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UNIVERSITY OF
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CHALLENGES TO NATIONAL DEFENCE IN CONTEMPORARY GEOPOLITICAL SITUATION

CNDCGS`2024

Abstracts of the 4th International Scientific Conference

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4th International Conference 2024

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The abstracts of the 4rd International Scientific Conference CHALLENGES TO NATIONAL DEFENCE IN CONTEMPORARY GEOPOLITICAL SITUATION contain short reviews of presented works.

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PREFACE

The fourth international conference *Challenges to National Defence in a Contemporary Geopolitical Situation* (CNDCGS'2024) held on 11 – 13 September 2024, Brno, Czech Republic is organized by University of Defence, Brno (Czech Republic), General Jonas Žemaitis Military Academy of Lithuania, Ministry of National Defence of the Republic of Lithuania, cooperation with the NATO Energy Security Centre of Excellence, National Defence Foundation and the Lithuanian Riflemen's Union.

The conference invites practitioners and researchers to discuss important issues related to current and future challenges to European defence capabilities and to collect great innovative ideas for future development. Also, an important contribution is made to defence innovation. The conference aims to attract the attention of the European society and increase the attention of the international political community and the U.S. and European decision-makers to the security of the Baltic region.

The aims of CNDCGS-2024 were to share the latest topical information on the issues of national defence in a contemporary geopolitical situation. The papers in the Abstracts presented the following areas:

- Defence Technologies and Aviation
- Cyber Threats and Security Issues
- Democracy, Contemporary Threats and Warfare
- Modern Technologies and Social Sciences
- Multi-Criteria Decision-Making
- Sustainable Defence Solutions
- The Impact of New Defence Technologies on Humans
- Education and Physical Training for National Defence
- Military Operation in Multidomain Environment
- Challenges to Face New Defence Technologies

The invitations to the CNDCGS-2024 include the instructions on the preparation of reports, abstracts and manuscripts as well as the deadlines for the reports.

The primary goal of the conference is to present the highest quality research results. The key element in attiring the goal is the evaluation and selection procedure developed by the Conference Scientific Committee. All the works presented in the conference and published in the Abstracts undergo the mentioned procedure. The instruction for submitting the proposals, including requirements and deadlines, are published in the Publication Opportunities on: *https://forum.lka.lt/guidelines/*

All the conference participants prepare their research results in an extended abstract format of 500-1000 words, including references, according to the requirements that make our Abstracts book a valuable recourse of new information which allows evaluating the investigations of scientists from different countries.

Prof. Dr. Svajonė Bekešienė

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Contemporary Decision Support Tools in Decision- Making Related to the Development of "Green Airports"

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Introduction. The environmental development of air transport and the reduction of atmospheric and noise pollution have also had a significant impact on airports in recent decades. Airports are vital national resources for the national economy. They play a key role in the transport of people and goods, as well as in regional, national and international trade. These are the places where the country's air transport system connects with other modes of transport, and where international responsibilities related to the management and regulation of air traffic meet with those of the state and local governments that own and operate most airports. In connection with this, Airport Carbon Accreditation (ACA) was created, the only institutionally supported, global carbon dioxide management certification program that provides airports with certified compliance and certification to prove their environmentally friendly operation. In addition, it makes visible the possibilities and ways forward that can ensure the realization of the long-term goal of "zero emissions".

The design and implementation of airport development decision support systems includes several key factors. First, it is important to consider the connotation of green airports (secondary meaning), including resource saving, environmentally friendly operation, efficient operation and people orientation. Coordination of airport design and construction, airspace system reform, APU replacement, and "oil-to-electricity" of airport vehicles are significant factors in creating a green airport. Assessing environmental sustainability in the design and planning phase of airport facilities using a multi-layered decision-making approach combined with cost and utility functions can help filter and prioritize alternatives.

One approach is to use electric ground service vehicles powered by renewable energy sources to reduce emissions and lower energy costs. Another approach involves testing different electricity management strategies to maximize objectives, such as reducing electricity costs or CO2 emissions.

Method of investigation. The authors analyzed the airport project planning process, rules and standards, as well as operational and project strategies through a literature review and study of international research results. An analysis was also carried out in relation to the relevant regulations and standards, which basically define the infrastructural conditions and operational processes of the airports.

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During the research, it was important to isolate and analyze in detail the processes that are usually present in the operation of airports, both in terms of commercial and military aviation.

The research included the search and analysis of modern decision support tools that can be effectively used in project decisions related to developments. It was advisable to evaluate and analyze the searched tools and procedures along the dimensions of scope, time horizon, and data requirements.

The Green Airport Design Evaluation (GRADE) method and its corresponding tools were used as a basic tool system for the planning and further development of the airport infrastructure, as well as the direct or indirect measurement and monitoring of the environmental impact.

An essential methodological element of the research was the detailed study and analysis of the case studies of "green airports", which provided the methodological background for the identification of methods, tools and best practices of sustainable airport development.

Investigation Results. When comparing the operational processes of commercial and military airports, many similarities could be detected, the differences within each process did not require the use of procedures different from the generally used methods. However, an essential difference arose in connection with the presence of weapons and related processes, which it was advisable to analyze separately.

As a result of the research, a methodological toolkit was created to effectively support the planning and environment-oriented development of airport infrastructure, as well as to measure and monitor environmental performance.

Conclusions. The new in the course of the research, it became clear the need to use process analysis and modeling procedures, as well as the development of uniform sustainability and environmental impact indicators, which can be used to identify the data and information needs of airport infrastructure planning.

When planning development projects and investments, it is necessary to define the basic goals tied to the appropriate time horizon, as well as to develop and record the policies and strategies that ensure the fulfillment of the goals. In this way, the criteria and priorities that greatly influence the applicability of decision support tools can be clearly recorded.

When developing strategies and policies, compliance with the long-term, global objectives and principles of sustainability, reduction of energy needs, circular economy, and carbon dioxide emissions is essential.

Limitations. However, the development of a framework for the management and management of airport development investments, which includes and properly manages the interdependencies of all aspects affecting the project planning and decision-making process, requires further research.

It is important to underline the consideration of Artificial Intelligence (AI) possibilities and tools in the context of the present research, which can identify further directions.

engineering, military and social science research in the field of national defence and national security at the Faculty of Military Science and Officer Training"). The project was funded by the Ministry of Innovation and Technology as the Sponsor and was carried out by the researchers of the Green Airport (GA) research group of the Integrated-model airfield Priority Research Area.

Keywords: *decision making, decision supporting tools, airport development, green airport, military aviation*

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Feasibility of Casualty Evacuation by Unmanned Systems

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Introduction. Main task of military medical services is to preserve and restore health and recover fighting ability and combat power. Military medical services therefore provide full range of medical care, containing preventive measures, treatment and medical evacuation (MEDEVAC).

MEDEVAC is the medically supervised process of moving any person who is wounded, injured or ill to and/or between medical treatment facilities as an integral part of the treatment continuum. MEDEVAC is executed by dedicated transportation assets, under supervision of medical personnel to most suitable Medical Treatment Facility. Complex operational environment and complicated tactical situation not every time offers possibility to transport wounded, injured or ill person by MEDEVAC assets and in escort of medical personnel and that is the reason why casualty evacuation (CASEVAC) is sometimes organized to cover insufficiency of sources or to reach medical timelines. CASEVAC is opportunistic transport of casualties executed either by transportation assets not dedicated to MEDEVAC or executed without supervision of medical personnel and usually both conditions are met.

Even in contemporary military conflicts unmanned systems executes unprecedented scale of tasks and operations to support military troops. Unmanned systems provide tasks from purely military tasks to tasks of logistic support. For purposes of medical support are used to resupply forwarded medical capabilities, including resupply of blood and blood products or medical equipment. The range of these tasks and operations will definitely grow in the future military operations.

The idea of unmanned systems to be used for CASEVAC is not new. Medical subject matter experts are dealing with it for more than two decades. Aim of the paper is to comprehensively investigate aspects of the CASEVAC executed by unmanned systems and possibility to use commercially produced unmanned aerial systems, unmanned ground systems and unmanned aquatic systems for military CASEVAC.

Method of investigation. Investigation was executed as qualitative research to comprehensively describe different aspects of CASEVAC executed by unmanned systems. Furthermore, as and quantitative research focused on multiple parameters of unmanned systems that are essential requirements for fulfillment of CASEVAC tasks, mainly carrying capacity, system range, ballistic protection of the casualty and possibility to carry required

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medical equipment. Applied research methods were analysis, observation, comparison and generalization.

Investigation Results. All commercial solutions that were part of our investigation for the use of unmanned systems, except for the systems that can convert land vehicles to become an autonomously operated platform, have the very same attribute that is the casualty during evacuation would not have any ballistic protection. That feature must be subject of further development, casualty must have protection comparable to the soft skin, better hard skin ground MEDEVAC assets, or other transportation assets that are used for CASEVAC. Common feature of the unmanned systems is the fact that platforms are being developed for other use and transportation of casualty is just secondary use of the unmanned systems. Positive outcome of the investigations is the fact that due to their ability to carry enough weight for long enough distance unmanned systems are feasible solution for CASAVEC. According to the publicly presented development outcomes of unmanned systems for CASEVAC purposes their use in peace conditions could be possible in near future. Source of a discussion for their use in combat conditions must be also ethical considerations and the fact that casualty should not be put into greater threat than is health risk based on his or her medical conditions. Important is note the fact that one piece of unmanned system would most likely transport one casualty. That creates implications for the value of the target for the enemy with one piece of unmanned system and one casualty, on the other hand limitations for medical planners. As well as the fact that costs and feasibility of such CASEVAC would probably make it executed only when specific conditions would be met.

Conclusions. Contemporary degree in development of unmanned systems is high and it is expected that range of the tasks executed by unmanned systems to support military operations will grow. Specific way of unmanned systems use is CASEVAC. In the past especially unmanned aerial systems were taken into account as far as CASEVAC is concerned. Nowadays unmanned ground systems are rapidly developing for this purpose and is just a matter of time when unmanned aquatic systems either on or under water level will be adapted for CASEVAC use as well.

Besides other important considerations, provision of medical care during evacuation supported by medical equipment on board, respectively monitoring of medical conditions and protection of casualty from possible intentional or unintentional enemy kinetic actions are the greatest concerns.

Limitations. Research was executed on technological solutions that are available as commercial offer on contemporary market and proclaims possibility to execute transportation of casualties.

Keywords: *unmanned systems; unmanned ground systems; unmanned aerial systems; unmanned aquatic systems; casualty evacuation.*

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Firing Data Accuracy and its Impact on the Effectiveness of Artillery Fire

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Introduction. Indirect fire support is a crucial element for ground forces in the successful execution of their military operations. The ongoing conflict between Russia and Ukraine serves as a reminder of its significance. According to available sources, approximately 20,000-50,000 pieces of artillery ammunition of various calibers are fired daily and both sides struggle to provide enough ammunition to troops [1]. When planning fire support, artillery commanders must consider principles of fire direction and control. The objective is to achieve the desired outcome with minimal rounds fired. This reduces the risk of detection by the enemy and also minimizes the logistical footprint. [2,3].

Artillery fire must be timely and accurate to be effective. However, its accuracy can be influenced by many factors, such as meteorological conditions, target location error, and many others. As a result, artillery fire is not always delivered accurately on target. The distance between the mean point of impact (MPI) of the artillery shells and the center of the target is referred to as the MPI error. However, this error can be minimized by applying appropriate means and processes, resulting in increased efficiency of artillery fire on the target [4, 5].

The precise firing data needed for truly effective fire for effect (FFE) can be obtained mainly in two fundamentally different ways. The first and most accurate is when adjust fire procedure is used. It has, however, several disadvantages; reveals prematurely the position of our guns, gives the enemy a chance to react and so to reduce the effectiveness of our fire, and many others. The second method is based on the principle of obtaining sufficiently accurate firing data to enable artillery units to utilize first-round FFE. The more accurate the firing data obtained, the more accurate and effective FFE will be, resulting in significant ammunition savings [6, 7].

The article emphasizes the importance of acquiring precise firing data to increase the effectiveness of artillery fire on a target. It argues that the implementation and utilization of modern and accurate means by all artillery units would significantly reduce ammunition usage while achieving the same effect on the target.

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Method of investigation. Analysis of currently applied accuracy standards for obtaining first-round FFE firing data was performed. Results were compared with the level of accuracy of modern assets commonly used in advanced armies. Based on the accuracy of investigated instruments and methods, authors created increased accuracy standards. Comparative

analysis of resulting firing data errors both for current and increased accuracy standards was conducted, using mathematical methods of artillery fire errors reduction and target segmental transformation [4]. The resulting data was used to calculate the optimal consumption of artillery shells needed to achieve the desired effect on three different types of targets.

Investigation Results. The results indicate that using firing data fulfilling increased accuracy standards results in significant savings in ammunition consumption when compared to achieving the same effect on the same target across all three target types. Specific results are presented in Fig. 1.
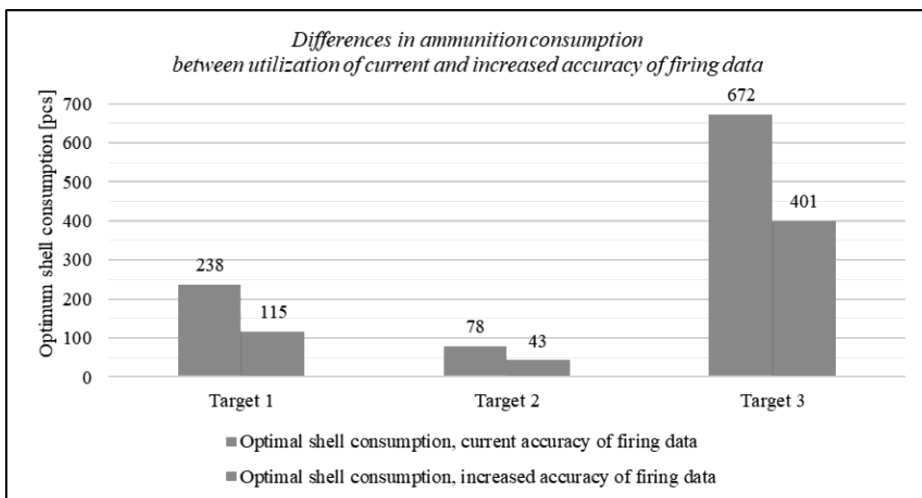
Fig. 1 Differences in ammunition consumption between utilization of current and increased accuracy standards for obtaining first-round FFE firing data.

Conclusions. Current accuracy standards for obtaining first-round FFE firing data do not comply with the accuracy achievable by modern assets and instruments. Satellite and inertial navigation systems, muzzle velocity radars, electronic aiming, and other devices allow increased precision in comparison with means and methods used in the past to set current accuracy standards. By providing artillery and maneuver units with means to precisely determine conditions affecting artillery fire, increased minimal standards of accuracy can and should be introduced. A significant reduction in ammunition consumption means a significant increase in available fire support capabilities. It is hoped that, as a result of the research, military units will be equipped with precise means to ensure higher efficiency of indirect fire support.

Limitations. The research was conducted on a model situation of the Armed forces of the Slovak Republic, where currently valid accuracy standards for first-round FFE were set in 2010 [2]. Computations of errors and shell consumption were conducted for the Howitzer D-30A and shell OF-462, currently used in eastern Ukraine but also by the

Armed forces of the Slovak Republic. Determining ammunition savings for a different weapon system and different doctrinal accuracy standards would require further research.

Keywords: *artillery fire; accuracy; fire for effect; ammunition consumption, firing data.*

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Application of AI in the Energy Sector of Ukraine in the Conditions of War

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Introduction. In the 21st century, the global energy industry is undergoing a transformation – a transition from an outdated model of the energy sector dominated by large producers, fossil fuels, and inefficient management systems to a new model with a competitive environment and equalization of opportunities for development. Preference is given to increasing energy efficiency and using energy from renewable sources. In this context, the development of artificial intelligence (AI) is the most important trend of recent decades, which contributes to the automation of technological processes, and the development of smart networks and innovative digital business platforms based on AI will allow not only to effectively manage energy supply and consumption modes, but also significantly affect strategic priorities, since certain technologies lead to changes in the conditions and principles of functioning not only of certain energy systems, but also of socio-cultural aspects of energy consumption. On the other hand, the global practice of using AI technologies, which contribute to the decentralization of the energy supply system and increasing the flexibility of responding to consumer needs, significantly affects the functioning of existing centralized energy supply systems. For Ukrainian energy companies in the conditions of a full-scale war, this circumstance is a serious challenge and will require the adoption of strategic decisions regarding the priorities of the country's energy development. The full-scale invasion of the Russian Federation against Ukraine destroyed the process of gradual modernization of Ukraine's energy enterprises. However, overcoming the consequences of the armed invasion and radical changes in the energy sector of Ukraine can become a factor in the transformation of the entire energy sector of the country.

Purpose and method of investigation. The purpose of the study is to determine the main directions of implementation of artificial intelligence technologies at energy enterprises of Ukraine based on the analysis of trends in the world energy sector and taking into account the attacks and destruction of energy infrastructure during a full-scale war. Achieving the goal involves solving the following research tasks: first, to characterize the potential and directions of application of AI in energy; secondly, to analyze the international and Ukrainian practice of implementing AI technologies in the activities of energy companies; thirdly, with the help of the SWOT analysis method, determine the areas of use of artificial intelligence technologies for Ukrainian energy enterprises.

General and special methods of scientific knowledge were used during the research. Among the general methods of research, the methods of analysis and synthesis, generalization,

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induction and deduction, comparison were used to study the specifics of the introduction of artificial intelligence in energy. Among the special scientific methods of research, the SWOT analysis method was used, which made it possible to determine the areas of application of artificial intelligence and optimal strategies in the conditions of a full-scale invasion.

Investigation Results. *The potential and directions of application of artificial intelligence in the energy sector.*

The development of the latest energy technologies significantly affects the strategic priorities of energy development. Separate technologies, at the same time, lead to changes in the conditions and principles of functioning not only of individual energy systems, but also of socio-cultural aspects of energy consumption. Experts have identified more than 50 use cases for AI in the energy sector. Many of these programs support the transition to a sustainable energy infrastructure that will allow efficient management of energy supply and consumption regimes. New technological solutions - a wide variety of generating capacities (for example, renewable energy sources or energy storage) or energy-consuming installations (for example, household appliances, electric cars, etc.) will allow to balance energy supply and demand. Moreover, the use of artificial intelligence (AI) technologies becomes not only a way to reveal new opportunities in the organization of the energy supply process for consumers' needs, but also an effective tool for ensuring sustainable development and operational security of energy supply systems. Artificial intelligence (AI) is a relatively new technology of wide application of digital technologies in energy, in particular, algorithms for processing large data sets to improve the processes of ensuring various aspects of the life of societies. Therefore, the use of this technology is still not standardized.

The large-scale armed aggression of the Russian Federation against Ukraine, which began on February 24, 2022, destroyed the process of gradual modernization of the country's energy assets and energy companies. However, overcoming the consequences of an armed invasion can become a factor in the transformation of the country's entire energy sector. Ukraine, in the process of post-war recovery, should use the chance to rebuild the energy infrastructure immediately on the latest technological base, already adapted for the widespread use of AI. Experts of the National Institute of Strategic Studies believe that "for participants in the energy market, digital tools and platforms provide more effective integration of various energy sources and types of consumers, contributing to better satisfaction of consumer needs and the reliability of the functioning of energy supply systems. At the same time, digitalization creates new business opportunities and revenue streams for energy service providers, while helping consumers better understand their energy consumption and reduce their bills" [1].

The practice of implementing the use of AI technologies in the activities of energy companies

Implementation of AI technologies in the energy sector occurs both at the level of countries and is initiated by business. For example, in Europe, on the basis of artificial intelligence, the EUPHEMIA algorithm was developed, which is used today to calculate electricity prices and allocate cross-border transmission power for a day ahead [2] in 25 European countries. The Siemens company has started testing a special device for accounting for the electricity consumed for charging electric cars [3]. The Meter Integrated Charger (MIC) integrates into standard metering systems with remote data transmission and allows to determine the cost of charging an electric vehicle and the total costs over a specified period of time. To promote its Power wall, Tesla has joined a Virtual Power Plant (VPP) operated by National Grid [4],

which will allow Power wall owners to feed excess electricity into the grid and earn money. Local authorities are also looking at opportunities to optimize energy consumption with the help of the latest technologies and the potential of AI. For example, London is launching a vehicle-to-grid project, when electric buses will supply electricity to the network [5].

Russia's full-scale invasion of Ukraine significantly complicated the country's energy transition to green energy and the introduction of artificial intelligence technologies. However, the Energy Strategy of Ukraine for the period until 2050 provides for the restoration of the country's energy sector using the most modern technologies, strengthening the stability of the system, strengthening the energy security of Ukraine and the European continent as a whole, and achieving climate neutrality in the energy sector by 2050 [6]. Individual examples of the application of AI technologies in Ukraine's energy sector already has, despite the full-scale invasion and significant destruction of the energy infrastructure. Such projects are mainly implemented in the framework of cooperation with well-known companies, developers of modern solutions in the field of automation of technological processes. For example, the South Korean KT Corporation (which is the largest provider of integrated telecommunications services in South Korea) has expressed interest in developing cooperation with Ukraine in the direction of the development of "smart" networks (Smart Grid) in Ukraine [7]. At the level of cooperation between the companies, a Memorandum of Understanding was concluded between JSC Khmelnytskoblenergo (the operator of the distribution system) and KT Corporation, which provided for the installation and use of advanced measuring infrastructure, which will allow increasing energy efficiency through the implementation of technologies using AI and big data. [8]. DTEK Energo, one of the largest Ukrainian energy holdings, is already implementing certain AI technologies to improve the efficiency of technological process management at TPPs [9]. Another Ukrainian company, MHP Eco Energy, put into industrial use the "virtual energy assistant" system, which, thanks to the use of developed algorithms for data processing and machine learning, provides more accurate forecasting of consumption and optimization of electricity costs at production sites [10]. Experts believe that Ukraine has the potential to fulfill its commitments, because currently there are more than 150,000 IT specialists in Ukraine, some of whom already work with AI technologies, but mostly for an external customer.

Opportunities for the use of artificial intelligence technologies for Ukrainian energy enterprises.

The analysis of the practice of applying AI on the example of the activities of Ukrainian energy companies during the period of full-scale Russian invasion and the application of the SWOT analysis method allowed to determine the opportunities for the use of AI. The analysis revealed that the strengths of the introduction of AI in the Ukrainian energy sector are, in particular, the introduction of the position of innovation manager, the possibility of piloting AI solutions on real projects, the availability of resources to pay for external initiatives, significant expert potential, etc. Weaknesses include insufficient internal resources to develop AI solutions, limited and distributed potential benefits among different organizations, low or slow return on investment, high initial costs and financial risk. Opportunities of the external environment can be considered, for example, the rapid development of AI technologies with open code in the world, the ability to implement AI projects remotely on a project basis. At the same time, military actions on the territory of the country and the destruction of the energy infrastructure, the lack of regulatory rules of the use of AI in distribution networks, limited access of end users to energy, smart technologies, means of payment or finance were

classified as significant external threats.

Conclusions. The latest energy technologies and business models of work in energy markets open up new opportunities for producers, suppliers and consumers of energy, both in terms of increasing the efficiency of their production activities or energy consumption, and in terms of the possibility of obtaining economic benefits from participation in work in the market, ensuring the country's energy security. The use of AI in the energy sector provides more efficient use of renewable energy sources, contributes to the decentralization of energy supply, participation in demand regulation, provision of system balancing services or direct online electricity trading. At the same time, Ukraine's need to rebuild its energy infrastructure after the large-scale destruction caused by Russia's aggression, the practical integration of Ukraine's energy systems into European systems (for example, the synchronization of the work of the United Energy System of Ukraine with the European Network of System Operators of Electricity Transmission) give Ukraine a chance to modernize the country's energy sector on modern technological base and using AI technologies. The conducted SWOT analysis demonstrates positive prospects for the use of AI in the energy sector of Ukraine. The results of the study enable the conclusion that in the coming years, the penetration of AI into various aspects of the activities of Ukrainian and global energy companies will increase, since the digitalization and application of AI is a key method and tool that allows managing large and increasingly complex systems.

Limitations. Modern developments in the field of machine intelligence are changing not only the subject of scientific research, but also the business environment, making it possible to reveal hidden patterns and combine the interdisciplinary knowledge and experience of thousands of researchers. Geopolitical trends indicate that in the next few years, all leading states will develop AI technologies in the energy sector, because the widespread implementation of AI can provide significant economic advantages through increased industrial efficiency and increased labor productivity, affect safety in the production and information spheres, and provide an advantage in the military - technical industry.

Keywords: *artificial intelligence, energy, energy security, RES, Russian invasion to Ukraine*

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4th INTERNATIONAL CONFERENCE

Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

27

Methodological Concepts of Appling AI into Military and Economic Capabilities Data Analysis

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Introduction. A range of studies have explored the use of AI in defense, intelligence, and economic data analysis. According to Atif (1). AI has potential benefits in military applications, HRMS, decision making, disaster prevention and response, GIS, service personalization, interoperability, extensive data analysis, anomaly and pattern recognition, intrusion detection, and new solution discovery using the highly configurable system and real-time simulation. For example, there is a significant potential for improvement in the effectiveness of special forces and amphibious units through the use of artificial intelligence. The role of artificial intelligence in conventional weapons as a factor in strategic deterrence and nuclear weapons, accelerating the innovation race. As a result, the strategic importance of artificial intelligence as a project of the future, with a comparison to the nuclear race of the mid-twentieth century. However, it is noted that only certain tasks have been solved on data analysis and pattern recognition, text translation. The pivotal role of the AI in in military strength evaluation and national security was emphasized by Utsav (2).

Truong (3) conduct a survey of the applications of AI for cybersecurity, discussion on potential security threats from adversarial uses of AI technologies, and the identification of potential research challenges and open research directions of AI in cybersecurity. Leenen (4) emphasizes the potential of AI and big data analytics in cyber defense, particularly in detecting patterns and correlations in security event data. Big data analytics and artificial intelligence have the potential to enhance cyber defense. Current automated systems based on syntactic rules may not be sophisticated enough to handle the complexity in the cyber defense domain.

Damaševičius (5) provides a comprehensive overview of AI's impact on various fields, including economics, finance, and innovation. This is further supported by Ruiz-Real (6), who identifies AI's role in business and economics, particularly in digital marketing and decision making. These studies collectively highlight the transformative potential of AI in these domains, from enhancing forecasting techniques to improving cybersecurity and business operations. Taylor (7) found that AI-enabled systems enhance defense capabilities, the challenges in acquiring such systems for governmental defense, and the need to recognize the misalignment of AI procurement with established procurement elements. According to Ramirez (8) artificial intelligence methods used to predict economic indicators are artificial neural networks, adaptive systems of diffuse neuro inference, genetic programming, support

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vector regression, machines extreme learning and other machine learning techniques. One of the most promising AI technologies is large language models (LLMs). Despite the fact that it is very difficult to monitor developing new models and architectures, the vast majority of the principles remain the same.

Method of investigation. To determine the potential consequences of the use of AI for military and economic capabilities assessment we used a systematic approach. Its components were used as a methodological basis, which made it possible to present a holistic vision of the system architecture of capabilities analysis.

The comparative method allowed authors to compare the potential of different instruments and models that were developed in the area of LLM, and to assess the possible consequences of using them. The basis of the work was the data from different sources: The United Nations (UNROCA), Stockholm International Institute of Peace Research (SIPRI), International Institute of Strategic Studies and Statista.

Investigation Results. During the development of necessary architecture, we started from interviewing practitioners in defense industry to create the list of requirements for our project. It was necessary to construct a system that could work completely on offline network or locally on only one machine. This could give us possibilities to work with sensitive information. The other consideration was about incorporation of users' metadata to restrict their access according to the privilege level. In our case we tested only local models on CPU/GPU which could be loaded into RAM. The resulting schema is presented in Fig. 1.
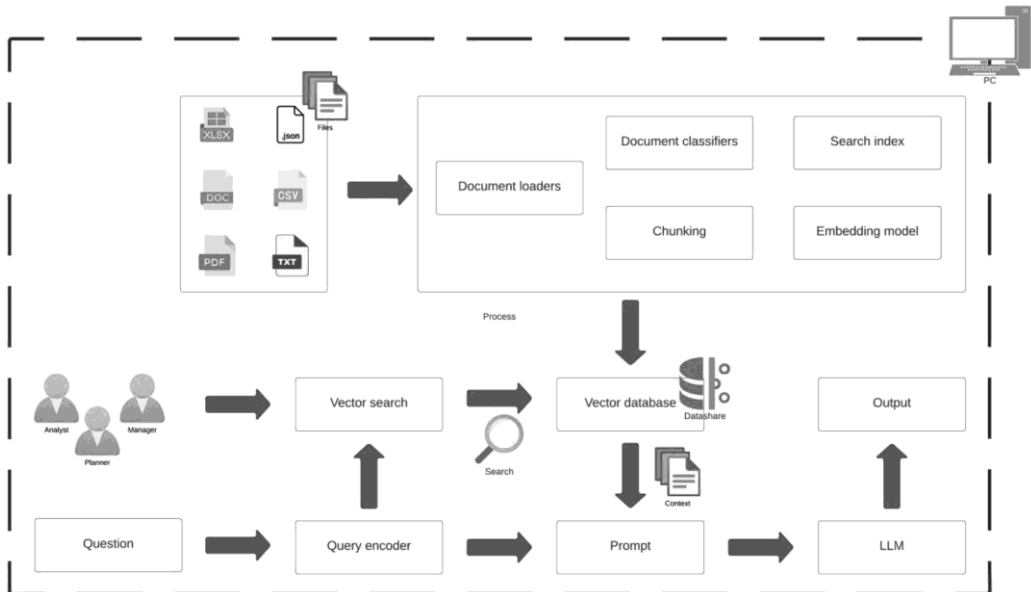
Fig. 1 The architecture of data exchange in defense industry based on offline network at the local level

Conclusions. This research demonstrated the potential for AI and advanced computational techniques to transform the analysis of military and economic capabilities. Extending these approaches to broader sectors could accelerate discovery and technology development. The data-driven analysis enabled by large language models points towards new possibilities for recognizing patterns and generating insights from vast troves of unstructured data related to economic and military factors. By training LLMs on domain-specific corpora of reports, research, and policy documents, they can surface non-intuitive relationships from across disciplines. Reinforcement learning further allows optimizing complex decisions and strategies through iterative modeling.

Together, the integration of knowledge-driven AI with rigorous statistical analysis and validation provides a methodology for military and economic analysis superior to either humans or AI alone. This study demonstrated the value of mixing computational and experimental methods in a hybrid intelligence approach. Applied thoughtfully, AI can enhance foresight and quantitative modeling to better inform capability planning and policy.

However, care must be taken to validate AI systems to prevent biases and misuse. Ongoing research should ensure transparency and ethics around military and economic AI applications. Overall, this emerging field promises to transform data-driven anticipation of threats and opportunities in a complex world, if deployed responsibly.

Keywords: *military capabilities; economic capabilities; artificial intelligence (AI); large language models (LLM); defence.*

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30 | **4ᵗʰ INTERNATIONAL CONFERENCE**

Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

Analysis of the Dependability of Position Lights of Aircraft

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Introduction. Estimation of the technical condition of aircraft and its equipment is a significant requirement to ensuring a high level of reliability of aviation technology and flight safety. The essential condition for dealing with the problem of failure prediction is either the collection of data from the operation of the given component, or from the values of specific diagnostic parameters. Since data collection systems are common part of modern avionics systems, it is possible to use the principle of analytical estimation of errors based on the evaluation of output parameters. If it is not possible to find a suitable parameter (mileage or time until oil change, visual condition of a tire until its replacement, etc.) for the estimation of failure, the technical condition of the aircraft system or entity is evaluated only on the basis of statistical prediction methods. [1] [2]

This article focuses on position lights on the subsonic light combat aircraft and advanced trainer Aero L-159 Alca (designed in the 90´s previous century) and Aero L-39NG (aircraft designed 20 years later – fully certified in 2022) with an emphasis on the dependability of these signalling components. [3] [4] Through long-term operation of the L-159 aircraft and continuous recording and reporting of faults, we are able to perform a comprehensive reliability analysis of lighting elements. Based on such observations, there will be possibility of creating a reliability predictive model for lighting and signalling components. In addition, analysis and comparing failure rates can deal with the degree of criticality of the influence of position light failures on air traffic safety. The results of this study are crucial for enhancing understanding and safety measures in the area of dependability of lighting and signalling systems on modern military aircraft.

Data and methods. Most avionics faults on an aircraft are diagnosed and recorded by on- board monitoring systems. In the case of position lights, the fault is diagnosed during a pre-flight, mid-flight or flight inspection. These inspections are carried out by the aircraft avionics engineer. It is therefore his responsibility to find and describe the fault and its cause. Records of defects and their descriptions are collected in an integrated logistics system. Part of this registration system is the "aircraft maintenance" functionality, where there is an agenda of "defect cards". All defects of lighting elements are listed just here. The collection and processing of data is therefore carried out thanks to this monitoring platform.

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Available scientific sources that deal with analysis of dependability in avionic lights and display systems use traditional methods like fault-free modelling and predicting reliability, but in addition, today's authors often use alternative models and methods to increase accuracy and applicability in real-world scenarios. [5] [6] [7] [8]

First, we use standard methods of descriptive statistics to describe the main characteristics of the data. Then, we use a Poisson process to develop probabilistic model based on operational data statistics in order to model failure rates of the position lights on the aircraft. If we have information about failure rates (e.g., how many times a position light fails in a certain time interval), we can use this process to model and predict reliability parameters of individual components. However, it is important to consider the specifics of the given system and to prepare and filter appropriate data. R software is used for data processing. [9] [10] [11]

Table 1. Example of tabulated data

A/C	DATE OF FAILURE	MTBF (days)
6062	28.05.2003	0
6062	31.08.2007	1556
6062	10.07.2012	1775
6062	11.07.2014	731
6062	29.07.2014	18
6062	07.09.2015	405
6062	28.03.2017	568
6062	03.10.2017	189
6062	14.10.2019	741
6062	30.01.2020	108
6062	05.03.2020	35

Results. To find the probability of a given number of events in a period of time, or the probability of waiting until the next event occurs, we use the Poisson process (where certain events occur randomly and independently, but continuously). Approximate results can be seen in Figures 1 and 2.
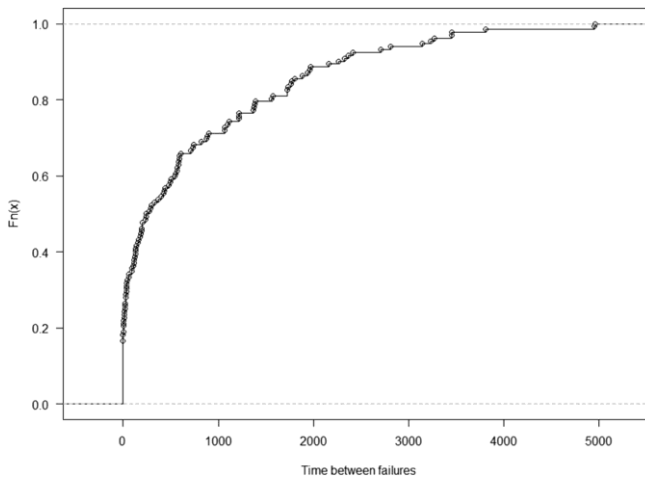
Fig. 1 Cumulative Distribution Function for operational based time between failures
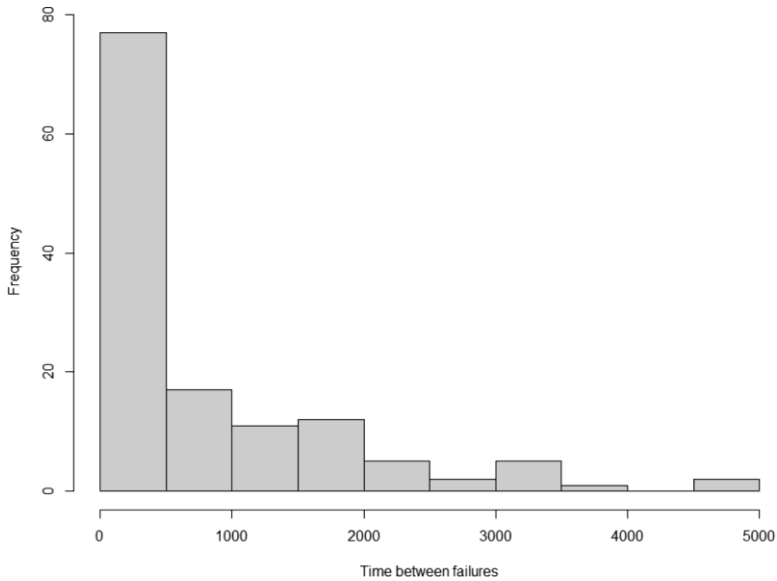
Fig. 2 Histogram for operational based time between failures

Conclusions. In future, using the attained results, a predictive reliability plan for the product can be modelled, or the level of risk associated with the component failure can be determined. As part of a long-term initiative, consideration is given to utilizing lighting technology from the new generation aircraft, which will be experimentally tested and measured through highly accelerated life testing, and the evaluated results will be compared with the lighting of the older aircraft. All of this leads to a more precise predictive analysis of the safety and reliability of lighting and signalling components in order to effectively plan relevant spare parts and maintenance tasks keeping the high level of operational availability of the fleet. [12] [13] [14]

Keywords: *aircraft, avionic, lighting, signalling, position light, dependability, reliability, failure, fault, error, descriptive statistics, Poisson process*

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34 **4th INTERNATIONAL CONFERENCE**

Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

Specific Activities in the Electromagnetic Spectrum and their Relevance in Future Military Operations

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Introduction. Dynamic scientific and technological development contributes to the introduction of new equipment and advanced technologies in all areas of human activity, including the military sector. A wide range of military equipment, such as radio-electronic and electro-optical equipment, based primarily on the use of electromagnetic (EM) energy, is in the arsenal of the armed forces. Soldiers who use this materiel in the performance of their duties automatically become users of the electromagnetic spectrum (EMS). Their dependence on the availability of the EMS then affects to some extent their freedom of action. If this availability is reduced or lost, then these military users of the EMS cannot adequately conduct their own combat activities. The situation is all the more complex because even if the availability of the EMS is not affected, military forces can still be targeted by EM energy. In fact, by directing the activities of military forces in the EMS, the nature of the electromagnetic environment (EME) at a particular place and time can be influenced, and this can be used by military forces to influence any actor of a military operation. The fact that the EME encompasses all currently recognized operational domains (land, sea, air, space, and cyber) then allows military forces to influence any actor of a military operation, in and from any operational domain, through the EME.

In order for the EMS to be effectively and efficiently used by military forces as a tool for multiplying military power [1], it is necessary to be able to adequately implement specific EMS activities. Although the following is not an exhaustive list, the most important specific EMS activities include electromagnetic warfare (EW), navigation warfare (NAVWAR), signals intelligence (SIGINT), EMS management or intelligence, surveillance, target acquisition, and reconnaissance (ISTAR) [2]. The ability to execute them is considered an unwritten standard of all modern armed forces in the current concept of military art. However, the day-to-day reality has shown that managing the above specific EMS activities may not be sufficient, especially in the context of the changing nature of the operating environment (OE) [3], [4].

Influencing and shaping the character of the OE is done, among other things, through the EME, which is an inseparable part of it. This is one of the reasons why military strategists and practitioners are currently faced with the dilemma of how to approach the OE, including the EMS. Creating a new concept of multi-domain operations (MDO) is then just one of the many challenges that not only North Atlantic Treaty Organization (NATO), but also experts at the level of the Alliance member states have to face in the context of security and defense. The form and manner of planning and conducting so-called electromagnetic

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operation (EMO) is also now being discussed with regard to the EME. According to military theorists, these could enable military forces to gain and maintain superiority in the EMS [5] through specific activities incorporated into them. With their help, these forces could then successfully develop their combat capabilities, operational readiness and achieve the expected end state of military operations.

Accordingly, the current question is whether all NATO member states should begin to see EMO as an indispensable capability for their own forces and whether such operations must inevitably become a national ambition. Similarly, the question of how specific EMS activities will be viewed in the implementation of EMO and whether there should be internal changes that alter their nature as a result of some integration into EMO must be answered.

Method of investigation. The article partly reflects the outputs of research activities in the field of specific EMS activities, in particular EW, which was carried out by the author in the period 2017-2020. It was a doctoral thesis on "The development of EW in the Czech Armed Forces providing combat support in the EME during operations in the near future" [6]. This thesis was developed using a combination of qualitative and quantitative methodological approaches. The methods used in its implementation were literature search, field research conducted through individual informal interviews, key issue identification, causal analysis, risk assessment and brainstorming. It also generalizes some outputs of the author's final thesis, prepared in 2022 on "Conduct of EMO from the perspective of the strategic level of command and control of the Czech Armed Forces" [7]. These outputs were created using a qualitative methodological approach with the use of a systematic literature research, a prognostic method "wheel of the future", brainstorming, questionnaire survey, interviews with experts and field research conducted using the method of semi-structured interviews.

