced to the defense education program, giving up typical military content, the number of civil defense course hours, as well as funding, has been reduced. Despite many changes applied to the content of the civil defense course, its essence in the national security structure was underestimated. Subsequent analyses of the military preparation programs and subsequent defense adaptations, which were in force in 1952–1990, show how unstable the content of the education was (Siuda 1996, p. 158).

The socio-political transformations in Poland, which took place after 1989, caused further changes in the goals and content of defense education of school children; one of the manifestations of these changes is the cessation of military preparation of school youth. In addition, in 1990, the civil defense course was withdrawn from primary schools, which instead introduced issues in the field of universal self-defense, the implementation of which turned out to be illusory and ineffective. This was caused by the lack of proper legal regulations, proper organization, teachers' cooperation, and supervision by school directors. On the other hand, new defense-improvement programs were introduced in secondary schools, the content of which referred only to the protection of health and life against various threats to peace (Kaliński 2005, p. 30).

The basis for the creation of a new defense education system is the assumption (supported by past experience) that the most rational, effective, and cheapest way to generally prepare a defensive society is defensive education of young people. As a consequence, the formula of education for safety was adopted (Kaliński 2000).

The requirement to implement education for security is imposed by the Constitution of the Republic of Poland in Art. 5, in which we read that the Republic of Poland ensures the security of citizens and Art. 166 of the Act of November 21, 1967 on universal obligation to defend the Republic of Poland (Journal of Laws of 2017, item 60), which states that pupils of primary and secondary schools, i.e., general and technical secondary schools and vocational schools, with the exception of adult school students, are subject to education for safety.

One of the subjects in the primary education plan is education for safety (Regulation of the Minister of National

Education of 28 March 2017 on framework teaching plans for public schools). It is intended to prepare students for proper behavior and appropriate reactions in situations that pose a threat to health and life. This subject covers various items in the area of state security, content regarding the organization of rescue operations, health education, and first aid.

4. Course contents of education for security

In 2009–2017, the content included in the core curriculum for the subject of education for security in middle school was oriented to developing skills in situations of various threats, such as fires, floods, accidents, road disasters that may occur in the nearest future in the student's environment, as well as the ability to provide first aid in these situations. Complementing this content is the issue of the functioning of the state defense system (Makowski 2012).

However, in the fourth stage of education, i.e., in the upper secondary school, the curriculum of the subject education for safety included threats to peace, their sources, countering their formation, and their removal (Urych 2013, p. 384). These contents include contemporary health threats – civilizational diseases and contemporary health threats such as nicotine addiction, alcoholism, drug addiction, and aggression (Słoma 2012, Tomaszewicz et al. 2012).

In the area of program changes in the contents of the subject, education for safety has departed from security as traditionally understood and associated with the ability to counter external threats, usually identified with warfare. Nowadays, it seems more important to educate people to cope with many threats that do not have the characteristics of typical external threats. The direction of education has been transferred from the pro-defense content to general safety and preparation in the event of threats to life and health. This subject also does not include the subjects of shooting and topography training, and its subject scope refers to issues related to emergency medical services and behavior in crisis situations to a much greater extent. Therefore, the issue of threats to peace and ways of behaving in crisis situations, possible in any place and time, is emphasized.

In addition, in accordance with the provisions of educational law, the headteacher, during the creation of a set of teaching and educational programs, was required to perform tasks in the field of education for safety according to the current core curriculum and appropriate to the environment in which the student is brought up. Local security threats need to be taken into consideration.

On September 1, 2017, a reform of the Polish education system was introduced, according to which middle-school schools were abolished, and the time of education in primary and secondary school was extended (Anon n.d.). The education reform set new tasks for the school, revolving around the gentle introduction of children into the world of knowledge, preparing them to perform the duties of students, and for self-development. The school is to provide safe conditions and a friendly atmosphere for learning, taking into account the individual educational opportunities and needs of the student.

The reform also influenced the implementation of the subject of education for security, which was to be conducted not only in secondary school but also made obligatory in the eighth grade of primary school at one hour per week.

Learning objectives – general requirements in grade VIII (Regulation of the Minister of National Education of 14 February 2017 on the core curriculum of pre-school education and the core curriculum of general education for primary school, general education for the industry-level school, general education for special education and apprenticeship school for post-secondary school):

- getting to know the essence of state security,
- preparation for emergency situations (catastrophes and mass accidents),
- shaping skills in the basics of first aid,
- shaping individual and social skills conducive to health.

It should be pointed out that the curriculum content of education for safety also occurs in higher education. In the field of education for safety, there are established courses of study, such as national security, internal security, security engineering, and European studies, which offer this type of knowledge to their students. Education for safety is also the subject of interest for many post-graduate studies (adult education), specialist and qualification courses (in-service training and continuing education), stressing these issues in the content and skills they teach. This subject also occurs during doctoral studies carried out in the field of security.

The contents of the subject: education for safety at various types of studies and courses for adults cover the whole spectrum of theoretical and practical elements of contemporary security, crises, and prevention. After completing this course, students have a significant amount of knowledge and skills in the field of security as broadly understood. They also acquire the skills necessary for planning, organizing, and managing people in states of danger. They also know how to act to counteract them well in advance of their appearance (Pieczywok 2012, pp. 167–179).

5. Summary

The purpose of this article was to highlight the essence and content of teaching the subject of education for security in the Polish educational system. The presented considerations lead to the formulation of a preliminary and demanding discussion of the conclusions.

1. On 1 September 2009, The Ministry of National Education, in agreement with the Ministry of National Defense in Poland, introduced a new subject to the core curriculum of the middle school and upper secondary school – education for safety. Thus, the previously conducted subject – civil defense course – was replaced. The essence of the change was the reorientation of threats of a typically military character to the concentration of educational activities on the issues of threats to peace, as well as behavior in crisis situations.
2. The consequence of identifying security not just with military aspects was the transition from a strictly defensive

education to education for security as broadly understood. In Poland, these transformations were accompanied by changes in the formulation of educational objectives, in which, apart from the issue of threats to security, the problem of challenges, i.e., new situations that may only turn into threats, is increasingly taken into account.

3. Education for security is a continuous process, encompassing a number of activities in the field of upbringing and education, especially for young people, including transferring knowledge, shaping attitudes and developing personality in order to function effectively in the event of various threats and to protect one's health.
4. The curriculum of the subject of education for security mainly concerns learning the essence of state security, preparing for emergency situations, passing skills in the basics of first aid, and shaping attitudes conducive to health. The curriculum of education for safety is currently carried out in primary and secondary schools, as well as during studies and specialist courses.

History and the present show that security was and is a great dream of humankind. Living safely – this is the motto that has influenced many human activities (Loranty 2012, p. 425). Education is an important area for ensuring safety, hence education in security in educational content from pre-school education to adult education can be found in Polish education. The tendency to change testifies to broader cognitive perspectives, especially in the area of personnel and structural security of individuals and social groups. It also testifies to the understanding of the essence and importance of education itself. However, the issue of to what extent the reforms of Polish education in the field of education for security are effective and sufficient should be subject to further reflections and thorough research.

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Military Law in the Republic of Poland

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Abstract

The article presents an analysis of military law in the legal system of the Republic of Poland. On the one hand, it is a very specialized area of law, and on the other, it is a very extensive field regulated in several hundred national legal acts of varying importance (universally and internally binding), as well as by international law. The author attempts to organize the subject matter of military law and to specify its elements divided into subject-specific blocks. At the same time, in order to ensure a better understanding of the nature of military law, the article discusses the role of the Armed Forces of the Republic of Poland in times of peace, crisis, and war.

The author used critical analysis of literature on legal science and security sciences, and source materials: mainly acts of universally binding law (the Constitution, acts, and regulations), as well as acts of internally binding law (instructions, ordinances, resolutions, decisions, guidelines, and agreements of various state authorities).

Keywords: defense law, law, legal system, military law, national security law, security law

1. Introduction

In a democratic law-abiding state, armed forces are one of the most important elements of the national security system. Their primary task is to defend the independence and sovereignty of the state (by combating external threats), but nowadays, the military is increasingly being used for internal tasks. There is no doubt that, as a result, legal regulations concerning the principles of the functioning of armed forces are becoming particularly important.

In the legal system of the Republic of Poland, the set of legal norms regulating the basis for the functioning of the armed forces is referred to as military law. On the one hand, it is a very specialized field of law (applicable to a specific group – soldiers and civilian personnel of the armed forces) and, on the other hand, it is a very extensive field regulated in several hundred national legal acts of various importance (universally and internally binding) and in international law.

At the same time, military law is both a separate part of national security law (related to military security) and a part of the defense law of the Republic of Poland.

The aim of the article is to analyze the military law in the legal system of the Republic of Poland and to try to organize its subject matter. At the same time, in order to ensure a better understanding of the nature of military law, the article will discuss the role of armed forces in times of peace, crisis, and war.

The main research problem was formulated as the following question:

– What is the subject matter of military law and can its characteristic elements be distinguished by subject-specific blocks for practical purposes?

Due to the fact that military law issues are interdisciplinary in nature, I used both critical analysis of legal science literature and security sciences in my research. Moreover,

I based my analysis on source materials: mainly acts of universally binding law (the Constitution, acts, and regulations), as well as acts of internally binding law (instructions, ordinances, resolutions, decisions, guidelines, and agreements of various state authorities).

2. The role of armed forces in the state

In the definition proposed by Waldemar Kitler, military law is “a set of legal norms governing the grounds for and the functioning of the armed forces, soldiers, and civilian personnel, and the relations between them and other national and international entities, as well as a set of special provisions for armed forces during states of emergency, mainly martial law (and war), criminal law, and disciplinary provisions in the military [own transl.]” [1, p. 168].

In order to properly understand the nature of military law and to indicate its scope, it is necessary to clarify the role of the armed forces in the state and their tasks in times of peace, crisis, and war.

The Armed Forces are defined as a specialized body of the state designed to protect and defend its interests by using it as a deterrent against aggression or, if necessary, to conduct armed combat until it achieves its stated political objective. From the point of view of organizational structures, they can be divided into regular and irregular armed forces, and from the point of view of the nature of the operations conducted – into operational forces and territorial defense forces and means, and from the point of view of the environment in which they conduct operations – into land forces, air forces, and navies [2, p. 121].

In the opinion of Bolesław Balcerowicz, the key to understanding of the place and role of the armed forces is to properly recognize and understand the relations between politics and its tools. In his opinion, politics uses certain means to achieve its objectives, three of which should be considered the most important: diplomatic, economic and military means. Among them, B. Balcerowicz considers diplomatic means (together with normative and psychosocial means) as the most important, followed by economic means, while military means are considered to hold third place (and constitute a kind of a reserve). This is because military forces should be used as a last resort (although sometimes it is decisive). Moreover, B. Balcerowicz points out that the role and significance of military power in politics (especially in foreign policy) are different in different states: peace, crisis, and war. During a war, military power definitely plays a primary role. During a crisis, the role of the armed forces is significant, but not necessarily decisive. In peacetime, however, the tasks related to support of the policy of the state, including the role of deterrence, come to the fore [3, pp. 27–29]. A similar point of view on the role of the armed forces is also presented by Ole Wæver and Barry Buzan [4, pp. 417–435].

Armed forces are supported by military intelligence. The intelligence has always assisted military operations. Actually, military intelligence is as old as war itself. As Jan Goldman noted, “military intelligence is an agency of the armed forces

that obtains and analyzes and uses information of strategic or tactical military value information about the armed forces of another country that is useful in planning and conducting military policy or military operations” [5, kindle location 179].

As mentioned in previous considerations, the armed forces are a tool of the state that can be used both externally and internally. The basic and priority task of the Polish Armed Forces is to protect the sovereignty of the Polish state, its territorial integrity, and the inviolability of its borders. This is expressly stated in Article 26 of the Constitution of the Republic of Poland, which provides that “The Armed Forces of the Republic of Poland shall safeguard the independence and territorial integrity of the State, and shall ensure the security and inviolability of its borders” [6]. Thus, in the performance of their external function, the Polish Armed Forces serve to counteract aggression and eliminate military threats as well as to maintain peace and defend national sovereignty.

However, the armed forces also play an important role in ensuring the internal security of the state and thus perform their internal function. This is related, among others, to the evolution of threats in the security environment, especially the increase in the terrorist threat and the transformation of the contemporary dimension of terrorism. In the modern world, there is a growing tendency for the military to support both civil authorities and other uniformed services responsible for the internal security of the country [7, pp. 10–14].

The detailed tasks of the Polish Armed Forces in their internal function are specified in Article 3 (2) of the Act of 21 November 1967 on common defense duty, Journal of Laws of 2019 No 1541, the Armed Forces may take part in combat against natural disasters and elimination of their consequences, counter-terrorist and property protection activities, search and rescue operations or operations aimed to protect human health and life, clearing of explosives and hazardous materials of military origin from the land and their neutralization, as well as in performance of crisis management tasks [8].

As Grzegorz Sobolewski emphasized, the armed forces are an effective tool of the state intended for protection of society, maintaining national and state identity, and the preservation of sovereign authority. Thus, when defining the function of the armed forces in the system of national security, it can be assumed that its essence is an organized defense and protection against external and internal threats, and its effectiveness is expressed as an appropriate ratio of the protective and defensive potential given the scale of the existing threats [9, p. 35]. The constant evolution of the security environment means that the armed forces play an increasingly important role in combating new internal and external threats, such as cyber terrorism [10, pp. 23–25].

However, the Armed Forces should not play a leading or dominant role in providing assistance to civil authorities and other uniformed services. As W. Kitler noted, the role of the Polish Armed Forces in fulfilling its internal function should be supported and serviced, and military assistance is provided when there is an objective need for it. The military must not compete with civil institutions that are subordinated to government administration bodies or local governments, or

even with commercial entities. Decisions about the use of the Polish Armed Forces are made when there is an urgent need and when specific actions exceeds the capabilities of the civil authorities, human life is endangered, the situation is of a crisis nature, when the legal order in the state and human health and life are endangered [11, p. 48].

3. Subject matter of military law in the Republic of Poland

The military law system in the Republic of Poland consists of legal acts of various importance. As far as national law is concerned, these are both the provisions of the Constitution of the Republic of Poland, acts (mainly in such fields of law as administrative, criminal, business, and labor law), and regulations (mainly of the Council of Ministers, the Prime Minister, and the Minister of National Defense). Additionally, the system is to a very large extent developed by normative acts of internally binding law, such as instructions (of the President of the Republic of Poland), ordinances (of the President of the Republic of Poland, the Prime Minister, and the Minister of National Defense), resolutions (of the Council of Ministers), decisions (of the Minister of National Defense), guidelines and agreements, orders, bylaws, regulations, and enforcement regulations. It is also possible to point to legal acts of other central states authorities and acts of local law issued by local military administration bodies [1, p. 171]. Of course, provisions of international law also apply to military law, and international humanitarian law for armed conflicts plays a special role in this respect [12, pp. 69–94].

Military law is a separate part of national security law and defense law that regulates an extremely important aspect of national defense. Its special position is emphasized especially by the provisions of the Constitution of the Republic of Poland. The relevant legal regulations can be found, i.e., in the main principles of the system of government (chapter I), freedoms, rights and obligations of the human being and citizen (chapter II), tasks of the legislative and executive authorities (chapters IV, V, and VI), and matters related to states of emergency (chapter XI) [13]. Although, as can be seen, these regulations are located in different parts of the Constitution, they are strongly interrelated and should be considered together, as indicated by verdicts of the Constitutional Tribunal, as well as the views of the doctrine of legal sciences and security sciences [14, p. 15].

In order to organize military law in terms of its subject matter, it can be divided into several subject-specific blocks:

1. legal and systemic issues (including leadership and supervision over the Armed Forces of the Republic of Poland and the powers of the supreme authorities of the state);
2. issues related to the functioning and organization of the Polish Armed Forces;
3. issues related to military service;
4. issues related to military discipline and the criminal liability of soldiers;
5. issues related to the role of the Polish Armed Forces in emergency situations;

6. issues concerning the equipment of the Polish Armed Forces and management of military property;
7. issues related to the stay of the Polish Armed Forces abroad and the presence of foreign troops on the territory of the Republic of Poland; and
8. issues related to military education and the training of soldiers.

The first group is legal and systemic issues, including the issue of authority and supervision over the Armed Forces of the Republic of Poland and the powers of the state's supreme authorities in this area. These are primarily constitutional regulations. This is a classic constitutional regulation, because in constitutional law, these powers very often belong to the organs of legislative and executive power [15, pp. 119–123].

It should be noted that the Polish Armed Forces is the only uniformed formation to which the provisions of the Constitution of the Republic of Poland refer directly, which additionally emphasizes their special role in the state.