The selected outputs of both of the above-mentioned papers were set in the context of current, publicly available information on the issue of specific activities of the military forces in the field of EMS. The article also took into account the knowledge of current challenges that the military forces may face in connection with the addressed issue.

Investigation Results. The field research revealed opportunities and challenges that military forces are exposed to in relation to specific EMS activities not only at present, but which they will certainly need to be able to respond to in relation to military operations in the near future. With the support of publicly available information, a possible approach and proposal for EMO solution was also formulated, although this issue is still in the process of being addressed, not only in NATO. All survey results were discussed in the context of current professional and military publications [8], [9], [10], [11].

Conclusions. The nature of the current OE and the trends that will shape it in the near future underscore the need for military forces to have realistic capabilities to gain and maintain superiority in the EMS. To achieve this goal, however, having the capability to conduct specific EMS activities will not be sufficient in the future. The development of the concept of MDO makes it clear that military capabilities will need to be addressed in all operational domains in the future. This means that the operational level of command will necessarily have to deal with both planning and conducting EMO, despite the fact that the task of conducting specific EMS activities that will be incorporated into EMO will remain at the tactical level.

EMO will therefore have to be an indispensable capability for those military forces or

political-military formations whose ambition will be to conduct military operations independently, not just to participate in them. However, it should certainly be the ambition of all NATO member states to understand the concept of EMO, as their military forces can participate in NATO EMO. Similarly, the issue of EMO should not go unnoticed for reasons of defence necessity, as the ability to plan and conduct EMO can hypothetically be acquired by adversaries or enemies.

Limitations. Due to the sensitivity of the specific activities of military forces in the EMS, some facts and findings have been generalized to avoid violating the rules of protection of classified information. However, this generalization did not affect or reduce the validity of the outputs or the theoretical or practical contribution of the presented outputs. The quality of the presented outputs remains consistent over time regardless of the length or duration of individual field surveys.

Keywords: *electromagnetic environment, electromagnetic operations, electromagnetic spectrum, electromagnetic warfare.*

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Technologies in the Ukrainian Conflict: Reflection and Perspectives from Viewpoint of Combat Unit's Utilization

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Introduction. In the Ukrainian conflict have been new technologies utilized, which have influenced effectiveness at all levels of command and control. A number of experts have labelled the character of the conflict as "a drone war" or the "first artificial intelligence (AI) war". At the same time, we can observe more news, tools, applications and processes, which have been more or less successfully utilized.

By studying various sources, most of the studies analyses and comments on the overall situation are from a higher perspective and does not go deeper into "tactical unit" level. The article highlights the technologies, which are somehow new or more widely utilized then in times prior to 2022. It describes how they affected tactical level operations and missions. The article proposes recommendations for tactical level units, mostly combat units up to battalion level.

Method of investigation. The research has been based on an in-depth study of a wide range sources and analysis. The information, data and conclusions were defragmented into elements and were linked to specific missions and tasks, which are conducting by combat units according to allied doctrine. The core of the research has been based on logic, mostly methods of deduction and induction also, based on knowledge of tactics of combat units, knowledge of new tools and processes.

Investigation Results. Unmanned aerial vehicles (UAVs) will be in future widely utilized. Small units have to be equipped with them. The partial autonomy in the field of Intelligence, Surveillance and Reconnaissance (ISR) and requires input into "network" for feeding the databases used for targeting and decision-making. The enemy will be (and is) also equipped by drones. Units have to train for destroying the enemy drones, various types of drones in various conditions (daytime, altitude, speed etc.). The superiority of UAVs and drones partially blocks the possibility of maneuvering and causes combat units "pinned down". This affects the dynamics of battle. Organic anti-drone units should be incorporated into the maneuvering units.

Facing enemy, equipped by amount of combat vehicles (meaning tanks and armored combat vehicles) leads to equip units by antitank weapons. The authors introduce idea of antitank units on battalion and company level, equipped not only by antitank weapons, but also equipped by unmanned ground vehicles with antitank weapons and loitering ammunition (one-direction UAV). This combination can significantly help mostly in defensive operations, what has been also lesson from Ukraine conflict.

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Unmanned ground vehicles (UGVs) do not play decisive role in current conflict. Despite this fact, they have been used as loaders, transporting causalities or material in and out of the front line. UGVs are waiting for their opportunity. In close future, it is highly possible, that they will be used generally as supporting tools, maybe equipped by weapons, in order to support maneuvering units by fire.

The utilization of a thermo-vision and a night vision rapidly increased. This should be usual gear of foot soldier, crew and vehicle. This enables better situational awareness and better ability to neutralize enemy. Not only for a night time is this tool applicable. Not always is a drone solution. Personal gear gives to the small unit's advantage. The success of the battle is created of a number of small successes.

The Ukrainian forces are supported by a 3rd actor in field of space operations. Immediate sharing of real time pictures, as one of results of space operations, can be the next advantage and the important input for decision-making. The battalion level should be equipped by technology, enabling immediate sharing the pictures. The satellite communication is a reality on tactical level. Units, which conducti decisive operations, may be equipped by this communication as an alternative. Missed communication makes network centric warfare as a concept useless. A new war will be about destroying the networks and links, not only entities in physical domains. The gaps in own and enemy network as a "overlay" has to be incorporated into a common operation picture.

Phenomenon of a software defined warfare started by the Ukrainian conflict. A leader's decision making is and will be more related on results of systems and devices, like applications, an artificial intelligence (AI), a data fusion and a Modelling and Simulation (M&S). Therefore, the sentence, that every soldier is a sensor, will be more valid. Units will not only fight, but will also collect data and information. Based on this, will be introduced possible options and recommendations, which will be chosen by a leader. Leaders have to be familiar with a targeting, which will be downsized on unit's level. Troop leading procedures (TLP´s) is necessary to adapt. Some phases of TLP last no more than seconds and have to be shared in the horizontal and the vertical axis, in order to safe a time. The technology enables track the actions, ordering troops and comparing, if the specific action is in line of higher commander´s intent. Because the development is enabling actions from a detection to destroying within decades of seconds, the units have to be extremely maneuverable or well protected. The combination is the key.

Nowadays, we speak about technologies more or less separately. The trend is the fusion of technologies. There exist for ex. combined personal scopes integrating night vision, thermos-vision, artificial intelligence, GPS and more "in one" small and compact device. This technical advantage, enabling tactical advantage, can be lethal for an opposite. The integration into structure of units is necessary.

Cross domain and multi-domain actions are starting to be more common. Small unit's leaders have to understand wide range of circumstances, tactical and technical details including. We can await increasing: integrating low level air actions (like using small drones), electronic warfare devices, linking and using results from space technologies and space domain, cooperation with all types of aircraft. The units have to be more combined, but as best, using same platforms: maneuvering element consisting from manned and unmanned teams, anti-aircraft / drone team, anti-tank team or equipment, indirect fire team (able to operate with loitering ammunition), battery packs and data storages operators, UAV team,

electronic warfare devices have to be integrated to each element. Battalions have to be able to operate in multi-domain environment independently, fully using all warfighting functions. The company level will be more complex and combined. Units have to be more autonomous. The way for preparing new generation of leaders is to have developed education and training programs, based on complex understanding of (hybrid) systems, together with lessons from praxis.

The phenomenon of private armies, consisting from poor soldiers to well-trained mercenaries, brings a risk, that enemy can be technologically better equipped and well trained. The intelligence, esp. enemy analysis, adaptability and initiative is the only way for small tactical units, how to resist this situation immediately and fulfil their tasks.

Above mentioned presumptions about technologies leads to the informational and technological superiority, but also to the informational dependence on comfortable technologies. As essential, it is important to know traditional tools and techniques because of the principle understanding and because of a contingency plan.

Conclusions. The armies, which have limited potential of manpower and sources, need to be focus on high level of effectiveness of units and formations. Lessons, made from Ukrainian conflict, can give us the opportunity for a development not only on strategical or operational level. The realistic development, applied into military education, training and successful implementation into real operations can be a way, how to support our national and common objectives in the field of defense.

Limitations. There have been used only literature, which is not classified and was found in open sources. Authors were focused on impact on tactical level, mostly on units. The ideas have not been tested in praxis or as a part of modelling and simulation. The ideas and results are based on the expertise.

Keywords: *artificial intelligence, multi-domain warfare, network centric warfare, units, unmanned devices, tactics, technologies*

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Practical Evaluation of Instruments for Determining the Exact Position During Artillery Operations of the Czech Artillery

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Introduction. The primary mission of artillery, along with other combat support units, is to provide support to combat units. Artillery supports combat units primarily by indirect fire. Therefore, for artillery units to conduct fires effectively, they must have accurately calculated firing elements. These elements are calculated according to the technical parameters of the fire vehicle, the ammunition used, the meteorological conditions and the position of the target and the firing position. The artillery of the Czech Armed Forces can be understood as a system consisting of a target tracking and detection subsystem, an information subsystem for command and control, firing means, ammunition, ammunition supply and security. All of these subsystems must have the capability to orient and determine the exact coordinates of their own position and other entities in the battlespace. The accuracy of coordinate determination will be particularly critical and essential for the target acquisition and fire unit subsystems as it will affect firing accuracy, ammunition consumption, and dwell time in firing positions.

There are a multitude of ways to determine position today. For artillery, the means of determining precise position based on satellite navigation system (GNSS) technology, such as the Global Positioning System (GPS) or the European Galileo system, and inertial navigation system (INS) technology are mainly used.

These technologies are implemented in assets that are manufactured and dedicated primarily for military use.

Civilian precision positioning technologies, such as smartphones and commercial GPS receivers, offer an interesting prospect for military use in artillery. These devices have become highly accurate and more affordable positioning devices, opening up opportunities for their integration into military systems, but with the need to meet strict military standards in terms of communication security and use.

This paper focuses on a practical evaluation of military and civilian precision positioning devices that are currently in use or have the potential for use by the artillery of the Czech Armed Forces. The aim of the investigation is to assess the potential use of commercially available devices for the needs of the artillery of the Czech Armed Forces, including a critical assessment of usability and potential threats. The analysis will include a comparison of the performance of the devices in different conditions and the possibilities of integration into

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the artillery of the artillery of the Czech Armed Forces. In support of the proposals resulting from the analysis, a practical experiment based on the identification, comparison, and verification of the accuracy of civilian and military instruments for precise positioning in different terrain conditions was conducted.

Method of investigation. The investigation was conducted as part of an experiment. The experiment to compare the accuracy of the positioning means was conducted using four specific means, two means from each category:

- Moskito TI - a multifunctional military acquisition device,
- DAGR (Defence Advanced GPS Receiver) - an advanced military GPS receiver,
- Smartphone - civilian smart phone,
- Outdoor watch - civilian sports watch.

The aim of the experiment was to quantitatively evaluate and compare the accuracy of the determined means in determining the position in four cycles. The first cycle immediately after switching on the device, the second cycle after 5 minutes from switching on the device, the third cycle after 10 minutes from switching on the device and the fourth cycle after 20 minutes from switching on the device, each cycle comprising five consecutive measurements taken at the shortest possible time interval. A total of 20 measurements were taken with each device, at each site. The individual sites were selected to represent possible artillery exposure environments, which are forest, open space and urban. A database of point arrays was used to control the measurements. The coordinates of the point arrays were used as reference values to calculate the measurement deviations of each technical means.

Investigation Results. The results of the measurements were used to compare individual assets and to verify the hypothesis that civilian assets can be used to the advantage of artillery units under certain conditions. Through experimentation, it was determined which means provides the highest level of accuracy under realistic conditions, and how the measurement results are affected by time and changing spatial conditions.

Table 1. Results of measurements in the Forest

Forest			
Measure	**ΔE**	**ΔN**	**ΔA**	**distance**
MOSKITO	2,606	4,839	-1,170	**5,496**
	7,206	4,039	5,230	**8,261**
	4,006	4,239	1,030	**5,832**
	2,406	-1,761	1,230	**2,982**
Measure	**ΔE**	**ΔN**	**ΔA**	**distance**
Smart phone	2,406	-0,161	14,630	**2,411**
	2,406	5,639	9,830	**6,131**
	3,606	3,839	8,830	**5,267**
	2,006	3,039	6,830	**3,641**
Measure	**ΔE**	**ΔN**	**ΔA**	**distance**
DAGR	3,806	-2,561	-8,770	**4,587**
	2,806	1,839	-6,570	**3,355**
	6,206	3,639	-1,770	**7,194**
	3,006	1,439	0,630	**3,333**

Measure	ΔE	ΔN	ΔA	distance
Outdoor watch	6,606	4,039	3,830	**7,743**
	7,206	1,439	4,430	**7,348**
	4,206	-2,561	0,830	**4,924**
	4,806	-3,961	0,430	**6,228**

Table 2. Results of measurements in the Open space and Urban area

	Open space					Urban			
Measure	ΔE	ΔN	ΔA	distance	Measure	ΔE	ΔN	ΔA	distance
MOSKITO	3,7	7,732	12,25	**8,571**	MOSKITO	7,976	3,509	-7,760	**8,714**
	1,3	7,532	7,05	**7,643**		10,976	6,909	-5,760	**12,969**
	0,5	5,932	6,45	**5,953**		8,976	6,109	2,840	**10,858**
	-0,5	4,532	4,65	**4,559**		7,176	1,909	0,840	**7,426**
Measure	ΔE	ΔN	ΔA	distance	Measure	ΔE	ΔN	ΔA	distance
Smart phone	-1,9	8,532	18,25	**8,740**	Smart phone	6,376	0,909	16,240	**6,440**
	-1,3	8,132	17,85	**8,235**		5,176	-0,891	15,240	**5,252**
	-2,5	6,532	16,25	**6,994**		-1,824	0,509	13,240	**1,894**
	0,7	4,332	14,85	**4,388**		0,176	-0,491	10,240	**0,522**
Measure	ΔE	ΔN	ΔA	distance	Measure	ΔE	ΔN	ΔA	distance
DAGR	-2,5	1,532	-1,15	**2,932**	DAGR	19,776	16,109	7,040	**25,507**
	-4,7	1,332	-7,95	**4,885**		32,776	24,109	17,240	**40,688**
	0,1	3,932	-0,35	**3,933**		10,176	35,309	17,240	**36,746**
	-0,7	1,132	0,25	**1,330**		18,176	19,509	25,240	**26,664**
Measure	ΔE	ΔN	ΔA	distance	Measure	ΔE	ΔN	ΔA	distance
Outdoor watch	4,9	8,332	-1,95	**9,666**	Outdoor watch	20,376	28,309	-3,760	**34,880**
	-6,7	6,332	-3,15	**9,218**		8,776	13,909	4,240	**16,446**
	-3,5	2,932	-2,55	**4,565**		7,776	13,709	1,240	**15,761**
	-2,3	0,532	-0,35	**2,360**		5,576	10,909	1,240	**12,251**

The Table 1 and Table 2 records the average measurement errors of each instrument at all three sites in meters. The error magnitudes are expressed as deviations from the ideal value in east (ΔE), north (ΔN) and altitude (ΔA). From these values the total real distance is calculated.

Conclusions. The analysis of the results of the research has shown that the use of civilian devices means for determining the exact position is possible, since civilian means achieve the accuracy of military certified means. The proposal resulting from the conducted research is to extend the experiment with additional variables accompanying positioning for the artillery of the Czech Armed Forces and to verify their use directly in the environment of the 13th Artillery Regiment and mortar units of the Ground Forces. Following the verification of the civilian means, analyze the situations in which it is necessary to use the instruments for precise positioning and, according to the specifications of each situation, assign the means for precise positioning that most closely matches the situation.

Limitations. All measurements were made in civilian areas, without purposeful interference, and variables affecting the accuracy of the instruments were based only on the surrounding environment.

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The Role of Artificial Intelligence in Military

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Introduction. Artificial intelligence has become a phenomenon of nowadays and has a significant impact on many fields, including military art and military science, what is also one of research directions announced by NATO. The use of AI tools can be considered as subsystem of "command and control function" at all levels. AI is included into "smart" weapons, weapon systems and processes (combat robots [5],[6] transport, supply chains, targeting etc.), training simulators [1] is being explored in the MASA software (By Sword Co.), but its further role will lie in the need to eliminate inaccuracies in tactical decision- making, increasing the effectiveness of commanders' decision-making. The aim of this paper is to describe possible tools that will support commanders' decision making using artificial intelligence.

Method of investigation. Military sources are, for obvious reasons, non-public and disposal of information is limited. Therefore, a literature research and analysis of documents available in public sources such as the proceedings of I/ITSEC conferences in 2016-2023[7], published papers in military-themed proceedings (Czech Military Review - Czech Republic [10],[8], Vojenské reflexie - Slovak Republic [9]) or specialized journals (CHIP) and papers in the national environment (Czech Republic) has been utilized. Analogically to the LikPik system [4] (Masaryk University Brno), using deduction and synthesis, an idea of variant using chatbots to support commanders' decision making was built. To test the outputs, the available chatbots (Bing AI, ChatGPT-3,4) were utilized. The chatbots were asked by identical questions, related to specific military topics, commonly used during Military decision making process, Troop leading procedure, Intelligence cycle or Targeting. Finally, the answers and proposals were evaluated, esp. agreement/disagreement, completeness or incompleteness in the final text and overall logic of respond. Here, heuristic methods, based on expertise were used to investigate the validity of the chatbot responses.

Investigation Results. Copilot with GPT-4 [3] was used to test the feasibility of using chatbots for military decision-making. The question "Compare the tactical-technical data of the T-80 and Leopard 2A4 tanks" was answered with a set of basic tactical-technical data with the conclusion "Both tanks have their specific characteristics and are major players in modern defense technology. The T-80 is characterized by its gas turbine and its ability to use different types of ammunition, while the Leopard 2A4 is known for its robust design and reliability. Each has its advantages and limitations, and their success depends on the

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specific conditions and deployment strategy." The answer to this question was expected to have a qualitative content expressed in terms of better/worse for each parameter. There was no photo of the Leopard 2A4 tank, when there is a photo available on wikipedia.cz. The end of respond consists also sources and literature with protective warning "Bing uses artificial intelligence, so surprises and errors may occur". However, the 11 sources from which the answer was compiled, were listed for the user. The numerical expression of the parameter "combat potential" as a comparison of (1:x) or (x:1) was not given.

Conclusions.

This article describes the possibility of using artificial intelligence in the segment of decision support for commanders. As a possible tool for this activity, the use of so-called chatbots appears (for now, the Chatbot /Chat robot combination is preferably used). In the abstract to the article, only one test question is presented, but total of 20 validation questions were asked, which the authors considered valid for reviewing the suitability of use for decision support.

The use of chatbots to support commanders' decision making and related administrative would be very beneficial in terms of time. It is important to follow information security policy. A possible way is to implement such chatbots in a proper way in the military environment or to develop completely new ones, being closed, protected, controlled, filled by verified and valid data, approved by relevant authority. In these terms, the information can be credible and reliable.

Limitations. The use of publicly available chatbots seems to be quite advantageous with respect to the speed of information retrieval. The problem, however, lies in the content and origin of the sources. The third wave of AI development (also known as enterprise AI), using large databases, utilizes data whose authenticity may not be verified and the validity of the information obtained may be doubtful.

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David Against Goliath - European Approach to New Military Technologies and Ukrainian War Improvisations

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Introduction. In the realm of international arms programs, there exists a prevailing notion during peacetime that such endeavors are a viable avenue for technological advancement. This sentiment persists, with the European Commission and the European Defence Agency (EDA) continuing to advocate for and organize international working groups, thus making this approach a vogue. However, upon closer examination, it becomes apparent that these programs entail significant drawbacks. Primarily, they prove to be exorbitantly expensive due to high administrative costs and the necessity for additional work to tailor future products to meet the unique requirements of individual countries. Moreover, these initiatives are plagued by unreasonable timeframes, especially due to prolonged coordination procedures. Consequently, the end products often fail to meet expectations. Examples abound, including the MTB tank, NH90 helicopter, Eurofighter, and the KNDS new tank project.

Goliath. The Goliath in this narrative is represented by the traditional international arms programs endorsed by entities like the European Commission and the EDA. These programs, while seemingly formidable, are burdened by their own weight—marked by exorbitant costs, extensive bureaucratic processes, and inconsistent outcomes.

David. In stark contrast, the events unfolding during the Ukrainian war have brought to light a David-like emergence of improvised weapons. These makeshift armaments underscore both the acute demand for such weaponry on the battlefield and the inadequacies of established industries and institutions responsible for conventional armament development. Notably, the conflict has witnessed the proliferation of small drones, signaling a transformative shift in warfare dynamics.

The Ukrainian conflict serves as a pivotal moment, revealing the disparity between the unwieldy, cumbersome nature of traditional arms programs and the nimble, adaptive response of grassroots innovations. It underscores the necessity for a paradigm shift in how we approach armament development, emphasizing agility, responsiveness, and innovation over bureaucratic rigidity.

Investigation Results. We find ourselves in a situation where the prevailing belief in the efficacy of amalgamating a multitude of forces from diverse countries for the development of defense technologies lacks substantial justification. Contrary to expectations, this approach proves to be slower, more expensive, and lacks the guarantee of achieving the desired outcomes. The inherent complexities involved in coordinating efforts across numerous countries with divergent interests and priorities inevitably lead to protracted timelines.

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Delays ensue as bureaucratic hurdles must be navigated, consensus reached, and disparate requirements reconciled. Consequently, the pace of progress is hindered, impeding the timely delivery of crucial defense technologies. Moreover, the financial implications of such collaborative ventures are substantial. Administrative overheads, logistical expenses, and the need for extensive customization to accommodate the varying specifications of participating nations contribute to inflated budgets. These costs escalate rapidly, often surpassing initial estimates, and divert resources away from other critical defense priorities. Despite the substantial investments made, there is no guarantee of achieving the intended outcomes. The inherently complex nature of multinational collaborations introduces inherent risks and uncertainties. Divergent strategic objectives, competing interests, and bureaucratic inefficiencies can compromise the efficacy and viability of collaborative defense projects. Furthermore, the diverse technological capabilities and industrial bases of participating countries may not always align, leading to compatibility issues and suboptimal solutions.

In light of these challenges, it becomes imperative to reassess the efficacy of multinational collaborations in defense technology development. While international cooperation undeniably holds promise, a more nuanced and pragmatic approach is warranted. Emphasizing flexibility, efficiency, and strategic alignment, nations can cultivate more agile and responsive mechanisms for advancing defense capabilities. By leveraging the strengths of diverse stakeholders while mitigating the inherent complexities, we can forge a path towards more effective and sustainable defense innovation.

Conclusions. The Ukrainian conflict has served as a poignant reminder of the stark disparities between the agility and efficacy of individual talented engineers and the cumbersome, bureaucratic conglomerates supported by current European structures.

Amidst the chaos of warfare, individual engineers, driven by necessity and ingenuity, have demonstrated remarkable speed, efficiency, and cost-effectiveness in developing improvised weaponry and countermeasures. Freed from the constraints of bureaucratic red tape and organizational inertia, these individuals have exhibited a remarkable ability to rapidly conceptualize, iterate, and deploy solutions tailored to the exigencies of the battlefield.

The lessons gleaned from the Ukrainian conflict underscore the imperative for European structures to reevaluate their approach to defense technology development. Embracing a more decentralized, bottom-up model that empowers individual innovators and fosters collaboration across diverse networks of expertise can unlock untapped potential and drive meaningful advancements in defense capabilities. By harnessing the agility and creativity of individual engineers while leveraging the resources and expertise of institutionalized structures, Europe can forge a path towards a more responsive, adaptable, and effective defense innovation ecosystem.

Keywords: *new military technologies; Ukrainian war; individual talented engineers; future products; unique requirements; improvised weapons*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Additive Manufacturing Technologies in Military Logistics

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Introduction. At the present time, we are rapidly approaching the onset of the fifth industrial revolution, which will be fueled by the latest innovations such as advanced artificial intelligence, robotics, nanotechnology, and biotechnology. These innovations will provide an unparalleled advantage in today's business environment. However, we are currently still in the integration and testing phase of innovations from the 4th industrial revolution, the application of which is crucial in logistics. Logistics plays a vital role worldwide in effectively managing the flow of material goods, delivering goods on time, and optimizing the costs of these processes to ensure customer satisfaction.

To enhance logistics, "Logistics 4.0" innovations are being utilized, which apply digital and information technologies and have become industry trends. These innovations include the Internet of Things, big data analytics, artificial intelligence, block chain technology, additive manufacturing, cloud computing, and cybersecurity. However, not all organizations can quickly adopt these latest trends. One such entity is armed forces (and its military logistic systems. For these reasons, it is important to consider the possibilities of applying "Logistics 4.0" innovations in military logistics.

According to NATO's science and technology trends for the years 2023–2043, additive manufacturing technologies are identified as having a high significance coefficient and are classified as disruptive technologies, meaning that they conceptually change previous operational procedures and shows the ability to revolutionize traditional manufacturing processes and supply chains. By enabling on-demand production of complex parts and components, additive manufacturing offers significant advantages in terms of flexibility, cost-effectiveness, and reduced lead times. In military contexts, these technologies can facilitate rapid prototyping, customization, and repair of critical equipment and vehicles, improving operational readiness and resilience. Additive manufacturing technologies have already reached an advanced stage of development, demonstrated in relevant environments, and it is anticipated that their potential application in military environments and logistics will be focused on the period between 2025 and 2030 (NATO Science & Technology Organization, 2023).

This paper focuses particularly on additive manufacturing technologies, also known as 3D printing technologies. The military environment is highly specific and complex, so "Logistics 4.0" innovations, specifically additive manufacturing technologies, face challenges and problems in the application process.

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Conclusions. Study highlights the tactical potential of additive manufacturing within the logistics framework of the Lithuanian Armed Forces (LAF), with future prospects for its application at the operational level and during international operations. Integration of 3D printing technology into LAF logistics operations aligns with principles of rationality, efficiency, and the 4T approach, offering the promise of providing high-quality equipment to combat units and enhancing their operational effectiveness. Specific applications of additive manufacturing in military logistics within the LAF encompass a range of critical functions, including expedient repair of battle damage, production of spare parts, prototyping and experimentation, addressing component obsolescence issues, and the fabrication of UAV components. These applications signify the diverse capabilities of additive manufacturing to address logistical challenges and ensure the readiness of military units.

Moreover, the adoption of additive manufacturing by LAF logistics units has the potential to catalyze the development of a more decentralized logistics approach, thereby reducing logistical footprint and enabling a shift from a traditional "push" model to a more responsive "pull" approach as necessitated by operational demands.

To facilitate the effective implementation of additive manufacturing in military logistics, a comprehensive three-phase plan or project should be developed. Such a plan would outline the necessary steps and milestones for the successful integration of additive manufacturing technologies into LAF logistics operations, ensuring seamless adoption and maximizing the technology's benefits for military readiness and operational efficiency.

In summary, the strategic adoption of additive manufacturing holds significant promise for enhancing logistic capabilities of the Lithuanian Armed Forces, enabling them to adapt to evolving operational requirements and maintain a high level of readiness in dynamic security environments.

Keywords: *additive manufacturing, 3D printing, military logistics, Lithuanian Armed Forces, technology integration, readiness enhancement.*

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Evaluating the Performance and Advantages of Electric and Internal Combustion Vehicles

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Introduction. The growing popularity and use of electric vehicles is clearly visible not only in today's traffic, but also in the analysis of the vehicle market. One example that reflects the needs of society is the rapid and drastic increase in the global purchase of electric vehicles. One of the most recent examples of electric vehicles in the military is the Delfast, an electric two-wheeled vehicle currently in use in Ukraine, which allows a soldier to carry a Javelin missile launcher or a sniper team to move quickly and silently. These figures and examples show that not only traditional electric vehicles are appearing on the market, but also electric vehicles that are not yet in use in the Lithuanian army. The study carried out an assessment of electric and internal combustion engine vehicles.

Method of investigation. The PERKŪNAS electric motorcycle and its internal combustion engine counterpart were selected for the study of thermal radiation level, noise level and acceleration. For the comparison of traction force and maximum speed on road surfaces, the electric vehicle OSTARA KRAMPUS and the MB G-Class were selected. FLIR C5 THERMAL CAMERA was used to measure the thermal image and DECIBEL X: dB SOUND LEVEL METER was used to measure the noise level. The acceleration of the motorcycles was measured using a DRAGY DRG-69 accelerometer.

Investigation Results. Experimental tests have shown that there is a significant difference in the level of thermal radiation between an electric motorcycle and its counterpart, as shown in Fig. 1. The main sources of heat in an electric motorcycle are the front and rear electric motors, which heat up to around 26 degrees Celsius, while an internal combustion motorcycle engine can reach a maximum temperature of around 90 degrees Celsius.

When looking at the traction forces of an electric and an internal combustion engine vehicle Fig. 2, there are clear advantages of an electric vehicle, such as high torque and simplicity of the powertrain - no need for components such as a clutch and gearbox. The KRAMPUS only needs one direct drive to reach a top speed of 120 km/h on sand, whereas the MB G-Class can only reach speeds of up to 40 km/h.

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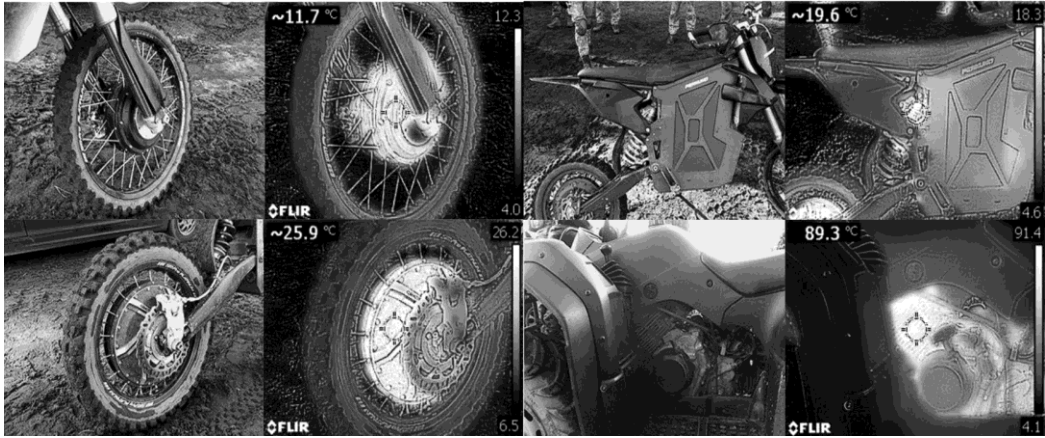
Fig. 1 Heat radiation of selected parts
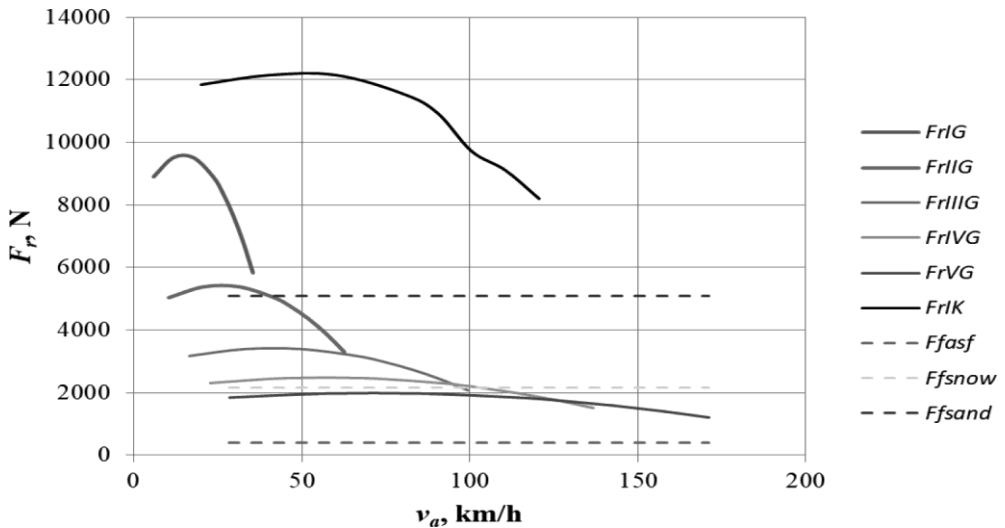
Fig. 2 Traction forces of different cars

Conclusions. Electric motorcycle components heats up ~71 % less than vehicles with ICE. Main heat sources are hub motors witch are rotating and hard to disguise, therefore still easily identified via thermal cameras.

Noise level of electric motorcycle drops by ~35 % and all created noise is from tires-sand contact, where comparing with ICE motorcycle peak noise levels measured from engine and exhaust system.

In all on sand measured acceleration all-wheel drive electric motorcycle accelerated faster and had more grip. As speed increases up to 60 km/h difference between rear wheel drive and all-wheel drive motorcycles decreases, because main advantages of all wheel drive is noticeable in low speeds.

Krampus uses electric motors with high torque and generates higher traction forces. Compared to MB G-class in all speed range Krampus has higher traction forces and could drive on snow or sand without speed limitation where MB speed would be limited to 95 km/h on snow and 40 km/h on sand.

Limitations. However, further research is needed before this new material can be used in military applications. Such as:

• Reliability testing of electric drives to compare the longevity of standard and electric vehicles and to assess the limits of selected components;

• Battery longevity tests assessing the degradation of the energy capacity of the selected batteries during vehicle operation under extreme conditions.

It is hoped that, as a result of the above-mentioned studies, the new vehicles could be incorporated in military transport sector.

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Quantum Technology and its Role (Not Only) in the Strategic Concepts of Central European States

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Introduction. The contribution is devoted to the emerging, but all the more relevant, issue of the strategic grasp of the quantum issue (including the North Atlantic Treaty Organization quantum strategy). The authors map the positives (added value) of the emphasis on this agenda and the weaknesses resulting from the delay in this issue. Attention will also be paid to the quantum capacities of the individual Central European countires, as Czech Republic, Slovakia, Hungary, Austria and Slovenia (including mentions of the topic in strategic documents and its possible personnel, organizational and financial coverage).

Method of investigation. In relation to the issue, both the approach of individual countries and the priorities of relevant international organizations (North Atlantic Alliance, European Union, possibly others) are being monitored. In this context, is it possible to claim that the European Union focuses more on technology as such, with the security dimension of the topic being left behind? Does the North Atlantic Treaty Organization monitor the parallel activities of the Union and individual member states, or does it carry out its activities in this area "on the green field".

In this context, the content and diction of existing strategic-conceptual documents will be monitored, respectively the related external constructive-critical comments, especially from the private sector environment.

The period after 2010 to the present is covered, with the fact that, in relation to all individual countries, as many identical variables as possible are monitored, which will enable a subsequent comparison, possibly also a SWOT analysis.

Investigation Results. In relation to the topic, there is an effort to formulate recommendations for relevant actors at the level of the mentioned states, including a summary of best practice from the environment of other (more advanced) countries.

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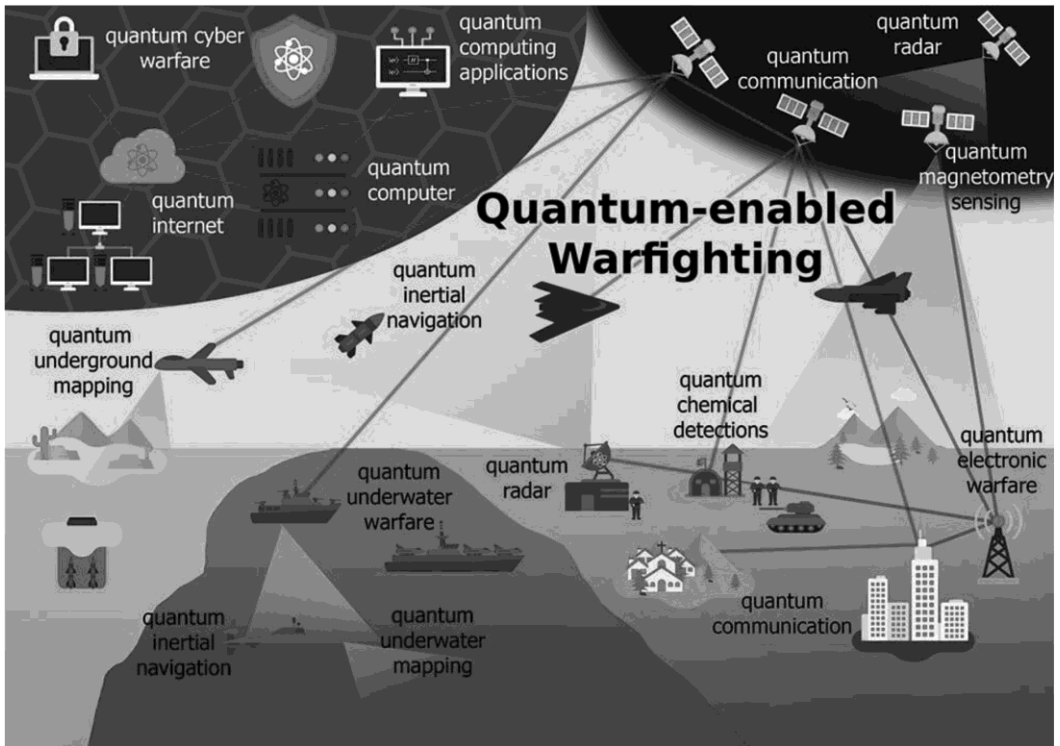
Fig. 1: Concepts of quantum warfare using various quantum technology-based systems
(Křelina, Důbravčík, 2023).

Conclusions. Quantum technology represents a relatively new solution, the anchoring of which at the level of states and relevant international organizations represents a very pressing challenge, especially in light of the sharp deterioration of the international security situation. Mastering the issue can thus be a decisive advantage in the event of a possible conflict, or rather play a role in the related deterrence. On the contrary, failure to master the topic can become a significant weakness, degrading the potential of a certain actor's security system.

Limitations. In relation to the topics, interviews with national experts and open sources are primarily used, with the exception of classified information. Althrough this aspect can be perceived as limiting, it is also a prerequisite for publishing a study in itself.

Keywords: *Quantum technology, military, security, exploitability, weaknesses, comparisons, recommendations*.

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Cyber Security and Business Continuity Management: Ensuring Resilience in a Digital World

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Introduction. Unexpected disruptions to an organization's operations, including cyber security incidents, technological failures, and process errors, underscore the need for implementing Business Continuity Management (BCM) with a focus on cyber security and the use of information technology. Cyber threats have become an integral part of the business environment, making it essential for organizations to take measures to minimize risk and mitigate the impacts of these incidents.

Business continuity in the context of cyber security involves planned procedures and actions designed not only to ensure the continuity of providing products or services after a cyber-incident but also to minimize damages and restore normal operations. Within business continuity management, it is necessary to consider specific threats and vulnerabilities associated with information technologies and ensure that recovery and resilience measures take the cyber context into account.

The implementation of BCM in the realm of cyber security includes the development of plans, testing their effectiveness, and continuously updating them based on new threats and technological developments. Close integration between cyber security and BCM is critical to ensuring that organizations can respond rapidly and effectively to cyber events and minimize their impacts on their business operations.

Conclusions. In summary, integrating BCM with a focus on cyber security is crucial in today's business environment due to the prevalence of cyber threats. This integration involves proactive measures to safeguard operations, comprehensive continuity planning, and aligning recovery efforts with evolving cyber risks. Continuous testing, updating, and collaboration between cyber security and BCM teams are vital for enhancing readiness and responsiveness to cyber events, ensuring business continuity, and minimizing potential impacts.

Keywords: *cyber security, information technology, cyber threats, risk mitigation, incident response, resilience measures, continuity planning, organizational preparedness*

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Securing Data Transmission Over Networks in the Modern Digital Landscape

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Introduction. When analysing issues related to information security, it is necessary to take into account the specifics of the aspect of security, that security is an integral part of information technology - a field that is developing at an unprecedented pace. In the modern digital landscape, the security of data transmission over networks, especially Wide Area Networks (WANs), is of paramount importance. As WANs span large geographical areas and often traverse multiple administrative domains, they are particularly vulnerable to various security threats. One critical aspect of ensuring the security of WANs is the development of secure routing algorithms. This essay aims to explore the challenges associated with developing secure routing algorithms in WANs and discuss innovative approaches that offer promising solutions to these challenges.

Challenges in Developing Secure Routing Algorithms for WANs: Developing secure routing algorithms for WANs presents several challenges due to the unique characteristics of these networks:

● **Scalability**. WANs often consist of numerous interconnected networks and devices, making scalability a crucial consideration in designing routing algorithms. Traditional routing protocols may struggle to scale efficiently while maintaining security measures.

● **Heterogeneity**. WANs encompass diverse networking technologies, equipment, and administrative domains. Securing routing protocols across such heterogeneous environments requires solutions that can accommodate varying security requirements and infrastructure configurations.