The aforementioned Article 26 of the Constitution, apart from the main mission of the Armed Forces, also indicates that "The Armed Forces shall observe neutrality regarding political matters and shall be subject to civil and democratic control." According to Article 134, the President of the Republic of Poland is the supreme commander of the Armed Forces of the Republic of Poland, and in peacetime, he exercises this authority through the Minister of National Defense. In addition, the President appoints the Chief of General Staff and the commanders of the branches of the Armed Forces, and during war, at the request of the Prime Minister, appoints the Commander-in-Chief of the Armed Forces. Moreover, pursuant to Article 136, in the event of a direct external threat to the state, the President, at the request of the Prime Minister, orders a full or partial mobilization and use of the Armed Forces to defend the Republic of Poland. With regard to the Council of Ministers, Article 146 (4) of the Constitution indicates that its scope of competence includes ensuring the external and internal security of the state and general management in the field of defense. As regards legislative power, pursuant to Article 95(2), the Sejm (lower chamber of the parliament) of the Republic of Poland exercises control over the activities of the Council of Ministers (and thus also of the Minister of National Defense) and, pursuant to Article 116, decides on behalf of the Republic of Poland on the state of war and the conclusion of peace. [6]

Apart from constitutional solutions, the issue of leadership of and supervision over the Armed Forces of the Republic of Poland and the powers of the supreme authorities of the state is also regulated in several acts, e.g. the Act on universal defense duty [16], the Act on the office of the Minister of National Defense [17], the Act on departments of government administration [18], the Act on martial law and the powers of the Supreme Commander of the Armed Forces [19], as well as in a resolution concerning the Rules of Procedure of the Sejm of the Republic of Poland (e.g. in the scope of parliamentary control powers) [20].

Another group of issues dealt with by military law concerns the functioning and organization of the Polish Armed

Forces. They include issues of leadership and command of the Armed Forces and organizational units of the military (including, but not limited to, the tasks and competencies of the Chief of the General Staff, the General Commander of the Branches of the Armed Forces, the Operational Commander of the Branches of the Armed Forces, the Commander of the Territorial Defense Forces, and the Commander-in-Chief of the Armed Forces in wartime); the organization of the Polish Armed Forces (including the division into the branches of Armed Forces – the Land Forces, the Air Force, the Navy, the Special Forces, and the Territorial Defense Forces); organization and functioning of the Military Police, the Military Counterintelligence Service, and the Military Intelligence Service; organization and functioning of military authorities and military administration; organization of personnel reserves administration; control in the Armed Forces; military diplomacy and organization of military attaché's offices; and cooperation of the Armed Forces with other state services and authorities. This broad subject matter is regulated by many acts, among which the following should be mentioned in particular: the Act on the universal defense duty, the Act on the office of the Minister of National Defense, the Act on the Military Police and military enforcement bodies [21], the Act on the Military Counterintelligence Service and the Military Intelligence Service [22], the Act on signs of the Armed Forces of the Republic of Poland [23], the Act on the protection of the state border [24], the Act on anti-terrorist operations [25], the Act on crisis management [26], the Act on martial law, and the competences of the Commander-in-Chief of the Armed Forces [27].

The next block of issues covers military service. These include, among others, the obligation to perform military service as part of the general defense duty; alternative service; professional military service; the rights and obligations of soldiers; the service relationship; models for the conduct of military service; appointments to senior military ranks and official positions; social and economic guarantees for soldiers (including soldiers' remuneration, awards, and benefits, Armed Forces' accommodation, health care, pensions, and disability benefits); apoliticism and professional ethics of soldiers; compensation benefits associated with military service; the labor code in military service; application of the code of administrative procedure in military service; status of Armed Forces' veterans; military grades and titles, as well as medals and decorations; military etiquette; and protection of personal data in the Armed Forces. The main legal acts in this field include the Act on the military service of professional soldiers [28], the Act on the universal defense duty, the Act on accommodation of the Armed Forces [29], the Act on pensions for professional soldiers and their families [30], the Act on alternative service [31], the Act on veterans of operations abroad [32], the Act on the protection of personal data [33], the Act on the protection of classified information [34], the Act on measures of direct coercion and firearms [35], the code of administrative procedure [36], and the labor code [37].

The next group of issues concerns military discipline and the criminal liability of soldiers. The key issues in this area

include military criminal law (including in particular offences specified in the Criminal Code and matters subject to the jurisdiction of military courts – criminal and criminal-fiscal proceedings, and misdemeanors); disciplinary liability of soldiers (including the principles of disciplinary liability, subjects in disciplinary proceedings, the role of disciplinary ombudsmen, the catalogue of sanctions, preventive measures, and the disciplinary procedure); organization and functioning of military courts; participation of the Military Police in activities intended to enforce military discipline; and the activities of military legal counsels and legal advisers. These issues are regulated, among others, by the Act on military discipline [38], the Criminal Code [39], the Code of Criminal Procedure [40], the Executive Criminal Code [41], the Fiscal Penal Code [42], the law on the system of military courts [43], and the Law on the public prosecutor's office [44].

Military law also regulates a group of issues related to the role of the Polish Armed Forces in emergency states: martial law, state of emergency, and state of natural disaster. These are primarily constitutional solutions, including the entire Chapter XI of the Constitution. Pursuant to Article 229 of the Constitution of the Republic of Poland, "in the case of external threats to the State, acts of armed aggression against the territory of the Republic of Poland or when an obligation of common defense against aggression arises by virtue of international agreement, the President of the Republic may, at the request of the Council of Ministers, declare a state of martial law in a part of or upon the whole territory of the State" and pursuant to Article 230 "in the case of threats to the constitutional order of the State, to security of the citizenry or public order, the President of the Republic may, on request of the Council of Ministers, introduce for a definite period no longer than 90 days, a state of emergency in a part of or upon the whole territory of the State. Extension of a state of emergency may be made once only for a period no longer than 60 days and with the consent of the Sejm." [45] On the other hand, the prerequisites for the introduction of the state of a natural disaster are laid down in Article 232 of the Constitution: "in order to prevent or remove the consequences of a natural catastrophe or a technological accident exhibiting characteristics of a natural disaster, the Council of Ministers may introduce, for a definite period no longer than 30 days, a state of natural disaster in a part of or upon the whole territory of the State. An extension of a state of natural disaster may be made with the consent of the Sejm". Detailed regulations concerning the role of the Armed Forces of the Republic of Poland during the three emergency states are contained mainly in three acts: the Act on martial law and the powers of the Commander-in-Chief of the Armed Forces, the Act on the state of emergency [46], and the Act on the state of natural disaster [47].

The next group of issues is related to the equipment of the Polish Armed Forces and the management of military property. The important issues in this group include financing and modernization of the Armed Forces; regulations on equipping the Armed Forces with weapons and military equipment and other materials related to military service; the

organization and functioning of the Military Property Agency (AMW); the principles of management of the housing and boarding contained in the resources at the disposal of the AMW; and the principles of management of the State Treasury property at the disposal of the AMW. It should be emphasized that the budget of the Ministry of National Defense (from which the Polish Armed Forces are financed) is subject to special regulations. Article 7(1) of the Act of 21 May 2001 on reconstruction and technical modernization and financing of the Polish Force Armed, Journal of Laws of 2019 No 1453, provides for a progressive increase in the expenditures related to the financing of defense needs amounting to not less than 2% of the GDP in 2018 and 2019, up to 2.5% of the GDP in 2030 [48]. As a result, the budget of the Ministry of National Defense in 2018 amounted to over PLN 41.5 billion [49, p. 2]. Detailed regulations concerning the equipment of the Polish Armed Forces and management of military property are included in the following acts: the Act on reconstruction and technical modernization and financing of the Polish Armed Forces, the Act on the Military Property Agency [50], the Act on public finance [51], the Act on real estate management [52], the Act on foreign trade in goods, technologies and services of strategic importance for national security [53], and the Act on public procurement law [54]. The important role of the budget law should also be emphasized.

In connection with Poland's membership in the North Atlantic Treaty Organization and the participation of the Polish Military in foreign military missions, the regulations concerning the stay of the Polish Armed Forces abroad are an important issue in military law. It is regulated primarily by the Act on the rules of use or stay of the Armed Forces of the Republic of Poland outside the borders of the state. On the other hand, the issue of the stationing in the territory of Poland of NATO troops and armed forces of other countries (both within the framework of joint exercises and maneuvers and for longer periods) is regulated by the Act on the rules of stay of foreign troops on the territory of the Republic of Poland and on the rules of their movement through this territory [55].

Military education and the training of soldiers are also a separate issue in military law. The military education system in the Republic of Poland currently comprises five higher education institutions subordinated to the Minister of National Defense. Three of them – the War Studies University in Warsaw, the Military University of Technology in Warsaw, and the Polish Naval Academy in Gdynia – were established on the basis of these statutes. The General Tadeusz Kościuszko Military University of Land Forces in Wrocław and the Polish Air Force Academy in Dęblin were established on the basis of regulations. All military universities and academies operate on the basis of the provisions of the Act on higher education and science and, at the same time, they have the status of military units. The military education system also comprises three non-commissioned officer schools (for the Army, the Navy, and the Air Force) established under the regulation of the Minister of National Defense, as well as eleven training centers (including the Signals and Information Technology Training Center in Zegrze, the Artillery and

Armament Training Center in Toruń, the Military Centre for Medical Education in Łódź, and the Military Training Centre for Military Police in Mińsk Mazowiecki). The principles of the education of soldiers are regulated in the Act on the service of professional soldiers and in the Regulation of the Minister of National Defense on the education of professional soldiers.

To conclude the discussion on the subject matter of military law, it should be emphasized that these issues are also covered by the norms of international law. In particular, international humanitarian law on armed conflicts plays an important role, regulating, among others, the legal status of persons in armed conflicts, the treatment of prisoners of war, civilians and vulnerable persons, as well as the prohibitions and restrictions on the use of means of armed combat, and the principles of conduct of combat (wartime necessity, humanitarianism, and proportionality). Issues concerning the general prohibition on the use of force in international relations and legal cases of use of armed forces, such as individual or collective self-defense, the authorization of the UN Security Council to use force, a national liberation war, a humanitarian intervention, and so-called brotherly aid, i.e. military intervention at the request of a legal government fighting against rebel or secessionist forces in its territory are also very important [56, pp. 123–140].

4. Conclusions

Given the important role of armed forces in a state in times of peace, crisis, and war, a set of legal norms that form military law is one of the key elements of national security. On the other hand, however, it is difficult to consider military law as a separate branch of law (within the meaning of the traditional division into branches of law applied in legal sciences in Poland). The main reason for this is that the scope of military law is vast (several hundred of various acts of universally binding and internally binding law) and includes legal regulations from various branches of law, such as constitutional law, administrative law, criminal law, business law, labor law, public international law, and others.

Consequently, military law derives from many branches and fields of law, constituting a separate field of law that regulates the basis for the functioning of the armed forces in a state. For practical purposes, it is useful to divide the scope of military law into subject-specific groups. One option is the division recommended in this article into legal and systemic issues, issues related to the functioning and organization of the Polish Armed Forces, issues related to military service, issues related to military discipline and criminal liability of soldiers, issues related to the role of the Polish Armed Forces in emergency states, issues related to equipment of the Polish Armed Forces and management of military property, issues related to the stay of the Polish Armed Forces abroad and the presence of foreign troops on the territory of the Republic of Poland, and issues related to military education and training of soldiers. It seems that such a division contributes to a better organization of the military law in the Republic of Poland.

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Ignorantia iuris nocet Principle in selected Polish legal regulations – outline of the problem

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Abstract

This article presents reflection made in the field of Roman legal thought in selected Polish legal regulations with potential impact on the functioning of the individual. The universal form of the principle – regardless of the legal system – implies a potential threat to the functioning of the individual in the form of uncertainty. The purpose of this publication is to indicate the need to update legal regulations regarding the indicated matter – in particular – in the form of an obligatory examination for the courts of the statute of limitations in a situation where a natural person is a party to the proceedings. Accurate provisions of the Code of Administrative Procedure, Code of Civil Procedure and selected court sentences were presented. In the research process, was made extensive use of qualitative research methods, including in the form of analyses (e.g.: legal and institutional analysis, comparative analysis, system analysis and methods: analysis and logical construction), generalization and implication. In turn, among quantitative research methods, intensively was used statistical analysis and a diagnostic sounding survey. In addition to the literature analysis – important support of the research process was the examination of documents (including provisions of national law) and available sources of knowledge about the problems studied. The source material included both open access and published studies in specialist journals. At this stage of the research, have been analysed the applicable legal regulations and selected sentences of Polish Courts. The mentioned above, empirical methods included the following: a diagnostic sounding survey – conducted in the form of surveys using the CAWI technique. The empirical stage of the research also consisted in the assessment of the legal status. The cognitive and utilitarian premises of the problems are the implementation of the adopted hypothesis: *Ignorantia iuris nocet Principle in connection with numerous amendments to regulations may have negative consequences for the functioning of the individual.*

Keywords: safety, law, Roman law

1. Introduction

Roman legal thought is considered the international foundation of legal knowledge, being not only an interpretation, but also a basis for subsequent legal regulations. The whole treasury of the network of concepts created on its basis, terminology

and rules – today, is used by the law authorities of the greater part of the modern world. Unfortunately, for citizens living in legal systems based on these principles and the interpretation based on them, it may imply adverse effects on the individuals who function in them.

The starting point of these considerations is one of the fundamental Roman maxims: *Ignorantia iuris nocet* – “ignorance of the law is harmful, not one can hide behind the ignorance of the law”. Threats resulting from this principle will be presented on the basis of an analysis, an example of which is the Polish organizational and legal system.

2. Number and volatility of legal provisions

The first criterion for the analysis is the legal volatility index, in which – according to calculations by Grant Thornton in 2012–2014 – Poland has achieved the highest level in the European Union. According to the estimation results (the verification coefficient was determined by the factor of the number and volume of the created legal acts), in the Polish legal system, on average, almost 56 times more provisions were made than in Sweden and 11 times more than in Lithuania. The indicated highest legal volatility indicator means not only an unpredictable legal reality for citizens, but also its uncertainty. In turn, these negative factors determine the potential danger to the functioning of an individual in a given legal system – especially in the area of an inability to keep up with emerging changes. It is worth adding that in 2016, the balance of enactment of legal acts in the form of laws and ordinances reached as high as 2,306. It should also be emphasized that in every legal act created, there are references to subsequent legal acts (from several appeals to even 24). An example of this is the Act of July 16, 2004 on the Telecommunications Law (Journal of Laws of 2004, no. 171 item 1800), which relations with other legal acts, both as an active or passive nature, are presented as follows:

- modified acts – 17,
- repealed act – 2,
- referrals – 7,
- executive acts – 147,
- amending act – 59.

Therefore, it becomes obvious that the possibility of functioning in a legal system with such intensity of change is only apparent and the citizen's situation – stable only until the collision incident does not exist in such an environment.

3. Judications

The consequences of the principle of harmfulness of ignorance of the law can be significant and disadvantageous for every individual – citizen. Starting from the lack of knowledge concerning the obligations resulting from the regulations, for which an obligation to pay specific taxes may be used (e.g. a perpetual usufruct fee – the user is not informed annually about the date and amount), after the possibility of evading from adverse consequences of actions or omissions – or simply implementing their rights. The Supreme Court in its justification of the decision of January 25, 2006 (The Supreme Court Order OSNC 2006/10/173, case I CK 233/05) stated that the functioning of the law, especially in a democratic state of law, is based on the assumption that all recipients of the applicable legal norm, i.e. both entities obliged to comply

with it and the bodies appointed to use it, know its proper content. This is the so-called fiction of the general knowledge of the law. Going further, it must be stated that this principle entails a state in which no one can evade the negative effects of a violation of the norm on the grounds that he did not know the norm or misunderstood it. In the judgment of the Supreme Administrative Court of July 13, 2018 (Supreme Administrative Court Sentence

Ref.: I OSK 990/18 – SAC judgment) it was stated that: In public law, the principle does not apply. However, in the next part of the discussion, an example will be illustrated, which confirms that placing an instruction in the administrative decision (or a verdict) indicating only the legal basis with quoting the relevant provisions is only a theoretical and apparent implementation of the thesis in practice. In the further part of the justification of the judgment, it can be read that: Requiring the authority to “instruct” the party in detail about its interpretation would go beyond the scope of the authority's duties resulting from the above principles (Judgment of the Supreme Administrative Court, Ref.: I OSK 990/18). It is worth indicating here the content of the referenced provisions of Article 8. § 1. and Article 9 of the *Code of Administrative Procedure* (Journal of Laws 1960 No. 30 item 168, as amended):

- Public administration bodies conduct proceedings in a way that evokes the trust of its participants to public authorities, guided by the principles of proportionality, impartiality and equal treatment (Article 8, The CoAP, Journal of Laws 1960 No. 30 item 168).
- Public administration bodies are obliged to duly and comprehensively inform the parties about the factual and legal circumstances that may affect the determination of their rights and obligations being the subject of administrative proceedings. The authorities ensure that the parties and other persons participating in the proceedings do not suffer any damage due to ignorance of the law, and for this purpose, they provide them with necessary explanations and instructions (Article 9, The CoAP, Journal of Laws 1960 No. 30 item 168, as amended).