● **Dynamicity**. WANs are subject to dynamic changes in network topology, traffic patterns, and security threats. Routing algorithms must adapt to these changes in real-time to ensure continuous and secure data transmission.

● **Security Threats**. WANs face a wide range of security threats, including malicious attacks such as spoofing, eavesdropping, and denial-of-service (DoS) attacks. Routing algorithms must incorporate robust security mechanisms to mitigate these threats effectively.

Innovative Approaches to Secure Routing Algorithms: To address the aforementioned challenges, researchers have proposed innovative approaches to developing secure routing algorithms in WANs:

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● **Trust-Based Routing**. Trust-based routing algorithms establish trust relationships among network entities and use trust metrics to make routing decisions. By considering the trustworthiness of neighboring nodes and network paths, these algorithms can mitigate routing attacks and ensure secure data transmission.

● **Cryptographic Techniques**. Cryptographic techniques, such as digital signatures, cryptographic hashing, and secure key exchange protocols, can enhance the security of routing protocols in WANs. By encrypting routing messages and authenticating network entities, cryptographic-based routing algorithms can prevent unauthorized access and tampering of routing information.

● **Intrusion Detection and Prevention Systems (IDPS)**. Integrating IDPS functionalities into routing algorithms enables proactive detection and mitigation of security threats in WANs. By monitoring network traffic and behavior anomalies, IDPS-enhanced routing algorithms can identify and respond to malicious activities, thereby enhancing network security.

● **Software-Defined Networking (SDN)**. SDN architectures offer centralized control and programmability of network resources, facilitating the implementation of secure routing algorithms. By decoupling control plane functions from data plane operations, SDN-based routing algorithms can enforce fine-grained security policies and adapt to dynamic network conditions more effectively.

Conclusion. Securing routing algorithms in WANs is essential to safeguarding the integrity, confidentiality, and availability of data transmitted over these networks. While traditional routing protocols may lack sufficient security mechanisms to address emerging threats, innovative approaches offer promising solutions to enhance the security of WANs. By leveraging trust-based routing, cryptographic techniques, IDPS, and SDN, researchers can develop secure routing algorithms that meet the evolving security requirements of modern WAN environments. As the digital landscape continues to evolve, ongoing research and development efforts in this area are vital to ensure the resilience and security of WANs against emerging cyber threats.

This paper introduces a novel method for enhancing the security of communication networks, particularly in the context of WANs. By incorporating a set of advanced functions tailored to each variant of the method, crucial details regarding the communication network's structure and initial data about network nodes and subscribers are specified. Additionally, the method calculates integrated security indicators, enabling the selection of secure routes between network nodes from all available communication routes. As a result, secure routes are efficiently provided to network subscribers, ensuring robust data transmission security.

The research presented in this paper contributes to the field of information communication and offers practical implications for the planning and development of new network connections. Specifically, the method's applicability extends to various network architectures, including corporate intranets and extranets, where ensuring secure communication is paramount.

Keywords: *computer networks, routing algorithms, information security*

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Analysis of migration in the Czech Republic and security challenges in the context of the current geopolitical situation

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Introduction. The problem of migration is an accompanying phenomenon in the history of society, caused by a number of factors (wars, deep economic crises, lack of living resources, etc.). These are phenomena that cause fluctuations in society and induce a series of problems related to forced migration and integration of refugees in the host country [1]. The Czech Republic was the first Visegrad country to regulate migration (resp. immigration) in detail since 2000 [2]. It responded in the same way to the 2015 refugee crisis. However, the current war in Ukraine is causing continuous and large-scale forced migration from Ukraine to Central and Western Europe, with significant differences from the 2015 refugee crisis [3].

This situation needs to be addressed not only by individual states but also by European integration groups. On 8 February 2024, a preliminary agreement was approved to support the reform of the EU's asylum and migration system. The Common European Asylum System (CEAS) [4] should set minimum standards for the treatment of asylum seekers across the EU, as they are not treated uniformly across the EU under the current rules. However, in the words of the Minister of Transport, the Czech Republic will not support the current form of the migration pact.

Therefore, the aim of this article is to analyse the legal aspects of migration in the Czech Republic, to analyse the development of migration, to make a comparative study of the state of migration before the war in Ukraine and currently during it, and to outline the approaches of the state to deal with the refugee wave and illegal migration on the territory of the Czech Republic.

Method of investigation. The article focuses on the analysis of migration in the Czech Republic from several perspectives. Part of the analysis is devoted to illegal migration in the Czech Republic, including its structure, the main migration routes and also illegal migration in transit. It also analyses the administrative expulsion of foreigners from the territory of the Czech Republic over the period under review. In the comparative study of the state of migration in the context of the war in Ukraine, the criteria focused on the number of refugees to the Czech Republic, illegal entries and legally residing citizens of Ukraine on the territory of the Czech Republic, the impact of migration on internal security and public order, and changes in the state's approach to migration in the context of the refugee wave.

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Investigation Results. A comparison was made of the situation before and during the war in Ukraine based on the criteria set out above. The comparison found that in 2022, there was a record increase in total irregular migration, of which a significant part of irregular migrants transited through the Czech Republic (16 times more than in 2021) and affected the numbers of persons reported as irregularly staying. The reason for this is that the Czech Republic is part of the main corridor - the Western Balkan route to Western Europe. Following the security situation on the territory of the Czech Republic, the protection of the internal border with the Slovak Republic was temporarily reintroduced, and police cooperation was intensified in the Western Balkan countries and at the border crossings between Slovakia and Ukraine.

In 2022, there was also a significant year-on-year increase in the number of foreigners with legal residence in the Czech Republic (by almost 160%) due to the high number of refugees from Ukraine (37% of the total number of all registered foreigners with legal residence) for whom Regional Assistance Centres for Ukraine were established.

Conclusions. The results of the comparison can be used as a basis for developing and improving the state of migration solutions in the future. With the help of the research results, it is possible to identify the positives and negatives of approaches to migration and to determine the direction of their further development in the framework of further research. In general, however, it is essential to promote legal migration to ensure the internal security of the state. In the fight against illegal migration, on the other hand, it is necessary to focus on new trends in the field of transit illegal migration and on the coordination of security measures throughout the Czech Republic to cooperate with the security forces of foreign partners to effectively detection smugglers of illegal migrants, to initiate the tightening of penalties for illegal crossing of the state border and unauthorized stay on the territory of the state.

Limitations. The results of the analysis may be distorted due to a possible lack of relevant information, as some facts related to the migration issue may be subject to secrecy and therefore publicly available information may not fully correspond to the actual measures taken. Another limitation may be the limited number of criteria included in the comparison.

Keywords: *migration; the Czech Republic; refugees from Ukraine; security environment; comparison.*

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Strategic Communication's Role in Eliminating Disinformation's Impact in Times of Crisis

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Introduction. Disinformation has become part of the 'hybrid war'. Social media and offline media are disseminating disinformation across the broad public. Public opinion polls illustrate that a majority of the public considers at least some disinformation to be accurate and relevant. There have been many attempts to map disinformation sources and tackle them from a rational point of view. Many approaches are primarily based on fact-checking and tackling disinformation in a very rational way. These approaches have limits, especially in times of crisis, such as the COVID-19 pandemic or the war in Ukraine. Our approach, therefore, develops methods to tackle disinformation respecting human nature and driving forces of our behaviour. People do not change their attitudes in the long term, but their behavior does. For this reason, it is more effective to change people's behaviour. The topic is very relevant now, as evidenced by the appearance of European Commission President Ursula von der Leyen at the World Economic Forum in Davos this year. She mentioned the urgency of this problem in her speech. There is a debate about which tools are appropriate to eliminate disinformation narratives. Countries are oriented towards different approaches, from restrictions to educational activities. Several tools bring results only in the long term. But if a crisis occurs, such as the pandemic. It is necessary to choose more effective approaches.

Method of investigation. The project is based on content analysis of key strategic documents, such as strategies, concepts, methodologies, etc. We will focus on countries where they have already created a strategic communication system and on countries where this system is still being created. Interviews with experts will eventually supplement the analysis of documents.

Investigation Results. The result of the project will be a summary of best practices of strategic communication functioning models. Next, recommendations will be formulated on what the ideal model of strategic communication should look like. We focus on conceptual starting points, institutional support and ways of implementing individual campaigns.

Conclusions. The strategic communication of the state is currently, especially in the CEE countries, a topical topic. There are two reasons. On the one hand, the countries of the CEE region are exposed to Russia's disinformation and propaganda activities, whose goal is to undermine the democratic principles of the Western world.

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The second reason is technological development and artificial intelligence, which are also becoming important "weapons of the adversary". For this reason, individual countries should create effective tools to withstand the mentioned pressure.

Limitations. A limitation of the project is the availability of individual documents, which can also be classified. For this reason, research will be based on open sources, but this should not fundamentally reduce the value of our study.

Keywords: *Strategic Communication, Disinformation, Fake News, Hybrid War, Security, Information War*

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The Impact of the War Conflicts on Residential Childcare: Survey into Czech Children's Homes

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Introduction. The explosions of war do not only tear up battlefields; they also tear up families. The most vulnerable members of our societies, children, suffer from war. Although children should be guaranteed the protection guaranteed by international conventions [1], many families prefer to send their children to the relative safety of a foreign country. As soon as a child enters the territory of the country of destination, he or she is subject to that country's socio-legal protection legislation. In many cases, the child is placed in an institutional setting.

The paper's main aim will be to present the results of a unique research that mapped the reflection of current war conflicts on the situation in Czech children's homes. We investigated whether ongoing war conflicts have an impact on the composition of children in these institutions and to what extent children's homes are transported to meet the needs of children from areas of war conflict. This issue is minimally elaborated in the Czech space; the responsible ministries need in-depth analyses. We focused our research on the area of special educational needs, the area of socialization of newly arrived children in the Czech school environment, and the area of social interaction of children with experience of war conflicts with children from the intact population.

Method of investigation. We are utilizing a qualitative research approach that has demonstrated efficacy in prior studies [2]. Qualitative research methodologies have the potential to significantly enrich the contemporary inclusive paradigm [3]. Our initial data collection employs semi-structured interviews and participant observation, with interviews being the predominant method in qualitative research [4]. Notably, researchers have a shifting perception regarding the interview process, emphasizing the need for researchers to reconcile their personal involvement with their professional stance [5].

We contend that an actively engaged researcher yields more dependable results than a passive researcher [6]. As qualitative researchers, we maintain close contact with the subject group, investing significant time within the research environment [7]. This proactive involvement mitigates respondent distrust, particularly in close-knit communities like the children's home we study. Data collected from interviews and observations are analyzed using grounded theory and interpretive phenomenological analysis, methods deemed suitable for our context. Research objectivity is paramount. Given the potential for bias inherent in qualitative research due to the researcher's presence, we emphasize objectivity and utilize triangulation. Triangulation involves subjecting our findings to scrutiny from other research methods or researchers [8].

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Conclusions. We found that the number of children from war zones in the children's homes surveyed has increased significantly. We recorded children from Ukraine, Afghanistan, and Yemen. In addition to these children, the number of children fleeing not from the war but from the economic situation in their home countries is steadily increasing. There is a clear need for intensive social and special education support in all cases. The trauma of war experiences has an impact on a wide range of personality traits in children [9].

Our research has identified several new areas where Czech children's homes need more experience. In particular, these are issues of religion and socio-cultural norms. We have also identified the need to significantly strengthen the training of teaching staff in the area of skills for working with children traumatized by war and refugee experiences. Our results will contribute to new methodological approaches that will significantly improve the quality of work with children whose temporary homes are children's homes.

Limitations. A major limitation of our research is the difficulty of generalizability, as we studied only a limited sample of children. Another significant limitation is that we have focused on highly personal areas of children's lives that are by default understood as difficult to generalize. Given the relatively short time that the issue of children from war zones in children's homes has been an issue, further and especially longer research in this area will be needed.

Keywords: *children's home; social-legal protection; trauma; special educational needs.*

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Risk Analysis of Strategic Commodities in Customs Procedures in Relation to Global Security Threats

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Introduction. Foreign trade in strategic commodities is as old as mankind itself. From a safety and security perspective, military equipment and dual-use goods are listed as strategic commodities in customs management. The definition of military material is given by the legal norms of the Czech Republic, in particular Act No 38/1994 Coll. "On Foreign Trade in Military Material" and its implementing Decree No. 210/2012, as well as Act No 594/2004 implementing the European Communities regime for the control of exports of dual-use goods and technology, including its implementing regulations, and Regulation No 2021/821 of the European Parliament and of the Council, including its implementing regulations amending the original Regulation No 428/2009. Dual-use items are a wide range of goods, technologies and intangible goods (licences or software) that are primarily produced for civilian use but, due to their nature and characteristics, can be used or abused for the production of weapons of mass destruction, biological weapons or for possible military purposes. Foreign trade in them is strictly monitored, defined by Commission Regulations and other implementing legislation, and their inclusion or removal from the list is accompanied by regular meetings of the expert groups responsible for updating the lists.

The World Customs Organization, through national customs organizations, carries out customs supervision of this foreign trade. Important partners are also the licensing administrations, which have decision-making authority over the granting of export or import permits necessary for the smooth and lawful foreign trade in these sensitive goods. Risk management in this area is particularly important for the determination of acceptable and unacceptable risk, which is based on an analysis of legal standards and a statistical assessment of exports and imports of these commodities within the territory of the Czech Republic. The identification of risky commodities, the establishment of conditions for international trade in them and effective monitoring of this kind of trade will contribute to ensuring greater security in the Czech Republic.

Method of investigation. Quantitative analysis of hard data obtained on the basis of official documents provided by the General Directorate of Customs of the Czech Republic for the purposes of this research shows the evolution of this trade over a period of 10 years. The objective of the research is to analyse the growth in exports and imports of selected strategic commodities by country of final consignee or exporter.

Investigation Results. International trade over the last two years has been strongly influenced by the change in the political order in the world and the emergence of several armed conflicts that may just be taking advantage of these technologies. The Czech Republic has committed to respect an embargo on selected commodities, but this does not mean that these commodities

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cannot be secured by interest groups in other ways and elsewhere. The statistical assessment of exports and imports shows an increase in both customs declarations and the volume of funds. A significant milestone has been the embargo against Russia and Belarus due to the invasion of Ukraine, which has seen a dampening of selected exports to these countries. Given the increase in exports to China, we believe that these deals are being conducted through a Chinese intermediary that supplies Russia with these goods as part of a long-standing relationship. The increase in the number of simplified declarations confirms that this practice is ideal for smugglers who make it difficult for customs to detect these exports.

Conclusions. Trade in strategic commodities is growing cumulatively, as shown by the statistics provided by the Directorate General of Customs. The Czech Republic is a country of interest especially for countries from the former Soviet Union and China, which seek these products because of their favorable price, friendly user interface and high quality of products that can withstand comparison with other, much more expensive products. Unfortunately, this is also a major liability, especially for government authorities and security forces that can manage and control the trade in these products. Ease of use, quality, as well as availability and accessibility of spare parts and service, make these products attractive to embargoed states and organizations or various terrorist or extremist groups with a risk of direct use against state-protected interests or sites. The international trade system, new trends in customs procedures, and the failure to comply with the ethical framework for trade make it difficult for control authorities to carry out rigorous controls and to set up quality control mechanisms, which can be a major risk in the area of safety and security.

Limitations. Unfortunately, this research was conducted only on the territory of the Czech Republic, which may reduce the relevance of the development of trade in strategic commodities in the area of safety and security, however, in the context of historical ties with other countries, the quality of the products required and their availability, especially for the Eastern Bloc countries and China, this research is useful for determining selected restrictions or sanctions on specific products or countries.

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War's Shadow: Exploring Multifaceted Strategies in the Politics of Fear

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Introduction. The number of arguments and explanations dealing with the description and definition of the politics of fear is increasing. This topic has become extremely important, especially after the beginning of the Russian aggression in Ukraine, as the war started not only on Ukrainian territories but also affected Russian citizens.

It was the French author Michael de Montaigne who wrote "The thing I fear most is fear" [11]. Of course, the entire history of mankind is marked not only by the use of fear in politics but also by a desire to free itself from it [13]. Fear, as a negative emotion, is a constant companion of individuals and society. In everyday life, it manifests itself as an instinct for self-preservation from objectively existing threats. And a significant portion of fears are generated by society. Fear, to the highest degree, is a political sentiment. However, we should emphasize that this feeling can arise in conditions of both real and imagined, illusory, and false dangers, but it is experienced as real. The quality of life in society depends on the intensity of this social sentiment [13]. It is of utmost importance to understand the scale and nature of this social sentiment in Russia nowadays in order to propose scenarios for the future of the country.

While there is no single, universally accepted definition of the politics of fear, summarizing the existing views on the problem gives us an opportunity to identify main methodological approaches that have been encountered in the academic literature. The socio-political approach, as exemplified by scholars such as Wendy Brown [4], Arjun Appadurai [2], Didier Fassin [6], and David L. Altheide [1], scrutinizes fear as a social and political phenomenon deeply embedded in power dynamics, institutional structures, and broader socio-political conditions. This perspective recognizes fear as a force that not only influences individuals on a personal level but also shapes and is shaped by societal structures. By exploring the nexus between fear, governance, and societal responses, scholars employing the socio-political approach contribute valuable insights into the ways in which fear operates within the complex tapestry of political landscapes [7].

The psychological approach, on the other hand, delves into the intricate realms of individual and collective psychology [3], dissecting the cognitive, emotional, and behavioural dimensions of fear. Pioneered by notable figures like Stanley Milgram [10], Philip Zimbardo [17], and Robert Jay Lifton [8], this approach sheds light on how fear can be harnessed or manipulated by political actors to influence decision-making, attitudes, and responses [12]. By examining the psychological underpinnings of fear within political contexts, scholars in

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this field unravel the complexities of authoritarian control, social conformity, and the erosion of individual agency in the face of fear-inducing tactics [5].

As this article embarks on a comprehensive exploration of the politics of fear in the Russian context, it draws on these diverse methodological approaches to unravel the complexities surrounding fear as a political instrument. The questions posed — What is the politics of fear, and how can we measure and analyze it? How is the politics of fear used in Russia? To what extent do Russian people want to participate in it? And what are the possible future scenarios for the development of such politics? — serve as guiding beacons in navigating through the labyrinth of fear's influence on political landscapes. This article seeks to contribute to a nuanced understanding of the politics of fear, transcending geographical confines to offer insights that resonate on a global scale.

Methodology is paramount in unravelling the intricacies of the politics of fear, and this article employs a multifaceted approach that draws from various disciplines to comprehensively explore its manifestations in the Russian context. To measure and analyse the politics of fear, the instrumental approach is leveraged, emphasizing the strategic use of fear by political actors. Insights from scholars like Corey Robin [14] and Sheldon Wolin [16] guide the examination of how fear is deliberately manipulated to shape public opinion, legitimize policies, and maintain authority. Through an examination of historical and contemporary events, this approach provides a lens to discern the calculated use of fear in Russia's political landscape.

The discursive approach, illuminated by the works of Brian Massumi [9] and Ruth Wodak [15], is integral to understanding how fear is constructed, disseminated, and reinforced through language and discourse. By analysing the narratives employed by the regime and other social actors, this approach unveils the discursive techniques used to perpetuate fear. In the Russian context, this involves scrutinizing political speeches, media narratives, and public discourse to discern patterns that contribute to the cultivation and dissemination of fear. The discursive approach ensures a nuanced exploration of how language becomes a tool in the arsenal of political actors to instill and perpetuate fear among the populace.

Complementing these approaches, the socio-political lens is employed to delve into the broader social, political, and institutional factors shaping the politics of fear in Russia. Scholars like Wendy Brown [4] and Arjun Appadurai [2] guide the examination of power dynamics, institutional structures, and societal conditions that both shape and are influenced by the politics of fear. This includes an analysis of state policies, the role of institutions in propagating fear, and the societal responses to fear-inducing tactics. By integrating these methodologies, the article aspires to offer a holistic understanding of the multifaceted strategies employed in the politics of fear in Russia, transcending traditional disciplinary boundaries.

Method of investigation. The concrete methods of research will include both computational methods and critical discourse analysis in order to understand what methods are used by authoritarian state in order to implement the politics of fear. The research will be based on data collection from Russian media, official documents and speeches. I am collecting data from these sources to gain insights into the evolving landscape of Russian society during the second half of the year of the war (from August 24, 2022, to January 1, 2023) - the period before and after the announcement of partial mobilization.

Investigation Results. The investigation into the politics of fear in Russia, utilizing diverse methodological approaches, reveals nuanced and interconnected results across different segments of society. In the instrumental approach, the opposition faces multifaceted strategies such as repression, legal constraints, and discrediting, illustrating the regime's systematic efforts to control dissent. Elites, on the other hand, experience coercion, patronage, and surveillance, indicating a complex relationship where fear is wielded strategically to maintain their allegiance. Supporters, manipulated through propaganda and the cultivation of enemy perceptions, showcase the regime's success in shaping a narrative that fosters loyalty and conformity.

Through the discursive lens, the investigation finds that the regime employs techniques like othering, demonization, and disinformation to control public discourse. The opposition faces silencing and repression, whereas elites are subject to loyalty cultivation and symbolic power utilization. Supporters, in turn, witness the construction of a national identity through othering and stereotyping, reinforcing the regime's narrative. These findings highlight the regime's astute use of language and discourse to perpetuate fear and shape societal attitudes.

The emotional approach reveals the profound psychological impact of the politics of fear. Opposition members experience self-censorship and radicalization, while elites grapple with compliance and loyalty. Supporters, in the face of amplified propaganda, exhibit increased loyalty and obedience, demonstrating how fear can mold emotional responses and behaviour. Lastly, the socio-political approach elucidates the broader societal consequences, including the suppression of dissent, erosion of democratic space, and reinforcement of regime legitimacy. Elites consolidate power through fear-driven compliance, while supporters contribute to social cohesion through conformity and limited critical thinking. Overall, the investigation underscores the intricate ways in which fear operates at different levels of Russian society, influencing individuals, elites, and the broader socio-political landscape.

Conclusions. The exploration of the politics of fear in Russia through diverse methodological approaches has provided a nuanced understanding of the intricate ways fear operates across different segments of society. This comprehensive investigation highlights the role of politics of fear in shaping power dynamics, influencing individual and collective psychology, and contributing to the broader socio-political landscape. The findings emphasize the regime's strategic manipulation of fear to consolidate power, control narratives, and maintain societal cohesion. As Russia navigates its future, understanding the multifaceted strategies employed in the politics of fear becomes crucial for envisioning scenarios that may either perpetuate or challenge the existing dynamics, ultimately shaping the trajectory of the country's political landscape.

Limitations. While this article provides valuable insights into the politics of fear in Russia, it is important to acknowledge certain limitations inherent in the research.

● Firstly, the availability and accessibility of information about the politics of fear in Russia may pose limitations. Given the nature of the topic, certain aspects of the regime's strategies, especially those related to surveillance and repression, might be concealed or challenging to access. This limitation can affect the comprehensiveness of the findings and may lead to an incomplete understanding of the actual dynamics at play.

● Secondly, the study primarily explores the politics of fear from an analytical standpoint,

and the subjective experiences of individuals within the society may not be fully captured. Future research could benefit from incorporating qualitative methodologies, such as interviews or surveys, to gather firsthand perspectives and experiences related to fear in the Russian political context. Despite these limitations, this research lays a foundation for further investigations and discussions on the multifaceted nature of fear in Russia's political landscape.

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The Positioning of Terrorism Issues in the Contemporary World and its Perception from the Perspective of Czech Republic Citizens

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Introduction. In an era of constant technological progress and globalization processes, terrorism emerges as one of the most significant threats to the contemporary world. Its ability to adapt to new technologies and global reach transforms terrorism into an unpredictable force, eliciting considerable attention at both national and international levels. As a complex phenomenon, terrorism reflects not only direct security impacts but also broader social and political dynamics shaping its manifestations and strategies.

History shows that terrorism is not a product of modern times; the changing forms and methods of terrorist acts are evidence of its adaptation to various epochs. However, the specific perspective on terrorism varies between societies, as evident in the Czech Republic (CR). The central theme of the article is the analysis of the perception of terrorism in the CR, a country that, although seemingly on the periphery of direct terrorist attacks, is not isolated from this threat. It explores how terrorism resonates among citizens and their reactions, both on an individual and collective level.

The goal is to provide a comprehensive view of terrorism, its historical development, current manifestations, and the ways society responds to its threats. Special attention is given to the specifics of the CR, bringing new insights into the issue of terrorism and its impact on society. The analysis of the topic reveals how terrorism is perceived in the context of the Czech public and what strategies are effective in preventing and addressing terrorist threats, enriching the discussion on global and local security policy.

Method of investigation. The quantitative study initiated with a thorough examination of academic literature and online resources on terrorism, laying a solid theoretical groundwork and providing a comprehensive summary of current knowledge in the field. Following this theoretical groundwork, a detailed and systematic questionnaire focusing on terrorism's critical aspects was crafted.

Data gathering was executed via a standardized online survey using Survio.com, streamlining the collection process from a broad respondent base. This phase spanned 50 days, with 198 participants. The online method was chosen for its quick distribution, anonymity for participants, and immediate data processing capabilities, emphasizing sample diversity to

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enhance result representativeness.

The statistical software R was employed for data analysis, facilitating the examination of categorical variables through contingency tables and the χ2 independence test. This approach yielded a quantitative evaluation of variable relationships, identifying statistically significant patterns. The findings provided a nuanced understanding of terrorism and its perception within the study's demographic, condensing the research process and insights into a focused examination of terrorism's multifaceted impact and public perception.

Investigation Results. The analysis reveals that nearly all respondents (99%) are acquainted with the issue of terrorism, uncovering significant awareness of this matter within Czech society. Although the majority of participants were able to identify the basic characteristics of terrorism, the variance in responses exposes variability in the depth and precision of their understanding. This phenomenon can be attributed to the diversity of information sources, primarily the internet and mass media, which serve as the main channels for acquiring information on terrorism. The study also indicates less consistent knowledge about specific terrorist events and their historical contexts among the public, suggesting a need to expand public discussion and education in this area. The importance of critical thinking in selecting and interpreting information, as well as the significance of scholarly literature for gaining a deeper insight into the topic, is emphasized. The findings underscore the necessity for further education and awareness to achieve a more comprehensive understanding of terrorism and its impacts, which is crucial for developing the public's ability to critically analyse and effectively respond to terrorist threats.

Conclusions. The analysis of the results revealed that although the public in the CR is generally familiar with the concept of terrorism, there is a significant disparity in the depth and accuracy of their understanding. The findings indicate that despite a large portion of respondents encountering information about terrorism, primarily through the internet and mass media, the quality of this information and the ability for critical thinking about terrorism remain limited. The predominant use of the internet and media as primary sources of information suggests a need to enhance awareness and provide deeper analysis of terrorist events and strategies, which would lead to an expansion of the public's understanding of terrorism.

Additionally, the research indicated that significant terrorist events with international repercussions, continue to have a strong impact on public perception of terrorism, emphasizing the importance of historical context in terrorism education. This finding underscores the significance of integrating complex historical and political aspects into educational programs and public discourse, to better comprehend terrorism in its many dimensions.

Given the low incidence of terrorism within the CR and the simultaneously high awareness of global terrorist threats, it is evident that terrorism is perceived as a global problem with potential local impacts. This paradigm emphasizes the importance of a societal approach to prevention and education, where critical evaluation of information and a deep understanding of both historical and current aspects of terrorism can significantly contribute to society's resilience against terrorist threats.

Limitations. The primary limiting factor is the difficulty in controlling the sample of respondents given the chosen method. Another limiting factor is the low willingness of respondents to participate in research surveys addressing the issue of BW.

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Interoperability as a Tool to Enhance Collective Defence

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Introduction. NATO member states are obliged to provide assistance to another NATO ally in the event of an aggression. Despite many critical or even antagonistic statements by political leaders of selected NATO member states, most contributors are taking a responsible approach to increasing their readiness for the defence of their own state and the collective defence of allies, and to the related development of military capabilities. The development of collective defence within NATO is thus based on the development of the armed forces of individual NATO Member States so that the capabilities and organisational structures developed are capable of responding flexibly to both military and non-military threats not only in the contemporary, but especially in the foreseen future operating environment. When each Member State provides for its own defence, it also becomes a reliable ally and a trusted partner in the collective defence system. Moreover, the provision of collective defence requires an increasing degree of interoperability with the armed forces of other Member States.

To this end, Member States shall develop the national defence system and defence capabilities and ensure the necessary resources and their efficient and transparent use. Also, of course, in response to the dynamics of the contemporary operating environment, a review of concepts and approaches, and the associated technological modernisation, is required to ensure that the individual armed forces, individually and collectively, are able to respond adequately to symmetric, asymmetric and hybrid threats. This also requires an alignment of the overall concept of development and deployment, as the high level of interoperability required in many cases poses an additional challenge. Interoperability among NATO countries is key to enhance collective defence, and NATO defines the term interoperability as: *"The ability to act together coherently, effectively and efficiently to achieve Allied objectives."* [1]

Interoperability is achieved on three interconnected layers, namely the technological, the process and the human element. We observe that most of the technologies used within NATO member states are compatible, which has been achieved through the joint efforts of NATO member states in the development of new weapon systems and their procurement. We consider the standardization of processes by individual NATO countries to be a problem area, which in turn directly impacts the interoperability of the human element. U.K. Royal Navy Vice Adm. Guy Robinson, chief of staff to NATO's Supreme Allied Commander Transformation said, at the National Defense Industrial Association's JADC2: All Domain Warfare Symposium July 18.: *"NATO has been clear enough in setting and communicating*

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standards and objectives to alliance members. So, why aren't we as interoperable as we'd want to be? ... Well, having a standard is one thing, meeting a standard is something altogether different " [2] The aim of the study is therefore, on the basis of a case study, to propose a

possible way of achieving interoperability applicable within NATO Member States.

Method of investigation. To address the research problem, the Joint Terminal Attack Controller (JTAC) national program accreditation case study was used as the main method [3], [4], [5], [6]. The auxiliary methods of investigation, namely synthesis, deduction and analysis, were also applied.

Investigation Results Given the nature of current and anticipated future joint operations, understanding and developing interoperability is a necessary step in achieving operational effectiveness. To ensure interoperability at the standardisation level, the implementation of NATO standardisation documents alone is not sufficient. Our analysis of the current state of play has shown that the very structure of NATO standard documents allows individual Allies to make their own national changes or to deal with specific events or situations in different ways, which can lead to a lack of interoperability and misunderstandings.

The case study demonstrates a solution in the form of accreditation for those elements and activities that, when implemented by a particular NATO member state, meet the minimum requirements for achieving interoperability, in terms of technology, processes and the human element. This implies the need for their clear definition in doctrinal documents and subsequent understanding by components of the armed forces of NATO Member States.

Conclusions. There are many political, security and military benefits to being a member of NATO. Passive membership based on Article 5 of the Washington Treaty can lead to a significant reduction in the benefits of NATO membership and thus to a reduction in the collective defence of NATO. The achievement of interoperability among Allies and with partner countries will enhance collective defence not only within NATO but will also contribute to the enhancement of global security.

We consider interoperability to be a critical aspect, and its development must be supported by the development of other areas of capability building, in particular the doctrinal environment, organisational structures, and material and technical means. Therefore, on the basis of the results of the research conducted, it is advisable to focus on the harmonisation of the development of the armed forces of individual NATO member states in order to be able to conduct joint military operations dynamically and surprisingly, even against a peer adversary, as part of the rationalisation of the ways to achieve interoperability.

Limitations. However, there is a need for further research, such as:

● a reassessment of current organisational structures, training concepts and equipment,

● the introduction of advanced technologies for interoperability with Alliance partners to ensure that all Member States are able to contribute fully to NATO's joint operations.

It is recommended that the concept of enhanced interoperability be applied in military practice as a result of this study.

Keywords: *accreditation, implementation, interoperability, standardization, NATO.*

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The Gray Zone and its Place in Security Environment

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Introduction. In the space between "peace and war", which is called the gray zone in international relations, state actors operate with the intention of achieving their interests without using their own military force. The term "gray zone" defies categorization as well as framing, which would establish an international legal framework and, if crossed, could trigger a legitimate response from the international community. Power actors such as the United States of America (US), the Russian Federation (RU) or the People's Republic of China (CN) operate within the space of the gray zone. Given the ambiguity of the term, the possibilities of conducting activities within the gray zone are also expanding in an increasingly sophisticated manner.

Despite the efforts of authors and institutions working in the field of military, there is currently no unified definition of the term "gray zone". In September 2015, the US Special Operations Command published "The Gray Zone", which states that "gray zone security challenges, existing short of a formal state of war, present new complications for U.S. policy and interests in the 21st century. We have well-developed vocabularies, doctrines and mental models to describe war and peace, but the numerous challenges of the gray zone between them defy easy categorization" [1]. The US Special Operations Command introduced the term gray zone to "describe activities, actions, or conflict in the space between peace and war" [2]. The former commander of the US Central Command (CENTCOM) retired (Ret.) US Army Gen. Joseph L. Votel described this area as a "characterized by intense political, economic, informational, and military competition or competitiveness that is stronger in nature than conventional steady-state diplomacy, yet short of conventional warfare" [3].

Method of investigation. Using relevant methods of qualitative theoretical scientific research, in this article we present our research findings and insight into some selected factors contributing to the clarification of the theoretical view of the "Gray Zone".

Investigation Results. The beginning of the use of the term gray zone in the 21st century can be dated to the year 2010. This concept, as well as its characteristics, has achieved a certain shift. Military leaders, strategists, institutions, etc. published a number of publications and perspectives on how to understand this space and how to operate in it at the same time. They react to the change and development of the modern way of conducting warfare and try to grasp the space of the gray zone in such a way that they can cover it and achieve their goals set in it.

We can see that the political, diplomatic as well as economic means that once side-lined wars now constitute a distinctive feature of modern military-political thought. The paradigm

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of war is part of the modern or contemporary world. In this context, there is a need for continuous refinement in the conduct of the approach to war to avoid stagnation. Operating in new domains, namely the cyber and space domains, have expanded the capabilities of actors to operate on multiple 'fronts'. This may result in achieving even greater ambiguity in achieving their objectives, as well as weakening the organisations that provide international security.

Conclusions. In connection with the development of the global security environment, the ways of waging war as well as the view of war itself are evolving. Currently, state actors will not achieve their geopolitical objectives through the use of military force, while its direct use requires a large amount of personnel, special military equipment and financial resources. Even if they are allocated and used for a particular military campaign, the objective of the campaign may not be achieved and this may result in unforeseen consequences [4].

The issue of the gray zone is addressed mainly by experts from the field of security studies. Representatives of the US, respectively the West, the RU but also the CN deal with the gray zone and try to use this space to their advantage as best as possible, which points to its importance.

Certain issues arise with the examination of the issue of the term gray zone within an international legal framework. The applicability of the gray zone is not uniform; actors must change certain elements to achieve their interests, e.g., based on geographical distribution. As part of the use of the gray zone by the RU, the US, or other great powers, it is difficult to evaluate the success of the operation because the gray zone is not defined, or framed. The evaluation of its success and/or effectiveness may differ based on the point of view of the conflict actors. An actor who operates within the gray zone may have a different perspective on the achieved results than the one against whom the activities are carried out.

Keywords: *security environment; war; hybrid warfare; gray zone.*

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Contemporary Civil-Military Relations

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Introduction. Civil-military relations are still an under-researched area in relation to the existence and deployment of armed forces. However, it is the factor that significantly influence the management of the state and the use of relevant power tools, including the armed forces. The problem of civil-military relations is as old as formally constituted armed forces. The roles of civilian leaders of the state and senior military leadership were created during the history and currently are formulated in the legislative documents. This relationship has implications for the effectiveness of strategic decisions in pursuance of national interests. The military is more than simply a tool to its civilian principals. Friction between the military establishment and its civilian leadership is not a contemporary phenomenon. The debate concerning civil- military relations has been a fundamental issue for long time and surely in the future will be as well. Tension between members of the military and civilian leaders existed, exist and will exist. Especially it was visible in the post-communist states in which democratization processes took place. The Central and Eastern European states have put in place the core institutions and practices of democracy and this is reflected in civil-military relations in these states. This was, among other things, requirement for their accession to NATO and the EU. The members of these organizations are currently using and planning military force in the future. This trend poses fundamental questions about the use of military force in world politics and the relationship between civilian political leaders and the military in shaping when and how force is used.

The aim of this paper is to carry out research of the fundamental factors affecting the establishment, deployment and control of armed forces. The intention is to provide a comprehensive and comparative overview of the approaches used in the application of civil-military relations in achieving goals at the strategic, operational and partially tactical level. The author's effort is to achieve a comprehensive view of the considered issue with an emphasis on use in democratic states and organizations.

Method of investigation. Due to the theoretical framework of the paper, empirical-analytical methods were used to achieve the goal. Subsequently, synthesis was used. The main functions of the chosen approach were: description, classification, abstraction and typology. When processing individual parts of the text, the analysis of the achieved theoretical knowledge as well as empirical conclusions were applied. These were subsequently generalized and deductions and partial predictions were made. The supporting methodological approach was the use of a combination of theoretical knowledge and practical experience of the author, using sociological and psychological approaches that were, are and probably will be used in the issue of civil-military relations.

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Investigation Results. It was found that in democratic states there is a legislative framework for the establishment, control and deployment of armed forces. Civil-military relations must be linked to security and to democratization. However, each state has its peculiarities. Their mutual understanding is important especially in multinational operations. This can help in reducing differences of opinion and in achieving both political synergy and military interoperability.

Security is a complex issue in democratic states as well as in the states with some form of authoritarian regime. Security in this context implies the only (external/national defence) role for the military in democratic and dual (internal/public safety and external/national defence) role for the military in authoritarian regime.

In transition states with weak civilian control, discussion of these roles runs the risk of challenging the status quo, in the absence of specific attempts to reduce the armed forces' role in internal policing. Coups d'état or undue military pressure on the government could result. Accordingly, a more propitious setting for civilian control of the armed forces must be consciously built. There is tension between the need to have the military focus on its mission of external security (notably where history and constitutional provision press the armed forces into internal security activities) and the need to have the military fill the gap where government capacity to deliver services or maintain internal security is low.

Conclusions. This paper can assist both civilian and military officials in understanding their place in civil-military relations and their competencies in managing the armed forces. The concept of civilian control of the professional military in the democratic states is strongly given. The concept of the subordination of the military to civilian control ensures the continued adherence of democratic principles. Mentioned principles produce impassioned discussion on both (military and civilian) sides. The primary question in the past was: what pattern of civil-military relations to create. Nowadays primary question is: where is the balance between impact of civilian nonprofessional decisions (in military point of view) and impact of military professional influence to political decision makers. The most important issue is: what pattern of civil-military relations will best maintain the security of precise nation.

Limitations. Despite some predictions, it is not certain which direction civil-military relations will take. Only the future will tell whether the military-professional aspect will be strengthened and respected when setting strategic goals, or whether the aspect of political responsibility will be more enforced. It appears that the evaluation of the mentioned aspects will be a never ending process and further research is needed.

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Impact of the War in Ukraine on Global Environmental Security

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Introduction. Environmental pollution is the least obvious but very serious consequence of war that cannot be underestimated. The war made Ukraine even more vulnerable. In addition to economic consequences, destruction of infrastructure and forced migration, war causes serious direct and indirect environmental consequences, including pollution of air, water and soil; destruction of natural ecosystems, reduction of biodiversity and deterioration of the quality of the environment as a whole; spread of diseases and pests; increasing the risk of man-made disasters. The ecological consequences of this war will be felt not only on the territory of Ukraine, but also far beyond the borders of the country, both in the short and long term. The war has a negative impact on the climate of the planet, in particular, due to the increase in the amount of greenhouse gases in the atmosphere, which were formed during the hostilities; deterioration of the quality of life of the population due to air, water and soil pollution; decrease in investment in renewable energy sources. The restoration of Ukraine's environment after the war will be a long and difficult process. Ukraine has assumed a number of environmental obligations, both at the national and international level, and is trying to fulfill them, since the fulfillment of these obligations is one of the factors of the success of the Euro integration policy of Ukraine and ensuring sustainable development.