4. Selected consequences and possibilities of solutions

The Polish legal system lacks not only a comprehensive education program at the basic level in the field of the knowledge of the foundations of law and its continuation at higher levels, but also system solutions in the area of citizen – state institution relations. Becoming familiar with and understanding the complicated legal status on the part of a citizen without legal training is objectively impossible. This fact does not concern the regulations themselves, but, in particular, related procedures. Burdened with forms and appropriate sequence of procedural events – including even deadlines for submitting relevant documents – the citizen becomes defenseless in a machine of incomprehensible records. The institution of the statute of limitations will be the crown example here. In the Polish legal system, the rule is that the limitation period for property claims is now 6 years. However, there are

significant exceptions to this rule, for example, periodic (repetitive) claims, which expire after 3 years, or resulting from a sales contract that expires after 2 years (concerning only claims of entrepreneurs). The principle is also that the limitation of claims does not cause their termination – they can be claimed, however, after the expiry of the limitation period, the one who is entitled to the claim, may evade its satisfaction, which means no need to meet it. The beginning of the claim settlement procedure takes place at the moment of the call to fulfil the claim (pre-court proceedings), and then with the referral to the lawsuit, however, it is crucial to indicate the type of procedure by the plaintiff (order mode). The possibility of evading the defendant's fulfilment

of the claim only takes place at the moment of the response to the statement of claim and the limitation of the claim. In this situation, two issues are of key importance, namely the lack of judicial control from the office of expiration of the limitation period and the inability to reverse the role of the debtor. It is undisputed that an examination from the office of expiration of the limitation period for persons without a professional attorney would be the implementation of a guarantee of equality before the law – especially in the aspect of having specialist knowledge. The second issue – the reversal of the role – refers to the inability of the debtor to submit a pleading to terminate the overdue liability relationship, which is still dependent on the plaintiff's decision (whether such a letter will ever be filed). The purpose of the previous considerations is not – obviously – gaining an advantage for the debtor, but in practice, debt collection companies often make massive purchases of obsolete liabilities for an undervalued value due to the debtors' low level of legal awareness. The issue of court limitation control was reflected in the draft of the Ministry of Justice of the Republic of Poland (as of May 31, 2018). However, there are no changes in the scope of the abstraction of the debtor's obligation of absolution. The adoption of such a solution in the legal system would allow balancing the position of the parties to the ratio of the obligation, which is currently non-existent. Until the plaintiff has lodged the claim, it still exists, causing the suspended state – possible to be solved by the debtor only by repayment. It is worth pointing to the research carried out in the area of level of knowledge in the field of expiration institutions.

5. Results of research

Respondents indicated that the institution was known to them in the same percentage share, i.e. 74.4 % (Fig.1.), in which these persons were parties to the proceedings related to issuing the payment order (Fig. 2.), but only 10.3 % of them used the expiration institution (research carried out by the author with the CAWI method. August 2018). On the other hand, the question of whether the respondents are familiar with the rules of the expiration in force in civil law – only 64.1 % of respondents answered affirmatively.

This example is of great importance in the context of potential threats – understood in the discussed matter as uncertainties – for the functioning of the individual. For the

question of whether the respondents know the provisions regarding the expiration of the limitation period – only 64.1% of respondents answered in the affirmative.

Particularly noteworthy is the fact that as many as for 46% of the respondents, instructions attached to the pleadings are incomprehensible.

Are the instructions attached to the pleadings understandable?

Do you know the institution of expiration of the limitation period in Polish law?

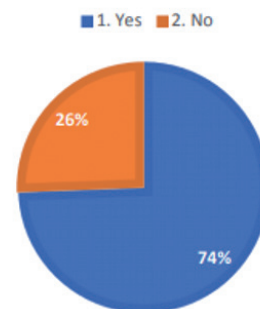


Fig.1. The result of the answers given to the survey question in the field of the institutions of limitation in the Polish legal system.

Have you been a party to legal proceedings for issuing a payment order?

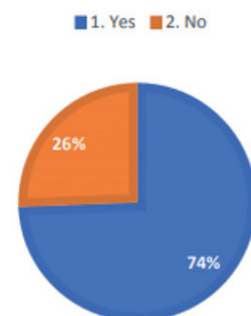


Fig. 2. The results of the questionnaire regarding participation in preparatory proceedings.

If you were a party to the proceedings, did you use the statute of expiration of the limitation period?

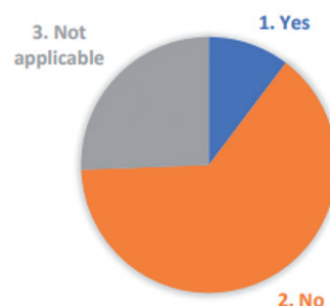


Fig. 3. The results of answers provided in the use of the expiration of the limitation period institution provided for by the law.

Does the instructions attached to the pleadings are comprehensible?



Fig. 4. The results of answers given to a question regarding the content of instructions attached to official letters.

For the question of whether the court should examine “ex officio” the possibility of limitation in property cases regarding payment orders – as many as 61.5% of respondents answered affirmatively in relation to 10.3% who provided negative answers.

In your opinion, should the court examine ex officio the limitation period in cases concerning payment orders?

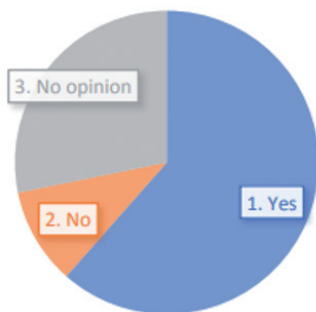


Fig. 5. The results of the answer to the question regarding obligatory examination by the court of expiration of the limitation period.

This example is of great importance in the context of potential threats – understood in the discussed matter as uncertainty – for the functioning of the individual.

6. Implications

The fact that there is an objective inequality of the parties is obvious – especially visible in citizen – state institution relations, in particular in the course of administrative proceedings. In accordance with the general principles of administrative law, contained in Act of June 14, 1960 – Code of Administrative Procedure, Journal of Law of 1960 No. 30 item 168, as amended), public administration bodies are obliged to duly and comprehensively inform the parties to the proceedings about the factual and legal circumstances that may affect the determination of their rights and obligations subject to administrative proceedings. The authorities ensure that the parties and other persons involved in the proceedings do not suffer damage due to ignorance of the law, and for this purpose provide them with necessary explanations

and instructions (Journal of Law of 1960 No. 30 item 168, as amended). This principle has been specified, among others, in the provisions on the obligation to indicate in the request of legal consequences of failure to comply with the summons, information on the consequences of failing to fill in the missing parts (leaving the application without recognition), informing the parties about the legal consequences of the suspension of proceedings at the party's request and instruction on admissibility and procedure in relation to an administrative

court. In this respect, the fact that the content of instructions is usually complex and incomprehensible for the citizen, which results in the inability to properly identify the legal situation as a party of the proceedings, which is also confirmed by the results of the research is of key importance. The consequence of this state of affairs may be the necessity of using professional services or leaving the matter without further action. An example may be the institution of restoring the date, which, however, in accordance with Article 58 of the indicated Act – is initiated at the request of a party together with the requirement to meet two prerequisites altogether, namely: submission of an application for reinstatement of the defaulted date and substantiation that the fault occurred without the fault of the applicant. An additional requirement is the deadline of 7 days from the day of cessation of the reason for the failure to comply with the deadline with the simultaneous completion of the activity for which the data was specified. It should be emphasized that the decision of the public administration authority to suspend a decision or a verdict in the event of a request to restore the deadline for lodging an appeal or complaint also requires the party to expressly request, however, in accordance with the provision of Article 60. of the Code of Administrative Proceedings, the authority may, but does not have to, accept the applicant's request in this regard (sic!). The decision cannot be enforced only within the time limit set for lodging an appeal. Returning to the example indicated in point 2 – the analyzed cases of administrative decisions indicate the use of a general formula in the instructions, which consists in indicating the provisions of Chapter 10 of the Code of Administrative Proceedings. Although Article 128 indicates that there is no need to prepare a special justification, it must result from it that the party is not satisfied with the decision issued. In practice, this means that it is not enough to express a lack of satisfaction by the party with one sentence. In addition, the second sentence of the abovementioned provision indicates the possibility of the existence of other requirements regarding the content of the appeal, which in fact confirms the thesis regarding a citizen's apparent right of to be ignorant of the administrative provisions. The example instructions attached to the order for payment in the ordering proceedings contain the following provisions:

1. Article 493 § 1. of the *Code of Civil Procedure* (Journal of Laws 2019 No. 1460), which: indicates the jurisdiction of the court that issued the order for payment and as the competent to file a letter containing the charges. It also indicates that the respondent should indicate whether he or she is appealing against the order in whole or in part,

which should be reported under pain of losing the case, as well as the facts and evidence.

The court disregards the delayed claims and evidence, unless the party makes it probable that they did not report them in the charges without their fault or that the inclusion of late claims and evidence would not cause delay in the consideration of the case or other exceptional circumstances (Journal of Laws 2018.0.1360).

Paragraph 2 indicates the absolute requirement to file the charges on the official form, if the claim was filed in this form.

2. Article 165 § 1. of the Code of Civil Procedure: Deadlines are calculated according to the provisions of the civil law. § 2. Submission of the procedural letter in the Polish post office of the designated operator within the meaning of the Act of November 23, 2012 – the Postal Law or in the postal service of the operator providing postal universal services in another EU member state is tantamount to submitting it to court (Journal of Laws 2019 No. 1460).
3. The applicant and participants in the proceedings and their representatives are obliged to notify the court about any change in their place of residence. In the event of negligence of this obligation, the court letter shall be left in the case file with the effect of delivery, unless the new address is known to the court (Journal of Laws 2019 No. 1460).

7. Conclusions

Summarizing the considerations in the matter covered by the subject, it should be pointed out that education in the scope of binding legal provisions most often concerns the hierarchy of norms, branches of law and general characteristics thereof. The later knowledge in practical terms comes, in principle, along with life experience. This fact causes a key paradox: the state requires its citizens to know the provisions of the applicable law without providing the opportunity for proper education in this area. The result of such incongruence is the intellectual overpowering of their own citizens who become defenseless against the existing system. This thesis is clearly confirmed by the words of the Human Rights Ombudsman, who explicitly stated: The address of the legal norm is not able to become acquainted with its contents without the professionals, and thus determine the scope of his rights and obligations.

This makes most citizens hostages of administrative bodies and accidental, usually selective and ad hoc, legal advice. Complaints that are received in this regard by the Office of the HRO constitute the majority of all complaints (Kochanowski, 2018).

In addition, apart from the relationship between the state and the citizen, the situation also applied to others, such as the client – entrepreneur relationship. This is evidenced by the adoption of contractual forms that are not negotiable and the use of abusive clauses by entities. For example, in the register of prohibited provisions announced on the website of the Polish Office of Competition and Consumer Protection, there are over 7,100 of such patterns (sic!).

Returning to the main thought, as it has been aptly observed by the Human Rights Ombudsman already mentioned: in a democratic state of law, one of the basic principles defining relations between a citizen and the state is the principle of protection of the citizen's trust in the state and its law, which is part of the democratic state rule (Kochanowski, 2018). This thesis is confirmed in particular by the ruling of the Constitutional Tribunal, also referred to by the HRO: In addition, the convergent position expressed in the case law of the Supreme Court should be pointed out, in which it was stated that the principle of trust in relations between a citizen and a state manifests itself among others in such making and exercising of the law that it would not become a kind of a trap for citizens and that they could entrust their affairs knowing that they will not expose themselves to legal consequences which they could not predict at the time of making decisions and taking actions, and that their actions under the applicable law and all related consequences will also be recognized later through the legal order (Judgment in the name of the Republic of Poland of May 24, 1994 (Constitutional Tribunal sentence of May 24, 1994, Case no. K. 1/94).

Conducted research allows to state, that *Ignorantia iuris nocet* Principle may have negative consequences for the functioning of the individual, for example the inability to use the provided rights or negative financial consequences (e.g. ignorance of the possibility of invoking the limitation period for the claim).

The necessity of revising the Roman principle, which in most cases is harmful to the individual, is beyond doubt. There is no objective possibility of some functioning in the legal system to which the individual is not prepared.

The polemic that comes to mind – by analogy – to other specialized fields, such as medicine, must give way, due to its nature. A hypothetically healthy individual may never encounter the necessity of using medical services, however, it is not possible to function outside the legal system of the state. Therefore, it becomes obvious that the possibility of functioning in a legal system with such an intensification of changes is only apparent and the situation of the citizen – stable only to the point where there is no collision incident in such an environment. The uncertainty of the individual's functioning is only one of the negative implications of the principle under discussion, but – undoubtedly – the most significant one.

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Transformation of Military Leadership as an Element Constituting Military Security

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Abstract

The armed forces of NATO, the foundation of military security in the collective and individual sense, have been, for years, constituting the determinants shaping their interoperability and effectiveness. Such actions are taken with varying intensity by all members also in terms of military leadership. The scope and comprehensiveness of these actions mainly oscillate around the perception of leadership in the context of the tool for shaping interpersonal relationships. The goal of the organizational context, which less attention is put to, is the proper selection and training of the leaders, who are not accidentally appointed, but were chosen on the basis of a thoughtful process. Therefore, in the area of leadership considered an important organizational phenomenon, a variety of transformations are carried out, which are intended to improve leadership and the units implementing them, so it is used for the benefit of the armed forces. The Polish armed forces have also undertaken such actions. Their scope is to be based on a broad analysis of leadership conducted in 2018. However, ensuring the optimization of further action requires the recognition of the most significant leadership transformations that have been implemented by the Alliance's leading armed forces and are a guarantor of substantially higher quality of military leadership. These transformations are described and discussed in this paper.

Keywords: military security, military leadership, leadership transformations.

1. Introduction

The armed forces of the countries that have joined and join the North Atlantic Treaty Organization undergo transformations, whose goal is to improve their alignment with the general requirements of allied interoperability. These transformations concern not only military equipment, but also patterns that are related to the personnel image of the armed forces; they are necessary to create an adequate level of military security.

One of the important elements of the social transformation of the armed forces is the evolution of military leadership and its integration in command. In the modern model of the

armed forces, leadership is intended to be a determinant not only of interpersonal relations, but also organizational culture and the atmosphere of service and work. At the same time, it does not undermine the principle of single-person command and does not interfere with the hierarchical nature of military organizations.

Such a formulated objective can be achieved by carrying out multifaceted actions in terms of full implementation of the goal combined with the building of a culture of military leadership. However, the scope of these actions differ in various NATO member countries. The best solutions are comprehensive leadership models that cover all relevant organizational,

interpersonal, and individual aspects. Polish efforts to develop military leadership have also been developed. However, as it is demonstrated by the 2018 extensive analysis of the Polish armed forces (RKP, 2018) the undertaken actions are far from the best NATO practices and models. These models, based on the achievements of management theories, point to a path that can be followed in order to create out of military leadership an organizational phenomenon that has the capability to affect the level of military security of the state and the Alliance as a whole.

The considerations presented in this paper are based on the results of the already mentioned analysis, in which the author participated as an expert and a member of the design team, as well as the author's qualitative comparative studies on military leadership models in NATO. The generalized results of this analysis and the research carried out focus on the most important aspects of leadership that determine its image and quality, and indirectly influence the level of military security in both the national and NATO context.

2. Leadership Philosophy

Military leadership in NATO countries is not based on uniform assumptions. National armed forces, when developing their own solutions, often rely on domestic management theories. However, the common denominator of the approach to leadership as a element that shapes military security treats it, as the Canadian Military Doctrine puts it, "as an important moral factor of the military power" (JDB, 2009, p. 3–4), or as the British Army (APD, 2010, p. 2.2.) or Dutch Army (NDD, 2005, p. 50) see it, namely, as a part of the moral component of the

combat force. This approach can also be much broader, as can be seen in the views expressed by the command of the American armed forces, where leadership is not only associated with morale, but is additionally a multiplication component that unifies other elements of combat power (Operation, 2011, p. 4–1.). Therefore, leadership in a number of NATO member states armies is not merely a relationship between the leader and their supporters, but it is also, from the perspective of military organization, a relevant phenomenon that is often referred to as "the lifeblood of an army" (DL, 2012, p. 1).

This approach to leadership is based on the generally assumed standpoint that success in combat depends on people more than on the best equipment or tactics. Moreover, effective leadership, as characterized by the British armed forces, is the externalization of personalities and objectives of the activities carried out (DL, 2012, p. 5) which, when directed towards people and situations, will ensure victory in the most demanding circumstances. At the same time, the basis of military leadership is a collection of moral values that are quite similar to those of many NATO member states, which is demonstrated in Table 1.

The proposed solutions recognize that the sound and authentic moral values, adopted as the basis of the leadership of all military leaders, are intended to make that leadership moral, fair, and accepted by the collective of soldiers and civilian personnel at different levels of command of the armed forces. However, the pursuit to base military leadership on the commonly adopted values and moral principles should bring forth the realization that both the leaders and their supporters can interpret specific values, moral standards, or sets of norms differently. Justice, honesty, equality, and responsibility can

Table 1. The Fundamental Moral Values of the Selected NATO Armed Forces

Canada	United Kingdom	U.S.A.	Germany	Poland
courage	courage	personal courage	courage	courage
duty	selfless engagement	selfless service	allegiance and conscientiousness	patriotism
loyalty	loyalty	loyalty	camaraderie and tactfulness	vocational solidarity
	discipline	obligation	discipline	responsibility
	respect for others	respect		dignity
integrity	integrity	honor		honor
		honesty	honesty and tolerance	honesty
			openness to other cultures	prudence
				justice
			competency and willingness to learn	bravery
			righteousness in relation to to oneself and other	truthfulness

Source: Based on (DWH, 2006, p. 16 & next); (APD, 2010, pp. 2-19-2-22); (IF, 2008, paragraph 102), (KHZZ, 2008).

have divergent interpretations, even among people with high moral standards. Therefore, extensive explanations, which are included in the best solutions, are needed because they introduce proper interpretation schemes.

Still, the adopted standpoints do not overestimate these values. It is recognized that even the best set of values is only a necessary, but insufficient condition for effective military leadership. The rightness of the act depends as well on the person, time and place, the nature of the environment, the participating people, the resources used, and many other factors. This is particularly important in military leadership at higher organization levels, where ethical choices are much more complicated and difficult to make. That is why other areas of transformation are also important, including comprehensive organizational solutions and appropriate educational and training models to improve the skills of military leaders at different levels of organization.

3. Organizational Solutions

Comprehensive models of military leadership, as in the case of most leadership theories, pay special attention to the importance of dynamic relationships between the leader, supporters, and the situation, including the factor of various elements that strengthen or weaken the leader's authority. The consequence of this approach is the emphasis on the issue of the proper selection of candidates for military leaders in the armed forces using such models. Real leaders do not appear accidentally, but rather on account of a selection process that identifies individuals who fit the military academies' programs and training centers, and further training based on established criteria.

The eligibility and selection criteria for candidates to participate in an education program or training are formulated on the basis of the general and detailed characteristics of the leader the given education form is designed for. An example of the general characteristics is the *Leadership Requirements Model* (LRM) (ADP, 2019, p.1–6), which contains the competences and attributes of the leader additionally described and explained in detail (in chapters 2 to 7), so that they are properly understood and can be accurately assessed.

On the other hand, the general characteristics are detailed, as in Canadian solutions, with a simplified model of leadership based on the system approach. It assumes a number of relationships between the various factors affecting the functioning and influence of the leader. These are four main groups of variables in this model, namely, the characteristics and behavior of the leader, individual and group factors, situational factors, and the achieved results. Effective leadership, according to the adopted assumptions, is to be ensured by the proper characteristics of the leader, which consists of: knowledge and skills, cognitive abilities, social competences, individual characteristics, vocational motivation, and adopted values. It is the foundation of the developed *Leader Development Framework* (LCF, 2007, p. 150), which differentiates four levels of leadership skills necessary to appropriately fulfill the leadership role at different organizational levels, as shown in Figure 1.

Figure 1. Framework Model of Leader Development
LEADER ELEMENTS

Leader levels	EXPERTISE	COGNITIVE CAPACITIES	SOCIAL CAPACITIES	CHANGE CAPACITIES	PROFFESIONAL IDEOLOGY
SENIOR	STRATEGIC	CREATIVE ABSTRACT	INTER-INSTITUTIONAL	PARADIGM SHIFTING	STEWARSHIP
ADVANCED	↑	↑	↑	↑	↑
INTERMEDIATE	↑	↑	↑	↑	↑
JUNIOR	TACTICAL	ANALITICAL	INTER-PERSONAL	OPEN	INTERNALIZE

Source: LCF, 2007, p. 150.

In order to achieve an adequate level of assessment, candidates for leaders of various levels must demonstrate different capacity ranges in five areas and related to them 16 attributes characterized in the descriptive part of the model (Edwards, Bentley, Walker, 2006, p. 10). Particular capacity areas include the following elements:

- expertise, including technical and specialist skills;
- cognitive abilities, including analytic skills, ability to make decisions, creativity;
- social skills, including flexibility, interpersonal, team and communicative skills;
- ability to change, including self-development, ability to form a group, ability to learn and build a learning organization;
- professional ideology, i.e. acquiring ethos, moral reasoning, reliability (LCF, 2007, p. 130).

The Americans use a very similar classification in their armed forces, distinguishing five categories of military leadership levels (Riley et al., 2013, p. 5), ranked according to the level of capability and opinion achieved in the assessed areas, as presented in Table 2.

Each of these categories is described in detail (Riley et al., 2013, p. 7 & n.), including proper indicators and their measurements, which provide an adequate assessment of individual efficiency and in relation to the particular organizational levels. Moreover, each category is enriched by specific saturation conditions that are treated as additional variables.

Due to the transformation of organizational structures and the new challenges faced by the armed forces, more and more attention is paid to leadership concepts in the functioning of the leader in various teams at every organizational level. At the same time, at the level of command, where there is a need for cooperation between lieutenants and officers, the relationship between the commander and the senior non-commissioned officer that ensures the building of the right image and good level of leadership is an element that is strongly emphasized as is the case in Canadian (Banks, 2006, p. 3), English, or American solutions. This approach stems from experiences from contemporary conflicts, which have shown that the rank of non-commissioned officers has increased not only as direct leaders of different levels, but also as leaders whose action can affect achieving goals at a much higher level, including

Table 2. Categories of Leadership Levels and Their Description

Exceptional leaders	Demonstrate excellence in leadership
High-performing leaders	Demonstrate very effective leadership; generally exceed basic expectations
Proficient leaders	Demonstrate sound leadership; generally meet basic expectations
Low-performing leaders	Have potential for improvement; strive toward basic expectations, but are still learning
Non-performing leaders	Have questionable potential for improvement; failing to meet most basic expectations

Source: Riley et al., 2013, p. 5.

the strategic ones (English, 2006, p. 48). Therefore, there are solutions that indicate the need to jointly train officers and non-commissioned officers at the proper levels of leadership in order to provide the opportunity to learn how to *be flexible in terms of style, but hardly follow the rules* (Kouzes, Posner, 2010, p. 47), what is supposed to enable appropriate contact with others on an emotional level.

Treating leadership as an organizational phenomenon also requires noting that creating effective solutions related to selection, competence management, and developing leadership skills is conditioned by the adoption of three organizational leadership levels. This division, currently used in many solutions of the Alliance army, and initiated by the Americans, is based on the structure of organizational levels found in management theory and specifies the following types of leadership:

- direct leadership – related to constant, direct contact and influencing leaders – typical for the commanders of the squad-company level, and often battalion, as well as the superiors in relation to the group of direct associates;
- organizational leadership – related to influencing on the organization (structure) indirectly through direct leaders, and a group of direct associates – typical at the level of regiments, brigades, divisions and corps, as well as in staff positions;
- strategic leadership – related to influencing by establishing objectives, standards, and various concepts for the whole organization – typical of the military executives.

This division is also of great importance for shaping military security by classifying and preparing potential units that can have a significant impact on it.

Leadership transformations also include building national structures responsible for creating and improving assumptions, as well as educating and training leaders at all levels. In the German army, such a solution was established in 1956 in the form of a school, and then a center – *Zentrum Innere Führung* in Koblenz. The Center is an active creator of leadership objectives, and an institution that is responsible for education and training in that field, as well as organizing various courses. The Center is also the implementer of new solutions in the area of shaping leadership skills..

The Center for the Army Profession and Leadership (CA-PL)¹ is currently playing a similar role in the U.S. military.

¹ It is part of The U.S. Army Combined Arms Center in Fort Leavenworth Kansas and has been operating since April 2019.

The Center develops doctrines and leadership development programs at different levels; it conducts research on requirements, developmental trends, improvement of capabilities and skills necessary for effective leadership. Furthermore, it develops other products and services used in the education of leadership candidates and creates new resources for the e-learning system with materials on leadership.

In contrast, in the British Army, the institution that focuses on leadership issues, the Defence Leadership Centre, established in 2002, operates as part of the Defence Academy of the United Kingdom in Shrivenham. The center deals with the educational aspect of leadership and supports various research projects that refer not only to the definition of its framework, but also tries to identify the fundamental differences between leadership and command or management in the military environment.

Of course, also at the NATO level, due to the rank attributed to leadership and its impact on military security, there are actions taken to institutionalize leadership.

Another organizational aspect of leadership, the importance of which has been significantly increasing in recent years is the culture of leadership. It stems from the fact that there is a similar interaction between leadership and organizational culture as between the leader and the ones who follow them, i.e., a mutual influence that determines both the form of leadership and behavior of the leader, as well as the shape of the organizational culture. At the same time, the leader often becomes, as E.H. Schein points out, a kind of animator of organizational culture in organizations that are created from scratch or have undergone significant reorganization changes. Then it is the leader's values, principles, behaviors, and rituals they have initiated that can significantly create the basics of the organizational culture (Schein, 1997, p. 82). Leaders with strong authority, thanks to their actions, adopted and conveyed values, behaviors, as well as the methods of conduct shape their followers, and indirectly, forge the culture of leadership in the community. Such a created culture of leadership demonstrates several important features, among which there are:

- an organizational climate conducive to unity, cohesion, and trust;
- promotion and rewarding mental skills of individuals and their ability to break with established paradigms and employ new solutions;
- choosing and rewarding leaders who have clear priorities and are focused on a specific mission;

- requiring and rewarding the transfer of responsibility by leaders;
- providing support to individuals and leaders using emerging opportunities.

However, the development of such a culture will not happen spontaneously, because it is initiated by properly prepared top-level leaders who understand and convey a clear vision of creating a working environment that will attract the staff sharing the same values. Still, despite the great consistency of the military environment in creating a culture of leadership, cultural differences must also be taken into account. These differences are manifested with the meaning given to the attributes that refer to particular people, e.g., a pilot, ship's captain, commando, tank soldier, artillery officer, as well as their distinctive attributes. They should be also seen between the personal corps and in all kinds of armed forces and troops. It means that only an adequate understanding and use of these differences, based on the knowledge gained by the leaders during their education and training, can result in a culture of leadership that has the power to transform the level of military security.

4. The Education and Improvement of Leaders

Effective education and teaching strategies are an essential element of military leadership models. They arose, like current leadership concepts, in a number of NATO armies at the end of the last and the beginning of the present century. They are based on the assumption that the development of the leader must cover all functional groups and components, and is continued from the moment of candidacy until the end of military service.

In comprehensive models of leadership, it is assumed that leaders "are developed through the career-long synthesis of the training, education, and experiences acquired through opportunities in the institutional, operational, and self-development domains" (ATDL, 2017, p. 247).

The current training challenge, in terms of military leadership, seems to be the optimization, synchronization, and support of education at military universities and training centers, in military units, and self-development that ensure the preparation of leaders at all levels capable of responding in various military operations. Therefore, the training of leaders in the currently adopted solutions is based on the principle of learning through interaction of theory (principles) and practice (experience), or vice versa, i.e., supported by exercises, examples, and case studies, as it is shown in Figure 2.

Generally speaking, the education and training of leaders is now divided into two types, namely:

1. education and training consisting in preparing candidates for leadership positions;
2. education and training improving leadership skills during the stay with the group they lead.

Although the unification of this element of leadership seems crucial, the detailed solutions of the various armies of the Alliance are significantly different. This results from the diversity of the approach to the education of individual

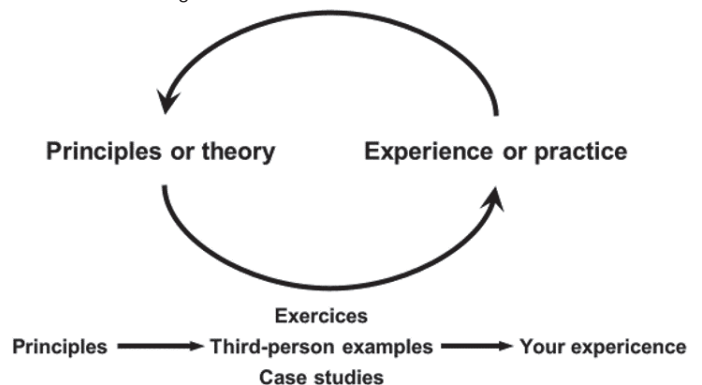
personal corps and the traditions associated with the relationship of the officer and non-commissioned officer, which are not yet uniform in all NATO armies. It is then an aspect of leadership that will be reorganized in many armies over the coming years in order to ensure an adequate level of allied interoperability.

Mentoring is the last element of improving leadership skills. It is becoming increasingly important. Its revival, because historically it is not a new phenomenon, is intended to make leaders reach successive levels of leadership responsibility better and faster, as well as to increase staff satisfaction. At the same time, as it is known from more than 20 years of research conducted by J.M. Kouzes and B.Z. Posner (Kouzes, Posner, 2008, p. 106), each skill can be strengthened, trained, improved if the leader has the motivation, will, and a chance to train and the opportunity to receive preliminary guidance and feedback that are provided by proper mentoring. Therefore, the current approach in comprehensive leadership models points out that organizing counselling sessions on professional development and feedback provided by senior leaders can significantly affect subordinates in terms of being able to identify one's own strengths and developmental needs, as well as designing a development plan as a leader (ADP, 2019, p. 3–6).

Mentoring is also intended to help mentees to identify and prepare for the positions that best fit their needs and interests. Its implementation, although stereotypically perceived as the younger-older relationship, can also depend on the length of employment, experience, or knowledge, and then the younger person can mentor the older one as a field expert. Mentoring relationships in leadership give both mentors and mentees a great opportunity to broaden their skills, not only leadership related, but also interpersonal and technical, which, especially in senior positions, can have a significant impact on military security. Preparation to become a mentor requires proper formation. It seems, however, that that need is still not recognized enough to commence the education and training of leaders in many armed forces.

The author's research and analysis carried out in the Polish armed forces indicates that intensification is required in another aspect of the leader's training, namely in

Figure 2. Interaction between Theory and Practice during the Process of Leader's Training



Source: Adair, 2007, p. 97.

self-development. After more than 30 years of research, R. Boyatzis (Goleman, Boyatzis, McKee, p. 129 & n.) points out that it is an equally important form of improving leadership skills as education and training. Self-development, however, is possible in organizational conditions conducive to learning and improving one's leadership skills, i.e., with significant support from higher-level leaders, who can themselves also initiate it through their own example of culture of learning. At the same time, it is necessary for the trainees to be aware that military leaders must learn on their own, and that it is required by the organization, which will also take this aspect into account in the individual assessment of the level of leadership.

5. Conclusion

Leadership in the military environment will be subject to continued transformations resulting from its role as a component of functional operational capabilities and a multifaceted organizational phenomenon. In the armed forces, as well as in other areas of life, the basis of these transformations is mainly the progressively higher awareness of the participants on the relationship necessary to build the position of the leader and the virtualization of the functioning of personnel. The latter problem related to the technological modernization of the armed forces will, in particular, force individuals who claim to be the leader, at each level, to keep acquiring new skills, and use, in their surroundings, solutions to ensure the most valuable aspects of leadership, namely, a direct relationship between the leader and the ones they lead.

The guidelines and comprehensive leadership models created by the Alliance's leading armed forces are very extensive. They are there to address the comprehensive organizational needs necessary for efficient functioning as a foundation for military security. That is why they take into account various aspects of the functioning of leaders at all organizational levels. This is the direction of military leadership transformation, which, if applied in other NATO armies, will significantly affect the performance of interoperability. It will also shape military security by improving the quality of the moral component of the military (combat) of particular armed forces. The scientific facts presented demonstrate that this is possible if a broader and more comprehensive view of military leadership and its impact on the functioning of the armed forces is adopted, and many important aspects of military leadership will be recognized, as well as the possibility of their further modification.

Solutions that seem most important in constituting models of military leadership, which is meant to positively influence military security, are, i.e., the following aspects: the proper selection of candidates for leaders at all levels, a precise definition and description of the leadership levels and sets of leadership skills for all leadership levels. A coherent framework model for the development and improvement of military leaders also seems necessary. An important element of support is the creation of a culture of leadership and the expansion of mentoring and intensification of self-development shaping the military leaders, especially at the operational and strategic levels.

The new challenge for further transformations of military leadership are the problems that have occurred during contemporary operations, e.g., in counter-insurgency operations. The valuable conclusions that can be used to modify national solutions for military leadership are the experiences of the national and allied armies acquired during the operations in Iraq, Afghanistan, Libya, and Syria. Monitoring civil environment solutions that bring about increasingly refined, sometimes surprising, solutions to leadership approaches also appears to be necessary.

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Methodological Basis of Logistic Support of the Air Force of the Armed Forces of Ukraine

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Abstract

This article proposes a unified theory of logistics for the Air Forces of the Armed Forces of Ukraine based on the existing theories of armament and the logistics of the Armed Forces, and on the general laws and established consistent patterns, trends, principles, forms and methods of the use of the logistics of the Air Forces of the Armed Forces of Ukraine. The objective function of the logistics system of the Air Forces of the Armed Forces of Ukraine is formulated to achieve compliance of the capabilities of this system with the predicted volume of logistics tasks. In order to implement this compliance, it is necessary to ensure the convergence of requirements and capabilities at all levels of logistics management. The assessment of the functioning of the Air Forces logistics system of the Armed Forces of Ukraine is proposed on the basis of the stated views on the logistics theory of the Air Forces of the Armed Forces of Ukraine by assessing the set of real capabilities of each subsystem that is a part of its structure and system as a whole. At the same time, the assessment of the quality of the logistic support of the military units (formations) of the Air Forces of the Armed Forces of Ukraine should be related to the level of implementation of the potential capabilities of the logistics system when solving problems of each subsystem at the various stages of combat training, unblocking and operational deployment, the preparation and conduct of operations (combat actions), restoration of combat capability of troops (forces).