Method of investigation. The issue of studying the impact of the consequences of the war in Ukraine in the context of global environmental security is complex and belongs to an interdisciplinary field of knowledge. This determines the methodological basis of the research, which is based on the principles of objectivity, multifactoriality and systematicity. Therefore, to study the phenomenon of global environmental security as a component of military actions, using the example of Russia's armed aggression against Ukraine, the most justified method is, first of all, the interdisciplinary method of discourse analysis, because it allows you to answer the following questions: first, what local environmental consequences will Russia's war against Ukraine have ; secondly, what are the environmental challenges of Ukraine's post-war recovery period; thirdly, what are the global environmental consequences of the war in Ukraine and how will it affect global warming; fourthly, what environmental obligations Ukraine has undertaken and how it is able to fulfill them during a full-scale war. The study of the impact of environmental consequences of the war in Ukraine was conducted using a systemic approach, which gave a holistic view of the environmental consequences of military actions at the regional and international level. The application of the method of analysis and synthesis made it possible to systematize environmental challenges, as well

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as to assess their short- and long-term consequences. The method of document analysis made it possible to determine the key components of climate policy at the level of the UN, the European Union, and Ukrainian climate commitments. The empirical basis of the work was the basic documents of the UN and the Council of Europe on the main directions of international climate policy, official documents of the Ministry of Environmental Protection and Natural Resources of Ukraine and the Ministry of Regional Development of Ukraine [2, 11, 12], analytical materials of ChatamHouse, the WorldBank and the National Institute for Strategic Studies [1, 3, 4, 8], studies of Ukrainian and international environmental organizations [5-7, 9-10].

Investigation Results. *Local ecological consequences of Russia's war against Ukraine.* The obvious consequences of military actions in Ukraine are the loss of life, the destruction of houses, the destruction of civil and military infrastructure, mass migration, the deterioration of the economic condition of countries and the living conditions of the population. At the same time, the Russian troops are carrying out deliberate actions that cause man-made accidents and threaten the ecological security of millions of people who live far beyond the borders of hostilities. Military actions pose a threat to the environment of the country and the region due to increased emissions of carbon dioxide, increased amount of waste and pollution of water bodies.

Fighting and the need to build fortifications lead to the destruction of forests and other natural ecosystems. The decrease in the number of trees, in turn, leads to an increase in carbon dioxide *emissions into the atmosphere*. According to Chatham House, during the first seven months of the hostilities, about 100 million tons of carbon were released into the atmosphere [1]. An increase in carbon dioxide emissions also caused by fires in forests, settlements, and fields; burning of oil and gas storage facilities, factories, gas stations; using of inefficient diesel generators; military equipment; detonation products of rockets and artillery shells.

The war caused a sharp increase in the volume of specific waste, including damaged and abandoned vehicles and equipment, projectile debris, household and medical waste. Some of the waste is highly toxic. The volume of such waste has already reached a scale not seen on the European continent since the Second World War. More than 325,000 tons of destroyed Russian equipment alone have accumulated on the territory of Ukraine [2]. In addition, huge volumes of waste from the destruction of residential and transport infrastructure were created. According to preliminary estimates, Russian troops destroyed about 6.8 thousand buildings, which generated 15.2 billion tons of waste. More than 200,000 cars and trucks destroyed in Ukraine during hostilities are currently stored in specially places [3]. According to the experts of the National Institute of Strategic Studies, the post-war reconstruction of Ukraine should not copy the pre-war structure of the economy, which was based on fossil fuels, but develop with the implementation of effective technologies for the processing of war waste for their reuse and be subordinated to the task of developing an ecologically clean Ukraine with «green» economy" [4].

Even before the start of the full-scale war, Ukraine had a shortage of *water resources*. In 2019, Ukraine ranked 125th among 181 countries in the world in terms of available drinking water reserves [5]. Forced withdrawal of Dnieper water from the Kakhovsky Reservoir by the occupiers and its supply to Crimea in violation of technological requirements had a negative impact on water availability in the region. It is impossible to fully estimate the losses, because

the Kakhovskaya HPP was under occupation before its detonation. Today, those crimes against nature that take place in the combat zone are defined by experts as ecocide [6]. The biggest of them is the destruction of the Kakhovskaya HPP dam.

Environmental challenges of the period of post-war reconstruction of Ukraine. According to experts, the largest share of *emissions* will be caused by post-war recovery, when power plants, industry and buildings will have to be rebuilt. The construction sector, which uses a large amount of concrete, is generally one of the sectors with a very high level of greenhouse gas emissions.

International and European experience shows that it is possible to reuse certain types of war *waste*, destroyed objects and property. For example, after the Second World War, the reconstruction of Warsaw was accelerated by the use of materials that remained after the end of hostilities. In particular, undamaged whole bricks were reused, and construction waste was crushed into concrete.

Even after the end of hostilities and restoration of the irrigation system due to global warming, the volume of fresh *water* in most river basins of Ukraine will decrease. This means that water resources in Ukraine are threatened not only by the actions of the occupiers, but also by climate change, which must be taken into account in the course of post-war reconstruction.

Environmental consequences of the war in Ukraine and global warming. The war aggravated the issue of international food and energy security, in particular, due to periodic blockades of food exports from Ukraine through the Black Sea. Global energy independence, which is a prerequisite for international security, has faced significant challenges. Although EU countries are attracting additional resources to get rid of energy dependence on Russia, in the short term there is a risk of a return to fossil fuels. But on the other hand, this military aggression can become an incentive for the gradual reduction of dependence on fossil fuels.

The environmental impact of Russia's war against Ukraine is not limited to the territory of Ukraine. Deputy Secretary General of the UN, Executive Director of the UN Environment Program, said that «the countries that directly border Ukraine are aware that the war unleashed by the Russian Federation has a cross-border nature of impact on nature» [7].

The greatest climate challenges for humanity in this century are the *reduction of biodiversity, overpopulation and global warming* of the planet, which leads to the mass extinction of species, the reduction of useful resources to maintain a normal standard of living of humanity. The war on the territory of Ukraine significantly increases the negative effect of these challenges. War accelerates the process of species extinction, as ecosystems are destroyed in the course of hostilities, leading to the death of plants and insects typical of those areas, as well as large animals such as mammals and birds. According to experts, the war is directly related to the overpopulation of the planet, since the use and destruction of natural resources during military operations occurs much faster. The main «resource» in Ukraine in economic terms is soil, so war directly destroys fertile soil as a resource, which leads to mass migration and increased struggle for resources for existence. Greenhouse gases formed on the territory of Ukraine as a result of military operations will directly affect global warming. The military is one of the largest emitters of greenhouse gases in the world. Due to the war, the military industry is growing, which is very energy-intensive and additionally emits greenhouse gases into the atmosphere [8], which can negatively affect the plans for the green transition [9]. The

sharp increase in greenhouse gas emissions was caused by the Nordstream pipeline accident and leak, which released about 300,000 tons of methane, one of the most powerful greenhouse gases [10], and emissions produced by long-haul flights over Asia after the imposition of sanctions against Russia.

Environmental obligations of Ukraine. In 2021, Ukraine undertook to reduce greenhouse gas emissions. But as a result of Russian aggression, the funds that were planned to be spent on energy efficiency, the green economy, renewable energy sources, the creation of new nature reserves and the preservation of species are now being spent on military actions. The government of Ukraine admits that this war is accelerating climate change and causing an increase in greenhouse gas emissions. The strategic goal of the country's post-war reconstruction is a clean and safe environment, compliance with the European green course, and reconstruction of the economy according to the principles of sustainable development. Among the main environmental issues that became relevant due to Russian aggression, the Ukrainian initiative
«Aggressor refunds» should be singled out - a mechanism for compensating the aggressor for damage caused to the environment and climate of the planet and including this mechanism in the Paris Agreement [11]. To date, the Climate Law has been finalized in Ukraine, which covers all directions in the field of climate policy formation and implementation, and work on the plan of measures to implement the updated Nationally Determined Contribution of Ukraine to the Paris Agreement has been completed [12]. Ukrainian experts emphasize the need to reflect the environmental consequences of the war in Ukraine in the reports of the Secretariat of the UN Framework Convention on Climate Change.

Conclusions. Full-scale Russian aggression against Ukraine will have very serious negative consequences for the ecosystem of the country and the region, both in the short and long term. This war is taking place in a period of global climate change and has a negative impact on climate trends. Since the beginning of the large-scale invasion of Ukraine, the country's environment has been under the constant destructive influence of new threats to environmental security. The active phase of hostilities in Ukraine not only negatively affects the environmental security of the country and the countries of the region, but can also become one of the factors of climate change and disrupt the achievement of global climate goals. The consequences of the war create a risk of destabilization of the world food and energy markets. Although EU countries are raising additional resources to break their energy dependence on Russia, there is a risk of a resumption of global dependence on fossil fuels, narrowing the window of opportunity to limit global temperature rise. On the other hand, although in the short term Russia's full-scale war against Ukraine resulted in an energy imbalance, in the long term such a shake-up of the system could accelerate the development and transition to renewable energy sources and bring the world closer to achieving climate goals.

Limitations. Emissions caused by military operations in peacetime and during hostilities have only been partially investigated. Today, there is no standardized procedure for measuring greenhouse gas emissions by armies, and military emissions are excluded from the Paris Agreement. Therefore, the introduction of universal methods for calculating environmental damage from military actions and their impact on global climate change remain relevant, as it should contribute to the successful implementation of the European «Green Deal».

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The Impact of Military Expenditures on the Government Debt of the Czech Republic and Lithuania

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Introduction. The development of the economic environment characterized by gross domestic product, inflation, budget deficit or government debt is one of the so-called economic determinants of military expenditures, which is the subject of various empirical studies examining the influence of defined factors on the size of military expenditures. The increase in military expenditures, caused mainly by the changing security situation in Europe, brings a natural pressure for an increase in military expenditures, which, however, especially for European economies suffering from government budget deficits, leads to an increase in the country's indebtness. The authors of this paper, through an estimated ARDL model, analyses the relationship between military expenditures and government debt of the Czech Republic and Lithuania over the period 1999-2022 by using nine variables characterizing the economic development. The analysis itself follows the work of Smyth and Narayan (2009) who focused on observing the effect of military expenditures on the external government debt of 6 Middle Eastern countries, where a panel study confirmed the relationship between these variables. Sheikh et al. (2013) observed the relationship between defense expenditures and debt for two rival neighbouring countries, Pakistan and India, concluding that funding of significant military expenditures strongly affects the debt of both countries. The following findings by Azam and Feng (2015) confirm the negative impact of military expenditures on external debt accumulation for 10 selected Asian countries. Similarly, empirical results from a study by Khan et al. (2021) found that military expenditures by 35 arms-importing countries increases foreign indebtness. Çolak and Özkaya (2020) also confirmed the weakening impact of military expenditures on economic performance and government debt of 12 transition economies.

Method of investigation. For the analysis itself, the authors of the paper use correlation analysis and the ARDL model (Pesaran, 2001) examining the link between government debt and selected economic characteristics, namely military expenditures, GDP, exports, imports, total government spending, total investment, foreign investment and inflation.

The authors used an autoregressive distributed lag model ARDL $(p, q_1, q_2, , p_k)$, where p is the number of lags of the dependent variable Y_t, $q_1, q_2, …, q_k$ are numbers of lags of explanatory variables X_{it}, $i = 1,2, …, k$. The model can be written as

$$Y_t = \alpha + \sum_{i=1}^{p} \gamma_i Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} \beta_{j,i} X_{j,t-i} + \varepsilon_t,$$

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where ε is a one-dimensional zero mean error term.

Investigation Results. The authors used correlation analysis and the ARDL model to analyses the relationship between military expenditures and the country's indebtness. The results of the correlation analysis in the case of the Czech Republic did not confirm the expected relationship between military expenditures and the country's government debt, with the correlation coefficient taking negative values. In the case of Lithuania, the correlation coefficient is positive, confirming the expected link between the increase in military expenditure and the country's increasing government debt.
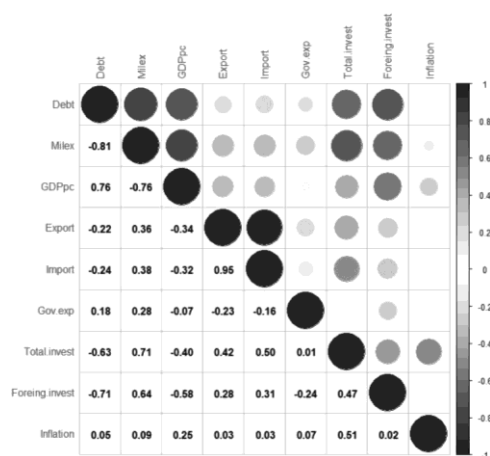
Fig. 1 Correlation matrix (Czech Republic)   Fig. 2 Correlation matrix (Lithuania)
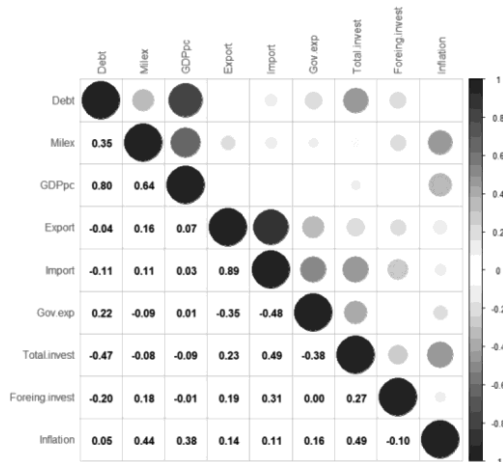
The results of the estimated ARDL model show the following equations describing the long-run relationship between these variables.

Czech Republic

$$EC_t = DEBT_t - (-17.8564\ MILEX_t + 0.0001\ GDPPC_t + 3.9453\ GOV\_EXP_t - 124.5784)$$

Lithuania

$$EC_t = DEBT_t - (-26.6249\ MILEX_t + 0.0019\ GDPPC_t + 0.8806\ IMPORT_t + 3.2988\ GOV\_EXP_t - 3.0133\ TOTAL\_INVEST_t - 48.8570)$$

In the case of the Czech Republic, the relationship between government debt and military expenditures, GDP and government spending is demonstrated. However, the expected negative effect of an increase in military expenditures and an increase in the country's indebtedness has not been demonstrated in the long run. In the case of Lithuania, it is possible to observe the relationship between government debt and military expenditures, GDP, import size, government spending and foreign investment. However, as in the case of the Czech Republic, the expected link has not been established in terms of the impact of military expenditures on the country's indebtedness.

Conclusions. Military expenditures as a part of government spending belong to the economic category of variables in which, especially in the case of the European NATO countries, can be noted a significant change in their size depending on the change in the security environment.

This trend can be observed in both analysed countries, especially in connection with the conclusions of the NATO Summits in Wales (2014) and consequently in Vilnius (2023). The results of the correlation analysis showed the expected effect only in the case of Lithuania. The results of the estimated ARDL model did not show the effect of military expenditures on the countries´ indebtedness.

Limitations. The availability of data and the time period.

Keywords: *military expenditures, government debt, indebtedness, correlation analysis, ARDL method.*

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Security Strategies of the Visegrad Group Countries in the Current Security Environment

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Introduction. The concept of security strategy is highly relevant in the current geopolitical situation. Significant changes are taking place in the international security environment, which is undergoing a major transformation process to restore the influence of strong states [1]. The Security Strategy is the Government's basic approach to ensuring the security of the State and can be used to ensure the safety of the population and to defend the sovereignty and territorial integrity of the country [2]. It is one of the basic documents that should contain basic information and assessment of the security environment, the direction of security policy and the security interests of the state. At the same time, it should identify the most serious threats to these interests and determine how the state will counter them in order to ensure national security [1, 2, 3, 4].

The aim of this article is to analyse the approaches of selected states to the issue of state and citizen security in the context of current global events. The comparison assesses the extent to which the current European Security Strategy [5], the Security Strategy of the Czech Republic [1] and other Visegrad group countries [2, 3, 4] are prepared to address the security threats that affect them and to respond to the security risks arising from global developments in recent years.

Method of investigation. The article focuses on the analysis of the security strategies of the Visegrad countries and the comparison of these strategies with the European Security Strategy. Using contextual analysis, it provides an expert analysis of the internal and external contexts and influences of security strategies on the current security environment, which is increasingly complex and uncertain.

Investigation Results. In comparing the security strategies of the Visegrad Group states, the method of contextual analysis was used to compare the individual areas and security interests of each state. These were then compared with the European Security Strategy to see whether the individual states meet the requirements for security in Europe. The result of the article is a comparison of the security interests of the Visegrad Group states and whether they pay sufficient attention to these security interests in their security strategies.

Conclusions. The analysis of the security strategy approaches of the Visegrad Group countries revealed that the European countries studied have many common features in terms of the development and current status of their security interests. The comparison revealed that, due

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to significant changes in the international security environment, it is appropriate to update the security strategies of some countries, as they do not include the protection of all security interests. The results can be used as a basis for updating the themes of security strategies in the future.

Limitations. The limitation lies in the subjective assessment of the contextual analysis by the authors. The results of the analysis may also be biased by the possible lack of relevant information from the security strategies of some of the Visegrad countries. For example, Hungary's security strategy is very difficult to find.

Keywords: *security strategy; Visegrad Group; threats; European security strategy; security environment; comparison.*

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Temporal Discontinuity of Defence Investment and Implementation in the Bucharest Nine Countries

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Introduction. Defence procurement attracts a great deal of political and academic attention because large-scale projects are regularly delayed and cost significantly more than the original estimate. Delay problems are often associated with the deployment of new technologies. Overall, the defence procurement environment is complex, characterized by uncertainties and significant resource constraints resulting from constantly evolving threat perceptions, limited dissemination of information on new technologies and defence-related spending (Patil, Bhaduri, 2020).

The time delay in the implementation of defence acquisition can be divided into two basic periods. The first period is associated with the government's decision that a given military equipment can be purchased for the armed forces, then how the purchase will be implemented. Already here there may be time delays in the order of years, for example, the Czech Republic knew since 2011 (White Paper on Defence) that it needed to address the replacement of obsolete IFV BVP-2 which will reach the end of their service life in 2018-2020, the signing of the contract for the purchase of new IFVs occurred only in 2023. The second period is characterized by the signing of the contract until the delivery of the last piece of ordered military equipment. This time period is dependent on a number of variables, the technical level and type of military equipment, whether the military equipment is produced directly in the country or exported, whether the purchase includes the development of the technology.

Method of investigation. The paper aims to show the time delays of investments on selected projects, which are shown both on specific examples and on aggregated data that are statistically analyzed. A simple correlation is used as the basic model to reveal the relationship between the change in the level of investment and the change in defence capability, which is represented by a selected part of the Global Military Index (GMI). In addition, selected military contracts in the Bucharest Nine (B9) countries are specifically analyzed. The conclusion of this grouping is based on its growing strategic importance, which is changing in relation to the security situation and the threat from the Russian Federation. In the context of the analysis of selected contracts, we will also look for sources of delays in the implementation of investments.

Investigation Results. Based on the statistical analysis, the hypothesis of the existence of a delay can be confirmed, when this finding is not so surprising. In general, sophisticated systems are the most time-consuming in terms of delivery, this is mainly the category of

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fighter aircraft, battleships, submarines and others. One of the reasons identified is that in today's tight security situation it is a problem that some manufacturers operate in a peaceful supply chain mode, according to the findings of the author Hellberg (2023) Swedish companies in the defence industry do not hold large stocks of raw materials, components or finished products, there is little opportunity to produce fast or larger volumes in a short time. The consequence is that the Swedish Armed Forces expect deliveries of military equipment within 3-5 years of the order being placed.

Table 1 shows the selected acquisitions for each B9 country with their timeframe from ordering to delivery of the last unit, it is possible that for some acquisitions the timeframe in deliveries may move forward and backwards in time. Generally, the most time consuming are the sophisticated systems, these are primarily in the fighter aircraft, battleship, aircraft carrier, submarine category.

Table 1. Overview of selected acquisitions with their timeline

#	Country	Equipment	Original Qty	Order Date	First Delivery	Contract Completion	Period of realization (Y)
1.	Estonia	155mm SPH K-9 howitzer	12	2018	2020	2023	5
2.	Czechia	APC Pandur II	199	2009	2009	2013	4
3.	Czechia	APC Pandur II	20	2017	2019	2020	3
4.	Czechia	AH AH-1Z Viper	4	2019	2023	2024	5
5.	Czechia	LTH UH-1Y Venom	8	2019	2023	2024	5
6.	Czechia	155mm SPH CEASAR	52	2021	2024	2026	5
7.	Bulgaria	FGAA F-16 C/D Block 70/72	8	2019	2025	2027	8
8.	Hungary	IFV KF41 Lynx	209	2020	2022	2027	7
9.	Latvia	IFV Patria 6x6	200	2021	2021	2029	8
10.	Lithuania	AUV JLTV	200	2021	2021	2023	2
11.	Poland	MBT Leopard 2PL	128	2015	2017	2020	5
12.	Poland	APC Rosomak S	60	2020	2021	2022	2
13.	Poland	155mm SPH Krab	96	2016	2019	2024	8
14.	Romania	227mm MRL M142 HIMARS	54	2018	2021	2024	6
15.	Romania	SAM M903 Patriot PAC-3 MSE	28	2017	2020	2026	9
16.	Slovakia	IFV CV9035	152	2022	2025	2028	6

#	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
1.															
2.															
3.															
4.															
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11.														
12.														
13.														
14.														
15.														
16.														

Order date   From first delivery to contract Completion

Source: own, data from database Military Balance+ (2024)

Conclusions. Examination of acquisition timelines in the B9 countries shows common trends, particularly in terms of extended lead times for advanced military systems. Delays in defence acquisitions occur at two distinct times: the decision-making phase within governments and the contract execution phase until delivery of the ordered military equipment. These delays, which in some cases last several years, underline the complex nature of the defence procurement process. The research conducted in this paper highlights the time delays that occur in defence investment, both through specific examples and through statistical analysis of aggregate data. One of the key factors contributing to these delays is the way in which the defence industry operates, with some manufacturers maintaining a peaceful approach to the supply chain, which limits their ability to produce quickly or increase production volumes. In the context of Russia's invasion of Ukraine, the demand for military equipment in all categories has increased manifold, with some firms responding by switching to "war" production, with the French firm Nexter, for example, increasing production of its 155mm howitzer to 8 systems per month (it was producing 2 systems per month in 2022); on the other hand, the US manufacturer Lockheed Martin, the main supplier and manufacturer of the fifth-generation F-35 fighter jet, is failing to deliver the aircraft ordered as ordered and is extending lead times. The paper highlights the issue of the time lag between investment decisions and the spending of funds on new military investments and the subsequent manifestation of these investments in defence capabilities.

Limitations. The paper focuses only on B9 countries (eastern flank NATO) and draws acquisition data from the non-public database Military Balance +.

Keywords: *acquisitions; military investments; delays; military equipment; defense capability.*

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Approaches to the Population Sheltering in Selected Countries in Relation to Threats and the Security Environment

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Introduction. The global aspect of security is becoming increasingly profound. Significant changes can be seen in the international security environment, which is undergoing an extensive process of transformation, aimed at regaining the influence of powerful states. Parallel to this change, non-military disasters at the local level are gaining momentum and the vulnerability of populations to them is increasing.

One of the tasks that should minimize the loss of civilian life, and which follows from Art. 61 of Protocol Additional to the Geneva Conventions (Protocol I) [1], is the management of shelters. The building of protective infrastructure to shelter the population took place mainly in European states during the Cold War. However, the changed security situation after the end of the Cold War often led to a rethinking of the field of civil protection and a focus on a different threat structure (e.g. floods, terrorism, biological threats). The issue of sheltering has been neglected in many states as fears of direct military threats to states have receded, while at the same time the potential use of shelter in relation to other threats has not been explored [2]. However, as a result of the evolving geopolitical situation in the world, there is a call to re-examine the options for approaching sheltering [3].

The present article therefore aimed to analyse the approaches of selected states to the issue of sheltering and conduct a comparative study of them.

Method of investigation. The article focused on the analysis of approaches to population sheltering in the Czech Republic, Poland, Austria, Germany and the United States in the context of current security threats. The article defined the basic methods of sheltering, types of shelters for the realization of population protection with regard to the current legislation, their current technical condition, protective properties, shelter capacity and the structure of threats for which sheltering is used.

Based on the methods of comparison and multi-criteria analysis, approaches to sheltering within the selected countries were assessed. A quantitative pairwise comparison method, the Saaty method [4], was used to determine the weights of the criteria. The weighted sum method was used for multi-criteria analysis [5].

Investigation Results. Variants of sheltering approaches within countries were subjected to comparison and multi-criteria analysis. In line with the focus of the article, the criteria focused

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on the shelter capacity, the realistic usability of shelters, the level of current initiative and innovation in sheltering, the range of threats to which sheltering is implemented, information support for sheltering, and the sustainability of the current sheltering approach. The output of the multi-criteria analysis is a ranking of variant approaches to sheltering, compiled on the basis of the criteria developed, which is complemented by a verbal comparison of the approaches to support interpretation and contextualization of the results.

Conclusions. In examining the issue of approaches to population sheltering within different countries, the above methods were used to compare these approaches based on established criteria. The criteria focused on assessing the current state of sheltering in the selected countries in relation to current threats, as well as initiatives to develop and sustain the use of sheltering in the future, in the context of population protection. The comparison found that the European countries assessed share many common features in terms of the development and current state of sheltering, but Poland in particular stands out in its initiative to develop sheltering for the future. The United States then offers a different approach and uses sheltering in relation to a broader range of threats than is usual in the studied European states. The results of the comparison can be used as a basis for developing and improving the state of sheltering in the studied countries, and possibly in other countries as well. With the help of the research results, further research can identify the strengths, weaknesses, opportunities and threats of each national approach to sheltering and determine the direction of sheltering development in a given country, using findings from other studied countries.

Limitations. The limits can be seen in the subjective evaluation of the multi-criteria analysis by the authors. The results of the performed analysis may also be distorted due to a possible lack of relevant information, as some information related to the sheltering may be classified. Shelter capacities may also differ if some shelters have recently been removed from the register or, conversely, re-registered. Another limitation is the limited number of countries included in the comparison.

Keywords: *population sheltering; threats; security environment; comparison; multi-criteria analysis.*

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Codes of Ethics and Their Place in the New Security Environment as an Important Part of Human Resource Management

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Introduction. Ethics is an important part of human resource management for any employer organisation that wants to succeed in the 21st century labour market [1]. Ethics in an employer reveals two levels. Firstly, it is the attitude and behaviour towards people according to the norms of labour law but also decency and responsibility. Larger and multinational employers are aware of this fact and they seek to include in their policies the realization that: the strategic goals of the organization should include the rights and needs of employees, employees have the right to be treated as human beings, employees will be preserved their natural rights and will be treated fairly, honestly and respectfully [2]. Secondly, it is an approach more related to the profession the employee is in. In this second approach, it also takes into account the competencies of the profession especially the soft ones.

By claiming to be a profession, the military claims a special moral justification to carry out acts of extreme violence and destruction. Unlike most professionals, military personnel are allowed to kill, destroy the infrastructure of enemy states, and endanger the lives of military personnel under their command. If this is a profession, then the military deserves greater moral scrutiny through a code of ethics, and military personnel can be expected to meet high moral standards. The status of professional brings with it special moral authority, but it also imposes moral constraints: professionals must guide their actions by the regulatory ideal of their profession and must respect important broad-based moral norms. Professionals' special moral authority to violate ordinary moral norms or to weigh moral values differently within the profession is justified only if the profession genuinely serves an important human need, and only if such special authority is necessary to satisfy that need. Given that the military claims special moral authority of a very serious nature, we certainly want it to be a profession that is governed by high professional standards and professional responsibility. Without such a status, a code of ethics, the Army would be no better than a mercenary army.

Method of investigation. The analysis was based on questionnaires. A written questionnaire was sent to 100 respondents of the military studies of the Defence University, in each 1st to 5th year, that was 20 respondents. From the year group, the questionnaire was sent to every fifth military professional. The typical survey participant was an officer-in-waiting, a student between the ages of 20 and 25. In this paper, we are concerned with defining the code of ethics of the military professional and finding differences between beginning students and students in their final year of study in assessing the values of the military professional.

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This research can also be classified as a mixed research because it includes quantitative research that analyses phenomena using variables, and at the same time interprets qualitative research of respondents' opinions about the relationship between ethics and behaviour of a military professional. The questionnaire contained closed-ended questions. The return rate of the questionnaire was 100%.

In addition, the opinion of military professionals from practice in selected NATO countries on the place of the code of ethics in the activities of the armed forces was surveyed. The return rate of the questionnaires was 100%.

Research question 1: Is it appropriate to examine the code of ethics of a military professional in the Czech Republic in relation to the new security environment?

Research question 2: Is the current code of ethics for military professionals in the Czech Republic sufficient?

Hypothesis 1: In the military education system, the importance of moral values tends to increase.

Investigation Results. The result of the research shows that the respondents' evaluation of the moral values of a military professional by the students of the University of Defence from the 1st to the 5th year has an increasing tendency [17]. 86 out of 100 respondents desire their own code of ethics. The research using guided interviews showed that 65 respondents believe that this code meets their goal. Only 8 respondents do not reflect it. A positive finding is that military professionals recommend not to adopt only a branch, related ready-made code of ethics, but the Army of the Czech Republic should try to take into account the specifics and specific types of troops. When asked whether a code of ethics is "mandatory" for you, 64 respondents answered "yes", 9 respondents answered "no". Respondents were dissatisfied that the values of the Code of Ethics do not reflect military specialization. Only 86 respondents called for legitimizing the code of ethics. On the other hand, only 8 respondents expressed negative views. The result gives us an answer to the question of whether there is any benefit to legitimizing the code of ethics. The majority of military professionals consider legalization necessary. Respondents state that if a code of ethics is adopted, it is more appropriate in judging the actions of military professionals and themselves in security and military situations, in fact, as some respondents' state, it is an anchor of behaviour. A code would eliminate the manifestation of excesses in combat situations and remove responsibility for the actions of the individual. 75 respondents said that a code of ethics would lead to greater loyalty in the performance of duties and measurable behaviour. Only 10 responses stated that a code of ethics is only advisory and yet should be respected. The results show that respondents view a code of ethics as something that largely promotes the quality of military professionals, brings units together, and helps fulfil subordination. In only 13 cases did respondents indicate that a possible adopted code of ethics would have shortcomings. These deficiencies can be summarized as follows: the code of ethics does not represent and respect military specialization, does not fully address the relationship to commanders, peers, or the public.

Respondents' attitudes towards codes of ethics are very interesting. 82 respondents were closest to saying that they considered codes of ethics very important. Although a significant

number of respondents appreciate that they exist, they do not concern themselves with them as much; 23 respondents indicated this possibility. Respondents who are not very interested in codes of ethics were 8 and 7 respondents also indicated that they are unnecessary. The results show that codes of ethics do have their place, as two thirds of the respondents said that codes have some influence on them. Figure 1 shows the perceived ethical values of Defence University military students towards the military profession.
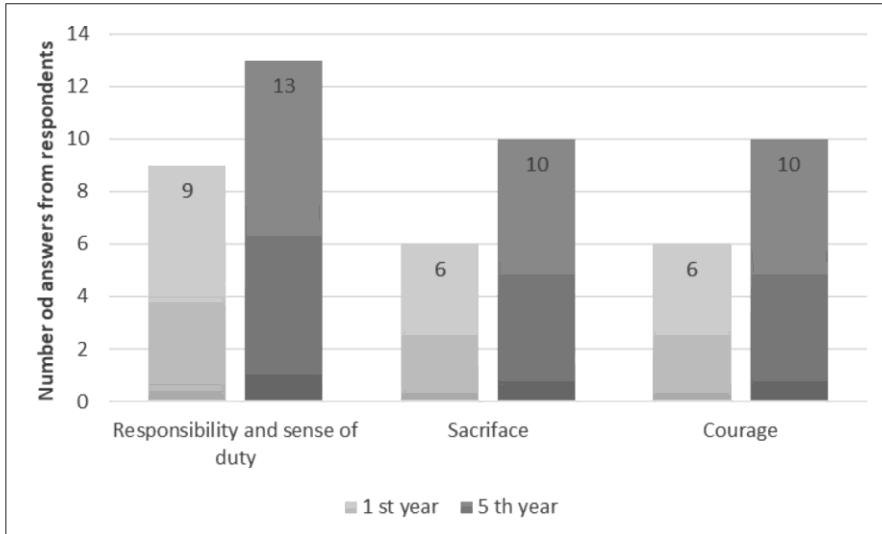
Fig 1. Perceived ethical values of military students of the University of Defence towards the military profession

Conclusions. Answer to research question 1: Is it appropriate to examine the code of ethics of a military professional in the Czech Republic in relation to the new security environment?

Yes, it can be stated that the existence of a code of ethics is of unprecedented importance in the new security environment. A code of ethics is lacking for military professionals who have to make decisions independently without interaction with the commander and the parent unit.

Answer to research question 2: Is the current code of ethics for military professionals in the Czech Republic sufficient?

Partially sufficient, codes of ethics should be part of the internal directive or organisational regulations of the Army of the Czech Republic. 86 respondents confirmed that the current code of ethics does not respect the differences and specifics of military specialties. The Code of Ethics should be specified according to the specific specialisation. The influence of the military environment, the system of military education is manifested in the fact that the importance of moral values for a military professional has an increasing tendency.

The behaviour of military professionals is governed by certain rules. Some assignments or guidelines may take the form of recommendations that are traditionally followed. Some need to be signed and affirmed. However, the legitimisation of a code of ethics does not enhance quality. On the contrary, the creation of a code of ethics specific to the troop types would

influence the behaviour of military professionals. This fact was also observed in this research. It seems appropriate to maintain the basic points of the code of ethics, which should be fulfilled according to the specification, professional focus and other aspects of the specific type of troops.

Answer to Hypothesis 1: The importance of moral values is increasing in the military education system.

The stated hypothesis was confirmed by the questionnaire investigation. The values listed in the Code of Ethics of the Professional of the Army of the Czech Republic have the highest rating among students of the last year of study. This confirms the importance of military education in the preparation of a military professional. Similarly, military professionals in the practice of the selected NATO countries perceive the same ethical values as courage and sacrifice.

Limitation. The research was conducted with military students at the Defense University between 2021 - 2022. In military professionals in practice in selected NATO countries in the years 2022 – 2023.

Keywords: *code of ethics; military professional; human resource management.*

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The Importance of Re-reading Solzhenitsyn and his "Gulag Archipelago"

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Introduction. The current geopolitical situation is of unprecedented concern because of Russian armed aggression, particularly against Ukraine. One of the current challenges arising from this situation is a deep, comprehensive, and systemic examination of the causes of the Russian aggression in question. From the existing research on this issue, we (the team of authors) see the need to further investigate the value and axiological context of the Russian mentality, the Russian world of values. Its foundations and firmly established characteristics imply the traditional and significant inclination of most of the Russian population towards violence and expansive behavior of the Russian state with mass public support. In addition to the many older and more recent sources suitable for research on this topic, Alexander Solzhenitsyn's epochal, world-famous trilogy The Gulag Archipelago, as well as his other works devoted to criticism of Soviet and Russian conditions in the modern era, can be considered the richest source. Solzhenitsyn, himself a prisoner in the notorious Soviet concentration camps, is a most compelling writer and provides us with an inexhaustible source of empirical evidence necessary for the research into Russian state violence. The purpose of this research is, first and foremost, to adequately understand Russian value realities, i.e. the prevailing inclinations, preferences, priorities or visions of ideologues and political leaders. We also want to show that they think differently in Russia than we are to use. Russia and its leaders and the majority of the population use a diametrically different "logic" and style of thinking. This fact has consequences that we can observe "live" from Ukraine daily. As recently as 23 February 2022, many people could imagine that the President of the Russian Federation would commit such an "insane act" as invading a neighboring country. After all, it had no logic, was not rational or in any way reasonable. In the morning of 24 February 2022, many of us were very surprised. So, the challenge today is not to be so surprised.

Method of investigation. The basic research method was axiological analysis of the text of Solzhenitsyn's epochal work "The Gulag Archipelago". Another method of research was the comparison of the text with other texts and sources of actual empirical facts related to the value aspect of the Russian aggression currently directed against Ukraine. The main sources of empirical material are, on the one hand, publications that somehow talk about the Russian world of values in context and, on the other hand, a number of reports, analyses or statements by Russian actors related to current Russian policy. The initial hypothesis was that the quoted works of Solzhenitsyn contain a great deal of evidence of a chronic tendency towards aggression and violence on the part of both the Russian state and most of its population. This argumentative material then allows us to further explore the axiological nature of

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contemporary Russian war aggression. The synthesis of the empirical and informational base thus accumulated has allowed us to formulate theoretical conclusions that clarify the fact that Russian state aggression and expansionism are deeply embedded in the Russian value system. This research also makes it possible to predict highly probable scenarios of further Russian aggression if the Russian troops operating in Ukraine are not pushed out of its territory beyond the original Ukrainian borders.

Investigation Results. We divide the results of the survey into several parts. The first part provides a historicizing context of the topic. The idea is to place the cruelty of the Stalinist regime and its repressive instruments in the context of the traditional and long-standing manifestations of violence by both the holders of power in the Russian state and the manifestations of violence widely practiced in all strata of Russian society. The next section is devoted to a particular extract of the characteristic phenomena of the state repressive system described by Solzhenitsyn, which have distinctive value aspects. It is about pointing out the axiological specifics of Russian mentality reflected in the practices and customs of exercising power and controlling public space. The last part is aimed at exploring the actualization of the reality described by Solzhenitsyn into the contemporary mode of governance in the Russian Federation. Emphasis is placed on the axiology of Putinism and its expansionist, imperial geopolitical goals. It concludes with a synthesis of the essential and general specific features of Russia's violent value world, for which military aggression into a neighbouring country is also a way of solving the internal power problems of the current state leaders. The conclusion also includes a prediction of the likely behaviour of the Russian state if it manages to achieve victory in the invasion of Ukraine and preserve Putinism for the period ahead. The authors of the article predict that the propensity for violence, aggression and expansionism in Russian society will not disappear even in the event of military failure in the Ukrainian war and even after V.V. Putin leaves the top position of power. Solzhenitsyn's The Gulag Archipelago and the other research sources used to provide ample argumentation for the claim that neither Stalin's nor Putin's violent and repressive actions are linked only to their persons and specific characteristics but correspond to Russia's deeply historically embedded value world.

Conclusions. It was a big mistake to view Russia's geopolitical behavior through the prism of Western thinking and assessment of the development of international relations and the threats arising from them. The Russian expansionism currently manifested towards Ukraine is in no way accidental or conditioned only by Putin's personality. It is deeply rooted in Russian society and in the mentality of the majority of the population. This aggressive expansionism is organically linked to the violent nature of the Russian value world and has deep historical roots. Since this phenomenon was prominent during the Stalinist period, which is being celebrated again in contemporary Russia, it offers an opportunity to explore it through the testimony written by Alexander Solzhenitsyn, particularly in The Gulag Archipelago. However, this work should be studied in the context of other sources of knowledge and information about the Russian value world, which is organically inclined towards the violent enforcement of obedience through fear and a very creatively constructed and operated repressive apparatus. An important conclusion of our research is the finding that the Russian value world is diametrically opposed to the Western value world, that the typical Russian mentality has historically developed in a significantly different way from the development of European societies, that Russians simply have a different logic and system of evaluating reality. The Russian fascination with violence and the tendency to succumb to the exercise of power by the 'strong hand' has a deep historical tradition. Similarly, the age-old desire of

Russians to belong to a powerful and feared empire. Re-reading "The Gulag Archipelago" very effectively helps both to understand the facts well and to provide an inexhaustible source of material that is highly persuasive and well illustrative of the research in question.

Keywords: *Ukraine, Russian aggression, axiology, Russian mentality*

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Citizens' Will to Resist: Attitudes of the Lithuanian Population

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Introduction. The current geopolitical situation encourages a rethinking of the concept and importance of civil resistance, emphasizing society's contribution and responsibility for the security and existence of their country in the context of current events. On the one hand, timely attention to the motivation of citizens to resist possible external aggression is already bearing results. On the other hand, it can be noted that more attention needs to be paid to developing citizens' competencies - when, where, what, and how to make the resistance bring the desired result [1].

Method of investigation. The study aims to investigate the attitudes of Lithuanian citizens towards defence in case of foreign aggression. A quantitative research method was chosen to determine the possibilities of Lithuanian society's civil resistance in case of foreign aggression. The quantitative research method was an online questionnaire survey. Mathematical statistics methods were used to analyze the empirical data. The calculations showed that 384 respondents were needed to make the survey representative. The sample consisted of 440 respondents aged between 15 and 85, divided into three age groups: young people aged 15-24, working-age people aged 25-49, and people aged 50 and over. The survey instrument was an electronic questionnaire based on the questionnaire of a sociological study conducted in 2017 (Ranonytė et al., 2018), with the authors' permission. The electronic questionnaire consisted of three blocks of questions: questions aimed at finding out how the population perceives threats to the state, the actions of the population and civil resistance in case of aggression, and the preparation for civil opposition. The empirical survey was conducted in January 2024.

Theoretical approach. In both international and national contexts, civil resistance is most often analyzed from a historical perspective, as states, including small ones, have many memorable examples of civil resistance in their history [1, 2, 6, 11]. The ideas put forward by the classics of civil resistance theory, Mahatma Gandhi and Gene Sharp (1973), are constantly being revisited in the current context [3, 5, 9]. The most frequently presented insights of scholars focus on nonviolent resistance.

Investigation Results. The data analysis shows that half of the respondents rate the likelihood of aggression as probable or very probable. 95% of respondents identified Russia as the likely aggressor. The survey results show that the respondents believe that society can organize civil resistance and effectively resist it by force of arms and peaceful means. 81% of respondents expressed the opinion that society should resist with arms in any case, while a minority of 9.8%

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expressed the opposite view. Analyzing the population's actions in the event of aggression has shown different societal attitudes. The respondents' answers fall into three main groups - they would resist in armed and unarmed ways, contribute to the resistance to the extent possible by providing material and non-material support, and not participate. Around 15% of respondents do not know what they would do in case of war. Equally important is that about 17% of the survey participants would choose to leave Lithuania, especially among respondents aged 15-24. The analysis of the respondents' attitudes towards the preparation for civil resistance showed that most of the respondents supported integrating military training into the curricula. At the same time, the analysis of the results shows that military service should be compulsory for young men immediately after school.

Conclusions. The study results lead to the following conclusions: 1. Civil resistance is understood by the population not only as armed and unarmed resistance but also as moral and values-based education. 2. The survey results suggest that more than half of the active population of the same age are determined to participate in civil resistance in various forms in case of aggression. 3. The analysis of the research results indicates that a part of the society lacks information and moral and physical preparation on the issues of resistance.

Keywords: *will to resist; civil resistance; opinion of Lithuanian residents.*

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Cross-Cultural Comparisons for the Analysis of Disinformation in a Geopolitical Context

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Introduction. Cross-cultural comparisons are a valuable tool for analysing disinformation in a geopolitical context due to the increasing interconnectedness of the world and the spread of information across different cultures and societies. By examining how disinformation campaigns manifest and are perceived in different cultural contexts, researchers can gain insights into the underlying motives, tactics and effects of such campaigns.

Disinformation has become a systemic challenge to society due to a combination of disruptive technological, political and sociological transformations of social spheres in a very short period. In addition, the geopolitical zeitgeist, which focuses on the vulnerability of democracies to structural changes in the security order and the risks of global interdependence, reinforces the tipping point effect.

Method of investigation. In terms of research methods, we conduct comparative studies across different regions or countries to identify common patterns or differences in the dissemination and reception of disinformation. This involves analysing media coverage, social media trends, public opinion surveys and other sources of information to understand how disinformation spreads and influences public discourse in different cultural settings.

Investigation Results. Research outcomes include the identification of cross-cultural trends in disinformation tactics, the development of counter-disinformation strategies tailored to specific cultural contexts, and a deeper understanding of how disinformation campaigns shape perceptions and behaviour in different parts of the world. Finally, cross-cultural comparisons provide valuable insights for policymakers, researchers and practitioners seeking to address the challenges posed by disinformation in a globalised world.

Conclusions. To use the method of cross-cultural comparisons to analyse disinformation in a geopolitical context, we follow these steps: (1) We examine how different cultures perceive and respond to disinformation campaigns targeting their respective countries; (2) We compare countries with different geopolitical contexts and experiences of disinformation; (3) We compare the United States and Russia.

We analyse relevant data from the United States and Russia, such as news articles, social media posts, official statements, and public opinion polls. The data provides insights into each culture's prevalence, impact and responses to disinformation.

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Ensuring National Stability and Resilience for the Safe Functioning of the Region (Zaporizhzhia, Dnipro, Kharkiv, Sumy - the Front Line in the East of Ukraine)

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Introduction. The full-scale russian invasion since February 24, 2022, has brought numerous losses and damages to Ukraine, therefore, raising the issue of national stability and resilience of the country. Given that Zaporizhzhia, Dnipro, Kharkiv, and Sumy form the front line in the East. That is why we should focuse on analyzing the specified regions' stability and resilience over energetic, social, ecological, and economic elements. Due to rocket shelling and air strikes, Zaporizhzhia, Dnipro, Kharkiv, and Sumy regions had human and civil infrastructure losses for billions of dollars. All armed hostilities affected the environmental sector. In this regard, ensuring stability and resilience should be oriented to the long and short term with properly developed mechanisms.

National stability is a structural prerequisite for developing the institutional structure of public administration, its modernization, and its transition to a new level based on national interests and influence. The main aspect of stability is the presence of a certain potential barrier, the overcoming of which, as a result of external disturbances, would mean the transition of the military-strategic super system of states to a new qualitative state - from interaction characteristic of peacetime to interaction determined by a fundamentally different logic leading to war with the use of weapons. At the same time, national stability correlates with national resilience.

Stability and resilience are always specific, and therefore public authorities are obliged to determine their degree and the subsequent actions to neutralize particular threats on an ongoing basis, taking into account the entire set of conditions and factors of the political, economic, social, and environmental process that can cause damage to the country's national interests. The system for ensuring the East region's stability in the frontline should be built based on strategic management of the elements of the regional security and stability system.

Conclusions. To sum it all up, stability and resilience are context-dependent concepts, meaning that their characteristics and requirements vary depending on the specific circumstances of a given region or nation.

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Consequently, public authorities bear the responsibility of assessing the degree of stability and resilience within their jurisdiction and devising appropriate strategies to counteract potential threats. This ongoing assessment process necessitates a comprehensive evaluation of the myriad conditions and factors encompassing the political, economic, social, and environmental spheres, all of which have the potential to undermine the nation's interests.

In the case of regions situated on the frontline, such as the East region in the context of the Ukrainian conflict, ensuring stability becomes particularly crucial. To achieve this, it is essential to construct a robust system grounded in strategic management principles. This involves carefully orchestrating the various elements comprising the regional security and stability framework to effectively mitigate risks and safeguard against potential threats. By adopting a strategic approach to managing these elements, public authorities can enhance the resilience of the region and promote long-term stability in the face of evolving challenges and geopolitical dynamics.

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Analysis of the Possibilities of Developing the Resilience of Employees and Members of the Integrated Rescue System in the Czech Republic as Part of Lifelong Education

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Introduction. Mental stability, resilience and the ability to grow post-traumatically in the wake of experienced emergencies and crisis situations form an integral part of the competences of members and employees of individual components of the Integrated Rescue System. At present, knowledge from psychology and psychotraumatology is used in undergraduate education to provide theoretical knowledge and practical skills in the use of coping strategies and prevention of traumatisation (including the possible development of psychopathology). The results of research in this area indicate a high prevalence of people with disorders following a traumatic experience, both on the part of victims of emergencies or crises and on the part of intervening professionals. The subject of the research investigation was the analysis of the possibilities of development of psychological resilience of employees and individual components of the Integrated Rescue System in the Czech Republic within the framework of lifelong learning. Attention was paid to the possibilities of resilience development, post-traumatic growth, prevention of rumination and traumatization. These psychological processes are closely related to the performance of the profession of these professionals, the experience of traumatic events. They also have an impact on the quality of providing first psychological aid and post-traumatic care to victims of emergencies and crisis situations. An integral part of the research investigation was the analysis of the frequency of use of post-traumatic care.

Method of investigation. Research methods: A) quantitative research method: non-standardized anonymous questionnaire. The criterion for selecting respondents was service or employment with the basic units of the IZS. B) literature search - domestic and foreign professional literature C) statistical analysis of the obtained data D) comparison E) analysis of annual reports - in order to statistically evaluate the frequency of providing post-traumatic care, crisis intervention and psychosocial intervention care over the last 10 years. A total of 819 members and employees of the integrated rescue system filled out an anonymous, non-standardized questionnaire that investigated the impact of traumatic events, deliberate rumination, and possibilities for developing resilience, post-traumatic growth and self-efficacy. Part of the research investigation was also an analysis of competencies to provide

psychological first aid, crisis communication and post-traumatic care. The criteria for the selection of the respondents were the performance of the profession in the basic components of the integrated rescue system and active participation in solving extraordinary events and crisis situations.

Investigation Results. The following can be considered as key findings: A) the frequency of respondents' encounters with an emergency event or crisis situation that they evaluate as traumatic is several times a month; B) despite the impact of traumatic events on their psychological state, respondents do not use the offered post-traumatic care or crisis intervention at the relevant IZS unit; C) the reasons, (C) the reasons why the respondents do not use the offered post-traumatic care or crisis intervention at the relevant branch of the IRS are their distrust of anonymity as well as the fear that the use of this professional help could be used to their disadvantage; D) the positive finding is that, that the respondents try to use coping strategies and strengthen resilience within the framework of self-regulation mechanisms in order to prevent the negative consequences of the traumatic event; E) the respondents (according to their subjective evaluation) have sufficient theoretical knowledge and practical skills in relation to the provision of first psychological aid at the place of intervention to the affected persons; F) on the basis of the analysis of the final reports it can be concluded, the frequency of post-traumatic care, crisis intervention and psychosocial assistance provided by intervention professionals to victims of emergencies and crisis situations is increasing.

Conclusions. The results show that the respondents are aware of their own experiences of traumatization with regard to dealing with extraordinary events and crisis situations in the performance of their profession. A positive finding is their effort to develop psychological resilience, the use of post-traumatic care, as well as their interest in education in the field of managing over-the-limit stress and the possibilities of post-traumatic development. The results of the research investigation, especially the findings of which experienced traumatic events have the greatest negative impact on the psychological state of the respondents, can contribute to a more comprehensive understanding of the mechanisms that influence post-traumatic growth and the development of competencies in the field of providing post- traumatic care. The results of the research investigation can also serve as a stimulus for the preparation of seminars in the framework of lifelong education.

Limitations. Based on the long-term experience in the field of the educational process within the framework of undergraduate education (including the provision of post-traumatic care) of intervening professionals, it can be stated that the limiting factor is the low level of willingness of respondents to participate in a research investigation dealing with the issue of psychological stability, resilience and the ability to grow post-traumatically in follow-up to experienced extraordinary events and crisis situations. Also, the persistent mistrust of the post-traumatic care offered by the intervening professionals. Therefore, in our opinion, it is important to pay attention to the possibility of implementing other knowledge into undergraduate and lifelong education.

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Evaluation of Modern Approaches to Crisis Management

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Introduction. Crisis phenomena have a negative impact on the natural development of human society. The issues of preventing their occurrence and, consequently, their solution are becoming more and more topical. Emergencies, with an emphasis on natural disasters, have a specific position in the crisis management system. They can affect large populations and have a negative impact over a wide area. Their consequences mostly negatively affect not only people and the environment, but also material and cultural assets located in the affected area. In the event of large-scale natural disasters, the functionality and stability of the overall economy of the country may be threatened and disrupted.

Decision making is an important function of crisis management and we can refer to multi-criteria decision making and its importance increases during the resolution of crisis phenomena. It is a complex and demanding process that influences the nature of the crisis phenomenon itself. Crisis managers and the various public authorities and institutions involved in dealing with natural disasters are under pressure from the media and the public, who demand a rapid and effective response to emergencies and the minimisation of damage and loss. The roles of public administrations, with an emphasis on local government, in dealing with emergencies are extensive and complex. The term crisis management was first used and practically applied in 1962 during the Cuban crisis. US President John Fitzgerald Kennedy assembled a group of experts from various fields whose task was to prevent the outbreak of World War III and to find a peaceful solution to the international crisis during the Cold War.

Method of investigation. Various quantitative and qualitative methods and tools were used to achieve the objective of the study, which is to evaluate modern approaches to crisis management and to make recommendations for the development of the crisis management system within government agencies. A comparative analysis was used to compare the different approaches (models) of crisis management, following the principles that the model should reflect the characteristics of the modelled reality that are important in terms of the objectives pursued. The comparative analysis was applied using the rules, relationships and regularities that apply in complex management models.

Investigation Results. The crisis management system respects the specificities of the principles as well as the legal environment and historical experience of the countries in which

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it was developed. An integral part of the crisis management system is its executive branches, whose members must be able to deal with even the most complex crisis phenomena. The various bodies and institutions of the executive branches of the crisis management system may include:

● professional staff (members of rescue units and specialised organisations, members of the armed forces used to deal with the aftermath of a crisis and members of legal entities, whose activities and professional focus are the same as those of the staff of the relevant crisis management organisations),

● non-professional staff (voluntary employees and employees who have been subject to a labour obligation under a special law).

In the event of a crisis, the crisis management executive must be able to intervene immediately at a specific location with the necessary human and technical capacity and appropriate technology. It is essential that all crisis management actors have clearly defined competences to be able to intervene in any environment.

There are several models and concepts of crisis management in the world, which were compared in the study and a Crisis Management Models Assessment Table was developed (Fig. 1).

Criteria	Model „Baubion"	Model „Marinov"	Model „Jaques"	Model „Hamani"	Model „Šimák – basic"	Model „Šimák – complex"	Model „Ristvej"
No. of steps	2	6	4	5	4	7	4
Users	OECD	NATO	Crisis management bodies in the public administration	Less developed parts of the world	Crisis management bodies in the public administration	Crisis management bodies in the public administration	Crisis management bodies in the public administration
Subsidiarity	NO	NO	YES	YES	YES	YES	YES
Algorithm structure	Linear	Linear	Non-linear	Non-linear	Non-linear	Non-linear	Non-linear
Applicability for crisis phenomenon	YES	YES	NO	YES	YES	YES	YES
Limitations	Legal	Subordination of military forces	The paradox of vulnerability	Acquisition of input data	Failure to accept the wider context	Loss of flexibility	Overlapping of activities in the model phases
WHO crisis phenomenon classification	Natural-climatic, economic, military conflicts	Natural-climatic military conflicts	Natural-climatic	Natural-climatic, anthropogenic	Natural-climatic, anthropogenic	Natural-climatic, anthropogenic	Natural-climatic, anthropogenic

Fig. 1 Crisis Management Models Assessment Table

Conclusions. The effectiveness and efficiency of emergency responders in the response phase of crisis phenomena is contingent on the existence of capable responders in individual countries, while the very applicability of crisis management concepts and models is also valid. The capacities necessary to deal with crisis phenomena must be trained and prepared in the prevention and crisis planning phase. Their deployment and the coordination of their activities are part of the response phase, with the emphasis on effective and efficient handling of crisis phenomena.

The assessment of selected concepts and models of crisis management can be considered as contributions of the study. Through analysis and comparison, theoretical bases for increasing the effectiveness of crisis management processes were identified, with emphasis on activities in the phase of response to crisis phenomena at the level of local government.

Limitations. However, there is a need for further research, such as:

● Optimisation of the organisation and decision-making processes at the local government level. Emphasis should also be placed on creating the most effective environment for the cooperation of all those involved in the crisis management process.

Keywords: *crisis management; crisis; models; comparative analysis; rescue services.*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Intensity Model and Traffic Quality Assessment of the Selected Section of the D1 Highway

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Introduction. The mobility of security forces within the European Union faces obstacles that prevent the movement of personnel and military equipment. The current transport network of the European Union is a modern transport network that serves the needs of Europeans as well as military needs. The Czech Republic, as the host state, its armed forces, as well as other departments of the Czech Republic's government, have full responsibility to support the activities of NATO forces and to jointly provide adequate support to the allied armed forces in the event that such support is requested.

When processing research on the analysis of traffic intensity in the area of interest, we used sensor data on the section of the D1 highway for the period 2016 -2020 and created trend and seasonal models of traffic intensity, taking into account the possibility of carrying out transport tasks on the brigade bridge and above for the section where abandonment occurs highway and crossing with Staging area.

The practical part of the work was the processing of data from traffic detectors on the Pávov (I/38) - Velká Bíteš (I/37) and the creation of daily variations in traffic intensity. Traffic census data for the years 2016 and 2020 were processed.

The reason for the measurement on this section was the fact that it is a section of the highway where transiting units will go down to the side road to rest overnight.

Method of investigation. The process of processing traffic data was divided into several steps. We obtained the data from the Directorate of Roads and Motorways of the Czech Republic. Data is obtained through microwave radar, passive infrared detectors and ultrasonic detectors. The basic data database provides information about the date and time of recording, the number of seconds of data reading, lane detection, vehicle intensity per minute, and vehicle category.

Another factor is the average profile (point) speed for each measured minute. The average speed represents the speed of all vehicles measured in one profile (point) of traffic by category. The mean profile velocity can be calculated according to the relation:

$$v = \frac{1}{n} \sum_{k=0}^{n} n_{i-1} - v_i \qquad (1)$$

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Furthermore, we pre-processed the data with the aim of removing errors in the data and editing them so that they could be used directly for input into other algorithms.

An important task is to filter the data to remove the random component (noise). The filter will allow the removal of the irrelevant component while causing minimal damage to the relevant signal. The ideal goal of this method is to fit a horizontal line through the measured data.

Investigation Results. Trend and seasonal models of traffic intensity make it possible to determine the long-term trend of the development of the average 24-hour intensity of individual days of the week in selected periods for all traffic lanes, and it is therefore possible to predict the development of traffic intensity and the number of vehicles from a long-term perspective and the resulting organizational measures from the level of the Ministry of Transport, the Ministry the Ministry of the Interior and the Ministry of Defense for managing the movement of military convoys.

Another evaluated area is the evaluation of the quality of transport, which analyzes the relationships "speed - density", "intensity - density", "speed - intensity".

Conclusions. Seasonal models showed how the values of average daily intensities of individual months developed in the monitored period. We found changes in the intensity of traffic, changes in average speeds and changes in the number of vehicles during the seasons of the year.

Limitations. The work is limited in the area of assessment of the load-bearing capacity of the bridge, where the load capacities V_n, V_r and V_e of the load-bearing structure and pillars of the steel road bridge are evaluated.

From the point of view of military equipment, especially when transporting the American tanks M1 Abrams, version M1A2, which weighs 63.1 t and has a significant impact on the variable load, which is weighed from the load models for normal, exclusive and exceptional load capacity according to Czech state standard 73 6222, further from two sets of tractors for transporting excessive loads (Tatra 813 sets and chassis).

During transport, a uniform load of $vn = 1 \, kN/m^2$ is chosen, when the load on the rear twin axle $V_{aw,1} = 2 \times 50 \, kN$ (one wheel 25 kN) and a surface load of 2.5 kN/m^2 occurs.

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Drone Swarming and its Use in Minefield Laying Using Mathematical Methods

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Introduction. Significant technological advances in autonomous vehicles and drones are changing the dynamics of modern conflicts. The war in Ukraine has provided evidence of how this technology can change the course of combat. Even well-equipped militaries, such as the Russian Federation, face challenges posed by the deployment of autonomous unmanned vehicles. Their ability to carry out long-range attacks with minimal risk to their own forces gives a new dimension to military operations.

One of the key areas of use of unmanned vehicles is kamikaze drones, which are becoming an effective tool in the fight against the enemy's heavy armoured vehicles. Their ability to penetrate defensive lines and destroy targets with a precision and efficiency that cannot be achieved by traditional means makes them a threat that is difficult to stop. Another innovative application is drones capable of dropping light explosive munitions on enemy positions, allowing them to effectively destroy hidden targets such as soldiers in trenches.

However, drones are not just a tool of attack. They are also used to scout and track enemy movement and targets. Their ability to quickly and efficiently gather battlefield information allows command staffs to better navigate and make strategic decisions in real time. In the area of mine warfare, autonomous assets are revolutionizing the field. Minefields built with unmanned assets enable faster and more flexible deployments. Analytical models and mathematical methods can be used to optimize mine placement and maximize the effectiveness of minefields, increasing the ability to resist enemy advances and defend strategic positions.

While technological advances bring new possibilities for warfare, it is important to recognize their ethical and humanitarian implications. Care must be taken to protect civilians and minimize unwanted collateral damage. The use of autonomous means should be subject to firm ethical principles and legal frameworks in order to minimize the risk of uncontrolled attacks and negligence in military operations.

Method of investigation. The paper presents a detailed analysis and synthesis of the possibilities of using drone swarms in military operations, with a primary focus on their deployment in minefields. This approach combines a thorough examination of available information and current trends in military technology, allowing the author to develop a comprehensive theoretical framework for the topic. One of the main elements of this work is the innovative approach to the use of drones, where they are equipped with the ability to carry mines and launchers that are attached directly to their bodies.

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This analysis allows the synthesis of a new concept in which drones are not mere reconnaissance devices, but play the role of self- propelled munitions carriers with an emphasis on strategic deployment on the battlefield.

In addition, a mathematical method of packing circles is used in the work to optimize the distribution of mines on the minefield. This method is an important element of the analysis that allows the author to effectively solve complex logistical and spatial problems associated with military deployment of drones.

Investigation Results. The paper presents a comprehensive approach to the issue of the use of unmanned aerial vehicles in the creation of minefields in military operations. The paper, using a two-dimensional discrete uniform distribution with two possible drone layouts, demonstrated the difference in the spacing of drones in a grid formed by a hexagonal and a square scheme. According to the shape of the obstacle area, a measurement was made in which the required number of drones carrying a mine was demonstrated to create a minefield of different density.

Conclusions. The article focused on a detailed analysis of drone swarming to lay a minefield. Starting from the analysis of the requirements for standard military minefields, a model was developed and applied to autonomous vehicles. By conducting a validation exercise, it was determined how many autonomous assets were required to create an alternative minefield and in what configuration these minefields should be created. These parameters can also be used to determine mine density, a key factor in determining the characteristics and purpose of a minefield in an operational environment.

Limitations. The paper presents the first steps into a new research area, which brings some unresolved questions. One of these questions is the specific form of the explosive component to be used in the drone. This issue still requires further research and analysis.

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Multicriterial Analysis and Comparison of Air-to-Air Fighter Jets

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Introduction. Fighter aircraft have historically played a crucial role in establishing the desired degree of control in the air. From an operations management perspective, achieving this position is necessary for success on the current battlefield. The unfolding conflict in Ukraine serves as evidence supporting this principle. Initial offensives conducted by the Russian Federation targeted various strategic locations, including air bases, air defence sites, and airspace surveillance systems. Despite the inability to completely neutralize Ukrainian air forces on the ground, ongoing confrontations between aircraft of the two opposing factions persist. [1]

The delivery of air power can be defined in terms of roles, missions, and sorties. For the purposes of this study, it will be further elaborated and focused only on Counter-Air Operations conducted to obtain and maintain the required degree of Control of the Air. The desired level of control of the air will allow the actual operation to be conducted under the required degree of freedom for ground units and other components at the required time and space. Achieving this level is ongoing, but further action is required to maintain this state.

The aim of this study is to introduce a systematic approach to the selection and comparison of suitable tactical aircraft for Counter-Air operations. To achieve this objective, it is essential to first identify the fundamental capabilities and characteristics of the aircraft that are critical to the performance of these missions. Evaluation criteria will then be derived from these parameters. The criteria will be selected based on the historical development of tactical aircraft, their operational deployment, potential tactics, principles governing air warfare, technical advances, and the capabilities of current platforms. A multi-criteria method will be developed to incorporate the significant number of sub-criteria that determine an aircraft's readiness level. The effectiveness of this method will then be demonstrated through a comparative analysis of a few selected aircraft.

The purpose of this study is not to evaluate aircraft for specific operations at a specific location or to select the appropriate aircraft for a specific military or government entity. Its primary focus is to evaluate the disposition of Counter Air Operations only, without regard to aircraft characteristics that are not analytically critical to this effort. An example would be acquisition cost or flight hour cost. The calculation of cost per flight hour or mission accomplishment is highly complex and can vary from nation to nation. Therefore, this study does not deal with price in general.

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Method of investigation. The operational deployment of fighter jets involves a wide range of factors that significantly impact the feasibility of deployment under specific conditions and mission requirements. These factors, such as information support, maintenance complexity, operational economy, logistics support, and navigation performance, must be considered in practice. However, this study focuses on assessing the effectiveness of air dispositions in achieving success in air-to-air operations, specifically in conducting air combat. Therefore, the study will not explore the aforementioned factors or consider scenarios where adversaries have equal capabilities in certain variables to isolate the analysis of aircraft dispositions.

The study employed the Multi-Criteria Decision-Making Method (MCDM) [2], which is based on the analytical hierarchy process (AHP) [3], to identify the most appropriate military fighter aircraft for air-to-air operations.

The analytical hierarchy method was used to establish three primary criteria, and their weights were determined by a group of experts using Fuller's pairwise comparison method. In the second level, experts identified four criteria for each category from the primary criteria. The weights of these criteria were again determined by a group of experts using the Saaty matrix. The structure of the AHP is illustrated in Fig. 1.
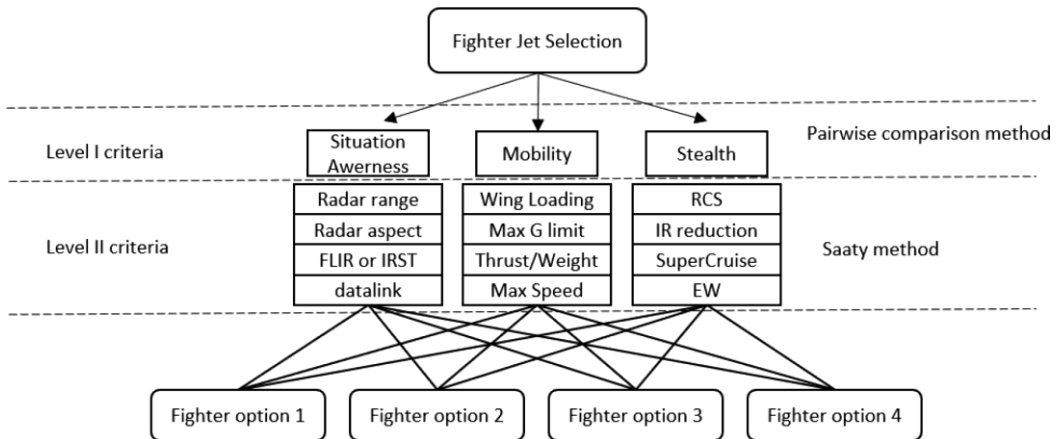
Fig. 1 Analytic hierarchy structure

The Saaty method was used to evaluate the criteria, the partial evaluation of the options, and to calculate the final evaluation of the options [4].

Investigation Results. Four representatives from the current armament of the North Atlantic Treaty Organization countries were selected to compare specific types of aircraft. This selection was made to demonstrate the method's functionality. This selection can be further supplemented or modified for possible specific use at the national or international level.

The data on specific aircraft was taken from publicly available sources, mainly from the English version of Wikipedia. The authors are fully aware of the imperfections of these data. However, again, the method can be supplemented with accurate and often classified data for any specific use.

The selected types of aircraft deployed in the North Atlantic Alliance include:

- JAS-39 C Gripen
- Dassault Rafale C
- Eurofighter Typhoon
- F-35 Lightning II

Conclusions. Thanks to the methodical comparison of aircraft for air-to-air operations, the final ranking of the aircraft was determined. In the stealth and situational awareness category, the F-35 stood out the most, thanks to its 5th generation aircraft concept. Conversely, the remaining aircraft were tied in these categories. On the other hand, the F35 fell short in mobility, where the aircraft lost points due to its higher surface load and lower top speed. However, the F35 outperformed the other aircraft in the overall rating. The Rafale and Eurofighter had similar score gains. The Gripen fell slightly behind due to its outdated airborne radar and single-engine concept. The resulting score is shown in Table 1.

Table 1: MCA results

aircraft type	result
F-35 Lightning II	95.9
Dassault Rafale C	91
Eurofighter Typhoon	90.1
JAS-39 C Gripen	86.7

Limitations. A limitation of the study is the source of valid data, where certain specific data are very often classified. The authors relied on publicly available sources mainly to demonstrate the method's functionality. For further specific use at the level of a particular army, the data can be further specified as categories can be expanded to include additional criteria for comparison.

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Theory of Spontaneous Order and Warfare – Strategic Studies

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Introduction. Strategic studies, more than any other field of knowledge, operate with incomplete information. The universe is infinite in both terms of scope and scalability. The extent of the universe surpasses human civilization – the speed of information transfer is limited – and its scalability is also unbounded – observation of a phenomenon (at the quantum level) influences the phenomenon itself. Yes, even the double-slit experiment prevents absolute determination of the current state, prediction of the future state, and therefore even manipulation from the current state to a desirable future state. However, it is precisely because of this fact of impossibility of absolute determination that strategic studies can exist. Otherwise, with absolute centralization of all information from the non- scientific world, strategic studies would be replaced by simple mathematical computation of the occurrences of relevant events in a specific place and time of reality.

From an economic perspective, information is thus a scarce commodity and simultaneously a fundamental input into the strategist's activity. The author articulates the hypothesis in this work that the current methodology of strategic studies might not be effective, as it does not sufficiently account for the impossibility of absolute determination. This subsequently affects the reduction of the effectiveness of the strategist's activity, including its output.

The article proposes a new methodological approach to strategic studies based on the theory of spontaneous order. By utilizing the theory of spontaneous order, which is theoretically grounded in mathematics and practically employed across a wide spectrum of scientific disciplines, the author points out the possibility of achieving higher effectiveness in strategic activity within the field of strategic studies.

In the introduction of the article, the author acquaints the reader with the terms used, as well as the ethics and methodology. Subsequently, the author connects the theory of spontaneous order from mathematics through economics, military art, and up to strategic studies. By utilizing a comparative method, the author further compares the current and proposed methodological foundations of strategic studies. The outcome is the methodological and philosophical grounding of strategic studies under the theory of spontaneous order, which seeks to coherently and holistically capture the entire pre-scientific world. Another outcome will be practical proposals for adjustments to the principles of warfare in the field of military science, stemming from the theoretical application of spontaneous order to strategic studies.

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Method of investigation. The author proposes a new methodological framework for strategic studies. The method of creating this methodological framework is axiomatic-deductive. The resulting methodology proposal is based on the axiom of the impossibility of absolute determination. With regard to this axiom, the author has chosen the theory of spontaneous order, specifically the theory according to F.A. Hayek, for its development.

F.A. Hayek dedicated himself to the theory of spontaneous order and its rules and institutions, considering the impossibility of absolute determination. In his conception, this impossibility refers to the inability of a centralized mind to acquire "dispersed" information that, taken as a whole, could be known to all elements as a system together. This theory describes free elements as elements of a unified system, wherein these elements are not capable, by themselves, of achieving absolute determination about this entire system to which they belong and within which they exercise their free actions. While free elements can informatively describe the rules at lower levels of the system, they are unaware of the rules at higher levels, which they nevertheless unconsciously create through their free actions at the lower level.

Investigation Results. The proposal of a new methodology for the science of strategic studies integrates strategic studies with closely related disciplines such as mathematics, economics, military science, as well as with more distantly related fields like biology, physics, computer science, among others. It also highlights the potential for a more effective approach to conducting strategic activities and provides new avenues for further research.

Conclusions. The proposal of a new methodology for the science of strategic studies and its integration with methodologies from other disciplines open up a wide spectrum of possibilities for the advancement of strategic studies. Moreover, it offers the opportunity to leverage insights gained from other fields, which also address descriptively or normatively the theory of spontaneous order. Consequently, strategic studies contribute another piece to the puzzle of the theory of spontaneous order, which aims to describe the entire non- scientific world. To further develop the theory of spontaneous order as a holistic system for understanding the non-scientific world, the author suggests further research in the following areas:

1) Quantitative studies on the practical application of the theory of spontaneous order in command and control, ranging from tactical to strategic operations.

2) Modeling of dynamic systems of war games and applying the principles of spontaneous order using quantum computing techniques.

Limitations. The hypothesis that the current methodology of strategic studies might not be effective, as it fails to adequately consider the impossibility of absolute determination, and the conclusions of this work are, in a way, among the first in the field of this research. For this reason, further research in both theoretical aspects and practical application, as well as quantitative outputs, is clearly necessary to support the new methodological grounding of strategic studies.

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4th INTERNATIONAL CONFERENCE

Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Analysis of Traffic Accidents with the Deployment of the Fire Rescue Service in the Regions of the Czech Republic

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Introduction. Traffic accidents are an ongoing safety issue. On the one hand, today's cars are equipped with all sorts of technology and manufactured with much more regard for safety than in the past, but on the other hand, cars are becoming more affordable, traffic is getting heavier and drivers are often encouraged to use high performance cars, which in turn has a negative effect on accident rates. The risk of a traffic accident is one of the most serious incidents investigated by the Integrated Rescue System. In traffic accidents such as those involving extrication [17], the need to deal with leaking fluids, the need to carry out fire- fighting measures on vehicles, or accidents in which it is necessary to restore traffic flow on the motorway, the intervention of fire brigades is required.

In the past ten years, a total of 198,773 accidents involving the departure of fire rescue units occurred in 14 regions of the Czech Republic. The records of accidents in the years 2012-2021 were taken from the database of the Fire Rescue Service of the Czech Republic, where they are characterized by geographical position and time of occurrence. The aim of this work is to use statistical apparatus to describe a discrete random variable, which is the daily number of accidents, and to model it using a generalised linear model (GLM). The work that deals with the modelling of the number of traffic accidents, as a random variable with a Poisson probability distribution, using GLM methods is unique in the Czech Republic.

First, the probability distribution of the explained random variable was tested. Based on the results of these tests, the analysis of variance approach for statistical analysis with a count variable, following a Poisson distribution, was chosen for modelling. Multifactor analyses without and with interactions were used to describe the daily number of accidents. In this paper, we will consider the following factors: day of the week, month, and region. The results of the estimated models were compared with the statistical characteristics of the dataset. Additionally, it is important to include an interaction term in multifactor analyses.

Method of investigation. During the initial stages of model development, tests were conducted to evaluate the normal distribution, but the results indicated that this probability distribution would not be appropriate. Therefore, goodness-of-fit tests were performed with the Poisson distribution, namely Cramer-von Mises or Anderson-Darling. Verification was also performed graphically using the values of the estimated likelihood function, or by plotting the relative frequencies for data sorted by region, month, and day of the week. Since

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the normality assumptions for parametric analysis of variance are not met, one option is to use non-parametric methods, which is the Kruskal-Wallis test [4]. Performing Nemenyi's all-pairs rank comparison test further shows which groups formed by sorting by factor differ. The tests were performed for all the factors under study. Another option chosen was the generalised linear model approach for count data (Poisson distribution) [5]. This approach allows for both one-factor and multifactor analyses. In the computational program, the natural logarithm was chosen as the link function. The calculations were performed in R, version 4.3.1.

Investigation Results. The hypothesis of normality of the data was rejected after performing tests of normal distribution. Goodness-of-fit tests with Poisson distribution were performed for data sorted by region, month, day of the week and showed approximately good results. As an example, the comparison plots for January Mondays in the Hradec Kralove region are presented in Fig. 1. For the Kruskal-Wallis tests we get a p-value much smaller than 0.05, based on these tests we can say that the daily number of accidents depends on the observed factors. The parameters estimated from the univariate analysis did not yield any surprising results, they just correspond to the statistical characteristics. Furthermore, additive (without interactions between factors) and multiplicative (with interactions) multifactor models were compared. Predicted values of the daily number of accidents in model without interactions for Hradec Kralove region are presented in Fig. 2. In the case of multifactor models, the addition of an interaction term appears to be significant. The percentage of explained deviance for the model without interactions is 32.54%, and for the model with interactions is 33.00%.
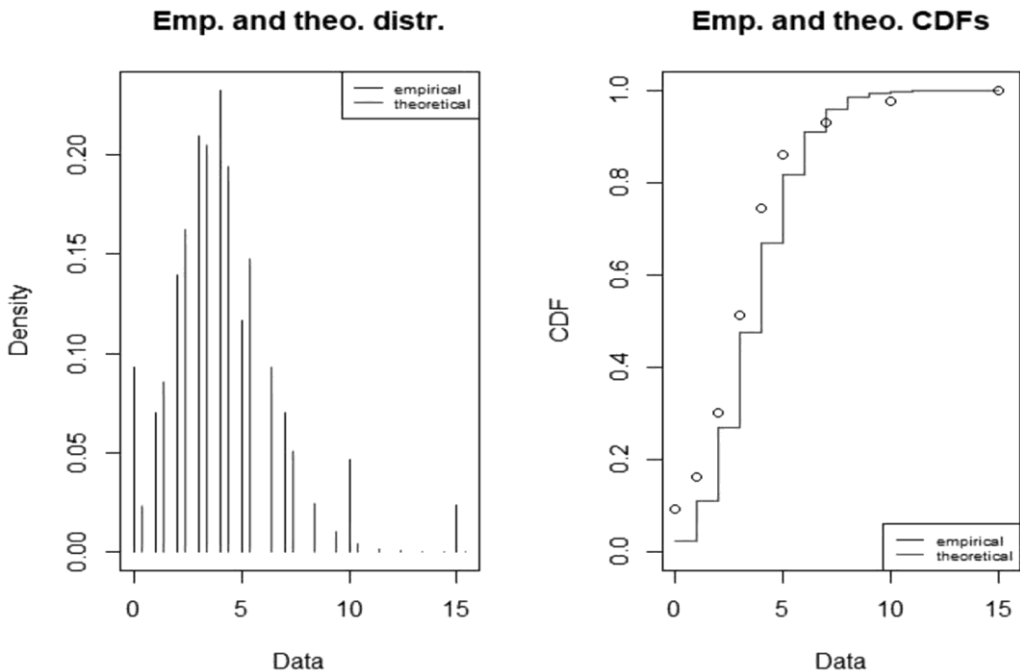
Fig. 1 Probability function and cumulative distribution function for the theoretical Poisson distribution function with estimated parameters and empirical data for accidents in the Hradec Kralove region that occurred on Mondays in January 2012-2021. The theoretical function is shown in red, the empirical function in black.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	4.02	3.80	3.84	3.95	4.51	3.76	3.21
2	3.73	3.52	3.57	3.67	4.18	3.49	2.98
3	3.29	3.10	3.14	3.23	3.68	3.07	2.62
4	3.49	3.29	3.33	3.43	3.91	3.26	2.78
5	3.95	3.73	3.77	3.88	4.42	3.69	3.15
6	4.70	4.44	4.49	4.62	5.27	4.39	3.75
7	4.45	4.21	4.26	4.38	4.99	4.16	3.56
8	4.62	4.36	4.41	4.54	5.17	4.32	3.69
9	4.69	4.43	4.48	4.60	5.25	4.38	3.74
10	4.52	4.27	4.32	4.45	5.07	4.23	3.61
11	4.11	3.88	3.93	4.04	4.60	3.84	3.28
12	4.51	4.26	4.32	4.44	5.06	4.22	3.61

Fig. 2 Predicted values of the daily number of accidents in model without interactions for Hradec Kralove region. A color scale from green (low values) to red (high values) is used.

Conclusions. The models showed that all factors examined were statistically significant. The day of the week factor showed that Mondays, Thursdays and Fridays were above average in terms of accident rates, while Sundays were below average in terms of the daily number of traffic accident involving the deployment of the fire rescue service. Overall, the number of accidents is above average on weekdays compared to the weekend when accidents occur less frequently. The trend in the daily number of traffic accidents over the year based on the data sample collected shows that the daily number is below average in the winter and spring months, and from June to October the accident rate is above average relative to the overall annual average daily number of traffic accidents involving the deployment of the fire rescue service. The dependence of the daily number of accidents on the region also proved statistical significance. The calculations show the lowest average of accidents per day in the Karlovy Vary Region and the highest in the Central Bohemia Region. The region factor was reflected in the accident rate mainly by the geographical conditions in the regions. Regions, where the winters are colder, show a higher accident rate, e.g. due to black ice. The number of daily accidents in the regions certainly depends on the density of the road network, the frequency of traffic, etc., in most regions the fewest accidents took place on Sunday, the most accidents took place on Friday, in some regions also on Monday.

The study provides a comprehensive view of the relationship between the number of accidents and days of the week, months of the year and regions of the Czech Republic. In the event of accidents, significant losses occur, not only financially, but also, and above all, in terms of damage to health and environmental damage. Reducing the need for call-outs would lead, among other things, to savings in terms of the equipment used and the costs of subsequent treatments and repairs [8]. Based on the knowledge of the development of the daily number of accidents, it is then possible to propose appropriate solutions to reduce the accident rate.

Limitations. However, further research is needed before it is possible to define more dependencies on the various factors influencing the number of traffic accidents with firefighter departures. Other possible factors are:

● The influence of weather and other meteorological phenomena, such as those mentioned in studies [6], [7].

● Impact of natural events, e.g. black ice. However, such phenomena are difficult to predict, they vary from year to year and their influence on the prediction of the number of traffic accidents is rather unpredictable, see [2], [3].

It is hoped that, as a result of the above-mentioned studies, models of the development of the daily number of traffic accidents with the departure of firefighters will be able to be useful in the field of traffic safety in the Czech Republic.

Keywords: *Traffic accident, fire rescue service, generalised linear models, Poisson distribution.*

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Degradation of Land Cover in the De-Occupied Territories of Ukraine

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Introduction. The North-Eastern region of Ukraine has a strong mining and processing industry and significant agricultural potential. The intensive economic activity is causing significant land cover transformation, which leads to mostly negative consequences for natural ecosystems and the region's economy. Analysing land cover change trends on the example of the Kharkiv region is an urgent task to understand the dynamics of changes and identify their causes. The analysis of land cover trends is of scientific importance in identifying land cover trends, which will contribute to understanding the causes of changes in natural ecosystems and developing strategies for their conservation and restoration. In addition, the analysis of land cover changes can be important for assessing the impact of anthropogenic and natural factors on land use, which is key in making decisions on the rational use of natural resources, especially in the post-war period.