Keywords: logistics of the Air Forces of the Armed Forces of Ukraine, logistic system of the Air Forces of the Armed Forces of Ukraine, logistics.

1. Introduction

The organizational structure of the logistics management bodies, the list of necessary assets of logistics, their functional duties and tasks were basically determined in accordance with the measures of the State Program for the Development of the Armed Forces of Ukraine up to 2020 (approved by the Decree of the President of Ukraine – Supreme Commander-in-Chief of the Armed Forces of Ukraine dated March 22, 2017, No. 73/2017) concerning the creation of a unified logistics system of the Armed Forces of Ukraine as a result of the joint work of the General Staff of the Armed Forces of Ukraine and the interested military authorities.

The perspective logistics system of the Armed Forces of Ukraine (UAF) provides for a vertical division: planning (determination and planning of meeting troops' requirements) and executive (maintenance of necessary material resources and provision of troops with material resources and services). Therefore, a set of measures are planned to be taken in the Air Forces (AF) of the UAF in order to improve the logistic system by creating a planning and executive authority for managing logistics, providing air commanders with satisfying functions for providing logistical facilities, forming airbases for the provision of aviation brigades, and the transfer of certain military units of logistics to the air commands.

The current integrated logistic system of the AF of the UAF is a set of combined logistic command units of the command of the AF of the UAF, departments of logistics of air commands, services and units of the logistics and combat service support of military units (subdivisions) with subordinated assets of logistics, the number of which is determined by the combat composition, structure, tasks of the military units (subunits) of the AF of Ukraine and intended for solving the tasks of planning and the logistical support of the forces (forces), as well as the implementation of logistics measures of the military units (divisions) of the AF of Ukraine in their daily activities, during combat training, mobilization, operational deployment and combat readiness, preparation and conduct of hostilities, restoration of combat capability of military units (subunits) [1].

The logistic system of the AF of the UAF is designed to fulfill the tasks of logistics of military units (subunits) in the conduct of operations (combat actions) under any conditions of the situation. Its main tasks are: the definition of the requirements of the AF of the UAF as for the armament and military equipment (weapons and military equipment) and other material means (MM); planning the supply of weapons and other military equipment to military units (subunits); the organization of military transportation; the creation of immovable stocks; accumulation, storage and accounting of weapons and military equipment and other MMs;

the provision and organization of the transportation of weapons and military equipment; the organization of the operation of the weapons and military equipment of the nomenclature of logistics; the organization of the restoration of the weapons and military equipment of the nomenclature of logistics; logistics assets control; organization of airfield engineering support of aviation basing; control over the

organization of airfield maintenance of flights in military units of the AF; and the organization of vital functions of military units (subunits).

The objective function of the logistic system of the AF of the UAF is formulated as the achievement of the compliance of the capabilities of this system with the predicted volume of tasks of logistics. In order to implement this condition, it is necessary to ensure that the requirements and capabilities are consistent across all levels of logistic management. Deviations from these conditions must be compensated within the set limits by the reserve of opportunities at each level of the hierarchy. In order to achieve this goal, the logistic system of the higher level, which is the logistics of the command of the AF of the UAF, must have a reserve of abilities to influence the lower level in case of critical situations appear. In this case, the scope and timing of the measures in the interests of air commands and units (subunits) of the UAF are determined.

2. Analysis of recent research and publications

An analysis of the logistic support systems of the leading countries of the world, NATO-member states (partner countries) [2–5] was carried out to determine the main views on the logistics theory of the AF of the UAF. In addition, an analysis of the logistic systems of the UAF [6] has been carried out and all elements of this system which participate in the combat service support of operations (combat actions) of military units (subunits) were examined. The approach of the decomposition of the logistic system of the AF of the UAF allowed for revealing the influence of each element on the implementation of its logistics functions.

When speaking about the logistic support system at the current stage, it should be noted that the AF is the only one service of the UAF in which logistics has been operating since 2004, when there was an attempt to approximate NATO standards concerning logistic support in the military sphere. It enables dealing with technical and logistics issues effectively, using an integrated approach to planning and organizing the implementation of security tasks. At the same time, combining the technical system and the logistic support system into a unified logistics system, as is currently the case in the AF, contributes to the guaranteed implementation of the tasks of support of subordinated troops, thus the unity of command determines the interconnection between the subsystems of technical support and logistic support.

The optimal composition and logistics structure of the AF of the UAF, improvement of forms and methods of logistic support, the development of logistics principles, management and elaboration of interaction methods contributed to the successful solution of tasks.

At the same time, the subsystem of the technical support for the AF of the UAF (under the nomenclature of logistics) requires improvement, as at present stage, separate technical support tasks are organized within different chains of command (there is no single authority who organizes the implementation of all kinds of logistics technical support).

The development of the theoretical elaboration of the issues of logistic support for conducting operations (combat actions) is based on solving the logistic problems of the UAF, namely the search for ways to resolve the discrepancy between the desirable and the actual state of logistics, which is considered in the publications of Romanchenko I.S. [7, 10], Khazanovich O.I. [7], Tarasenko A.V. [8], Shuenkin V.O. [9, 10], Rolin I.F. [11], Servatyuk V.M. [12] and Krizhny A.V. [13].

In today's conditions of conducting operations (combat actions) the theory of armament and the theory of the rear services of the AF that exist separately, as components of military science, lose their functional purpose as partial theories.

Taking into consideration the modern forms and methods of conducting operations (combat actions), as well as requirements for forming a unified logistics system for the UAF and logistics, created management bodies, forces and means of logistic support of military units (subunits) of the UAF, the purpose of the article is to define the main provisions of the new the unified logistic theory of the AF of the UAF. In this context, the basis of the unified theory of logistics is the following methodologies:

- the methodology of system logistic analysis – a set of methods and techniques for the development, adoption and substantiation of solutions while examining, creating and managing of logistics systems;
- the methodology of the cybernetic approach to the management of logistics systems – the research of the logistics system based on the principles of cybernetics in particular through identification of direct and feedback links, the study of the set of processes of exchange, processing and transformation of information;
- the methodology of operations research – research of logistics system with the use of mathematical quantitative methods for substantiation of tasks of logistic support;
- forecasting methodology – a set of methods and techniques for forecasting the development of both the logistics system and its subsystems in dynamics.

3. Presentation of the main research material.

On the basis of the analysis of the logistic support of the AF of the leading countries of the world and NATO member-states (partner countries) [2–5], certain types of activities, requirements and tasks of logistic support [1], created logistic structures of military units (subunits) of the UAF, scientific methods of research of logistics, a unified theory of logistics for the AF of the UAF is proposed, which includes the following main components:

- the conceptual apparatus and the empirical basis of logistics of the AF of the UAF, which are based on the forms of scientific knowledge and contain scientific positions and results, as well as the mechanism of their implementation;
- initial conceptual provisions according to the types of logistics activities of the UAF, which consider and provide the development of the necessary methods for calculating the needs of forces and assets of logistics of the AF of the UAF;

- the main provisions for the preparation of the logistics infrastructure for the accumulation, separation and conservation of material resources, the use and replenishment of stocks, the operation of weapons and military equipment;
- increase of efficiency of logistics by activities;
- rules of logical conclusions which are based on the generalization of experience of creation and functioning of the logistics management bodies of the Armed Forces of the leading countries of the world and NATO member-states (partner countries), determine the direction of the long-term development of logistic support of military units (subunits) of the UAF providing the ability to integrate logistics systems while performing compliant operations.

That is, as for its structure, the theory of logistics of the AF of the UAF is an internally differentiated integral system of knowledge about material, transport, evacuation, information and financial flow processes according to types of activity, which characterizes the logical dependence on some elements from others, the derivation of the content of the theory of logistics from a certain set of statements and concepts according to the defined logical and methodological principles and rules, the basic components of which are: principles, axioms, postulates, laws, judgement, concept, categories and facts.

The analysis of the logistic support of military units (subunits) of the UAF indicates the availability of approaches as for the use of the proposed logistics theory. The main approaches the following:

- solving tasks according to the types of activity of logistics of the AF during the conduct of operations (combat actions) in the established scope of tasks and in interaction with the logistics systems of the Land Forces of the UAF, the Naval Forces of the UAF, other military formations and law-enforcement agencies of special assignment, defense industry, and other branches of the national economy of Ukraine;
- logistical maintenance of high autonomy of conducting operations (combat actions) of military units (subunits) of the UAF;
- maintenance of high maneuverability and mobility of military units (subunits) of the UAF in the conduct of operations (combat operations), which is provided by resettlement, transfer and promotion of military units (subdivisions) of the Airborne, development of the aerodrome network;
- creation and improvement of the logistic system of the AF of the UAF on the basis of a functional integrated system of logistics of the UAF;
- the capacity of the logistic system of the AF of the UAF to conduct operations in the operational groups of the Army (forces) of the UAF;
- achievement of high efficiency and functionality of logistic processes and their compatibility with the NATO logistics system by applying the relevant NATO standards in the activities of the AF of the UAF [14].

The basis of these approaches is the modular and territorial principles of logistics constructing the infrastructure for

the provision of military units (subunits) of the UAF. In this case, the territorial system of logistics of the AF is represented by a multilevel hierarchical structure, the basis of which is logistics bodies. Organizationally, it includes the logistic bodies of the Command of the UAF, air commands, and military units of the AF. The logistic structure of the AF of the UAF will be brought in line with the typical structure of the logistics management bodies in all services of the UAF and the logistic units of the strategic level.

Methodologically, the central role of the formation of the proposed logistics theory of the AF of the UAF is to determine the patterns, trends, principles, forms and methods of logistic for conducting operations (combat actions) of military units (subunits) of the AF of the UAF, which are formed within the framework of the theory of logistics and relate to logistic support.

Analysis of the development of logistic support of the AF of the UAF enables the identification of patterns that reflect the stable links of the logistics system of the AF of the UAF, with the development of the branches of the national economy of Ukraine, the infrastructure of logistics and the transport system of the country. That is, for the logistic system of the AF of the UAF the dependence of the quality of the preparation, conduct and outcome of the operation (combat actions) on the state and capabilities of the logistic support system is inherent.

The complexity and interconnection of logistic support measures, namely, a clear and transparent logistic support management system (material, transport, evacuation, information and financial flows management) in the logistic system of the AF of the UAF give rise to the second regularity of its construction and functioning. This is expressed in a unity of infrastructure support of logistics of the AF of the UAF, which is an integral part of the engineering and infrastructure support of the UAF, both stationary and mobile, for the purpose of measuring of their vitality. The creation of a single logistic space of the UAF logistics system of the UAF within the framework will allow for fulfilling the requirements of logistics of the AF of the UAF in accordance with the modular and territorial principle of construction of the logistics infrastructure.

The next regularity of logistic support is the centralization of management and the decentralization of the implementation of the tasks of using the logistic system of the AF of the UAF provided that the assets of logistic support for conducting operations (combat actions) are sufficient.

Knowledge of the law allows us to understand the operation and properties of the logistics system and to form a more adequate decision-making model. In the future, the patterns are manifested in the form of trends that determine the existence and improvement of the logistics system of the AF of the UAF through the interaction of this system with the infrastructure of logistics, transport system and branches of the national economy of Ukraine.

On the basis of an analysis of the organization of the operation and development of logistics systems of NATO member-states (partner countries), in particular by examining the logistical support of the troops, it is possible to identify a number of stable tendencies that are related by

the limitation of most resources, the high destructive ability of enemy weapons, and the speed of conducting operations (combat actions). The tendencies, which belong to the logistics of the AF of the UAF, are the following:

- centralization of planning and organization of logistics at the level of logistics Command of the UAF;
- the dependence of the organization and management of logistic support on the structure of the AF of the UAF, the material base and conditions for the implementation of logistic support;
- implementation of the territorial system of providing military units (subunits) regardless of their belonging to one or another service of the UAF;
- maintaining the proportionality and optimum correlation in the organization of logistic support of the AF of the UAF in the general system of logistics of the UAF;
- the unity of organizational and methodological foundations (organizational and information support, analysis, planning, control) of the logistic system of the AF of the UAF at all levels of logistic support;
- compatibility of logistic assets of interacting military units (subunits);
- reduction of intermediate levels of provision, concentration of major efforts in the air command and military units (subunits), where the expenditures of logistics are incurred;
- optimization of processes of making logistic decisions based on efficiency indicators used in the logistics of the AF of the UAF [15];
- automation of the processes of material, transport, evacuation, information and financial flows management [16];
- the dependence of the efficiency of the solution of the increasing scope of tasks of logistics of the AF of the UAF on the amount of information used.

Therefore, in order to solve the problem of processes optimization for making logistic decisions based on efficiency indicators used in the logistics of the AF of the UAF, the indices and criteria for evaluation of the effectiveness of the functioning of the prospective logistics system of the AF of the UAF have been developed.

The methodology includes [17]:

- assessment of the performance indicators of the logistics system of the UAF;
- analysis and generalization of performance evaluation indicators for various studied variants of logistics system contention and their verification with the use of relevant criteria;
- proposal development for the choice of rational structure of the management elements of the forces and means of logistic support of the UAF on the basis of the values of indicators and verification of criteria for various studied variants of logistics system construction.

Indicators and criteria for the effectiveness of logistics system are divided into groups (directions), which are used for:

- assessment of temporary indicators of the accomplishment of tasks by the logistic support by the group of troops; evaluating the required resource;

- evaluating the quantitative and qualitative involvement of personnel, weapons and equipment of the logistics divisions of the group of forces;
- evaluating accounting, organizing the supply of weapons and other materiel, repair and restoration of weapons and equipment;
- military evaluation of the organizational structure.

Trends in practice are realized through the principles of logistic support, which are consistent with legislative acts on national security and defense of Ukraine, NATO logistics standards, and determine the specifics of the functioning of military units (subunits) of the UAF in the course of the preparation and conduct of operations (combat actions).

In essence, the principles of logistic support represent a provision according to which the necessary properties of the logistic system of the AF of the UAF are formed. At the same time, the principles of logistic support provide the basis for the construction and operation of the logistics system of the AF of the UAF.

When using these principles in practice, it is possible to justify the recommendations for carrying out a complex of measures to determine the tasks of logistics, the order of management of the logistic system, the volume of weapons and military equipment, logistics and the order of their transportation and supply, the sequence, timing, methods of action, interaction, the necessary composition of the group of forces and logistics, the development of appropriate planning documents on troop-contributing tasks in peace and war time.

The basis for systems of intellectual support of life cycle of the knowledge-intensive products are databases about products where statistical data, arrived from military units with armament and military equipment (AME), is saved. Results of processing this statistical data and developments of recommendations of further operation of AME sample and other data arrays about a product [18] are kept in these databases.

In work the structure of technical support system of AME of the AF of UAF is offered. The structure provides control of operation, technical state and recovery of military products in a common information space.

Basis of information support system is the AME database of Ukraine which is created at a development stage and scientific and technical maintenance of the corresponding AME sample. The database is stored and refined during production, operation, combat use, write-off, utilization. It comprises all technical information about a military product and its components, with obligatory use of the database of the Logistic of the UAF concerning existence and the movement of stores.

The Control Center of operation, technical state and recovery of military products (analog of the center of logistic support of life cycle of complex technical products) is created in the Logistic of the AF Command.

The main tasks of the Control Center are [20]:

- collecting and the analysis of technical data on a state, service conditions and resource expenses of AME samples, types and causes of failures, level of readiness of attending personnel;

- elaboration of the nomenclature of military and technical facilities and the set of spare parts, tools and accessories which is contained in storehouses of military units of AF;
- determination of work amounts, use of repair bodies and use of military and technical facilities during intermediate and capital repairs of AME samples (as necessary), big interval maintenance of AME samples, maintenance (scheduled works / preventive maintenance) of them, monitor and recovery works on AME samples which are subject of transfer to maintenance on technical condition, control of a limit condition of AME samples which are operated on technical condition;
- providing applications for repair (replacement) of knots, blocks, subblocks, units with the plant facilities, repair bodies, providing centers of the Logistic of Ukraine, storehouses, bases and arsenals of UAF.

Devices for monitor and diagnostic of technical state of a military product are one of basic elements of perspective technical support system of AME of the UAF. Elements of these means as a part of the automated test system have to be constantly in AME samples and provide timely receiving, processing and transfer of data about the product technical state for formation of control decisions. The formation of control decisions with use of the AME databases of UAF is provided by support system of decision-making (SSDM) of the person which makes the decision based on data about the product technical state [20]. At the present time, an example to solve a problem of optimization of processes of making logistic decisions used in the logistics of the AF of the UAF during operation of compound technical objects (CTO) (AME of the UAF) two strategies of maintenance and repair are used: regulated strategy of maintenance and repair and strategy of maintenance and repair according to state [21].

The method of planning to move complex technical objects to repair during the operation according to the state it is in divides the same type of complex technical objects into two groups. CTO from the first group will not need repair during the next year. CTO from the second group needs repair during the next year. In addition, for CTO from the second group, the order of repair is defined according to the minimum time of achievement of no-failure operation index limit value.

Practical use of this method of planning of moving CTO into repair during operation according to its state requires the execution of following actions [21]:

- complex technical objects operation according to its state with the accumulation of data about CTO failures;
- quarterly estimation of mean-time-to-failure of each compound technical object;
- execution of the limit state check of compound technical objects;
- verification of limit state achievement of the compound technical object;
- prediction of the mean-time-to-failure for the next year;
- verification of mean-time-to-failure achievement of limit value;
- determination of quarter when the mean-time-to-failure achieves to the limit value;

- planning of moving CTO into repair for the next year in the quarter which is previous to the quarter when the mean-time-to-failure achieves to the limit value;
- execution of repair of a complex technical object according to its state.

The results of limiting state checks of complex technical objects and the results of their operation between these checks are the initial data for the application of the method of planning of moving CTO into repair during operation according to its state. If, during the limit state check, the limit state of a complex technical object is fixed, the object will need immediate repair according to its state. For other CTO, according to the result of the operation, the quarterly estimation of mean-time-to-failure is made.

Thus, in accordance with the General Provisions of the Logistic Doctrine of the UAF [1], the principles of logistic support are the following:

Priority – is the determination of the directions of concentration of the main assets of logistics in order to fulfill of the priority and most important tasks of the troops (forces);

Sufficiency – timely provision of necessary weapons and military equipment and logistic support in accordance with determined requirements;

Efficiency – use of assets of logistic support with the achievement of the maximum possible result;

Flexibility – a proactive approach with the ability to adapt and respond quickly to changing circumstances;

Transparency – the exchange of reliable information as for the requirements and availability of weapons and military equipment, and logistic support at services at all levels, taking into account the degree of access to it (ensuring the protection of confidential information);

Coordination – is the interaction of all components of the logistic system of the AF of the UAF to provide an effective functioning of the system in general, as well as with the logistics system of the UAF, the bodies of foreign states, international organizations and armed forces of other states on the basis of the concluded international treaties of Ukraine, NATO –members states;

Responsibility – the logistics departments of all levels in their activities must strictly adhere to the powers granted and be responsible for the timely execution of specified tasks;

Cooperation – cooperation between the AF of the UAF and other components of the defense forces, central and local executive authorities, local government authorities, state enterprises of the military industrial complex, other enterprises of the national economy of Ukraine, as well as with the authorities of foreign states, international organizations and armed forces of others states on the basis of concluded international treaties of Ukraine as for logistic support. Cooperation should be directed towards meeting the requirements of the UAF in an effective and timely manner;

Interoperability – the logistics of the UAF aims to achieve full interoperability with NATO logistics, which will enable the integration of systems in the course of joint operations, as well as the possibility of using individual weapons and military equipment samples and logistics nomenclature of NATO

member-states (partner countries) for meeting the requirements of the UAF;

Stability – the organization of logistic support should include measures aimed at minimizing losses of allocated resources from the influence of certain factors (external and internal, positive and negative), and in the course of operations (combat actions) from the influence of the enemy.

Together with the established laws, tendencies and principles of logistic support, the AF of the UAF require the concept of forms and methods to be defined. In essence, forms of logistic support represent the actions of the logistics management authorities regarding the use of logistic assets. In the meantime, the forms of logistic support are directly related to the forms of action of the military units (subunits) of the UAF and are important in the operation of the logistic system of the UAF. Therefore, the main forms of logistic support of military units (subunits) of the UAF are:

- Logistic support for combat training and combat duty;
- Logistic support for everyday activities;
- Logistical support for mobilization, operational deployment and bringing into combat readiness;
- Logistic support for operational and tactical regrouping;
- Logistic support for the preparation and conducting of operations (combat actions);
- Logistic support for the restoration of combat capability of military units (subunits).

In turn, as part of the logistical support for the preparation and conduct of operations (combat actions) it is expedient to identify:

- Logistic support for military units (subunits) of the UAF in defense operations;
- Logistic support for the preparation of military units (subunits) of the UAF for a counter-offensive (offensive) operation during a defensive operation;
- Logistic support for military units (subunits) of the UAF in the counter-offensive (offensive) operation;
- Logistic support for military units (subunits) of the UAF in the air operations of the UAF;
- Logistic support of aircraft maneuvers of the AF of the UAF of Ukraine;
- Logistic support for the regrouping of military units (subunits) of the UAF.

The implementation of these forms is carried out by means of logistic support. On the basis of the analysis of logistics systems in the leading countries of the world and NATO member-states, it is possible to define the content the “methods of logistic support” concept. This concept implies the complex of questions of theory and practice that characterize the order and methods of using assets of logistic support for the tasks of preparation and conduct of operations (combat actions). In this case, the logistics support methods will depend on:

- the nature and methods of conducting operations (combat actions) of military units (subunits) of the UAF;
- directions of concentration of the main efforts of logistics;
- the available assets of logistic support and the sequence of their application;

- the degree of centralization of the management of the logistics system and decentralization of the tasks of logistic support;
- physical and geographical conditions of the area of operation and the nature of the deployment of assets of logistic support on the ground;
- the nature of the maneuver and the regrouping of forces and means of logistic support.

Combinations of these factors determine a number of specific methods of logistic support that characterize the proposed forms of logistic support for military units (subunits) of the UAF in the course of the conduct of operations (combat actions). The choice of specific methods of logistic support for the AF of the UAF will be determined by the Deputy Chief of the logistics unit – Chief of the logistics of the AF in the process of making a decision on the organization of logistic support in the preparation and conduct of operation (combat actions). Changes in conditions during the conduct of operations (combat actions) will change the combination of factors, as well as the change in the methods of logistics in general. In the subsystems of logistic support of the AF of the UAF, at operational and tactical levels, each form of logistic support will correspond only to the inherent methods of these forms.

4. Conclusions and perspectives of further research.

In conclusion, while taking into consideration the stated views on the logistics theory of the AF of the UAF, the functioning of the logistics system of the AF of the UAF should be assessed on the basis of the requirements for logistic support by assessing the totality of real capabilities of each subsystem that is part of it and the system as a whole. In this case, the assessment of the quality of logistic support for military units (subunits) of the UAF can be related to the degree of implementation of the potential capabilities of the logistic system in solving the tasks of each subsystem during the stages of combat training, mobilization and operational deployment, the preparation and conduct of operations (combat actions), and the restoration of combat capability of troops (forces).

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Introduction to Reliability Tests of Unmanned Aircraft Used in the Armed Forces of the Republic of Poland

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Abstract

This paper is a theoretical introduction to the reliability tests of unmanned aerial vehicles used in the Polish armed forces. The purpose of this article is to determine the type / model of the unmanned aircraft used in the service of Polish Armed Forces, which results from the conducted reliability tests, will be the basis for generalizing them to the largest group for the subsequent research. In order to achieve the assumed goal, the author, firstly, reviews the terms and definitions describing the subject of the study. The trends occurring in the description of the examined subject-matter were recognized. Then, the typologies and classifications of unmanned aerial vehicles are analyzed on the basis of Polish and international sources, as well as normative documents. The last part of the paper comprises of a comparison of tactical and technical data of unmanned aerial vehicles used by the Polish Armed Forces.

Key words: reliability, safety, unmanned aerial vehicles

1. Introduction

The broad spectrum of using unmanned aerial vehicles (UAVs) on the battlefield and their relatively low cost (several dozen times lower than it is the case of crewed machines) generate an increasing interest in this equipment, not only in developed, but also developing countries. This is reflected in both the unmanned fleet already owned by Poland, as well as in the Plan of Technical Modernization of the Polish Armed Forces [*Plan Modernizacji Technicznej Sił Zbrojnych RP*], where UAVs are the most frequently mentioned devices in three main operational priorities (OP): OP Image and satellite reconnaissance, OP Modernization of Artillery (as an accessory to the RAK system), and in the task Warmate circulating ammunition (Ocena astanu, 2019) (Dziennik Zbrojny, n.a.)

The growing interest in this equipment drives further dynamic technological and conceptual development. The artificial intelligence capabilities of UAVs are developed, the concepts for cooperation of these devices with crewed machines are created, as well as of their possible use in the swarm formation. Given the above, it can be unequivocally stated that the growing importance of unmanned aerial vehicles on the modern battlefield is unquestionable. This is the reason why it is so important for the Polish Armed Forces, which, in order to develop and maintain defense capabilities, should have devices of this sort. The purchases of new UAVs are carried out under individual operational programs stemming from the above-mentioned Technical Modernization Plan increase of the defense capabilities of the state. However, from the point

of view of maintaining these capabilities, it is equally important to increase the reliability parameters of devices already owned by the Polish Army. The constant need to carry out reliability tests is determined by the necessity to improve the UAVs' operation process, as well as by the need to enhance reliability allowing to complete the combat task.

Bearing in mind the fact that reliability determines the probability that an object will perform its function in a given time in certain conditions, one may even be tempted to state that possessing modern equipment, as UAVs undoubtedly are, and not carry out an analysis and evaluation of the possible improvement of their reliability parameters, is unacceptable. For, this can cause the failure of a potential mission, and in extreme cases, it may endanger the life and health of soldiers who operate a given device, or whose task depends on the success of the UAV's mission (e.g., reconnaissance).

Considering the above, it can be concluded that there is a justified need to perform reliability tests on unmanned aerial vehicles, and it is in the interest of the armed forces to perform such tests on the equipment used by the Polish Army. However, due to the existence of different types of UAVs, detailed testing of all unmanned aerial vehicles could prove too costly and time-consuming, and hence economically unjustified. The solution to this problem may be to find such an unmanned aircraft, whose examination results could be then extrapolated onto a larger group of aircraft (more types). Still, it is necessary to take into account the construction differences that occur in different types of UAVs. The analysis of the subject literature indicated shortcomings in the area of uniform studies related to this research area. Most of the researchers focus on one type of UAVs (e.g., MALE) (Goetzendorf-Grabowski, Frydrychewicz, 2006), or they are very general and do not analyze any specific aircraft (Petritoli, Leccese, 2017) (Caswell, Dodd, 2014).

Bearing in mind the lack of synthetic scientific studies on the reliability of UAVs and their ever-increasing impact on state security, the author decided to undertake research aimed at determining the type / model of the unmanned aircraft used by the Polish Armed Forces. The results of the conducted reliability tests will be methodologically generalized and will be referred to the largest possible group of UAVs. To achieve this adopted goal, it was decided to begin the research with analyzing the term 'unmanned aerial vehicle' that would include the criterion semantic features (Anusiewicz, 1994) of the examined subject. This was dictated by the results of the preliminary analysis indicating the interchangeable use of several concepts related to the subject of the study, i.e., an unmanned aerial vehicle. The results of the tests carried out at this stage are also an additional value consisting in an attempt to systematize the terminology associated with unmanned aerial vehicles. Then, the typology of unmanned aerial vehicles was analyzed to finally select one model. The most important research methods employed for this study include: analysis, synthesis, comparison, abstraction, and inductive and deductive inference.

It should be emphasized that this research is a basis for further work related to the enhancement of reliability of

unmanned aerial vehicles carried out by the author in her doctoral dissertation.

2. The Semantic Problem

An analysis of the subject literature showed the occurrence of various terms related to unmanned aerial vehicles. These terms, often used interchangeably, can cause cognitive problems related to semantics. Therefore, further research investigations were carried out to refine the scope of research, including reliability tests. In the analysis of the literature, five basic terms related to the subject of the study were distinguished:

1. Unmanned Air System (UAS);
2. Unmanned Aircraft;
3. Remotely Piloted Aircraft (South Africa);
4. Remotely Piloted Aircraft System (RPAS);
5. Radio-Controlled Aircraft (RC Aircraft);
6. Unmanned Aerial Vehicle;
7. Drone.

The analysis indicated that the term "unmanned aerial systems" belongs to the scope of a broad term defining the group of unmanned platforms "Unmanned Systems". It also took into account the center of operation of these systems. Currently, one can distinguish three basic types of Unmanned Systems: air, sea, and land (Cwojdzinski, 2014).

Due to the limited scope of the paper, the focus is solely put on unmanned aerial systems. In NATO, the term is defined as "a system whose components include the unmanned aircraft, the supporting network and all equipment and personnel necessary to control the unmanned aircraft" (AAP-6, 2011). Further analysis showed that unmanned aerial systems include (Adamski, Rajchel, 2013):

- flight ground control station (GCS – Ground Control Station) with an antenna system and a data transmission system;
- data transmission and exchange terminals and software;
- communication systems (ground / air; air / ground);
- a specified number of unmanned aircraft (including spare);
- UAVs take-off and landing (recovery) devices;
- means of communication (voice and data exchange) with air traffic management cells;
- devices (equipment) necessary for the operation, storage and transport of UAVs;
- all necessary documentation (technical, operational) regarding the abovementioned elements;
- additional devices necessary to carry out tasks (still camera, video camera, means of destruction).

When comparing the above with the term 'unmanned aerial vehicle', it should be noted that this term first appeared in military semantics in the 1990s (Gregorski, 2017). One of the first definitions of this term describes it as a reusable aerial apparatus (vehicle, ship, object) of any aerodynamic configuration, capable of carrying armament or other equipment, with no pilot-operator on board and capable of flying along a programmed route (Popularna Encyklopedia, 2002). This definition does not correspond to the current

reality, e.g., Polish Armed Forces are in possession of disposable UAVs that are intended for “kamikaze” attacks. Another definition was created in 2005 and defines UAVs as powered and unmanned apparatus. In order to stay in air, it can use the lift generated by the laws of aerodynamics on fixed (wings), movable support surfaces (rotor), or aerostatic buoyancy (aerostat). It can be controlled by autonomous systems or remotely by the operator (from the ground, air, or ship). It has been designed to return and be reused. It can be a single-use aircraft (Karpowicz, Kozłowski, 2003). The above definition seems to reflect the essence of the term in question. However, it is very complex. Therefore, in order to find an appropriate definition elucidating the subject of the study that would also take into account the environment in which the research is carried out, the author has adopted the NATO definition, which states that a UAV is: a power-driven aircraft, disposable or reusable that uses aerodynamic forces to provide force for a carrier that flies independently or is remotely piloted; capable of carrying deadly or incapacitating loads (AAP-6, 2011).

In 2011, ICAO introduced (ICAO, 2011) the concept of “remotely controlled aircraft,” which is part of the remotely controlled air system. Pursuant to air traffic regulations, the term “remotely controlled aircraft” includes an “unmanned aircraft which is piloted from a remote piloting station” (Załącznik do obwieszczenia, 2011). This means that a remote-controlled aircraft is a much narrower concept than an unmanned aerial vehicle, as it does not include autonomous systems. However, similarly to the previously considered unmanned air system, the remotely controlled air system includes all other devices (elements) necessary for the implementation of the flight. In this case, it will be a remote pilot station (ICAO RPAS, n.a.) (ICAO, n.a.). Similar to a remote-controlled aircraft, a radio-controlled aircraft is defined as a UAV subtype. The main difference resulting

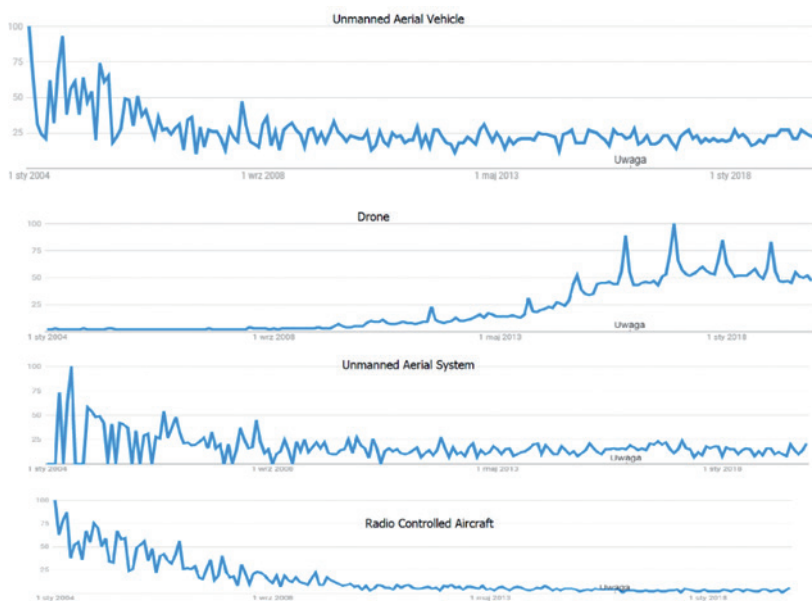
from semantics is the way aircraft is controlled. In the case of the previous term, the word “remotely” specifies how the aircraft is controlled and not the control method, while in the term radio-controlled aircraft the word “radio” limits the control method to radio control. In addition, other characteristics that distinguish a radio-controlled vessel can be found in the literature, such as limiting the number of operators – to one and the number of hours of work in the air – up to two hours (Ministerstwo Infrastruktury, 2019).

An analysis of the literature on the subject of research shows that the concept of “unmanned aerial vehicle” is synonymous with unmanned aircrafts. This is due to the fact that the term “unmanned aerial vehicle” defines the center in which the vessel operates – air. In contrast, the unmanned aerial vehicle determines the activity of a ship in the air, i.e. flight. According to the Aviation Law and accepted terminology by the scientific community, each flying apparatus (floating in the air) is an aircraft (Prawo lotnicze, 2002). The use of two terms to determine the same results from the previously misunderstood BSP characteristics, namely the use of the term “Unmanned Aerial Vehicles,” which due to the fact that the pilot always operates the aircraft, was a mistake.