The object of the study is the land cover of the Kharkiv region and its changes. The purpose and objectives of the study are to identify negative trends in the land cover of the Kharkiv region as a result of hostilities, using satellite data and open source statistics. The main objectives of the study are: to analyse statistical data on changes in the land cover of the Kharkiv region for the period 2015-2022; to analyse the state of land cover based on remote sensing materials; to identify trends in the change of certain land covers that have the largest share among all the covers of the Kharkiv region; to assess the impact of hostilities on the state of the Izyum forest and the air as a result of numerous forest fires using satellite data.

Methods of investigation. The main methods of our research are the analysis of remote sensing materials, in particular, Sentinal-2 and Sentinal-5P satellite images. To obtain detailed information on land cover changes for the period 2015-2022, we used the web sources Land Cover 2022 [1], WORLDCOVER_2021_MAP [2], Global Land Cover 2015 [3]. The mathematical and statistical method was used to process statistical information and obtain index images as a result of processing satellite images and obtaining thematic rasters.

Investigation Results. The results of the analysis of land cover changes conducted using the Global Land Cover service [3] and statistical data of the Kharkiv region [4] are presented in the graphs (Fig. 1, 2). Land cover trends reflect the interaction of various factors, such as climate change, human activity, development, pollution, and warfare.

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The knowledge and consideration of these trends is key to developing strategies for biodiversity conservation, provision of environmental services and sustainable economic development.

Forests

	2015	2016	2017	2018	2019	2020	2021	2022
Forests	25,2	25	24,7	24,6	24,5	19,1	19,6	13,3

Years

Agricultural land

	2015	2016	2017	2018	2019	2020	2021	2022
Agricultural land	64,2	64,1	63,9	63,9	63,8	63,8	63,4	61,5

Years
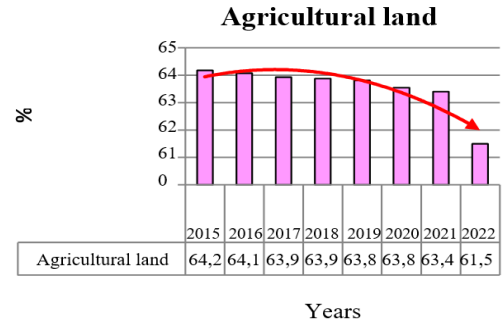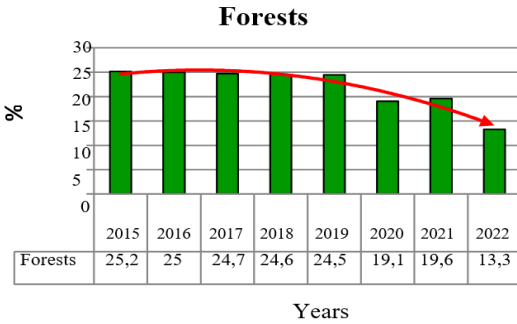
Fig. 1. Graph and polynomial trend line of forest cover changes change for 2015-2022 2022

Fig. 2. Graph and polynomial trend line of in agricultural land cover in 2015-

The forests cover a significant area of the Kharkiv region (over 20%) and play an important role in the industrial sector of export production. Following the extremely strong impact of the hostilities in 2022, the forest cover of the Kharkiv region has become a focus of special attention. The Izyum forest in Kharkiv region was severely affected by the military events, suffering extensive damage from fires caused by the fighting. The significant areas of the forest have burned out, especially after the summer fires of 2022, as can be seen on satellite imagery (Fig. 3). In addition, the danger from forest fires is the release of CO_2, a greenhouse gas equivalent that exacerbates climate change. Another dangerous gas is NO_2 - nitrogen dioxide caused by the burning of fossil fuels and biomass.

Fig. 3. Sentinal-2 satellite images of 06.05.2022 of forest fires in the Izium forest, Kharkiv region, caused by military operations in the spring of 2022 in natural colours and SWIR combination

The results of the analysis of land cover change in Kharkiv region show an extraordinary level of economic development of the region's land. The general trend since 2015 has been a decrease in forests and agricultural land, with a significant reduction in 2022, which is the result of hostilities and their consequences. The military operations lead to a number of mechanical, physical and chemical impacts on the land cover. The vegetation destruction, soil disturbance, and desertification are common consequences of military and technological pressure.

In particular, land cover degradation due to military operations has become a major trend in land cover change. The hostilities in the Kharkiv region have severely damaged all natural resources: land areas have been contaminated and polluted with various wastes, the air has been polluted by explosions and fires, water bodies, forest resources and biota have fallen victim to enemy equipment, pollution and deliberate destruction. As a result of the armed aggression of the russian federation against Ukraine, the significant damage has been done to land resources. According to the National Scientific Centre "A.N. Sokolovsky Institute of Soil Science and Agrochemistry", the greatest impact on agricultural land and soil cover is caused by enemy aircraft and artillery (80% of the surveyed areas) [5]. The air, soil, and water pollution can cause significant reductions in yields, food contamination, and threats to human health. During the war, more than 20,000 facilities were damaged or destroyed in the region, 31% of which were in Kharkiv. Of the total number of protected areas in the temporarily occupied territory and in the combat zone, there were 84 protected areas covering an area of 35.1 thousand hectares (46.8% of the total area) in Izium, Kupiansk, Kharkiv, and Chuhuiv districts of Kharkiv region [4]. For a more detailed study of land cover changes related to military activities, including the destruction of the humus horizon, soil contamination with metal fragments and explosive residues, and soil contamination with heavy metals, field research and the use of high-resolution aerial or space imagery are needed.

Conclusions. Thus, the following actions and measures can be recommended to overcome the consequences of the hostilities and restore economic activity:

- to conduct demining the territories of the region's nature reserves and forests;
- to conduct a comprehensive study on the assessment of the degree of contamination of territories and soils;
- to establish the necessary measures to clean up the territory and restore its suitability for agriculture;
- to establish control over the quality of air, soil and water;
- to introduce support from the state and local authorities.

Keywords: *land-cover, de-occupied territories, agriculture, nature, war.*

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Mathematical Modeling of Fuze by Explosives: Applications in Engineer and Artillery Support

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Introduction. The work deals with the fuze by explosives from active to passive charge, which is a typical issue in the field of engineer support, but has its significant overlap into the sphere of artillery support. In military engineering, the fuze by explosives can be used, provided that the distance is shorter and auxiliary fuzes are lacking. On the other hand, this activity requires a greater number of detonators, as each must be in a single charge. Detonators contain a primary explosive that is sensitive to the transfer of energy and pressure from the active to the passive charge. Examples of the use of fuze by explosives include the destruction of timber piles, structural elements of bridges and buildings, disposal of ammunition, etc. In the case of artillery fires on explosive obstacles, it is necessary to assess, in addition to the shrapnel effect, the effect of the fuze by explosives, which may result in a chain reaction and a subsequent series of detonations.

Aim and limitations. The aim of the work is mathematical modeling and prediction of the effect of active charge on passive charge due to the variable weight of active charge and distance from it to passive charge. The data for the development of the predictive model were obtained from a military document dealing with blasting works [1]. The limitation of this data lies in its small quantity and short range.

Another limitation of the data is due to the fact that they were created with the assumption of using TNT. For this issue the following principles apply:

- direct distances between charges without obstruction;

- the detonators are oriented so that their open ends face the active charges;

- the detonator serves as a fuse and is not included in the total weight;

- fuze by explosives is valid for land use.

Methods of investigation. We used statistical modeling to describe the relationship between the weight of the explosive charge and the distance between the active and passive explosive charges. The linear regression model [2] is based on the typical blast characteristics, i.e. the square root dependence between these two variables. Since the data are small and rounded, and the rounding mechanism is not known, we applied the so-called "unrounding" procedure with the uniform distribution. Finally, we constructed confidence bands for the regression lines using the bootstrap procedure [3].

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Results. The resulting linear regression model for the original data is presented in Fig. 1(a). The graph illustrates that the square root model describes the data quite well ($R^2 = 0.97$). Based on the data, we used the uniform distribution with the range [0, 0.5] to simulate ten thousand bootstrap samples of the data. Fig. 1(b) shows the bootstrap-based model with the 99% confidence band.

(a)

(b)
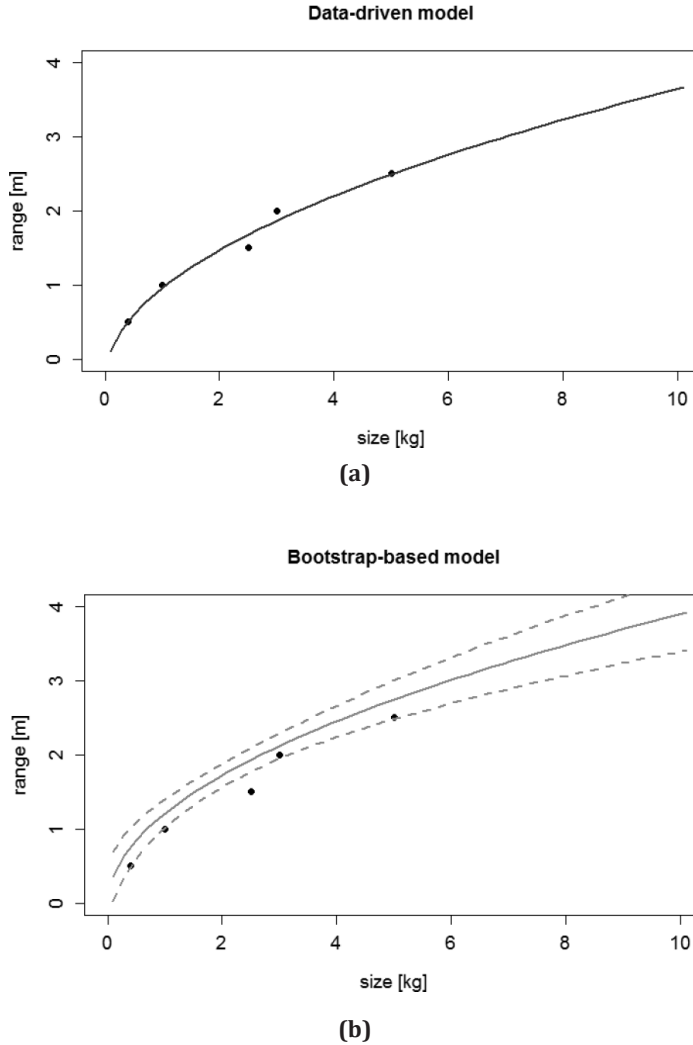
Fig. 1 Linear regression models; **(a)** linear regression model based on raw data; **(b)** same model as in (a) based on the bootstrap resampling (solid line) with 99% confidence band (dashed line).

Conclusions. The results of this modeling study show that the linear regression model with the square root function describes the data quite well and the bootstrap resampling with the uniformly distributed errors characterizes the unknown rounding errors. The resulting lower confidence curve can then be taken as the optimal combination of distance and the weight of the explosive charge. This modeling is then applicable to all tasks of engineer support where explosives are involved. Examples include the disposal of unexploded ordnance, setting up or removing obstacles, and more.

The contribution of the work lies in the proposals for the reduction of detonation nets (counter-mobility) and in the determination of the distance of detonation during the explosion of artillery munitions in the case of establishing passages in engineering obstacles using artillery fire (mobility). Damage of wires is a common failure of a fuze (whether by detonating cord or by electrical fuze). Other benefits include the possibility of applying this predictive model to other types of explosives, thus creating a comprehensive data set for use in military engineering. Currently, there are no explosives that retain the sensitivity of a primary explosive while being as safe as explosives (e.g., trinitrotoluene) against impact, friction, and thermal effects.

These calculations become the basis for determining the design of artillery fire control procedures during joint fires support, especially procedures and methodologies for establishing passages in minefields and also in artillery tactics procedures. In particular, they will be used to evaluate theoretical ammunition consumption and to determine the duration of artillery support which affects the management of maneuvering within the artillery restricted area [4].

Fuze by explosives is based on the energy transfer and pressure of the explosion. The presence of shrapnel or other fragments is not taken into account. These can, of course, also initiate the detonator in a passive charge. The probability of shrapnel spread location and detonation of the passive charge by shrapnel can then be evaluated statistically. The explosion of active charges also affects the distance of shrapnel spread location with respect to their weight. Thus, artillery fragmentation munitions or hand grenades can become active charges to fuze by explosive under certain circumstances.

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Predictive Estimates in Population Models with Variable Dynamics Under Uncertainties

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Introduction. Today, a significant number of publications are dedicated to the study of the behavior of dynamic systems [1 - 5]. Such interest is caused by the variety of applications to real processes that are described using the mathematical apparatus of dynamic systems. The information spreading in social networks, the change in the number of patients during epidemics, the dynamics of the number of people with stress syndrome can be modeled with the help of hybrid dynamic systems.

In the paper, we investigate the predictive estimates of the model, which at the initial time interval describes a slower population growth, and later turns into a model with a rapid growth of such a population.

Method of investigation. The analysis of population dynamics was studied in many papers. The most common models studied, for example in [1 – 3], are logistic or more generalized Volterra models. With rapid population growth, it is advisable to use Gompertz models [4 – 6]. Given the known initial conditions and parameters of the models, such an analysis is reduced to solving Cauchy problems for linear or nonlinear differential equations.

In the case when the initial conditions or parameters of the models are unknown and belong to certain sets, it is not possible to obtain accurate predictive estimates and it is necessary to determine the predictive sets at a given time under certain conditions. With unknown initial conditions and parameters of differential equations, however, for a known number of persons in the population at certain moments of time, formulas are given for calculating the minimum and maximum number of persons in the population.

Investigation Results. Let functions $x_1(t)$ and $x_2(t)$ be solutions of the system

$$\frac{dx_1}{dt} = \gamma_1(t)x_1(t)(N - x_1(t)), \quad x_1(0) = x_0, \quad 0 < t < t_1,$$

$$x_1(t_1) = x_2(t_1),$$

$$\frac{dx_2}{dt} = (b(t)u(t) + \gamma_2(t)\ln\frac{x_2(t)}{N})x_2(t), \quad t_1 < t < T. \tag{1}$$

Assume that the functions $\gamma_1(t), \gamma_2(t), u(t)$ are integrable with the square on the corresponding intervals, and the function $b(t)$ is continuous on $[t_1, T]$.

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Lemma 1. *Equation system (1) has the unique solution that is continuous and differential almost everywhere (a. e.).*

Let us introduce the set $G_y = \left\{ x_0 : x_0^- \leq x_0 \leq x_0^+, v_k^- \leq y_k - x_1(s_k) \leq v_k^+, k = \overline{1,m} \right\}$, and also the sets $G_y^{(1)}$ and $G_y^{(2)}$

$$G_y^{(1)} = \left\{ x_1(\overline{t}, x_0) : x_0 \in G_y, s_m < \overline{t} \leq t_1 \right\},$$

$$G_y^{(2)} = \left\{ x_2(t, x_1(t_1, x_0)) : x_0 \in G_y, t_1 < \overline{t} < T \right\}.$$

The sets $G_y^{(1)}$ and $G_y^{(2)}$ are called the sets of predictive estimates for values $x_1(\overline{t})$ and $x_2(\overline{t})$.

Lemma 2. *The set G_y has the form*

$$G_y = [\alpha, \beta] \cap [x_0^-, x_0^+] = [\max(\alpha, x_0^-), \min(\beta, x_0^+)] = [\alpha^-, \alpha^+].$$

Suppose that the function $\gamma_1(t)$ is also unknown and belongs to the set $\Gamma = \left\{ \gamma_1 : \int_0^{t_1} q^2(t)(\gamma_1(t) - \overline{\gamma}_1(t))^2 dt \leq 1 \right\}$, where $\overline{\gamma}_1(t)$ is a well-known function integrable with the square, the function $q^2(t)$ is continuous on $[0, t_1]$ and such that the following inequality holds: $q^2(t) \geq q^2 > 0$. Also assume that we observe some given values

$$y_k = x(s_k) + v_k, k = \overline{1, m}, \text{ where } v_k \in [v_k^-, v_k^+], \quad s_1 < \ldots < s_m \leq t_1.$$

We put that $x_0 \in [x_0^-, x_0^+]$. Let us denote by

$$\Gamma_y = \left\{ (x_0, \gamma): x_0^- \leq x_0 \leq x_0^+, \gamma \in \Gamma, v_k^- \leq y_k - x_1(s_k) \leq v_k^+ \right\}.$$

An interval $[x_1^-(\overline{t}), x_1^+(\overline{t})]$ is called a set of predictive estimates for the values $x_1(\overline{t})$, where $x_1^-(\overline{t}) = \min_{(x_0, \gamma_1) \in \Gamma_y} x_1(\overline{t}, x_0, \gamma_1), \qquad x_1^+(\overline{t}) = \max_{(x_0, \gamma_1) \in \Gamma_y} x_1(\overline{t}, x_0, \gamma_1), \quad x_1(\overline{t}, x_0, \gamma_1)$ is the solution of system (1) at the initial value x_0 and the function γ_1. Similarly, for the predictive interval $[x_2(t, x_1^-(t)), x_2(t, x_1^+(t))]$ is called a set of predictive estimates for the values $x_2(\overline{t})$.

Lemma 3. *Let x_0 and γ_1 belong to the set Γ_y, the functions $b(t)$, $u(t)$ and $\gamma_2(t)$ are given. Then the predictive set for the value $x_2(\overline{t})$ as $t_1 < \overline{t} < T$, has the form $[x^-(\overline{t}), x^+(\overline{t})]$, where $x_2^-(\overline{t})$ and $x^+(\overline{t})$ are found from the solution of the system (1) $x_2^-(t_1) = x_1^-(t_1)$ and $x_2^+(t_1) = x_1^+(t_1)$, at respectively.*

Conclusions. The research provides formulas for calculating predictive estimates of the number of individuals in the population with unknown non-stationary parameters included in the right-hand sides of special nonlinear differential equations. The obtained results can be applied in the tasks of analyzing the dynamics of the number of persons who received certain information, the dynamics of the number of persons with stress syndrome, the dynamics of the number of sick persons during epidemics.

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

Geographical Distribution Analysis of Field Hospitals Along the Frontline: 2SFCA Method-based Approach

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Introduction. When it comes to health care accessibility we can monitor multiple parameters to monitor the situation in a given location. Among the most basic ones are hospital capacity, which measures how many patients can particular hospital treat in a predetermined amount of time, and patient's demand, which describes how many patients will visit given hospital in a specific amount of time.

Measuring hospital capacity can be achieved by different means, for example, by calculating the number of hospital beds, hospital physicians or hospital size. On the other hand, it is more difficult to estimate patient's demand as it involves unknown variables. For example, only a portion of ill patients will go to a hospital. Furthermore, patients can usually choose between several hospitals and will decide which one to visit based on variable criteria. However, even when patients decide between multiple hospitals, they can visit only one hospital at a given time.

For this reason, mathematical-geographical models were developed to estimate patient's demand (where groups of patients are considered instead of individual patients) in a simplified manner. Furthermore, 2SFCA models aggregate ratios of hospital capacities to patients' groups demand to measure health care accessibility in an investigated area (see [1-3]). Special meaning is assigned to the distance between hospitals and patient groups.

2SFCA models were used under different settings to address various civilian needs. However, these models are yet to be deployed for military use. Nevertheless, there is a clear difference between civilian patients and military patients. This article then investigates a theoretical background for a potential application, where 2SFCA models are utilized in a military environment. As a consequence, a new modified 2SFCA model (named P2SFCA) was obtained and it analyses geographical distribution of field hospital along a frontline.

Method of investigation. Strictly theoretical data were generated based on the system proposed in [8], where model's performance is tested on various small case scenarios on which 2SFCA and P2SFCA models are compared. Two classes of nodes are generated, one representing hospitals and another representing groups of patients. Distances between nodes, hospitals' capacities and patients' groups demands are then generated and varied to obtain several scenarios. Finally, it is observed how scenario's parameters impact each model.

Another set of simulated data was utilized as well. A segment of Ukrainian frontline (roughly 160 km long, depicting the situation at the end of January 2024) was taken and locations for

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field hospitals and military units were simulated. Each hospital was assigned semi randomized capacity and similarly each military unit was assigned semi randomized number of seriously wounded soldiers (representing patients' demand). Distances between hospitals and military units were calculated in ArcGIS pro software. Finally, classic 2SFCA model is then compared with P2SFCA model visually and statistically by Wilcoxon Signed Rank.

Investigation Results. New P2SFCA model was theoretically developed, where each j hospital with its capacity S_j and each military unit i with its demand P_i are assigned coefficients

$$R_j = \frac{S_j}{\sum_{d_{i,j} \in M_{k_0}} P_i f(d_{i,j})}, \qquad A_i = \sum_{d_{i,j} \in M_{k_0}} R_j f(d_{i,j}),$$

where $d_{i,j}$ - distance from i to j, $M_k = \left\{ d_{i,j} \middle| \frac{min_i(d_{i,j})}{d_{i,j}} \geq 1 - \frac{1}{k} \right\}$ and $k_0 \geq 1$ is maximal integer that satisfies inequality $|M_{k_0}| \geq k_0$, $|M_{k_0}|$ denotes number of elements in the set M_{k_0}.

Furthermore, comparison between P2SFCA and classic 2SFCA model was carried out on theoretical and simulated data. Visual analysis of said comparison is presented in Fig. 1 and Wilcoxon Signed Rank Test was performed with p-value=0.5918.
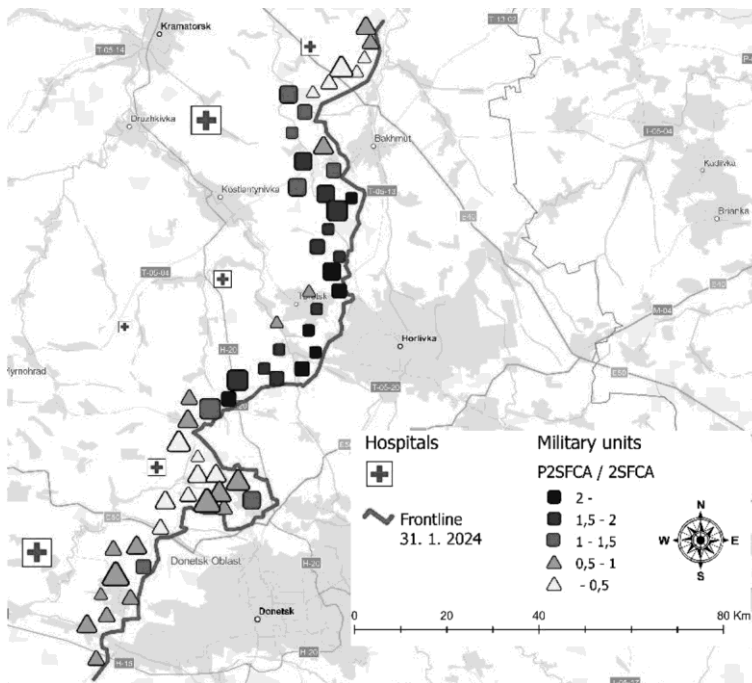
Fig. 1 Segment of Ukrainian frontline with simulated military units (triangles and squares) and field hospitals. Symbols' size represents hospital capacity and patient's demand (number of seriously wounded soldiers). Triangles mark military units for which is $P2SFCA < 2SFCA$ and squares mark units for which is $P2SFCA > 2SFCA$.

Conclusions. The newly derived P2SFCA model was theoretically developed to better represent frontline situation as opposed to classic 2SFCA model. Simulation showed that we cannot reject the hypothesis that medians for both models are significantly different and it is concluded that

both models allocate similar amount of 'accessibility' across the region differently. Furthermore, 2SFCA model underestimates hospital availability in certain areas and overestimates in others, which might lead to hospital overcrowding and unnecessary deaths.

Limitations. Further research is necessary before P2SFCA model could be deployed for military purposes. Proposed model works with the number of wounded soldiers. Statistical models could be employed to infer this number for each military unit. Additional insights about P2SFCA model could be achieved by consulting military experts and by reflecting particular needs of any given army that could lead to further improvements to P2SFCA model. Finally, practical applications of 2SFCA based models could lead to improved decision-making process such as in

● Field hospitals location selection: Location selection algorithm based on P2SFCA model could show where to place field hospitals to improve their efficiency (see also [7], [9]).

● Analysis of actual situation: Software tools analyzing real time data could alert problematic situations in need of attention.

Keywords: *2SFCA; field hospitals; spatial accessibility; frontline; proportional distances.*

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4th INTERNATIONAL CONFERENCE

Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Information Warfare Model with Internal Conflict

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Introduction. Humanity has entered an "information society" where the importance of the information sphere has sharply increased, leading to new threats and dangers. As technology facilitates the dissemination of various information, including harmful propaganda, the need for information security and regulation has become paramount. Understanding the mechanisms of information dissemination is crucial for effective countermeasures against negative effects. Modeling is identified as an effective approach. The text outlines the purpose of studying the model of informational struggle and references various articles for further exploration, ultimately aiming to create a complex system describing the model of information struggle with internal conflict, such as inter-regional migration, using the Lotka-Wolter model with cyclic migration as an example.

Information warfare model. In a scenario where a social community is exposed to two contrasting information streams, a mathematical model is constructed to dissect the dynamics of this information struggle. The model accounts for both external and internal channels through which information is disseminated, with parameters α and β dictating their respective intensities. The primary objective is to grasp how each stream permeates through the community over time and ascertain the eventual "winner", defined as the side that manages to sway a larger portion of the community.

Key assumptions of the model include the independent distribution of information through these channels and the incorporation of both external and internal recruitment mechanisms. These mechanisms determine the rates at which individuals are influenced by the information streams, considering both the existing followers and those yet to be recruited.

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Furthermore, the model acknowledges that certain members of the community may accept information from both streams, even if one stream appears to exert a stronger influence. This suggests a nuanced interplay between the information streams and individual perceptions within the community. The mathematical representation of the model involves the following equations: External channel propagation:

Rate of change of followers for I_1: $\alpha_1(N_0 - N_1(t) - N_2(t))$

Rate of change of followers for I_2: $\alpha_2(N_0 - N_1(t) - N_2(t))$

Internal channel propagation:

Rate of change of followers for I_1: $\beta_1 N_1(t)(N_0 - N_1(t) - N_2(t))$

Rate of change of followers for I_2: $\beta_2 N_2(t)(N_0 - N_1(t) - N_2(t))$

These formulas capture the dynamics of information spread through the community, incorporating both external and internal influences on recruitment. They provide a mathematical framework for analyzing the complex interplay between information streams and individual perceptions within social contexts.

Model of conflict interaction between complex systems. The goal for each opponent is to control as many positions in as possible. This scenario is modeled as a complex system where is divided into a finite number of separate regions, , with the field of common interests being the union of these regions: $\Omega = \cup_{(i=1)}^n \Omega_i$, n <, where n is the number of regions.

The behavior of substances A and B is described using vectors with non-negative coordinates: $A = (A_1, \dots, A_n)$, $B = (B_1, \dots, B_n)$, $A_I, B_i \geq 0, i = 1, \dots, n$, where A_I and B represent the quantity of substances A and B in region, respectively. These vectors evolve over discrete time steps, denoted as N, according to a dynamic system:

$$\{A^N, B^N\} \xrightarrow{*} \{A^{N+1}, B^{N+1}\}, N = 0,1, \dots,$$

The symbol * denotes the law governing the conflict interaction between A and B, which is generally unspecified. However, for the purposes of the model, it is defined based on intuitive understanding and the conditions of the system.

The text then introduces the concept of migration as a form of interregional interaction within the framework of the model. This migration is inspired by the Lotka-Volterra model with cyclical migration. The principle of migration is described by a formula representing the change in quantitative values of substance p in regions under the influence of substance r:

$$\rho_i^{(n+1)} = \frac{\rho_{ai}^{(n)}(1 + \gamma r_i^{(n)})}{1 + \gamma \sum_{i=1}^l \rho_i^{(n)} r_i^{(n)}}$$

Here, $\rho_i^{(n+1)}$ represents the quantity of substance p in region i at time step n+1, $\rho_{ai}^{(n)}$ represents the initial quantity of substance p in region i at time step n, $r_i^{(n)}$ represents the quantity of substance r in region i at time step n, γ is the intensity coefficient, and I is the total number of regions.

This formula illustrates how substance p flows between regions based on the quantity of substance r in each region and the intensity coefficient γ. The direction and magnitude of the

flow depend on the relative quantities of substances p and r in each region.

Furthermore, the text emphasizes the use of normalized (stochastic) vectors for calculations and provides formulas for normalization and denormalization:

$$\widetilde{\rho_l} = \frac{\rho_i}{z}, z = \sum_{i=1}^{l} \rho_i$$

$$\rho_i = \widetilde{\rho_l} z$$

These formulas ensure that the vectors representing substance quantities are normalized before and after calculations, maintaining consistency in the model.

Finally, the text acknowledges that the model is based on the concept of informational struggle within a community and relies on intuitive conventions to enable practical application and future refinement.

Conclusions. The text explores the impact of integrating internal conflict into a model of information struggle. It identifies that while various scenarios unfold based on external and internal intensities, initial values, and coefficients, predictions can be made accurately using the win function. Notably, the direction of migration, influenced by the signs of interaction coefficients, holds significant sway over model behavior. Internal conflict can transform the model, resembling standard information struggle models or exhibiting unique behaviors, especially with coefficients reflecting natural conflict. Predicting outcomes becomes challenging, often requiring computer simulations due to the complexity introduced by internal conflict. Consequently, understanding the behavior of the model, particularly in the presence of internal migration conflict, necessitates thorough modeling and remains a crucial area for further research.

Keywords: *Information warfare model, Conflict interaction, the Lotka-Voltaire model, Stochastic vector.*

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Reliability Analysis of the GEOSL2000 Soil Passability Prediction Model

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Introduction. Soils play a crucial role in assessing terrain passability for military vehicles [1]. Consequently, the evaluation of soil passability has received considerable attention across various armies. Within the context of soil passability assessment, particular emphasis is placed on the granularity composition of soils, soil properties reflecting the formation of individual soil types and the methods for measuring passability [2, 3]. Penetrometric measurement is currently a pivotal method for determining soil passability [4, 5, 6]. The determination of soil passability through penetrometric measurements typically follows procedures established and utilized by the United States Army [7, 8].

Newer methods focused on predicting soil passability rely on the utilization of digital geographic soil data, remote sensing imagery, meteorological data (especially soil moisture and precipitation) and the use of GIS tools [9, 10, 11, 12]. One such method is the model created by the Geographic Service of the Czech Army at the end of the 20th century (GOESL2000).

Method of investigation. The aim of the conducted research was to verify the results of soil passability modeling based on field measurements of soil bearing capacity using a penetrometer. Several locations in the Moravia region with different soil classifications were selected for the actual measurements. Regular repeated measurements of soil bearing capacity were carried out at each location using a set for measuring soil passability (E-960), which allows the measurement of both penetrometric resistance and soil compaction associated with vehicle passages. Based on the measured values, the soil bearing capacity determined using RCI (rating cone index) was calculated and compared with the VCI (vehicle cone index) value determined for the basic types of vehicles used in the Czech Army.

The measured passability value was categorized into three basic categories: GO, SLOW GO, NO GO for the purpose of comparing with the results of the GEOSL2000 passability model. The obtained real passability at each location was then compared with the outputs of the analytical model GEOSL2000, which considered actual precipitation totals for individual locations and measurement dates in its calculations.

Investigation Results. The results were compared with respect to soil characteristics in different locations. The identified differences in individual locations were further analyzed with regard to precipitation totals. During all conducted measurements, the precipitation totals were below the established limit value. In the majority of selected locations, the

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measured and modeled values of soil passability significantly differed. Based on the observed discrepancies, soil properties and weather conditions, some causes of these differences were identified and recommendations for further use of the GEOSL2000 model were defined.

Conclusions. By comparing the obtained dataset, significant differences in the passability prediction by the GEOSL2000 model compared to real measured values were identified. The causes of these differences can be sought in several areas. The first is the limited detail of the input geographic database describing soil properties. This database, with its precision corresponding to a 1 : 200 000 scale map, could be replaced with a more detailed soil database. The second cause is likely the inappropriately set parameter for passability classification, which relies solely on the precipitation total for a specified period, without considering the varying soil properties. Especially soil ability to drain rainfall into deeper layers is significant. A third equally significant factor is the method of evaluating soil passability in the GEOSL2000 model. This model predicts passability as a general concept, while all conducted field investigations and tests with military equipment have shown that soil bearing capacity, which determines their passability, depends on the type of vehicle chassis. The last apparent cause may be changes associated with climate change, particularly evident in the distribution of precipitation totals and a significantly higher occurrence of temperature extremes in the measurement area. Overall, it can be stated that the current analytical model GEOSL2000 is unreliable for soil passability modeling, significantly distorts the real situation and it is necessary to modify or replace it with a new model.

Keywords: *soil, passability, vehicle coin index, GIS, modelling, penetrometric measurement.*

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Understanding and Awareness Among the Czech Public Regarding the Potential Deployment of Biological Weapons on their Territory

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Introduction. In the current era of rapid technological advancements and global security challenges, the issue of biological weapons (BW) became increasingly significant in the strategic considerations of national security entities. This study was conducted in the Czech Republic (CR), undertakes a multidisciplinary examination of public perceptions regarding BW while identifying significant gaps in educational and preventative measures. It aims to evaluate the level of awareness and preparedness among CR citizens for potential incidents involving BW, amidst growing attention to biological risks fueled by geopolitical tensions and advancements in biotechnology. Recent global events, including the COVID-19 pandemic and advancements in biological research, have underscored the urgency of enhancing awareness and readiness for biological threats among both professionals and the general public. Study has revealed significant gaps in public awareness regarding BW in the CR, particularly concerning appropriate responses and preventive measures in the event of a biological incident. Despite a basic understanding of the existence and potential risks associated with BW, there is a notable lack of knowledge regarding specific actions individuals should take in the event of an outbreak. The absence of this knowledge poses a significant concern, particularly with the rising capacity of both states and non-state entities to develop and possibly deploy such weaponry. Emphasizing the significance of a holistic strategy toward public enlightenment and bolstering national readiness against biological hazards, this research lays a foundation for continued dialogue and measures.

Method of investigation. A thorough examination of existing Czech and international academic literature on BW was undertaken as part of the theoretical groundwork. The objective was to summarize essential insights on BW by utilizing pertinent data from online databases and current legal frameworks. This comprehensive approach facilitated a detailed exploration of the fundamental attributes and obstacles linked with BW within scholarly discourse. In the empirical phase, a quantitative research methodology was adopted, employing a survey questionnaire to gauge public sentiment on BW matters in the CR. The survey was administered in 2022. Distribution was carried out through direct web links and across diverse demographic segments via social media and email channels. Data analysis was conducted using R software, employing contingency tables to compare categorical variables.

Hypothesis testing utilized the χ^2 independence test to ascertain the presence or absence

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of relationships between observed variables. The study encompassed 301 respondents, constituting a representative sample of the general populace, aimed at illuminating their perspectives and stances regarding BW.

Investigation Results. In the conducted research, it was found that the public exhibits significant ignorance and lack of knowledge regarding the issue of BW. Although the topic of BW is perceived as a current and serious threat, only a marginal percentage of respondents possess adequate knowledge about measures to protect themselves in case of their use. The questionnaire survey revealed that while the issue of BW is subjectively perceived as inadequately discussed and presented in the media, more than 91% of respondents have encountered the term "biological weapon." However, only 72.4% of them were able to correctly describe this term. Further findings indicate a considerable level of uncertainty in the public perception of international agreements and their effectiveness in controlling the spread and use of BW, contributing to an overall sense of insecurity and fear regarding this issue. In the context of international perception, it was found that public trust in international agreements is low, suggesting a significant need for more active communication and educational activities focused on this area.

Conclusions. Based on the obtained results, the implementation of extensive awareness programs and educational initiatives is recommended to inform the public about the risks, prevention, and protective measures associated with BW. It is imperative to enhance media coverage of the BW topic, support the integration of relevant information into school curricula, and develop targeted media campaigns aimed at expanding public awareness. Furthermore, strengthening international cooperation and transparency within control mechanisms is proposed to increase public trust in the effectiveness of international agreements. The creation of a unified online platform providing access to verified information and resources on BW could significantly contribute to demystifying the topic and increasing public awareness. Additionally, it is crucial to incorporate this issue into awareness and educational programs within the broader context of weapons of mass destruction. This approach can significantly contribute to overall public awareness of risks and protective strategies in the current security situation.

Limitations. The primary limiting factor is the difficulty in controlling the sample of respondents given the chosen method. Another limiting factor is the low willingness of respondents to participate in research surveys addressing the issue of BW.

Keywords: *Biological weapon, weapons of mass destruction, biological agents, security, bioterrorism*

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Increasing the Protection of the Population in the Czech Republic in the Zone of Emergency Planning for Major Chemical Accidents

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Introduction. Industrial activity brings together with satisfying of the increasing human needs, a number of negative impacts. One of them is a possibility, which can be connected with the leakage of hazardous substances of toxic, flammable and explosive nature. There is a number of known major industrial accidents in last history, which have had a serious impact on lives and health of humans, environment and property. In order to prevent such accidents, the risk analysis developed for industrial and agricultural activities.

Human health can be affected, directly or indirectly, by routine discharges of hazardous chemical industrial substances or waste from industrial installations or even major chemical accidents could happen. A series of major industrial accidents both at fixed installations and during the transport of hazardous substances in recent 3 decades highlighted the urgent need for better management of risk in routine industrial operations and from threat or even existing chemical accidents.

The need for risk analysis connected with industrial safety is growing in developing and also in developed economics to protect humans, domestic animals, environment and property. Integration of safety and its development is closely related to social and economic development of the society and bears a priority in majority of the states.

Thus development of the risk analyses took place in the engineering practice. The aim of such analyses is to detect the risk, meaning the objects, installations and technologies, which have a high potential to threaten their vicinity and consequently to propose additional organizational and technical safety measures to decrease the risk and increase the safety. It is especially important in a large industrial regions or administrative units such as the regions in the framework in the Czech Republic.

The Czech Republic has the fully implementation of the European Directive SEVESO I from 1982, SEVESO II from 1996 and SEVESO III from 2012 in the national law system. Mentioned directives deal with prevention of major chemical accidents. The named European directives were a necessary basis for the creation of the Czech Republic's own national laws, as discussed below.

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Method of investigation. On the basis of the worldwide, European, and even home experience, the national Act No. 353/1999 Coll. *"on the prevention of major accidents caused by chemical substances"* was approved in the Czech Republic, too, by the end of 1999 (the first law on the prevention of major chemical accidents in the Czech Republic).

A new and upgraded issue is the national Act No. 224/2015 Coll. The major accidents, which had taken place – and particularly their negative impacts on the lives and health of population, injury to the living environment, and direct and indirect economic and property losses – proved that the issue of prevention and remedy of their consequences should be clearly legislated.

In general, it can be summarized that the Act imposes a series of responsibilities to both individual, as a rule big and medium plants, and to the bodies of the state administration. The purpose of all the measures consists in reducing to minimum the risk of major accidents inception and – in the case of a major accident should arise – the people living in the threatened surroundings – be warned up quickly and reliably on the imminent danger. This, nevertheless, assumes for the ordinary citizen living close to an industry facility to be clearly and in advance informed on the possible major accidents and the ways of being warned up, but mainly on the appropriate and indispensable models of the people's behaviour. However, at present time – in accordance with the valid legislation – the responsibility of protecting and informing the population is the full competence of the state administration. But in addition to the state administration, also the autonomous bodies, which as a rule accomplish many tasks and measures of the state administration in the position of the so called "*conferred authority*", play and important role in the whole system. The segment of population's protection – see Decree of the Ministry of Interior No. 380/2002 Coll., and the like – may serve as examples.

The original concept assuming that only the object or facility of the B group may threaten the population living in the undertaker's area surroundings is not accurate. Practical experience of evaluation of the various manufacturers, their objects and facilities revealed that not only objects and facilities belonging to the A group, but even not classified objects and facilities can represent, and they actually do, a danger for the civilian population living in the vicinity of the manufacture. On the other hand, it should be admitted that those are only rare and exceptional cases. In other words, this means that the breakdown effects of fires (thermal radiation), explosion (pressure wave), toxic leaks (toxicity) get off the manufacturer's area – beyond the manufacturer's fence.

Investigation Results. The most hazardous chemical substances in fixed installation and on transport could be toxic gases such as phosgene, chlorine and ammonia they can kill and affect a lot of people especially in the areas with high population density, such places as busy residential areas, shopping centers, centers of city, etc. The killing cloud could be, depending on to the local urban conditions and local weather conditions, at least hundreds of meters or even kilometers (in the case of phosgene and chlorine).

For that purpose, modelling of possible consequences of breakdowns and accidents must be performed. And these consequences may involve fire, explosion (or dispersion of fragments) or leak of toxic substances. All this represents a danger for human beings. A large amount of combustible, explosive, and toxic substances represents the *"breakdown potential"*, which can become evident not only in the case of technological failure or operators' mistake, but it can be misused – relatively easily – for terrorist or hostile purposes.

The potential attacker needs only to know, how to cause for example chemical release of the hazardous source or how to damage it and initiate a crisis situation. Due to human being technical maturity and invention, it is an important threat. There are many misused hazard resources in industrial nations and they are very often located near human settlements. Unfortunately, in future we can expect increase in terrorist's knowledge and creativity and that is why also an increase in importance of this problem for industrial nations in the world.

At the time being, ROZEX-Alarm and/or TerEx (acronym for "terrorist expert") computer programmes are ready to evaluating the accidental consequences of all serious breakdown phenomena (fires, explosions, and leaks of toxic substances). The modelling of possible breakdown consequences is the first, indispensable, and qualified step in the whole process of crisis management and emergency planning.

The area of prevention of major accidents is an important area in the system of preventive measures in ensuring the safety and security of residents, preservation of the environment and property values. A number of experiences in the field of chemical industrial safety can be drawn from rich domestic information sources, as a lot of professional experience has been gained especially in the last decade. These are mainly the following important areas: in the field of risk analysis and assessment, safety program for the prevention of serious accidents, safety reports, internal emergency plan, but also in the protection of the population in the emergency planning zone, informing the population and in other professional areas.

The expert article in the form of a full text (10 pages) will contain concrete results for the modelling of the three main dangerous chemical toxic substances: phosgene, chlorine and ammonia. Especially in the case of chlorine and ammonia, it is clear that there are hundreds of sources of risk with these toxic substances on the territory of the Czech Republic.

The main output of the expert article (it will be detailed and explained in the full text of the contribution) is undoubtedly the well-thought-out and well-reasoned proposal of the authors of six new measures, which will ultimately lead to an increase in the level of protection of the population in emergency planning zones for major chemical accidents in the Czech Republic.

Conclusions. The chemical safety and security management system has existed in the Czech Republic for a long time. The European Union issued the first SEVESO I directive in 1982, and then two more European directives followed. These positively influenced national legislation in the field of prevention of major chemical accidents. In essence, every other European directive required the issuance of a new national law on the prevention of major chemical accidents in the Czech Republic, as well as several implementing decrees.

The first law of this type was issued in the Czech Republic in 1999, but currently the valid version is the national law No. 224/2015 Coll.

It is also very important that a total of five implementing decrees for the Prevention of Major Chemical Accidents Act were issued by three ministries of the Czech Republic (Ministry of the Environment, as the guarantor of the entire area, Ministry of Industry and Trade, Ministry of the Interior).

In the Czech Republic, great attention is paid to both prevention and preparedness for handling major chemical accidents, should they occur. In this area, a very important part is the modelling of accident consequences, which is actually the prediction of an adverse

event, or adverse events must be modelled during their origin and course. Although there are special SW tools for modelling in the Czech Republic (e.g. ROZEX-Alarm or TerEx), their use is unfortunately not very common. In addition, the fact that the European Union issued three binding directives SEVESO I, II and III, but did not supply any SW product for modelling dangerous emergency manifestations for toxic leakage, explosion and fire, has a very unfavourable effect.

In the Czech Republic, attention is also paid to the protection of the population from the emergency planning zone, which, among other things, is mandated by law and implementing decrees. Unfortunately, it is a sad fact that the preparedness of the population to manage possible major chemical accidents is at a low level.

Keywords: *population protection; prevention of major chemical accidents; hazardous chemical toxic substances; modelling accidental consequences; increasing population protection.*

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Improvement in the Field of CBRN Prevention, Preparedness and Protection in the Czech Republic

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Introduction. Science will continue to develop at high speed, even revolutionary leaps. Improvements in information technology, the benefits of nanotechnology, new innovations in biotechnology, and continued investment in science and technology will provide both opportunities and threats to infiltrate knowledge towards agents with hostile intentions. As a result, the proliferation of WMD will become a much more serious problem. In the areas of defence and protection, information technology will contribute to the acceleration of decision cycles. Space and cyber-space will be interconnected and more widespread through military applications than ever before.

Nanotechnology will enable not only the military, but also various terrorist and extremist groups to use miniaturized, remote-controlled or even robotic systems, while biotechnology will increase the level of personal protection and the accuracy of sensors for targeting biological elements. Ultra-terrorism, sometimes called super-terrorism, i.e. chemical, biological, radiological and nuclear terrorism, represents not only future, but, unfortunately, also contemporary security threats, as demonstrated by the use of super toxic lethal sarin by the Aum Shinrikyo doomsday cult in 1994 and 1995.

Incidents of chemical, biological, radiological, and nuclear (CBRN) situations are on the rise and a clear understanding of the threats, vulnerabilities, and modus operandi of the perpetrators is required for reliable prevention and rapid, effective, and reliable response. CBRN incident management, both prevention and response, is a matter of multiple government institutions and agencies striving for mutual coordination and a clear understanding of rules and jurisdictions. Although international treaties have been concluded prohibiting the use of these weapons, the misuse of chemical, biological, and bacteriological substances by terrorists in any part of the world and at any time cannot be ruled out. Therefore, the response to such events must be quick, effective, and coordinated to avoid casualties and prevent the escalation of such an adverse event.

The Czech government and the responsible Czech authorities consider security problems to be key issues of the State's internal policy. It is obvious that, at present, issues of state security are becoming a priority in the daily activities of the government, constitutional officials, and

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individual departments of the national economy.

Therefore, it is important that the Czech Republic also pays increased attention to prevention, preparedness and protection against chemical, biological, and radiological terrorism in vulnerable public places (for example, in the Prague Metro). However, they must also seriously deal with all possible catastrophic scenarios of attacks and assaults using CBRN.

Method of investigation. Efficient protection of citizens through anticipation, deterrence, preparedness, response and adaptation to crisis situations – in other words, maintaining disaster resilience – faces new challenges. Collaboration between national, European and international stakeholders requires unified processes and management systems as well as technical, procedural, operational and semantic interoperability.

The Czech Republic has certainly not lagged behind in such an important area as CBRN protection. It is possible to be confident of this, be it through the development and introduction of means of radiation, chemical, biological research, means and reagents for the decontamination of equipment, material of all kinds, and persons, individual and collective protection, prophylaxis and the treatment of affected persons of the armed forces and the general population.

The question of the executive, responsible and control body, which in the Czech Republic is the State Office for Nuclear Safety, is also essential. It may have escaped the uninformed that a state office that has nuclear safety in its name also includes the following three important expert areas of activity: *Non-proliferation of nuclear weapons, Prohibition of chemical weapons, and Prohibition of biological (bacteriological) and toxin weapons.*

In another case, a habilitation thesis from 2011 focused on the issue of protecting the population from chemical terrorism, where a total of 91 different measures were proposed in specific areas, i.e., preventive measures, punitive measures, rescue and protective measures, liquidation measures and recovery.

The good preparedness of everyone (paramedics, medical personnel, police, special hospitals, special military units, the general population, etc.) for extraordinary events, especially for managing their consequences, including possible terrorist CBRN attacks, requires the following necessary procedures in particular:

– systematic preparation of control units and authorities for the possibility of CBRN terrorism;

– sufficient knowledge of CBRN terrorism acquired by the population (knowledge of the population about possible extraordinary events and emergency situations at the place of their residence or work, including terrorist attacks; clarification of the methods of warning and protection of the population; questions, etc., answered by the administrative authorities at the place their residence);

– basic provision of written instructions related to CBRN terrorism to the general public and their correct response (description of possible emergency events, including terrorist attacks; methods of warning the population; shelters for the population and protection systems; improvised protective equipment and aids, what to pack for an evacuation, evacuation routes, assembly points for the evacuated population, etc.);

– practical training of residents for cases of CBRN attacks; necessary activities and use of various personal protective equipment and aids; production of improvised protective

equipment; training in what to pack in the case of an evacuation; training in the evacuation of the population; comprehensive training of acquired skills and habits; training of the population in response to possible extraordinary events and emergency situations);

– theoretical training of rescuers, medical staff and policemen for cases of CBRN attacks and assaults (acquiring the necessary basic knowledge and awareness of CBRN issues);

– practical training of first responders, rescuers, medical staff and police officers on training grounds and in exercises in the case of CBRN terrorism (acquiring the necessary skills and habits for operations in extraordinary events and emergency situations [terrorist attacks]; and

– systematic, regular, and comprehensive verification of knowledge, skills and habits of rescuers through not only written tests, but also practical verification in the field.

The overall preparedness of the population for extraordinary events, emergency situations, and their adverse effects is a very complex, complicated, and long-term issue. In the Czech Republic, a system for preparing all groups of residents for extraordinary events and emergency situations has not yet been created (only partially for primary school pupils and secondary school students). An integral part of such preparation must be regular and systematic preparation of the population for possible CBRN attacks.

The Czech Republic has gradually developed several large and detailed integrated rescue system emergency response plans (type activities) for the most important areas of CBRN, as shown below:

– reaction to the misuse of biological warfare agents and biological agents against the population (General Directorate of the Fire and Rescue Service of the Czech Republic, Emergency Response Plan 2006),

– reaction to dirty bombs or other dangerous radioactive materials (General Directorate of the Fire and Rescue Service of the Czech Republic, Emergency Response Plan 2015),

– reaction to the misuse of chemical warfare agents and toxic industrial chemicals in the Metro in Prague (General Directorate of the Fire and Rescue Service of the Czech Republic, Emergency Response Plan 2013).

The above-mentioned three plans are regularly practiced, for example, it is possible to briefly recall the exercise METRO 2014 (underground, subway, tube), which was a large verification exercise of the entire Integrated Rescue System with a simulated use of the chemical warfare agent, sarin. This thoroughly and consistently verified the correctness, comprehensiveness and reality of the new plan, issued one year before.

Investigation Results. Despite the fact that the above-mentioned emergency response plans cover the area of CBRN quite comprehensively, we still see certain professional gaps in the area of CBRN protection. That is why it would be very useful and beneficial to create a *National CBRN Strategy* in the Czech Republic and subsequently a *National CBRN Action Plan* to protect the population and professional rescuers from the mentioned threats.

A great advantage is that many developed countries have created such documentation, and it is mostly publicly available (Canada's example). This already created documentation can be very inspiring for the Czech Republic, and it may largely become a basic model to be elaborated in accordance with the conditions in our country.

It may seem that such expert and relatively detailed scenarios can be inspirational and, in this way, also a kind of guide to carrying out a terrorist attack for terrorists and hostile persons. On the other hand, one must see the necessary main and fundamental reason for creating possible terrorist scenarios. To find the best, fastest, and most reliable ways to rescue and protect against CBRN terrorism, we need to ingeniously create such fictional but realistic scenarios of terrorist attacks that will be the basis for countermeasures throughout a complex and interconnected chain of measures.

Here we should chronologically list the measures from prevention, detection, identification, and monitoring of hazardous substances, through the evacuation and sheltering of the population, protection, rescue, mitigation of consequences, first medical care, safe and quick treatment of victims, hospitalization of affected persons and rescuers, to decontamination, restoration, and reconstruction of affected and contaminated areas.

The problem of dealing with extraordinary events and emergency situations is at a very comprehensive level in Canada. In addition, various manuals, aids, guidance documents, recommendations, management plans, and videos are readily available on their website. Why not learn from the experienced, why not use what has already been done and what has worked? It would perhaps be useful to establish fruitful international cooperation in this area.

The most important element of the whole process is the reliable collection of the most accurate information about a CBRN event for the authorities. This will create the necessary conditions for quick and correct decision-making on the need to take various measures. Obtaining the necessary information about the location of the event, the nature of the event, and the results of the first measurements, as well as information about the number of victims and injured and disabled persons, the extent of contamination, and other damages is undoubtedly very important. In addition, the correct and quick evaluation of the event by the control centre is of fundamental importance.

Conclusions. There is a clear need to pay great and permanent attention to the issues of defence and protection of the state and its population, and have the necessary documentation prepared for the management of activities in extraordinary conditions at all levels. It is also necessary to prepare not only experts in the components of the integrated rescue system, armed forces, but also crisis managers in the national economy, in state and self-governing bodies, and public institutions.

Therefore, it is very important that the Czech Republic also continues to pay increased attention to protection against chemical, biological, radiological and nuclear terrorism in vulnerable public places (e.g. in the Prague metro). However, they must also seriously consider all possible catastrophic scenarios of attacks and ambushes using CBRN agents and material.

Cruel, brutal, and violent acts of terrorism are planned to affect the public and to create shock and stress in entire nations. Negative experiences resulting from the horrors and memories of dead and disabled victims will leave a lasting impact on all persons affected by the attack, as well as their families and relatives, friends and acquaintances. [5]

If the proposed management system saved a single human life (even though it can protect and save tens, hundreds, if not thousands of lives), it is undoubtedly worth it. The Czech Republic has many important professional publications that could greatly support the creation of a

National Strategy for Protection in the field of CBRN and, as a result, a National Action Plan for this area. [6]

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Gloves in the Pharmaceutical Industry and Selected Aspects of their Evaluation

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Introduction. Protecting workers′ body surfaces who use toxic chemicals in the course of their professional activities is a very important protective measure. Acids, bases and organic solvents and dyes, for example, are very important starting materials (reactants) in the manufacture of medicines, medical products and the now widely used food supplements. The amount of personal protective equipment (PPE) used in the pharmaceutical industry is quite significant. Even though it might seem that the product portfolio of each pharmaceutical company would be the same in terms of the type of glove PPE used, in reality it should be noted that quite significant differences were found. In this research, only those gloves used in production plants and laboratories will be described, analysed and compared, not gloves used in external work. This approach meant that attention could be focused only on those types of gloves that are actually used in the production process.

There is no consistent and uniform definition of occupational safety and health (OSH). However, there is no doubt that it is an interdisciplinary or inter-scientific field, which can be defined as rules or measures established by legislation to prevent danger or damage to human health during the work process [5]. Employers have a duty to create suitable and safe working conditions for the performance of work by a particular employee. It is therefore necessary to know what hand protection is most appropriate and which particular hand protection to use in a particular situation and what degree of protection it will provide the employee. The issue of OSH is closely related to the issue of occupational hygiene. The aim of this branch is to ensure that the working environment and other working conditions are consistent with the natural characteristics of employees and protect them from harmful effects and excessive and unnatural stresses on the human body.

Method of Investigation. Data collection was carried out in the following pharmaceutical companies: Teva Czech Industries s.r.o., K2pharm s.r.o, Farmak, a.s., Macco Organiques, s.r.o. In the case of Teva Czech Industries s.r.o. and K2pharm s.r.o., the research included a personal visit by a safety technician and a current list of glove-type PPE used was requested. An email request was sent to Macco Organiques, s.r.o. and Farmak, a.s. by the main author of

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the paper, specifying a request to send the same list of gloves used.

Investigation Results. The data collected through literature searches and interviews with employees of each organization were compared. The results of the comparisons are published in the form of a table and then discussed. The publication and discussion of the results is also preceded by an introduction to each type of glove and references to the information from which the descriptions were drawn.

Table 1 Results of glove comparison

Glove number corresponding to the established marking	Parameter No. 1 Resistance to chemicals	Parameter No. 2 Abrasion resistance	Parameter No. 3 Resistance to puncture	Parameter No. 4 Permeation
1	+	+	-	+
2	+	+	-	+
3	+	-	-	+
4	+	+	-	+
5	-	0	0	+
6	-	0	0	+
7	+	-	-	+
8	-	0	0	+
9	+	+	-	+
10	+	-	-	+
11	+	0	-	+
12	+	-	-	+
13	-	+	-	+
14	-	0	0	+
15	-	0	0	+
16	-	0	0	+
17	-	-	-	+
18	0	0	0	0

Conclusions. Within the framework of the conducted research, a comparison of the portfolio of gloves used in selected pharmaceutical companies was carried out. Initial results showed that each of the companies uses different types of PPE type gloves, moreover in different numbers. The overwhelmingly dominant representative of the gloves supplied was Ansell Ltd. It turned out that this company offers a very wide range of gloves capable of protecting the employees of pharmaceutical companies in a comprehensive and maximally effective way against the effects of the hazards associated with the use of chemicals and preparations that can occur in the pharmaceutical industry. The parameters that have been purposely selected represent the most important and significant risks that can be associated with the use of chemicals and preparations, both in the manufacturing process itself and in the process of laboratory experimental work. In the suggestions and discussion section of the article, some recommendations were made that could be followed by the companies involved, both to ensure maximum cost-effectiveness and to provide effective protection for employees. It is evident that the parameters chosen and the evaluation of the gloves were based on subjective evaluation and assessment of publicly available data. In the next step, research will be guided

to carry out targeted experimental work that could be devoted to the verification of the parameters declared by the manufacturer and their subsequent comparison with reality.

Limitations. Although the results are based on the experience of experts dealing with occupational safety and health issues, it is not possible to state unequivocally that the results could be used universally. However, it can be assumed that the proposed procedures and conclusions from the comparison of gloves used by different companies in the pharmaceutical industry could lead to considerations that would contribute to the rationalization of purchases and the possible sharing of data. Another partial limitation is that no experimental research has been conducted on the durability of gloves under laboratory conditions. This will be implemented as a follow-up step as part of the follow-up research.

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Tornado Strike in Mikulčice and Options for Dealing with its Consequences

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Introduction. The occurrence of strong and destructive tornadoes is not a frequent natural phenomenon in the Czech Republic. Although there are units of tornadoes formed annually in the Czech Republic, these are tornadoes of a weaker nature, which are practically not reported. Despite this, a tornado of a very strong nature occurred in South Moravia in 2021. Specifically, in the village of Mikulčice, which is the primary focus of the communication, it devastated almost half the village. At the outset, we would like to add that although it might seem that the declared relatively rare occurrence of this extraordinary event may not be of much interest and that it does not need to be systematically addressed, another devastating tornado also occurred in the Svitavy region in 2023. This tornado also caused considerable property damage, but in comparison to the events in South Moravia it was disproportionately smaller.

Although this is a natural phenomenon that occurs relatively rarely in the CR, it is necessary to actively prepare for this type of extraordinary event. Although this is undoubtedly a sequence of very tragic events, the subsequent reconstruction of the village should be seen not as a mere rebuilding and restoration, but as an opportunity to prepare effectively in case a similar EE occurs again [3].

Method of investigation. A historical-descriptive method of data collection was used. On the basis of the description of the historical and current state of occurrence of tornadoes in the Czech Republic, their characterization from the point of view of population protection was carried out. Since this was a relatively unique phenomenon that does not occur very often in the Czech Republic, relevant historical data are not available. Subsequently, data on the village of Mikulčice was collected using descriptive methods to provide a framework for ongoing research.

The research survey was conducted in the form of an anonymous online questionnaire. The content of the questionnaire was consulted with a member of the FRB from the Population Protection Department. Furthermore, the questionnaire was consulted and tested with an IT consultant from Arkance Systems. The questionnaire contained both open and closed questions. The questionnaire also included questions where the respondent expressed their

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level of satisfaction on a scale from "very satisfied" to "very dissatisfied". The variety of questions was intended to increase the quality of the research, and the questions were asked in a clear, simple and easy to answer way. A total of 64 respondents took part in the survey, with a ratio of 70.3% women (45 respondents) to 29.7% men (19 respondents). Women made up more than two thirds of the respondents. The questionnaire was distributed only among the citizens of Mikulčice. To support the sub-theoretical areas, the method of concept mapping was used, which is currently proving to be a very progressive tool for publishing and processing texts and data.

Investigation Results. The results of the research were summarized on the basis of the knowledge of theory and practice of population protection. Questionnaires were used to collect data and to provide the basis for the design part of the communication. The main part of the paper is the proposal of measures that could be implemented in order to better and more effectively prepare for future tornadoes. Attention was also focused on the area of education, where the public administration plays a very important and, one might say, irreplaceable role. All the proposed measures are based on the actual state of knowledge of the facts and work with the possibility of implementing the proposed measures over the next few years to the long term.

Fig. 1 Comprehensive statutory concept of population protection

Conclusions. Dealing with the consequences of EE, which are not a normal part of the crisis management activities of a municipality, municipal district, region or even the state, is not a simple matter. The authors of this communication are sufficiently aware that the training of response to MU, which are very difficult to predict in advance, is a very difficult and basically unfeasible matter. Furthermore, we are aware that there is not enough experience to date that could be passed on for further evaluation in the form of tactical procedures, typical activities of IRS units, lessons learned, etc. We are aware that the time that has elapsed since the EE may have been a limit to the acquisition of relevant information. Since the authors' efforts were motivated by the desire to obtain information on the functionality of the systems at a time when rescue and disposal work, usually associated with great enthusiasm and determination of the intervening personnel and volunteers, was completed, we do not consider this shortcoming to be a handicap, but rather an advantage. We base this statement on the fact that the draft measures, which were based on a questionnaire survey and the retrospective assessment of the situation by the inhabitants of the village themselves, are more relevant

than ad-hoc opinions expressed under the influence of strong emotions.

Limitations. The data that were obtained based on the conducted research were created two years after the emergency in the Mikulčice municipality. It is therefore possible that some proposals and measures may no longer be relevant in terms of time. However, it can be assumed that the preparedness of other municipalities in the future could be based on the knowledge gained in this stage of the research. The question is therefore whether this is a limitation or, on the contrary, that some of the proposed measures have been or will be actively pursued.

Keywords: *Tornado, emergency, protective measures, meteorological phenomenon, Mikulčice, prevention, school, Fujita scale, population*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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Military Engineering Aspects Assessment in Scope of Russian-Ukrainian Conflict

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Introduction. Military engineers are part of most military operations. Their role consists of mobility support, counter-mobility support, survivability support and general engineer support. The form and intensity of military engineer involvement depends on the nature of the operational environment and the type of operation. The main focus of NATO armies over the last two decades has been counterinsurgency in many asymmetric conflicts. The main effort of military engineers in these operations has been to eliminate the threat posed by improvised explosive devices. Much of the thinking about the nature of the future theater of war has been directed toward asymmetric, expeditionary operations outside the territory of NATO nations.

The anticipated shape of the future operational environment and type of operation has changed significantly following the development of the Russian-Ukrainian conflict, when a full-scale invasion of the territory of Ukraine by the Russian Federation was launched on 24 February 2022. The likelihood of a future armed conflict between NATO and the Russian Federation has been significantly increased by this act. Thus, the real threat is a prolonged high-intensity conflict with a technologically advanced adversary equipped with nuclear weapons.

The assumed form and intensity of military engineer involvement in this type of conflict has changed. The main effort will be directed towards the performance of combat support engineering at an intensity commensurate with the strength and capabilities of the enemy. This paper is concerned with an open-source assessment of the military engineering aspects of the Russian-Ukrainian conflict.

Method of investigation. Based on the analysis of open sources, the military engineering aspects of operations on both sides of the conflict were assessed with emphasis on the performance of combat support engineering. Substantial aspects of military engineering are assessed in relation to the expected capabilities and procedures of NATO armies.

Investigation Results. A crucial factor in the Russian-Ukrainian conflict is innovation and the speed with which it is implemented on the battlefield (especially in the area of reconnaissance and information transfer). In the case of mobility support (obstacle breaching, wet-gap crossing), there are two opposing factors. The first factor is the concentration of sufficient forces to achieve the desired objective, and the opposing factor is the desire to minimize the number of forces and assets grouped into a single priority target that is soon discovered and

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destroyed by the enemy. Minefields are often oversized, and some parameters of minefield breaching means may not be sufficient to create a breach. A key factor in accomplishing the core tasks of combat support engineering (obstacle breaching, wet-gap crossing) is control of airspace and suppression of enemy artillery on a given section of the battlefield.

Conclusions. Based on available open source information, the military engineering aspects of the Russian-Ukrainian conflict were assessed. On the basis of the findings, possible measures can be proposed for the training of military engineer units.

Limitations. The main limitation of this assessment is the analysis of unclassified open source information. Furthermore, it must be accepted that the Russian-Ukrainian conflict is still ongoing. It is therefore desirable to monitor and analyze further developments in the field of the military engineering aspects of this conflict.

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Analysis of Trends in Defense Financing in the Member States of the North Atlantic Alliance

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Introduction. After long years of peace, there is a gradual deterioration of the global and regional security environment and deepening of some security problems around the borders of the NATO member states [5,6]. This was due to the continuous increase in tensions in international relations, especially after Russia's annexation of Crimea in 2014, the growth of tensions in relations between major powers, and the rise of several militaries, but mainly non-military security threats. [7]. The rapid worsening of the security situation on the European continent occurred after the military invasion of Ukraine by the troops of the Russian Federation on 24 February 2022 [1].

Methods of investigation. The aim of the article is to analyze the impact of the development of security threats on the financing of the defense capabilities of NATO states. The author is based on the theory of defense financing as a public good and the analysis of empirical data on the development of defense spending and the negative impact of the "free rider". In the first part, attention is paid to the theoretical definition of defense from the point of view of economic theory, and in the second part to the analysis of defense expenditures in NATO member countries. The author draws on the works of authors such as Samuelson and Nordhaus [15] etc. and Ivančík [6] and domestic authors Odehnal et al. [14], Boulouad et al.
[2] In the first and second part of the article, the author chose a positive approach. The author of the article conducted an extensive literature search of theoretical literature and relevant political and legal documents (NATO, EU, Czech and Slovak Republic). For the purpose of analyzing the impact of security threats on military spending, the author analyzed trends in defense spending by NATO member states in the context of the "free rider" impact on the state's defense capability.

Investigation Results. The easing of tensions in international relations at the beginning of the second decade of the 21st century caused NATO member states to gradually reduce defense spending. The drop in spending from 2011 to 2015 was 15% [10]. The reduction mainly concerned the expenses connected with the training, deployment, replacement, maintenance and withdrawal of military forces in military operations outside the own territory of the states. A number of coalition states fell well below the agreed 2% of GDP. E.g. in the case of the Czech Republic and Slovakia, defense spending hovered around 1% of GDP. The governments of both countries benefited from peace in Europe and from the position of the so-called free rider.

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The turn in development occurred under the influence of the crisis events in Ukraine, the subsequent annexation of Crimea by the Russian Federation and the successful offensive of the Islamic State in Syria and Iraq.[5] In the years 2015 - 2019, there is a gradual increase in defense expenditures of NATO countries by approx. 13.2%, i.e. almost at the level of 2011.[8]

The growth of defense spending in the member states of the Alliance continued in the following years. Several sharp statements by former US President Donald Trump, who repeatedly criticized representatives of European NATO member states for abusing the benefits of collective defense, also contributed to this. Personally or through his ministers of defense and foreign affairs, he requested an increase in defense spending to the limit of 2% of GDP[6].

After the outbreak of the war in Ukraine, the member states fully realized the need to have adequate military capabilities and capacities necessary for self-defense. The increase in defense spending compared to 2019 amounted to almost 16.7%. When analyzing expenses, it is necessary to include the negative effect of the free rider position. I.e. the difference between an agreed obligation and its non-performance. In that case, it is clear that defense spending, for example in the Czech Republic and Slovakia, should be at least threshold of 3% of GDP.

Conclusions. The dependence of NATO countries' defense spending growth on the development of the security situation in the world can be clearly demonstrated. The implementation of decisions to increase defense resources always comes with a delay. In the case of reducing threats, politicians quickly redistribute defense money to other areas, benefit from the "free rider" position and get more preferential votes. The unfulfilled obligation and the indicator of the level of modernization create an internal debt of defense financing. Failure to follow the agreed rules causes discontent among allies who respect the agreements. Despite increasing defense spending, 18 NATO states, including the Czech Republic, were still in a "free rider" position in 2023.

The increased spending only makes up for the commitment deficits of previous years. This significantly delays the modernization of military equipment and armaments. Existing macro analyzes usually do not take this fact into account, thereby distorting the benefit of increased resources. From the above, it can be concluded that the "free rider" factor can have a positive effect on the state's economy in the short term, but in the long term, it is an undesirable factor threatening the defense capability of the state and the entire NATO coalition.

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The Impact of the Deteriorated Political and Security Situation on the Financial Stability of Arms Companies Operating in an Oligopolistic Market Environment

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Introduction. The article presents the results of research on 15 technological arms companies, manufacturers of technologically advanced products, which have long been active in the market for special military and security equipment. The case study presents a qualitative analysis of the impact of state demand, human and material capital on the level of potential product. We address a series of research questions as to whether and how the deteriorated political-security situation affects the level of potential product, whether this level creates potential scope for closer military and industrial cooperation between the B9 states in the product portfolio under study, and whether this level is sustainable in the long term with the possibility of further growth using the principle of comparative advantage and the implementation of joint projects.

For the B9 countries, the mismatch between growth in national wealth and defence spending over the last 20 years is symptomatic. We demonstrate this mismatch and detect changes in the approach to defence spending post-2014.

Method of investigation. On the supply side, we rely on publicly available data, final reports and financial statements, which are published in accordance with applicable legislation. We verify the validity of the hypothesis that growth in the number of personnel and capital contributes to the growth in sales and the ability of the firm under study to deliver the desired product to the government on time and within the required range of specified combat capabilities. We use a case study of the application of the principle of comparative advantage to demonstrate the positive benefits of cooperation among the B9 states and compare each case with existing practice.

Fig. 1 - using S1 as an example, we see that an increase in the number of employees is not always accompanied by an increase in revenue. Local revenue peaks result from the successful completion of large projects, usually carried out on the basis of precise customer specifications. The Revenues ±95.00PI curves show the upper and lower bounds of the forecast range of revenue development under current conditions. We refer to the upper end of the forecast band as representing the Company's potential product.

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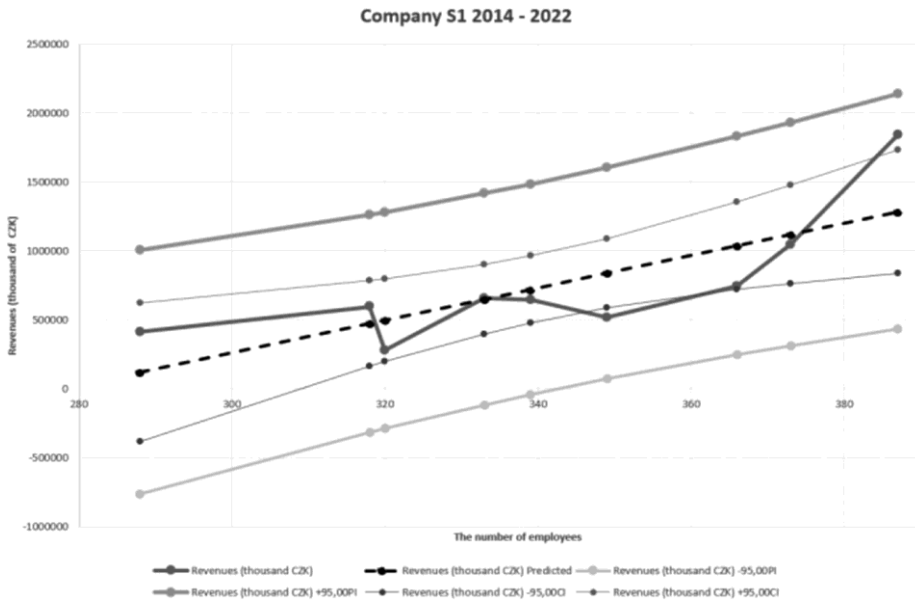
Fig. 1 Company S1 revenue development by number of employees from 2014 to 2022

Fig. 2 – Fig. 1 is related to the time series development of sales. The year 2014, the occupation of Crimea by the Russian Federation, and the increase in the risk of a military conflict are reflected in the volume of sales, along with an extreme increase in 2022, the outbreak of war between Ukraine and the Russian Federation.
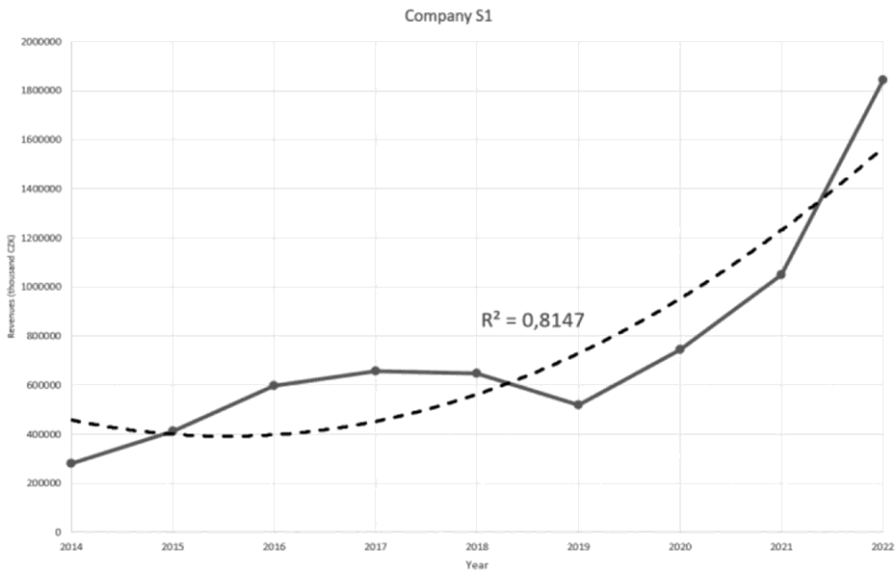
Fig. 2 Company S1 revenue development from 2014 to 2022

Fig. 3 - shows the evaluation of the QCA analysis of the impact of the number of employees on the level of sales. The graph shows that the number of employees does not meet either the necessary or sufficient conditions for the level of sales.
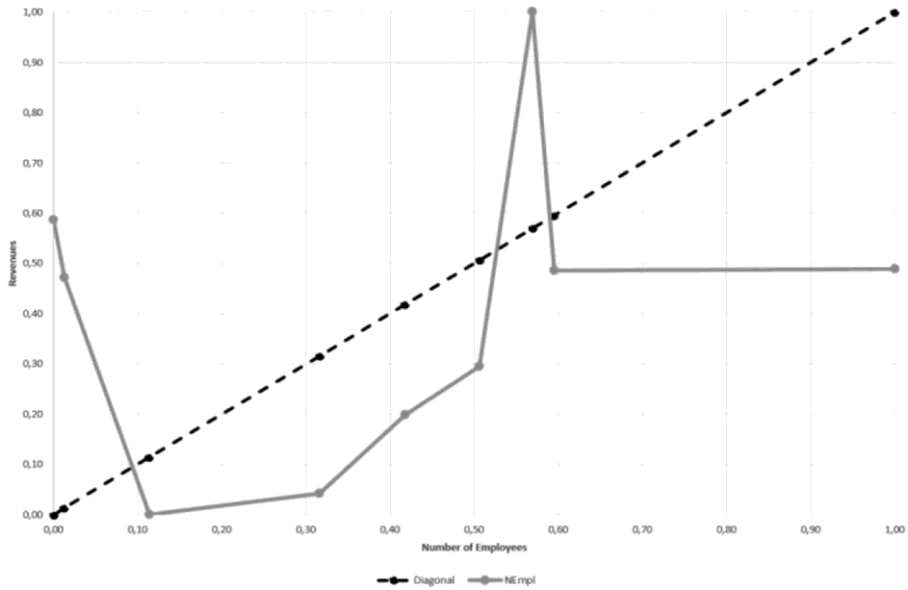
Fig. 3 QCA analysis of the impact of the number of employees on sales

Investigation Results. Above, see Figure 1, Figure 2, Figure 3, we present fragments of our research results on a demonstration example of one of the surveyed arms companies:

● for weapons technology firms with in-house development, firms whose production is rather piece-rate, the hypothesis of the effect of the number of employees on the growth/decline of sales cannot be clearly confirmed - the development of sales shows local maxima and minima that are not related to the number of employees,

● the above conclusion is also supported by the QCA analysis, and the number of employees does not meet either the necessary or sufficient conditions for the level of sales,

● the potential product can be expressed in the form of the boundaries of the prediction band; this is an essential result that can be used as a calculation figure in the formulation of the share of military budgets and the fulfilment of arms deliveries by the forces of the own arms industry,

● the production and focus of armaments firms is significantly influenced by the specification of domestic customer demand (usually the MOD) and the predictable range of demand, which enables firms to make effective and strategically sound decisions about the structure of their product portfolio,

● the exogenous factor of the development of the security-political situation affects the development of sales only for those firms that have a demanded product with completed development, while the possibility of accelerating development in the short term is limited within the upper and lower limits of the prediction band,

● the possibility of an effective quantitative increase in output is to use the principle of comparative advantage.

Conclusions. We consider the subject of our research significant for several reasons. The capabilities of the arms industry are an important determinant of the technological level of its own armed forces. This means that all development concepts can realistically only include technologies that are commercially available, either domestically or from foreign partners.

Further, we believe that not all potential opportunities for cooperation between B9 arms companies are being exploited, and that there is a much greater potential for cooperation between government, commercial and R&D departments. Statistical data show an almost constant level of financial coverage of research and development within the scope of the Ministry of Defence of the Czech Republic.

Given the deteriorated political and security situation not only in Europe. We see the solution of the problem of strategic stability of the formulation of demand on the part of the state and the ability of acceptable supply on the part of arms companies as a crucial interdependence. The analytical understanding of the real situation is thus the centre of gravity for the formulation of realistic concepts or the modification of existing ones, considering the impact of all risks.

Limitations. The main limitation lies in the possibility to analyse only publicly available information.

Acknowledgements. The authors are grateful to the University of Defence for all the support during the scientific research.

Keywords: *Defence, Oligopolistic market environment, Capacity of the arms industry, Comparative advantage, Research.*

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Exploring the Defence Industry´s Macroeconomic and Microeconomic Perspectives under New Security Conditions

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Introduction. In the presented analysis, aspects of the defence industry under new security conditions are examined from both macroeconomic and microeconomic viewpoints. At the macroeconomic level, it is investigated how the export of arms can be conducive to the stimulation of GDP growth, augmentation of public sector revenues, and the bolstering of foreign trade [1]. At the microeconomic level, attention is given to the exploration of research, development, employment, and issues pertaining to fixed capital.

National economies are required to incessantly adjust to global shifts that encompass financial aspects, climate change, warfare conflicts, migration waves, economic cycles, among others. Numerous analyses that portray global trends and the adaptation of the defense industry to these trends are also reviewed. Analyses conducted post-2008 [5] and 2021 [6] imply a substantial necessity for the restructuring of the defense industry and defense policy. Such restructuring is suggested to encompass the identification of critical technologies and competencies for national security and defense, the establishment of acquisition agencies for the centralization and enhancement of public procurement, as well as the mitigation of the habitual underestimation of the defense sector´s significance in comparison to other sectors [6]. The war in Ukraine has been identified as an influential factor contributing to the macroeconomic and microeconomic fortification, as well as to an improvement in the industry´s reputation. Increased support for arms manufacturing by the banking sector is observed. The standing of the arms business has transitioned to becoming pivotal post the invasion by Russia, indicating a shift in the approach of governments and society towards the growth in military expenditures.

Method of investigation. During the preparation of this article, Stockholm International Peace Research Institute´s databases (SIPRI databases [7], [8]) were utilized. These databases contain comprehensive information about companies involved in the manufacturing of weapons and the provision of military services. This includes both, public and private entities but excludes production or maintenance units of armed forces. Access to these databases enabled the acquisition of data for arms companies based on open sources. The sources included annual corporate reports and articles in journals and newspapers. Data for all years are revised annually based on new information. Since the early 1990s, an increasing number of

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governments have decided to publish national reports on their arms exports. Currently, there are no data series comparing the values of arms exports between countries, apart from SIPRI yearbooks. Methods for generating data series are largely based on already available data series relevant for arms production [2]. This pertains to the import and export of weapons, state contracts, and the turnovers of the world´s largest arms companies. Various methods employ different definitions of the scope of arms production; therefore, it was necessary to adhere to a single definition, namely SIPRI. For addressing the behavior of the defense industry in new security conditions, the method of descriptive and comparative analysis was employed. From statistical methods, regression analysis and statistical representation of arms exports of selected countries between 2014 and 2022 were employed.