The last term discussed is “drone,” and in the case of unmanned aerial vehicles, drone and BSP describe the same devices. The reason for the next term for the same device results from the interchangeable use of these terms by the media (in particular Western media) (BOTLINK, n.a.). It should be emphasized that the word drone is becoming more popular due to frequent use by the media as shown in the figure below.

The above charts illustrate the process of replacing all terms with the term drone. However, despite the growing popularity of the term “drone” due to the proliferation of unmanned systems themselves and the increasing use of the term by the media, it should be noted that it is slowly replacing the term “unmanned aerial vehicle” (Dougherty, 2016). Notwithstanding the above, analysis of the literature indicated that the most common term describing the subject of research in scientific literature is “unmanned aerial vehicle.”

Fig. 1. Trend of search terms in Google Trends



Source: <http://www.google.trends.com>, access 02/11/2019.

3. The Problem of Typology and Classification

Technical parameters and reliability parameters depend directly on the UAV type. Since the UAV type determines its construction, it thus also determines the structural elements used or tasks it will carry out, and in consequence, also the external factors to which it will be exposed during carrying out tasks. Given the above, it was considered important to analyze the UAV typology.

The typology of all aircrafts, including UAVs, may depend on many factors, the most common in the subject literature are typologies associated with aircraft attributes, i.e., their characteristics. The characteristics of aircrafts may be related to their flight or take-off and landing

characteristics (e.g., vertical take-off and landing). Other frequently used parameters describing aircrafts include: operating radius, flight time, equipment, load capacity, structure, aerodynamic system, etc. In addition, the division of aircraft may depend on their function and the scope and purpose of use. The generally accepted division concerns their use on the civil and military market. In relation to UAVs, other divisions can be found in the literature including e.g., the responsibility and risk associated with their use, or the business model where UAVs are divided into product and service. Keeping in mind the purpose of this paper, some of the most common UAV typologies are described below.

The first typology refers to functions that can be implemented by using UAVs. At the same time, the general division of the implemented functions can be categorized into civil functions and military functions. In the civilian area, UAVs functions are classified as follows (Ministerstwo Infrastruktury, 2019):

1. Monitoring-related functions – terrain or air imaging to obtain data for further analysis.
2. Functions related to transport – activities related to the movement of people and material goods.
3. Functions related to communication (telecommunications) – ensuring the safe use of airspace by many types of UAVs, especially autonomous unmanned aerial vehicles.

In the military area, the general division of UAVs divides them into reconnaissance, combat, and special ones.

However, it should be noted that the division both in the civil market and in the military area is directly related to the currently performed tasks (functions) of these devices. Therefore, it is not difficult to imagine that this typology will evolve as the concept of using UAVs in both areas develops further. This typology can also take various shapes, e.g., including equipment carried by UAVs. One such example is the following breakdown of military reconnaissance UAVs:

1. IMINT – optical recognition – equipment: infrared sensors, lasers, and radar sensors;
2. SIGINT – interception and recognition of electromagnetic waves;
3. MASINT – detection and tracking of ballistic missiles, tracking and detection of means of air attack with the possibility of determining their impact parameters, traces of submarines and aircraft using boosters;
4. OTHER – warning against: radiation, electromagnetic attack and others, especially used in combating systems intended for SEAD tasks.

However, in the subject literature, the most common classifications refer to UAVs. An example of such a classification is the distinguishability of these measures by the range of activity:

1. Close range up to 50 km;
2. Short range (performing reconnaissance and tracking operations) up to 150 km;
3. Medium range (carrying out complementary tasks for manned aircraft);
4. Long range (high altitude) – acquisition of information about the target;
5. UAVs of vertical take-off and landing used in the Navy. (Jane's Airport Review, 2007)

Another characteristic feature of UAVs, and thus the most common division of this type of aircraft, is their weight. In the subject literature, the most common classification divides UAVs into five categories. This typology is presented in the table below.

Tab. 1. Classification of UAVs by mass

CLASS	CATEGORY	MASS	EXEMPLARY UAV
II / III	Very heavy	> 2000 kg	RQ-4 Global Hawk
	Heavy	200 – 2000 kg	A-160
I / II	Medium	50 – 200 kg	Raven
I	Light	5 – 50 kg	RPO Midget
	Very light	< 5 kg	Dragon Eye

Source: Mazir, n.d.

The mass division was adopted not only in the scientific and military environment, but it was also sanctioned by Polish legislation. For, the binding regulation also covers the classification of UAVs in Poland and divides them into two basic categories on the basis of their mass (Rozporządzenie Ministra Transportu, 2013).

It should be noted, however, that due to technological development, including the miniaturization of electronic systems, the typology based on the mass of the device is progressively less useful. Therefore, more and more often one can find “hybrids” of various UAVs' attributes. Partial data resulting from the literature analysis are presented in the table below and include the classification taking into account four attributes:

Tab. 2. Aircraft classification according to the Polish Ministry of Transport

UMW Heavy unmanned aerial vehicle	K1. basic	Not applicable	MTOM > 150 kg
	K2. conventional		
	K3. special		
UML Light unmanned aerial vehicle	K3. special	UML-150 BSP	MTOM > 25 kg i <150 kg
	K5. unqualified	UML-25 BSP	MTOM < 25 kg

Source: Rozporządzenie Ministra Transportu, 2013.

Tab. 3. UAVs technical and tactical data

DESIGNATION	FLYING TIME	RANGE	ALTITUDE	LOAD CAPACITY
HIGH	> 24 h	> 1500 km	> 10000 m	> 100 kg
MEDIUM	5–24 h	100–400 km	1000–10000 m	50–100 kg
LOW	< 5 h	< 100 km	< 1000 m	< 50 kg

Source: Mazir, n.d.

A different division, which takes into account two UAVs attributes can be found in the classification proposed in the 2009 NATO documentation. UAVs there are divided into three main classes:

1. The first class – objects weighing less than 150 kg and with the flight time up to 6h;
2. The second class – objects in the range from 150 kg to 600 kg and with the flight time up to 24h;
3. The last class – objects weighing over 600 kg with the flight time of up to 40 h (Mazir, n.d.).

However, it should be noted that the above typologies have serious limitations. They make one attribute dependent on the second, which, due to the continuous miniaturization of aviation technology stemming from technological progress, prevents the proposed classification from reflecting real possibilities.

Given the above, it can be concluded that UAV typology that takes into account such attributes as unladen mass, or joints together two features (e.g., mass and operating radius) is not precise. Moreover, these typologies do not have significant cognitive value in determining UAV reliability. Therefore, guided by research inquisitiveness, a new division was made, which distinguishes UAVs according to their structural element, and in particular, their aerodynamic system, namely, a fixed-wing aircraft, rotorcraft, and aerostats (rotorcraft as well as balloons and airships):

It should be further noted that the aerodynamic system that includes all UAVs in its group is a system with fixed bearing surfaces i.e., fixed-wing vehicles. Therefore, it seems justified to carry out a reliability analysis taking into account the broadest UAV group. It should be emphasized that in the subject literature there are also other examples of typologies focusing on UAV constructions. One of them takes into account their propulsion systems: piston, jet, turbojet, and electric. Another one divides UAVs using the take-off and landing criterion: folding and retractable landing gear, fixed landing gear, UAVs fired from the launcher, carried by carriers, vertical take-off and landing, and multi-variant take-off systems that can also be equipped with classic landing systems, i.e., using a hook and airport braking ropes or a net or parachute (which is often treated as an emergency system). However, the analysis of the above classification has shown that it is impossible to unequivocally indicate the most common types of UAV structures in the above typologies.

4. Comparison of Tactical And Technical Data of UAVs Used by the Polish Armed Forces

Practical and technical data are a source of information on the structural elements used and constitute necessary knowledge about the expected operational values of particular UAVs, including the values affecting their reliability.

Tab. 4. Divisions According to the Aerodynamic System

Aerodynamic system	Micro	Mini	Close Range	Short Range	Medium Range	Medium Range Endurance	Low Altitude Deep Penetration	Low Altitude Endurance	Medium Altitude Long Endurance	High Altitude Long Endurance	Unmanned Combat Aerial Vehicle	Lethal	Decoy
Fixed-wing aircraft	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rotorcraft	✓	✓	✓	✓	✓						✓		
Aerostats		✓	✓	✓									

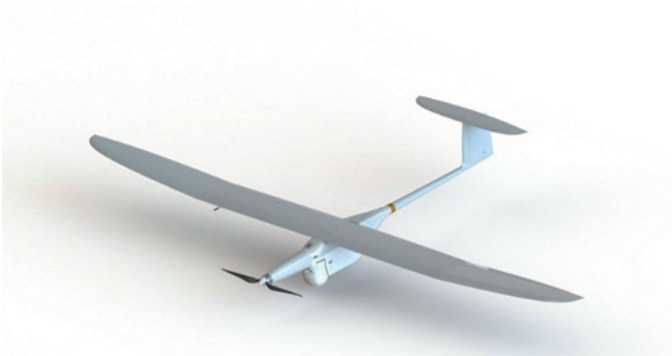
Source: Adamski, Rajchel, 2013

On the basis of the analysis and synthesis of the data on particular technical parameters, it is also possible to indicate differences and similarities in the UAV design, which will ultimately allow us to achieve the adopted goal. Taking into account the previous research results, an analysis has been carried out that focused on the fixed wing aircraft used by the Polish Armed Forces including: Warmate, FlyEye, Orbiter, RQ-21 Blackjack, and Scan Eagle. All of them belong to the Class 1 according to the NATO typology. Warmate belongs to the single use combat type, while the rest of the discussed UAVs are designed for reconnaissance missions. Due to the one-off nature of Warmate use, it was considered pointless to carry out a detailed analysis of this type of aircraft. Further research showed that the Polish Armed Forces have 15 sets of Orbiter and FlyEye, one set of Scan Eagle and one set of RQ-21A Blackjack. This fact determined the decision to conduct a detailed UAV analysis of only the largest group. Among the tactical and technical parameters that were analyzed there were: materials and construction, dimensions (wingspan, length) and weight, payload, maximum speed, and maximum altitude, operating range, maximum flight time. However, due to the similarities, the research results have led to the conclusion that it is impossible to unequivocally indicate one type of composites used in a particular UAV, because different elements are made of different materials. This means that, for example, a different composite was used to build the rotor blades and a different one for the cover construction.

5. FlyEye

The first example of a UAV introduced in the Polish Armed Forces was the FlyEye, produced by WB Electronics. Currently, the armed forces are equipped with 15 sets of this UAV model. This unmanned aerial vehicle is characterized by its composite structure and the possibility of taking-off in an almost vertical position, the so-called steep-angle. There is also the possibility of carrying out a two-stage steep-angle landing – it facilitates completion of tasks in adverse conditions. The UAV possesses fully automated flight control systems and the ability to coordinate and correct them (FLYEYE, n.d.).

Fig 1. FlyEye



Source: <http://www.reutechcomms.com/flyeye>, access 02/11/2019.

The mounted space recognition elements are equipped with specialized optical as well as thermal imaging cameras. The UAV can perform a flight with a radius of up to 30 km, and stay airborne up to three hours with constant data transmission in real time. After completing the task, it proceeds to perform a two-phase landing consisting in: in the first phase – dropping the container with the head and electronics on the parachute, and in the second – its own landing.

The FlyEye, thanks to its potential and modularity, can be transported by just one soldier, while the second soldier carries other pieces of equipment, such as ground flight control and data communication station (Brzezina, 2013).

Table 5. Tactical and Technical Data – FlyEye

Wingspan	3.6 m
Length	1.9 m
Maximum take-off mass	11 kg
Load mass	up to 4 kg
Speed of flight	from 50 to 170 km/h
Altitude	4000 m
Operation range	10/30/50 km
Time of flight	from 120 to 180 min

Source: WB GROUP, n.d.

6. Orbiter

Another discussed UAV, which is used by Polish Armed Forces is the Orbiter manufactured by the Israeli company Aeronautics Defense System Ltd. This aircraft was built in the arrangement of a flying wing with a single electric motor, which was mounted in the rear part of the fuselage, and the reconnaissance elements were installed in the forepart of the vehicle. The set includes: a portable launcher, one or more recognition cameras, and a communication console. The mounted reconnaissance elements are designed to operate in daytime and nighttime conditions. It also has a GPS receiver and inertial navigation systems (Brzezina, 2013).

Fig. 2. Orbiter



Source: <https://www.israeli-weapons.com/weapons/aircraft/uav/orbiter/Orbiter.html>, access 02/11/2019.

In order to perform a combat task, the above UAV should be placed on a small catapult or ejected by hand from a standing position into the air, after previous preparation. The main task of the service crew and the operator is to prepare the ground and flight control station for operations. Using the console components, one can plan the flight route and observe images in real time. If necessary, the control can be performed manually using the built-in joystick located next to the flight and mission console. The latest modernization of this weapon is the Orbiter-2B version, which is characterized by a range that is two times larger, duration of flight, and newer elements of the head with a built-in camera for HD reconnaissance (Modernization Plan, n.a.) (Aeronautics, n.a.)

Table 5. Tactical and Technical Data – Orbiter

Wingspan	2.2 m
Length	1m
Hight	0.3 m
Head mass for daytime missions	0.65 kg
Head mass for night-time missions	0.95 kg
Data transmission range	up to 15 km
Operational speed	46–120 km/h
Maximum speed	139 km/h
Maximum altitude	~ 5000 m
Maximum flight time	up to 1.5 h

Source: Wydawnictwo Nowa, 2006; Wydawnictwo Nowa, 2007.

Taking into account the development of unmanned aerial vehicles and the adopted methodological limitations, only the construction of the Orbiter-2B version was characterized.

The analysis of the tactical and technical data of the two discussed UAVs has shown that there are many similarities regarding their capabilities. The FlyEye has a longer operating range, can stay longer in the air, and is able to carry a heavier load than the Orbiter. On the other hand, Orbiter has a higher maximum speed and a higher altitude. Nevertheless, the differences are small and do not significantly affect their combat abilities.

7. Conclusions

Concluding the presented results of the theoretical research, it can be stated that despite the existence of several terms related to the subject of the study, the most suitable is “unmanned aerial vehicle”. It should be emphasized, however, that it is much narrower than the unmanned aerial system and wider than the controlled aircraft. Moreover, the research has shown that the variety of functions and equipment, as well as the dynamic development of these objects often makes the adopted typology obsolete, or it is impossible to assign a particular UAV to one class (one type), and in consequence, it is difficult to formulate a detailed, unambiguous description of

the UAVs types. The research has also shown that due to the large number of different types of UAVs, there is a justified need to limit reliability tests to a specific type of structure. Additionally, it has been demonstrated that despite the existence of numerous UAV classifications, it is the reliability tests that determine the usefulness of vehicles. The typologies focusing on tactical and technical data, although used in legislative documents, have little cognitive value from the point of view of the reliability of the objects. Therefore, in this particular case, the typologies based on structural elements seem to be most suitable for the research assumptions, and the typology based on the aerodynamic system showed unambiguously that the largest UAV group is the fixed-wing aircraft. Therefore, limiting the research group (which is justified from an economic point of view), it is expedient to carry out further research on the UAVs of the fixed-wing type.

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Biological Security of Polish Military Contingents Outside the Country

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Abstract

Polish soldiers have been participating in peacekeeping and stabilization missions around the world for several decades under the auspices of the UN, OSCE, NATO and the EU. They were first sent to Korea in 1953 to oversee a ceasefire between the North and South Koreas. Since then, nearly 70,000 Polish troops have taken part in 58 peace and humanitarian multinational missions on different continents (SKMP ONZ, 2019), which required from them great skills to cooperate with soldiers from other countries, to overcome cultural barriers, as well as adaptation to difficult climatic conditions, often completely different than those experienced in Europe, and to create a system of safeguards and procedures against dangerous tropical diseases. As a result, biological safety, i.e., medical, sanitary-hygienic, and anti-epidemic security of the contingent, plays a significant role in every mission because it allows the soldiers and civilian personnel stay healthy in unfavorable and different climatic and environmental conditions.

Keywords: biological security, identification of threats, Polish Military Contingent, safety

1. Introduction

The 21st century has brought forth a great opportunity to move people over long distances in a short period of time, often by the means of air transport. These destinations are often distant countries and continents with a different climate where one gets exposed to various pathogens which are harmless to natives, but may cause many unpredicted health issues among foreigners. Simply drinking water can become a cause of unpleasant stomach problems. The dangers posed by infections with biological agents like viruses, bacteria, or parasites, are a fundamental problem for biological security of the Polish Military Contingents stationed in various places around the world, today mainly in Asia and Africa. Apart from the health risks and problems caused by active participation in war and stabilization missions (e.g., gunshot

wounds), soldiers and civilian personnel are exposed to numerous exotic diseases and the possible use of biological weapons by terrorists (and, if that occurs, the troops should be provided with a secure transfer back to the country). For these purposes, a structure of the mission military health service has been established. Its main goal is to protect and prevent unforeseen health incidents among the soldiers, and it starts already in Poland. Every soldier of the Polish Military Contingent (PMC) is thoroughly examined in terms of their health before leaving the country. Moreover, all of the troops receive a series of vaccinations that are included in the Preventive Vaccination Plan (GIS, 2018) published at the end of each calendar year for the following year and are recommended by the Ministry of Health and Ministry of Foreign Affairs and the Department of Military Health Service.

The goal of this review paper is to identify and characterize the biological hazards the Polish Military Contingents can be exposed to. Furthermore, legal framework related to this issue is discussed, and safeguards against the possible consequences of the occurrence of such threats are analyzed.

2. Polish Military Contingents in the Past and Present

The Polish Military Contingent (PMC) is a separate military unit of the Polish Armed Forces (operational forces) intended to participate in a foreign military operations (peace-keeping, stabilization, or war) in accordance with the decision of the President of the Republic of Poland at the request of the Council of Ministers (Mróz, 2004). This definition sets out that each soldier and civilian personnel member designated for the mission are treated in particular in terms of preparatory training. They all undergo detailed health tests and the entire vaccination cycle necessary to protect the “missionary” against possible infections with tropical or parasitic diseases, which do not commonly occur in Poland.

Polish soldiers have been participating in missions abroad since 1953. The first mission took place in North Korea where the Polish military participated in the Neutral Nations Supervisory Commission (NNSC) as observers overseeing the ceasefire. Three hundred Polish troops were deployed there as well as 60 military doctors who worked at the Polish Red Cross hospital. Later on, the PMC was sent to other destinations, including missions in Indochina in 1954–1976 and Nigeria in 1968–1970 (Krzemińska, 2014). However, the first Polish military contingent operating under the United Nations Emergency Force (UNEF) – Polish Special Military Unit (PMSU) was sent to Syria as part of the so-called “blue

helmets” in 1973–1979. The name “Polish Military Contingent” was officially used for the first time in 1979. Since then, Polish soldiers have been involved in numerous missions: since 1992 as PMC in Croatia; in 1996, Polish military units were sent to Bosnia and Herzegovina, Albania, and Kosovo as NATO support (since 2000, these units have been called Polish Military Contingents). After this period, the largest contingents were deployed, i.e., PMC Afghanistan and PMC Iraq, within the North Atlantic Treaty Organization. During these missions, 2,600 Polish troops were deployed in one turn. Until recently, Polish soldiers also participated in international peacekeeping operations and stabilization missions in Congo, Chad and Lebanon. (Pawłowski, 2010). The deployment of the Polish troops in Asia and Africa is shown in Map 1; and Map 2 depicts the presence of the PMC in Europe.

Since 2003, Polish soldiers have served in Bosnia and Herzegovina as part of the European Union peacekeeping forces, and since 2006, the Military Gendarmerie has played a special role. The PMC also operated as part of ad hoc multinational coalitions, e.g., in 1985–1987, the Polish Relief Helicopter Squadron served in Ethiopia during the Tessa humanitarian operation. The following years brought two wars in the Persian Gulf in Iraq, where Polish soldiers played a significant role in the stabilization of the region. It was the second largest Polish Military Contingent in history – about two and a half thousand soldiers were deployed in one turn.

Since 2009, Poland has significantly reduced its presence in the United Nations peacekeeping forces by withdrawing all military contingents, and since 2014, i.e., the completion of International Security Assistance Force (ISAF) missions, the PMC have been mainly involved in training and patrol activities (Smolarek, 2016).

Map 1. Polish Military Contingents in Asia and Africa (as of July 13, 2017)



On the basis of: https://pl.wikipedia.org/wiki/Polski_kontyngent_wojskowy; 03.11.2019.

Map 2. Polish Military Contingents in Europe (as of July 13, 2017)



On the basis of: https://pl.wikipedia.org/wiki/Polski_kontyngent_wojskowy; 03.11.2019.

3. Biological Safety of the Polish Military Contingent

The American Center for Disease Control and Prevention (CDC) defines biological safety or biosafety as “the discipline addressing the safe handling and containment of infectious microorganisms and hazardous biological materials” (CDC, 2016). In other words, biosecurity includes, i.e., undertaking measures to reduce public health risks by controlling and eliminating pathogenic factors such as viruses, bacteria, fungi, toxins or other microorganisms commonly found in nature.

Biological safety is an essential element of the proper functioning of soldiers, not only in their home country but, above all, during international missions. One of the most important Polish documents governing the procedures for dealing with the emergency caused by biological, often pathogenic, factors, is the Ministry of National Defense Decision No. 53/MON issued on March 5, 2013, which introduces instructions on sanitary and anti-epidemic protection of the military during peace, crisis and war (MON, 2013). It clearly lays down the principles of protecting the health of troops and supervising the health risks of soldiers and civilian personnel outside the country during ongoing peacekeeping

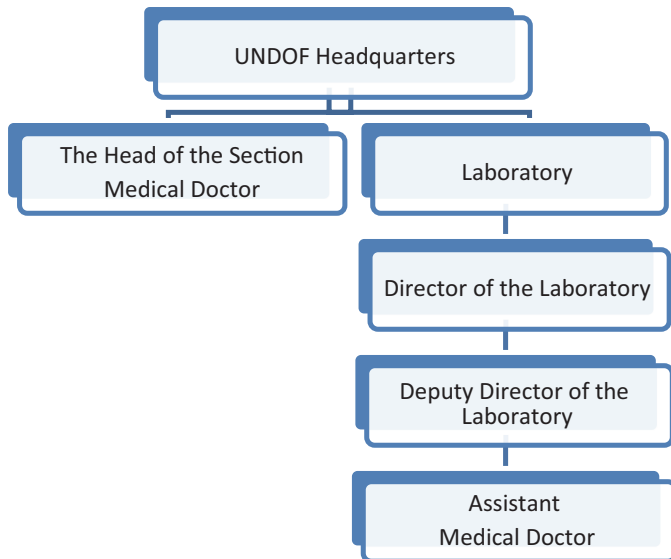
and stabilization missions. Detailed operational procedures for foreign missions are described in the NATO standardization documents (Kucharek, 2017), i.e., AJMedP-4 – Allied Joint Medical Force Health Protection Doctrine (NATO, 2018) and AMedP-4.1 – Deployment Health Surveillance (NATO, 2017).

The aforementioned sanitary-hygienic and epidemiological documents accurately clarify the health risks of soldiers on foreign missions, among which there are pathogenic factors, and related diseases that occur mainly where there is a low level of hygiene, poverty and armed conflicts. Other threats include environmental contamination in low-industrialized areas of the world and the deliberate use of weapons of mass destruction (WMD), including biological weapons.

Military missions involving Polish soldiers and civilian personnel in African and Asian countries pose a very serious threat to the infestation of pathogenic biological agents. This is related to the nature of the activities carried out in politically hostile, military, and most importantly, potentially epidemiological areas by the troops. Such situations involve economic, social, and political destabilization. Proper infrastructure is destroyed by the ongoing conflict. The acquisition of water

often becomes very difficult, sometimes even impossible. All-present famine causes a decrease in immunity, and consequently, the spread of infectious diseases, which poses a serious threat to the health and life of soldiers stationed in these areas. The drastic epidemiological situation is exacerbated by climate conditions, e.g., high temperature leads to the development of infectious and parasitic diseases. Such conditions encourage the development of respiratory

Fig. 1. Organizational Structure of the Health Service of Polish Military Contingent in Syria (UNDOF)

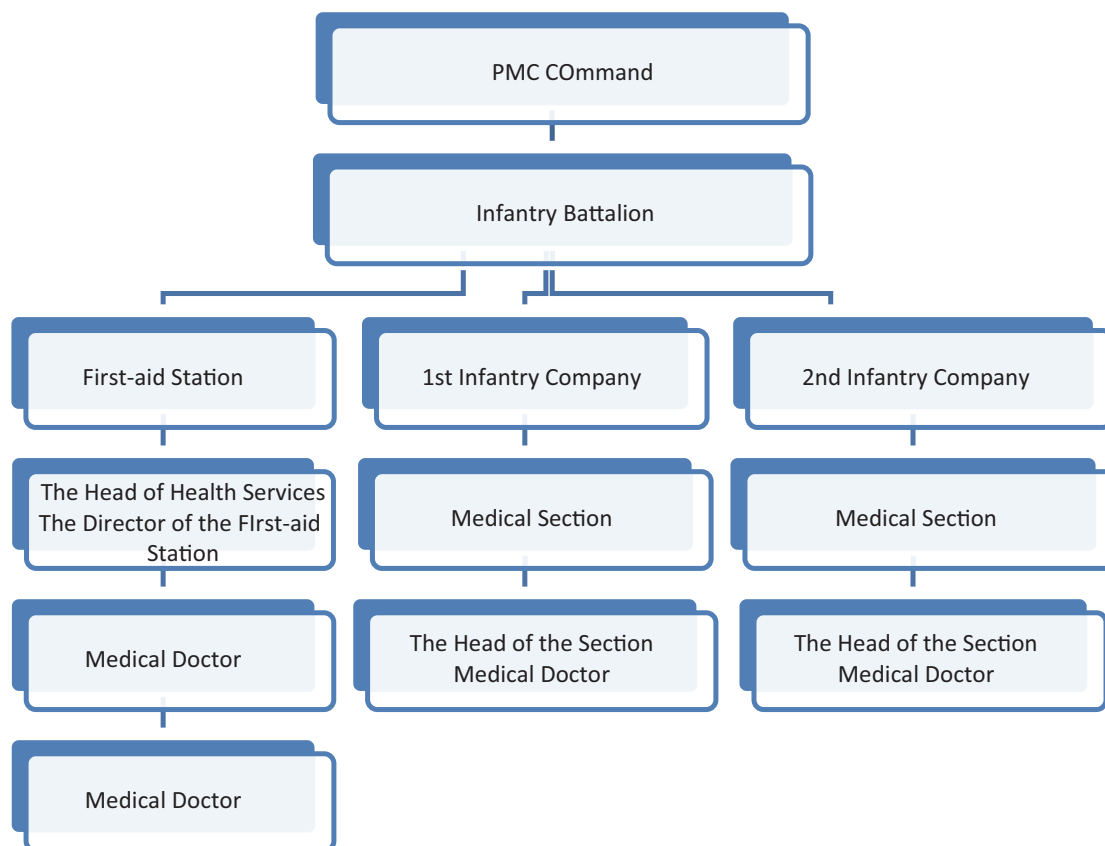


diseases, while low hygiene standards largely contribute to the spread of diseases transmitted by food, zoonoses and transmission diseases (Korzeniowski, Smoleń, 2015).

A soldier's health and life can also be threatened while on a mission by potential deliberate use of biological weapons (BW), commonly known as bioterrorism that can be defined as "is the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops" (CDC, 2018). In other words, it can be understood as an unlawful, illegal use of biological factors such as bacteria, enzymes, parasites, toxins, viruses and other materials of biological origin against humans, plants or animals with the intention of intimidating or forcing a specific action of the government or civilian population to achieve personal, political or social goals (MON, 2013). Soldiers on missions are particularly vulnerable to terrorist groups who can use that type of weapons against them. It is particularly justified due to the fact that, in the base, there are many people in one place, and when the soldiers operate outside of the base, they move in a column, what increases the possibility of transferring the biological factor to the base.

4. The Organizational Structure of the Polish Military Contingent Health Services

The Ministry of National Defense and the relevant structures controlling the medical aspect of the Polish Army, i.e., the Department of Military Health Service (earlier the



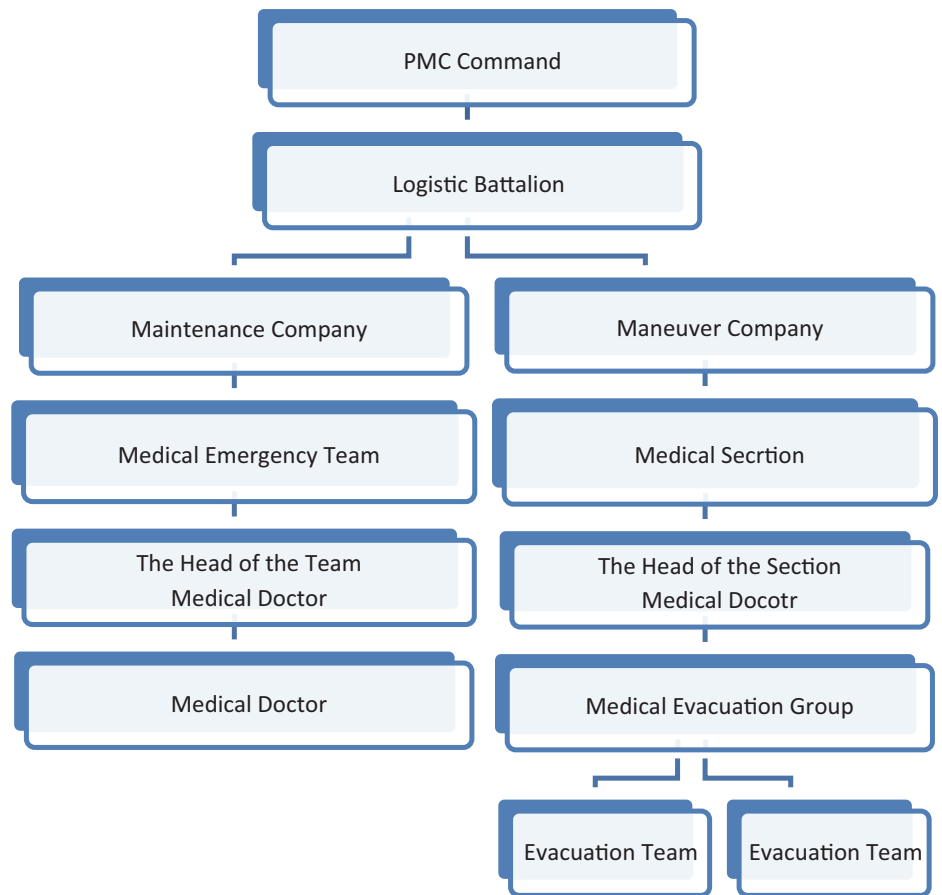
Source: Korzeniowski et al., 2009, p. 153.

Inspectorate of Military Health Service) have created a comprehensive organizational structure of health service for missions outside the country. The health service of Multinational Division Center South (MND CS) in Iraq can serve as a great example, because it was led by the head of health services who was also a medical officer of the PMC. He reported directly to the chief of staff of the division, and was an adviser to that commander with regards to medical, sanitary-hygienic, anti-epidemic security, as well as medical supplies. At the same time, he cooperated with the health services of the other three stabilization zones and with the Iraqi health service. The Polish Military Contingent had a field hospital, which was given to the Polish Armed Forces in 1992 by Sweden, an out-patients' clinic, and an analytical and microbiological laboratory. The hospital actively participated in the medical evacuation of the victims during convoys or fighting outside the base. Figure 1 shows how complex the organizational structure of the health service on the mission in Syria (UNDOF) was. The structure of the health service during the Lebanon mission (UNIFIL) was much smaller, as depicted in Figure 2. The complexity of the structure depended on the position of the PMC in the Multinational Division and on the number of soldiers deployed.

Another important person in securing PMC was the Force Hygiene Officer who was responsible for sanitary and hygienic and anti-epidemic protection of the MND CS units. Among his most important responsibilities there were:

- controlling food and nutrition (important health aspect);
- supervising water testing and determining its suitability for consumption;
- supervising bacteriological and parasitological feces;
- controlling means for disinfection, disinfection and dera-tization;
- implementing measures to prevent infectious and parasitic diseases, especially food poisoning;
- controlling of the disposal of wastewater and biologically contaminated material;
- carrying out epidemiological investigations in the event of infectious diseases;
- preparing information together with the staff of the Mobile Biological Laboratory on the possibility of using biological weapons and many other tasks related to the health risks of PMC soldiers (Korzeniowski, 2004).

Fig. 2. Organizational Structure of the Health Service of Polish Military Contingent in Lebanon (UNIFIL)



Source: Korzeniowski et al., 2009, p. 154

5. Conclusions

The service of the soldiers of the Polish armed forces in peacekeeping and stabilization missions in various parts of the world, especially on the African and Asian continents, carries a huge risk of being infected with biological agents causing infectious and parasitic diseases. A different climate, associated with tropical weather, diseases that endemically do not occur in Poland, stress caused by service, a different diet and a number of other factors contribute to both soldiers and civilian personnel being exposed to many health threats. Therefore, the skilled medical personnel exercise protection over the troops having at their disposal a field hospital, an out-patients' clinic, diagnostic and microbiological laboratory and well-prepared procedures for the case of a tropical disease causing not only respiratory, digestive, but also skin complications. The rapid response of medical services will prevent the spread of the disease, which can lead not only to serious complications, but even death, e.g., hemorrhagic fevers caused by the Ebola virus, Dengue or Nipa.

The organizational structure of the health service on missions is supervised directly by the Department of Health Services in Poland, which delegates qualified and trained medical personnel for such tasks. Sanitary and anti-epidemic

aspects are clearly defined by the instruction on sanitary and anti-epidemic security of the army during times of peace, crisis and war [*Instrukcja o zabezpieczeniu sanitarnohigienicznym i przeciwepidemicznym wojska w czasie pokoju, kryzysu i wojny*] (MON, 2013), which is a master document for the Polish Army, and the extensive experience of the medical personnel on missions has contributed to creating this manual and hence eliminate many threats.

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