Investigation Results. In addition to the analysis of the microeconomic and macroeconomic aspects of arms production, a regression analysis was conducted, yielding the following results:

Arms Export: Trend-indicator value: p-value: 4.726e-09 and Pearson: 0.9904353

Regression analysis for 11 selected countries in 2014 and 2022 is presented in Fig. 1.
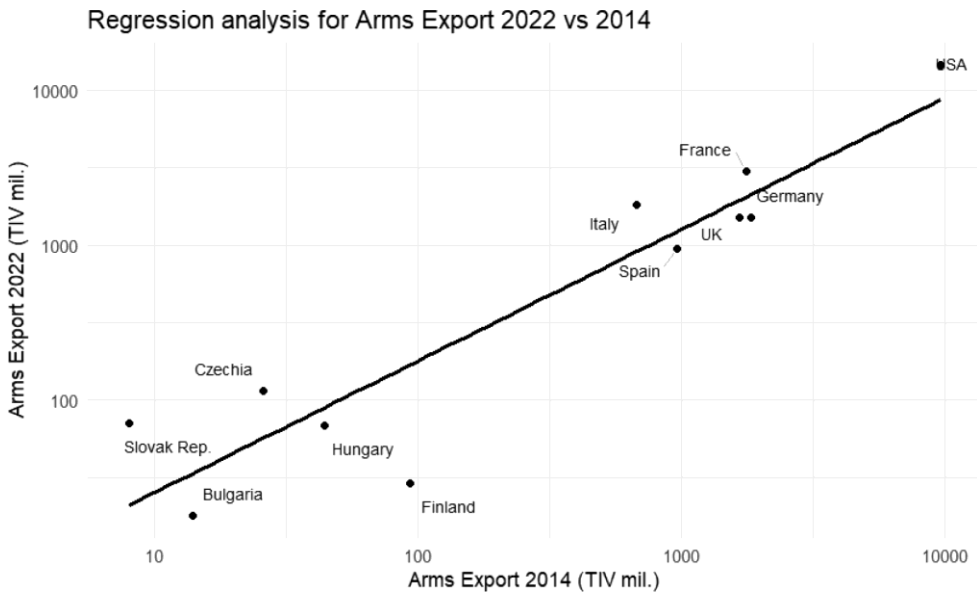
Fig. 1 Regression analysis of arms exports in selected countries during the comparative period 2014 and 2022

Source: SIPRI (2024)

Fig. 2 shows an increase in arms exports for most of the examined countries during the period of 2014 to 2022. Arms exports together with issued licenses for the export of weapons can be seen as a driver of gross domestic product growth.
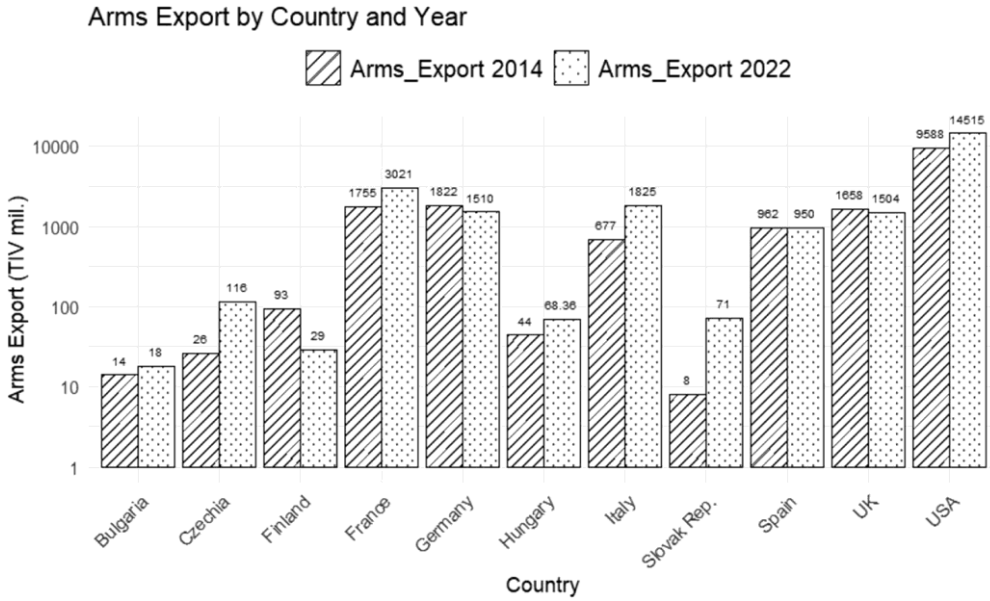
Fig. 2 Arms export in selected countries during the comparative period 2014 and 2022

Source: SIPRI (2024)

Conclusions. The defense industry is undergoing a far-reaching process of adaptation because of changes in the security environment [9]. Based on our study, the following main trends can be distinguished:

• defense production markets in several countries have been affected by greater market freedom, competition, and exhaustion of arms deliveries for Ukraine;

• new conditions are leading to transformations in the traditionally close relationship between the state and producers [3];

• the military conflict in Ukraine is driving the modernization and expansion of the defense industry [4];

• increased defence budgets are triggering a crisis in the defense industry, which is now operating in a much more complex environment than before and is seeking new resources for production—bank loans, raw materials, machinery, and labor.

Limitations. Restrictions were set on the number of countries for the analysis of developments in the arms industry and arms exports, relying on available data. In the future, the availability of published data for 2023 and subsequently 2024 will benefit this analysis.

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Trends, Requirements, and Rigors of Environmental Policy Formulation: The Czech Military Perspective

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Introduction. Various conflicts throughout history have shown that military activities have a significant impact on the environment. Whether it was the use of chemical weapons in World War I or the excessive dispersion of defoliants during the Vietnam War, with technological advances in used weapon systems greater damage has come to nature and the landscape.

Armed conflicts of the 20th century were symmetrical conflicts using the latest weapon systems and technologies [1–3]. With the renewal of asymmetric and guerrilla-style warfare after 2001, in the Middle East particularly, the environmental damage has not been severe enough to be actively addressed [4, 5]. However, the ongoing conflict in Ukraine once again shows the other side of the technological progress within conventional armed conflict showing massive and especially long-term impacts on entire habitats.

On 14 November 2022, the UN General Assembly endorsed Ukraine's right to war reparations and called for the establishment of an international mechanism to enable their recovery [5, 6], although, the extent of environmental damage that these reparations will consider is still under discussion. The reason for this uncertainty is based on the current lack of a legislatively embedded assessment framework for the evaluation of environmental damage [7]. Thorough and appropriate wording of environmental policy is then the cornerstone for quality implementation and prevention of potential damage not only to habitats but also to entire ecosystems.

With the growing threat of climate change, environmental protection represents one of the most important societal issues [8] and environmental policy has become a more widely discussed topic at the NATO level in the last decade [9]. Unfortunately, with the consequences of the war in Ukraine, the need for prevention and remediation of environmental damage is rising.

Method of investigation. The paper aims to summarize the current military strategy of the Czech Armed Forces (CAF) in the scope of NATO's environmental policy and how it reflects the national environmental legislation of the Czech Republic as a member state of the European Union (EU) regarding the current situation in Ukraine. The study is developed in the form of a graphical representation of the links between national and international environmental policies using grounded theory for data collection and a method of qualitative content analysis and SWOT analysis. The data obtained were interpreted using research synthesis.

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Investigation Results. To perform the research, it was necessary to identify the links between the adopted environmental policy at the national and international levels. A search for the common links was carried out from the 1970s to 2022. The observed relationships are shown in Fig. 1.
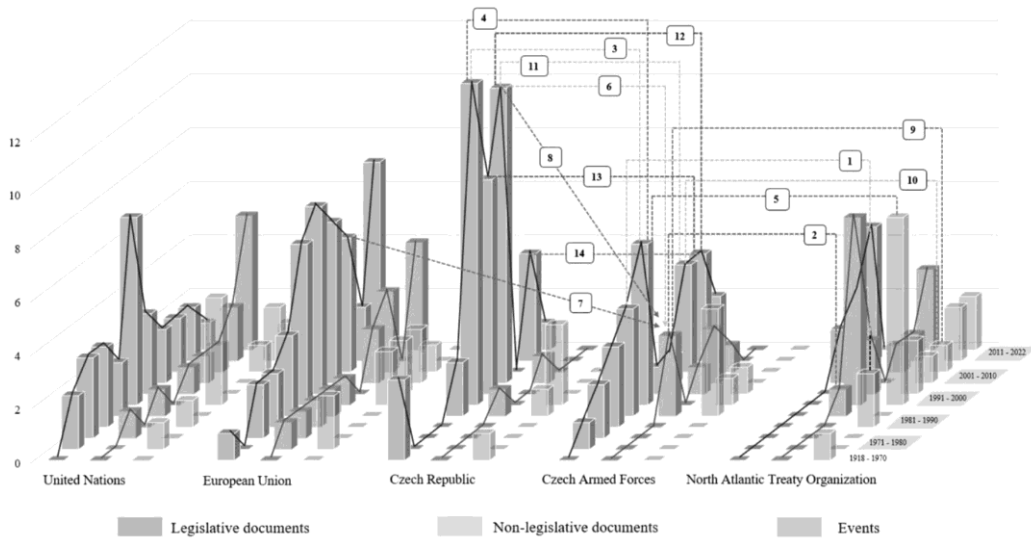
Fig. 1 Development of environmental legislation in the national and international context

Based on the links found, it can be concluded that the incorporation of environmental issues into military regulations is shaped by the Czech legal system and NATO policy mostly. The influence of the current issues on the UN and EU level does not affect the policy of the Czech Armed Forces in the short term. The environmental issues are incorporated only after the adoption of the policy of the international organizations into the national legal system.

Conclusions. The outcomes of this study comprise the current state analysis of incorporating the necessary environmental legislation into the Czech military strategy and addressing the environmental policy issue by its strengths, weaknesses, opportunities, and threats. However, the rigidity imposed by a system of slow adoption of new policies is not necessarily a problem. On the contrary, in some cases, it can act as a brake on hasty and untested decisions that could damage the existing system.

Limitations. In the context of the reciprocal interaction between the activities of the armed forces and the environment, the research deals only with the first variant, namely the impact of military activities on the environment. The second option, i.e., the effect of natural influences on military activities, including e.g., climate change, is excluded from research.

Keywords: *Czech Armed Forces; Environmental Policy; Environmental Protection; NATO.*

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Current Trends in Research Methodology in Security and Defence Research

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Introduction. Defence and Security Studies is an interdisciplinary field that encompasses the study of military affairs, security issues, defence policy, and national security strategies [1]. It includes the study of military organisations, defence technologies, strategic planning, conflict resolution, and the role of the armed forces in securing national interests. Therefore, as Nikolic [2] argues, research in the defence and security sector often has a specific multidisciplinary character, that is, in order to fully understand the dynamics of defence and security in modern societies, researchers draw on knowledge and research methodologies from the sciences of politics, economics, sociology, strategic management, international relations and others.

The changing nature of security threats and technological advances presents increasing challenges to the security and defence sector. Given the complexity and interdisciplinary nature of the field under analysis, it is argued that it is necessary for researchers studying security issues, assessing risks or predicting future patterns to apply not only new, but also properly selected methodological approaches, and data collection and processing methods. Therefore, researchers should keep the field of research, the methodological approaches and methods used, and the flow of topics and issues under analysis constantly reviewed.

From a methodological point of view, defence and security studies face a number of challenges related not only to the choice of the topic and the formulation of the problem, but more often to the selection of appropriate research methodologies, limitations of data collection methods, challenges in the application of data analysis techniques, and difficulties in the interpretation of results [3]. Moreover, defence studies, as an interdisciplinary field, pose unique methodological dilemmas in the study of complex security problems, as researchers have to navigate between quantitative and qualitative methodological approaches and different data collection and analysis methods. For this reason, it is essential to justify the suitability of the choice of methodology for the stated purpose and the reliability of the results [4]. Therefore, to identify the contemporary trends in research methodology in security and defence studies, this paper reviews the methodological approaches used in security and defence studies and the specifics of their choice in relation to the research topic.

Method of investigation. The review adopts a qualitative thematic research approach which aims at structuring the research areas (objects), methodological approach and methods used in the research of scientific publications in the field of defence security studies for the period

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2023-2024. For this purpose, scientific journals included in the Scopus database were selected. Considering the large sample size of scientific journals, those that use the term 'defence' in their title were selected. The five most recent publications from the following journals were selected for exploratory qualitative analysis: Defence and Security Analysis, Defence Studies, Defence and Peace Economics, Journal of Defence Analytics and Logistics, The Journal of Defence Modelling and Simulation. Due to the large sample of articles, the study excluded articles that dealt with cyber security or security in the broader context, i.e., related to social phenomena such as crime, acts of terrorism, violence, etc. Qualitative content analysis was used to analyse the data.

Results and conclusions. The thematic analysis of the articles shows that the most frequent topics covered in the academic journals related to Security and Defence Studies reflect contemporary geopolitical developments in the world. The most common areas of research are defence spending, defence strategy development, defence intelligence, and defence industrialisation, as well as cooperation between the Armed Forces and the defence industry [5]. It is also worth mentioning that the research papers have identified an interdisciplinary approach to the purpose of research and the analysis of results. It is argued that Security and Defence research is inherently multidisciplinary, requiring insights from various fields such as political science, sociology, psychology, and technology. Therefore, current trends show the importance of interdisciplinary collaboration, where researchers draw on insights from different disciplines to fully understand complex security challenges. The integration of different perspectives is likely to lead to the development of comprehensive strategies and solutions.

The choice of the research methodology approach and methods in research is highly dependent on the content and requirements of the scientific journal. It is arguable that, while security and defence research is still dominated by quantitative methods, particularly in the field of security economics (econometric methods), recently the value of theoretical and qualitative methods has been increasingly recognised. In addition to the traditional quantitative research methods, the analysed articles also include qualitative research methods: analysis of secondary data - qualitative document analysis, interviews and focus group discussion.

The analysis shows that the research methodologies used in the field of security and defence are very diverse and perhaps even chaotic. It is fair to say that researchers use a wide variety of methodological approaches (narrative, systems analysis, systems-thinking approach, etc.). However, on the methodological side, there is a problem with respecting the rules of methodological application or with the quality of the methodological description of the study. The problem is compounded by the fact that security and defence studies are interdisciplinary, so methodological approaches to research are transferred and adapted from other scientific fields. However, it is precisely this factor that can lead to situations where the results of the research are flawed or do not support any of the hypotheses or assertions put forward. Therefore, a comprehensive scientific debate on the feasibility and appropriateness of the use of different methodological approaches and methods in security and defence studies is needed.

Limitations. The research carried out is exploratory in nature, thus allowing for the identification of only general trends. Therefore, the results obtained cannot be considered as scientific truths, but rather as material for further discussion. A more realistic assessment requires a larger sample of articles and more precise evaluation criteria.

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The Complexity of Military Force Readiness to Respond to Changes in the Electromagnetic Environment

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Introduction. The readiness of military forces to conduct combat activities in an assigned operational area is closely related to the operating environment (OE) and their operational readiness. Unfortunately, the complexity and variability of the individual operational domains (land, maritime, air, space, and cyber) are no longer the only factors that shape the ultimate nature of the OE. The interactions and potential synergies resulting from the interdependencies between the individual operational domains, as well as the influence of other factors, actors, and wider environmental effects, can have a significant impact on the final nature of the OE. [1] Since operational readiness itself is understood in the military context as *"the preparedness of a unit, formation, weapon system or item of materiel to perform the missions, tasks or functions for which it is organized or designed"* [2], it is essential that the OE, in which military forces operate or will operate, shall be clearly specified.

However, such a specification of the OE cannot be based solely on analysis and description of the current nature of that environment. The aim is to achieve the most credible prediction of the OE in order to develop the capabilities of own military forces with regard to the nature of future military conflicts, more precisely the nature of the future OE. The accuracy of predicting the OE is then to some extent a reflection of the ability of a comprehensive approach that does not, however, neglect the details that have the ability to shape that environment. Due to the comprehensiveness of the OE, its prediction can be viewed from different angles. The view through electromagnetic (EM) energy, which has the potential to change the nature of the electromagnetic environment (EME) at a specific place and time, appears to be quite interesting and sometimes unfortunately neglected. Since the EME encompasses all operational domains and can theoretically be used to influence any actor in a military operation, it is inevitable to give it due consideration. [3], [4]

The question is not only what impact the development of assets and technologies based on the use of EM energy will have on the changing nature of the OE and with which problems will the military actors have to deal with in the near-future military conflicts. In addition to abovementioned predictable challenges related to the EME, there are also a number of very dynamic issues. Military actors must be prepared to respond to those issues in an unplanned and ad-hoc manner. The readiness of military forces to respond to changes in the EME is a fairly complex issue that requires a balanced approach across all functional areas. These areas are known in military environment by the acronym DOTMLPFI (doctrine, organization, training, materiel, leadership development, personnel, facilities, and interoperability).

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The challenge is to determine, or at least outline, which challenges must the military forces be prepared to respond to as the EME changes.

Method of investigation. This article reflects the outputs of the research activity in the field of OE, which was carried out in 2022 in connection with the final thesis of one of the authors on the topic "Conduct of EMO from the perspective of the strategic level of command and control of the Czech Armed Forces". Data and information to predict the nature of the OE were gathered through a systematic literature search, brainstorming and discussions with experts. These discussions included experts in the fields of electromagnetic warfare (EW), electromagnetic spectrum management (EMS), intelligence and military operations. The selection of these respondents was made with regard to the addressed trend of "development of assets and technologies based on the use of EM energy". The Futures Wheel tool was used to identify and visualize the direct and indirect consequences of the trend. [5] Military practice was then confronted with the identified consequences through unstructured interviews. The results of these interviews were used to formulate challenges regarding the readiness of military forces to respond to changes in the EME.

Investigation Results. The research has articulated the opportunities and challenges that military forces may face in the near future as the nature of the EME changes. Due to the sensitivity of the issue addressed, these possibilities and challenges have been generalized so that the expert public could use them as reference material for subsequent analysis of the real readiness of military forces to respond to the complex and changing nature of the OE, more precisely the EME.

In order to enable anyone to further elaborate on the direct and indirect consequences of changes in the nature of the EME and the resulting opportunities and challenges for armed forces, Fig. 1 has been published.
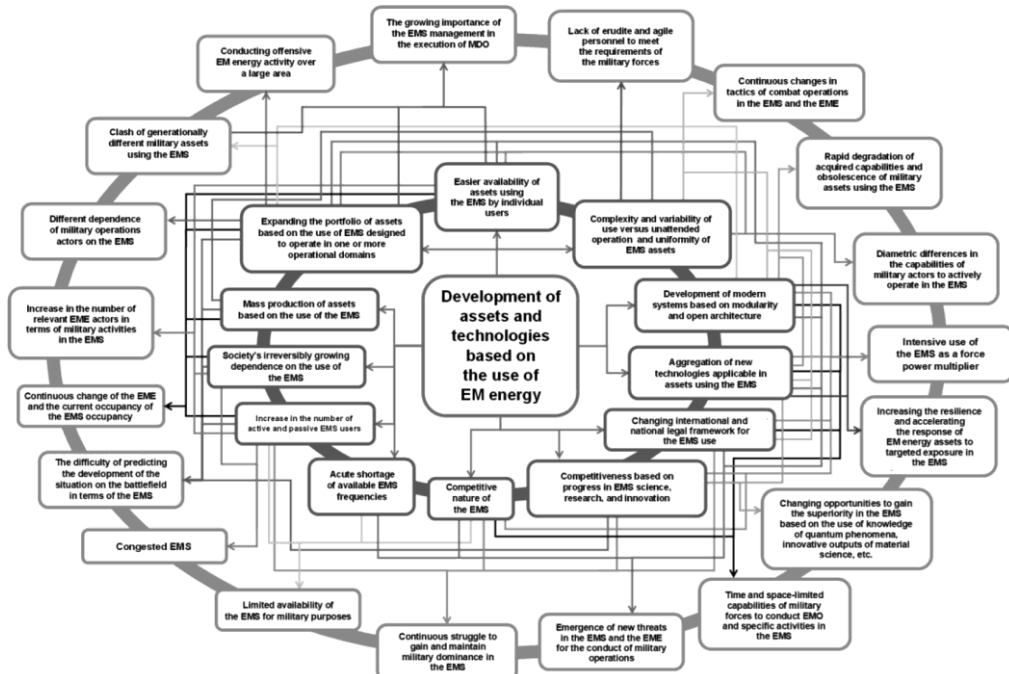

Fig. 1 Prediction of the future OE from the EMS perspective

Conclusions. Research has shown that the development of assets and technologies based on the use of EM energy is and will undoubtedly continue to be a cause of changes in the EME. These changes, which are visualized as direct and indirect consequences in Fig. 1, will certainly have a major impact on the ultimate character of the OE. Thus, military forces in all operational domains will face many dilemmas as a result of dynamic OE changes.

If military forces are unable to adequately address these dilemmas, their operational readiness may be significantly compromised by EM energy. It is therefore very important that all measures responding to the variability of the EME are addressed and implemented in all functional areas of DOTMLPFI. In addition to the assumption of continuous change in the EME, these measures must also reflect anticipated developments in the technical and technological fields, both on the part of the own forces and those of enemies and adversaries.

Limitations. The sensitivity of the EME and the use of the EMS, or more specifically EM energy for military purposes, does not allow for an open assessment of the readiness of military forces to respond to changes in the EME. The real operational readiness of military forces is subject to protection, that is, this information is treated as classified. The present text therefore reflects selected generalized opportunities and challenges that military forces are already exposed to today or may be exposed to in the near future in connection with changes in the EME.

However, this generalization does not affect the validity of the presented results or their theoretical or practical contribution. This is because the given outputs can be used by military practice as reference material in the context of addressing operational requirements or achieved operational capabilities. Equally, they can be used for the development of military art in relation to the activities of military forces in all operational domains.

Keywords: *electromagnetic environment, electromagnetic spectrum, operating environment.*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

Design of Web GIS Application for Planning of Military River Crossing

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Introduction. The planning of ground military operations is conditioned by understanding the operational environment. One of the tasks of planning is to ensure the mobility of one's own forces in the area of interest. Individual military formations interact with the terrain in the operational space. The terrain is very complex, and its individual components influence all military activities. The individual components of the landscape sphere are dynamic and mutually influential. For this reason, military operation planning is a dynamic process in this regard, which can change rapidly. One component of the landscape sphere is water bodies. In particular, the characteristics of watercourses, which pose obstacles to the maneuvering of military equipment, can change rapidly due to meteorological influences and the impact of the rainfall-runoff process in a short period. Operational planning for overcoming water obstacles is therefore very demanding. It is conditioned by the reliability of meteorological and hydrological forecasting models. Assuming knowledge of the outputs of hydraulic models, i.e., how the characteristics of watercourses change under certain conditions, these models can be effectively utilized within the operational planning process.

Since it is necessary to utilize various outputs from different models for planning the overcoming of water obstacles, it is efficient to create a clear application system that would compile all input data and, within a user interface, provide users with comprehensive information support interactively. For this purpose, the software ArcGIS Pro and the web environment ArcGIS Online have been selected, as they are capable of appropriately processing the user's specified requirements.

Method of investigation. The application design is based on the availability of terrain and hydrological data, as well as knowledge of the tactical and technical characteristics of military vehicles. Relevant terrain and hydrological data necessary for application design include river channel profiles, modeled characteristics of watercourses for typical flow levels for a given river in the operational area. Web application works with these base data as raster layers in a GIS environment. The primary scenario addressed is the crossing of a watercourse at a specific location under modeled conditions derived from predictions of water level developments in the river. The software products used for application development are ArcGIS Pro, and for modeled hydrological data, the software HEC-RAS is utilized.

Investigation Results. The outcome of the project is a web application design. The application is capable of analyzing the possibilities of crossing a watercourse under various conditions by selecting the crossing location, initializing river conditions (forecast data), and choosing a specific military vehicle.

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The application provides information about the possibility of crossing a watercourse at a specific location; the variables determining the outcome include water level and flow velocity compared to the parameters of the military equipment used for crossing.

Conclusions. The developed application and its functionalities are only in the conceptual stage and have not been verified. According to available information sources, there is currently no application dedicated to the purpose of planning the crossing of water obstacles within the Czech Armed Forces environment. However, there is a geoprocessing tool that only works with long-term hydrological data. Therefore, it can be assumed that the reliability of forecasts for planned watercourse (water obstacles) crossing will be higher when using outputs from hydraulic models in the proposed application.

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

Enhancing Military Employment Appeal for Professional Personnel: A Case Study of the Lithuanian National Defence Volunteer Forces

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Introduction. The recruitment and retention of highly qualified employees pose significant challenges for many employers. National armed forces face challenges in recruiting, retaining, and adapting to the expectations of modern society [1]. With globalization, technological advancement, and changing social and economic dynamics, career options for individuals have expanded significantly. Even traditionally prestigious employers, such as the military, face difficulties in the highly competitive job market today. It is no longer sufficient for the armed forces to rely solely on duty, patriotism, or promises of clear, structured career opportunities. Today, potential recruits considering joining the military and existing professional military service members (PMS), contemplating whether to stay or leave, evaluate a multitude of factors, from personal development opportunities and work-life balance to organizational culture and societal attitudes.

The attractiveness of the military as an employer, perceived by existing PMS, not only influences satisfaction with service, engagement, and productivity, but also significantly impacts the challenges faced by the military: high personnel turnover, retention issues, shortages of necessary specialists, and other human resource management-related problems. As such, addressing the recruitment and retention challenges in the military is essential to maintain operational effectiveness and ensure the long-term success of the armed forces in the contemporary landscape.

Some authors have extensively examined the topic of employer attractiveness [2-6]. Therefore, it can be argued that there is a wealth of research related to the attractiveness of organizations as employers. However, there is a lack of such studies in both the Lithuanian military and the armed forces of other countries, particularly from the perspective of existing military personnel. Therefore, this study aims to investigate the attractiveness of the Lithuanian Armed Forces as an employer from the perspective of professionals who serve in the National Defence Volunteer Forces. By focusing on this specific context, the study seeks to fill the gap in the existing literature and provide valuable insights on the factors that influence the recruitment and retention of military personnel in Lithuania. Through an in-depth examination of the military's attractiveness as an employer, this research contributes to a better understanding of human resource management challenges within the armed forces and informs strategies for improving recruitment and retention efforts.

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Conclusions. The characteristics of an attractive employer were identified to be diverse, encompassing a wide range of attributes that are fundamentally categorized into instrumental and symbolic factors: tangible aspects such as competitive wages, career opportunities, and job security; intangible factors related to subjective perception and emotional response. These factors include organizational culture, values, and perceived employer prestige. The employer brand, a key component of employer attractiveness, heavily relies on these symbolic attributes and plays a crucial role in shaping the organization's identity and attractiveness.

The quantitative research findings indicate that the Lithuanian Armed Forces are perceived as an appealing employer among members of the National Defence Volunteer Forces engaged in professional military service. However, the study also highlights seven critical areas where improvements are necessary to further improve the attractiveness of the Lithuanian Armed Forces as an employer. These identified areas for improvement, articulated through the statements within the research instrument, are predominantly aligned with three dimensions of employer attractiveness delineated by the EmpAt scale: interest, economic, and development value dimensions. Consequently, it is inferred that targeted enhancements in these specific areas of the identified value dimensions have the potential to increase the allure of the Lithuanian Armed Forces as an employer in prospective recruitment efforts.

Keywords: *Employer attractiveness, Lithuanian Armed Forces, National Defence Volunteer Forces, Professional military service, Instrumental factors, Symbolic factors, Employer brand, EmpAt scale.*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024), 11 – 13 September 2024, Brno, Czech Republic

Conceptual Mapping in the System of Population Protection Education

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Introduction. Concept mapping is a complex system that integrates various types of information, including visual elements, textual descriptions, and logical relationships, to create a com-prehensible and coherent overview of a given topic or concept. Experience so far shows that concept mapping can be a very useful tool in the educational process, not only from the perspective of the teacher but also from the perspective of the pupil or student. During the preparation and de facto decision making process for a sub-topic, both the student and the teacher can create a concept map that includes individual concepts representing the issues that will need to be considered in the preparation process. Based on this initial analysis, the decision making process can then decide whether the difficulty, interest and relevance of the topic are adequate in terms of the abilities of the target audience. Based on an assessment of the initial linear text and against the background of a running decision making process that helps to interrelate the concepts into a logically organized concept map, it can be decided whether concept mapping will be beneficial for a given learning unit or whether another form of processing or presenting the information would be more appropriate.

Method of investigation. The following methods were used to develop the article: analysis, synthesis, analogy-comparison and abstraction. The analysis was understood as a method of thought in which the whole was decomposed into its individual parts. The aim of the analysis was to explain the current possibilities of using conceptual mapping and thus to investigate the observed problem in detail in terms of its parts. The flowchart of the methodological procedure of the analysis method was used in the following sequence: 1) definition of the object of investigation; 1) determination of the research objective; 3) determination of the essential element of the investigated object with respect to the research objective; 4) analysis of the role of the elements with respect to the investigated object. Synthesis was used in order to select a specific application tool based on the analytical work. It was also used in the formulation of conclusions. Another method used was analogy - comparison. This was based on such operations where similarities and differences between the applications under study were examined. The comparison was then approached on the basis of the data obtained from the literature search. From the findings of a given individual phenomenon, we attributed the identified characteristics to a broader group of software tools and their applicability within the context of teaching population protection.

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Generalization was used in conjunction with abstraction. Its use was based on the principle of studying the differences between application tools, taking into account differences, peculiarities and uniqueness. The aim of using abstraction was to define general and essential properties and relationships and to fix them in concepts, in general and abstract ideas, but with the result of introducing the possibility of using specific application outputs (concept maps) processed in ContextMinds.

Investigation Results. The results of the research are connected with the acquisition of data using the above-mentioned scientific methods and with the presentation of the specific functionality of the software and application equipment designed for conceptual mapping within the framework of conceptual mapping. The tools that are currently available for the creation of conceptual and mind maps are presented in summary in the form of tables. They provide basic data on information obtained from published sources, i.e. in particular information on the basic functionality and requirements that need to be met for the operation of the application. At the same time, information is given on the possibilities of using the individual programs in terms of the possibility of using the web environment free of charge and for a fee, which is of course subject to change. Nevertheless, the data obtained can be considered as the result of the authors' analytical work. Their presentation in conjunction with the presentation of one application, in the development of which the authors participated, creates the possibility of a comprehensive reading of the principle and applicability of concept mapping in the teaching of students focused on the issue of population protection. It is evident that the possibility of creating an overall picture is not limited to one particular discipline but can be applied across other disciplines and especially with practice.

Conclusions. Concept mapping is currently a relatively progressive approach to managing large amounts of information. It allows teachers and pupils (students) to work with information by converting long linear text into structured concept maps. Although there are several software and application tools on the market that can be used to create concept maps for free or for a relatively low fee, it should be noted that only a small number of them are programmed and fully usable in multiple languages. Despite the considerable user intuitiveness when using application tools for creating concept maps, it is still preferable to work with applications that are created in the teacher's native language. In this paper, attention was further focused on specifying the advantages and disadvantages of concept mapping. Furthermore, one specific example was given of how concept maps can be used in a particular field. This illustrative example shows that concept maps can be adapted not only to the level of pupils and their knowledge, but also to the level of individual schools. For this reason, we believe that concept mapping should be used as one of the very advantageous methods and forms of presenting the curriculum to pupils and students.

Limitations. It is possible that some data have changed in terms of price trends. However, this limitation does not have a significant impact on the content of the communication in terms of its factual and conceptual correctness. Based on this statement, it can be concluded that no limitation is essential. The fact that some applications have undergone partial evolutionary changes as their development has been refined can also be considered as a partial limitation. However, even this cannot be considered a fundamental limitation.

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The Specific Position of R and N Agents Among other CBRN Components Related to the Appearance of Stochastic Effects

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Introduction. As is the case with any dangerous substances, the total risk of CBRN has to be assessed using relevant quantities and units for each of their components [1], i.e., chemical (C), biological (B), radiological (R) and nuclear (N). Particular properties characterize each of these dangerous agents as to their ability to move in the environment and inflict harm on persons affected. While in the case of R (radiological] and N (nuclear) components, the dangerous substance is radioactive material, which can be reasonably easily quantified through their activity and radiation flux produced, the assessment of the level of hazards from C (chemical) and B (biological) agents is much more complicated. In the case of R and N groups, radiation is emitted either by primary radioactive sources (R) or radioactive materials produced during the controlled fission process in nuclear reactors or by spontaneous (deliberate) fission and fusion nuclear reactions in nuclear weapons (N). On the other hand, C and B agents have completely different origins and cause health effects in entirely altered processes. This is why we cannot consider that CBRN agents present a homogenous group of dangerous substances.

Method of investigation. Many recently published papers and other available scientific literature were scrutinized to analyze different methods and approaches to quantify CBRN agents reflecting their biological effects. Particular attention was paid to finding out the levels of individual CBRN components, which cause specific symptoms associated with stochastic and deterministic affects. The study concentrated on interpreting available experimental data to demonstrate stochastic effects, which appear with a frequency proportional to the amount or intensity of the particular agent. As to radiation exposure, these probabilistic effects are well established and understood so that the biological effects can be predicted. There is no system to predict such effects as the reaction of human organisms to low levels of intake or skin contamination in the case of C and B components.

Investigation results. The present situation in quantifying and assessing stochastic effects due to the R and N agents is discussed and analyzed in order to find a way in which experience from this area can be used in the evaluation of the danger of C and B components where, so far, attention was mainly concentrated on protection against deterministic effects. The preliminary results based on many statistical reviews of results published in scientific literature and other available data clearly indicate that also, in this case, low-level exposure to C and B agents may produce stochastic (late) effects appearing after some time following such

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exposure. At very low exposure, no visible harm is observed, but it has been proved that even these exposures are harmful since they contribute to the increased level of cancer occurrence with a certain probability, which is proportional to the dose received. At much higher levels (above a threshold) of radiation exposure, deterministic effects occur with the probability of 100% with severity proportional to the exposure (Fig. 10).
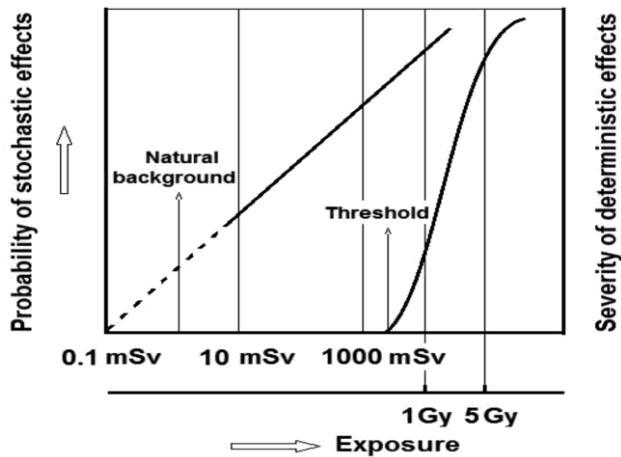
Fig. 1 The main difference between the stochastic and deterministic biological effects [2].

Our approach to assessing stochastic effects reflects some ideas expressed in recent publications. In the case of chemical agents, where the understanding of stochastic processes is particularly relevant to genotoxic carcinogenesis, where the assumption of a linear dose-response relationship at low dose (exposure) has often been adopted [3,4]. Even more complicated in quantifying stochastic effects are related to the effects of biological materials, which include very specific agents such as bacteria, viruses, fungi and internal human parasites (endoparasites) [5].

Conclusions. The aim of the paper was to discuss the quantification of CBRN agents as a whole, where attention was paid to two possible consequences of exposure initiating effects appearing later, with certain probability. This has been documented for the effects of ionizing radiation (R and N), but so far, such studies have not been systematically carried out in the case of C and B agents, although everything suggests that also, in this case, one can expect both deterministic and stochastic biological effects.

Keywords: *CBRN; stochastic effects; deterministic effects; radiation exposure.*

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Age Structure of the Population of the Czech Republic and its Development

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Introduction. If we look at the age structure of the population of the Czech Republic between the years 1920 and 2060, in 1920 almost 40% of the Czech population younger than 20 years old and only 10% are older than 60 years. The average age of the population of the Czech Republic this year was only 30 years old. At present, the proportion of people under 20 years only 20%, the proportion of people over 60 years exceeded 20% and the average age ranges have about 40 years. Given that fertility does not guarantee the simple reproduction of the population in the future probably will not increase the proportion of persons under 20 years, the proportion of seniors will continue to grow in all variants of design. The average age of the population will continue to increase and by 2060 will increase to approximately between 45 to 50 years depending on variant projections.

Method of investigation. When compiling population forecasts we solve two problems. First, we formulate the best hypothesis for future development of reproduction of the population and we must also choose the method of calculation to use – methodology. Reliability prognosis depends almost entirely on how we can get right assumptions about the future development of population reproduction.

Let us describe in more detail the component method with one step, first without migration. Calculation of the projections is performed for each gender separately. The inclusion of migration in the projection is all the greater, the smaller territorial unit investigate. Given that we consider particularly important for migration in the future, we will have the opportunity to migrate to include in the projections.

Investigation Results. First biological generation (children) gradually decreases from a value of around 30 % in 1920 to 20 % around 1990 and then at about 12 % in 2060. In contrast, the share of biological third generation (grandparents) increases from 20 % in 1920 to 30 % in 1990 and around 48 % in 2060. Changes in the proportions of the various biological generations can be divided roughly into three phases - the first in about 1965, another from 1965 to 1990 and the third since 1990.

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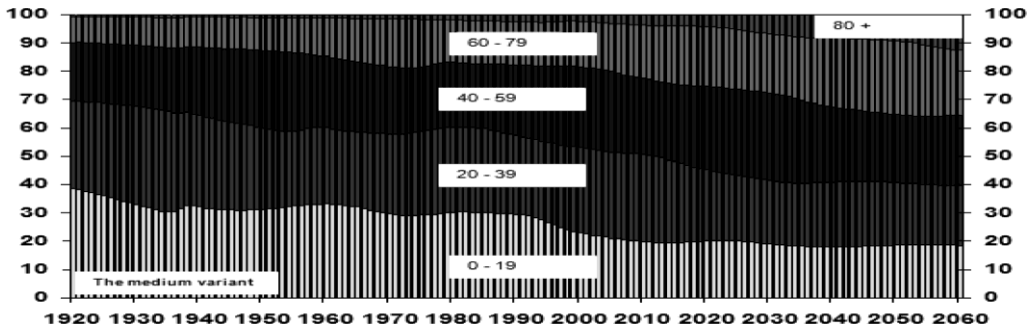
Fig. 1 Development of the age structure of the population in the Czech Republic and their prediction to 2060 (in %) – the medium variant
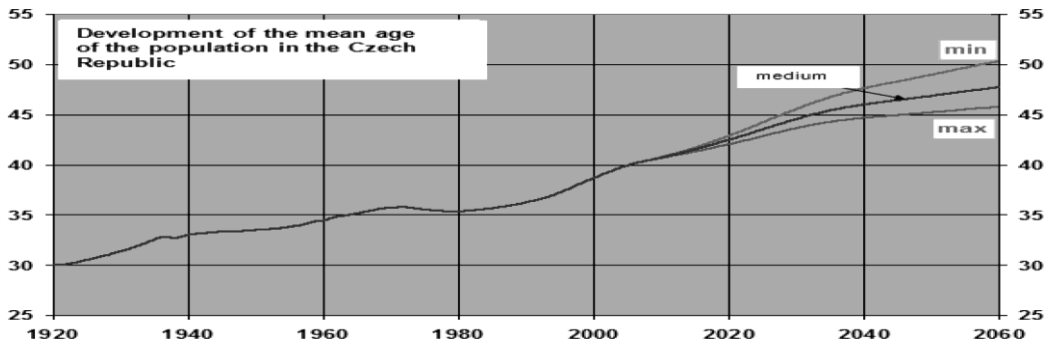

Fig. 2 Development of the mean age of the population in the Czech Republic
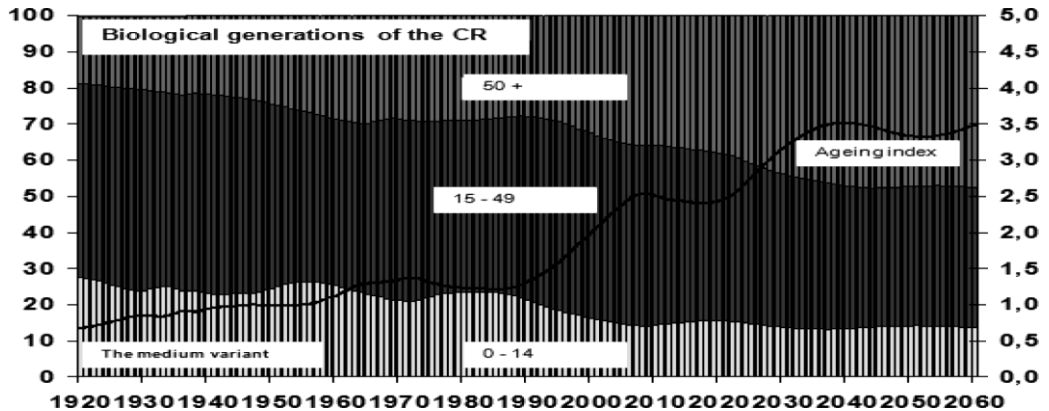

Fig. 3 Biological generations of the CR – the medium variant

Analogical development can be expected also for primary schools define age 6-10 years completed the second stage then completed the age of 11-14 years.

High school students can define the age of 15 to 18 completed years. There is already the potential number of students because not everyone in high school.

University students, we can divide the bachelors degree (19-21-year old) and a masters degree (22-23-year old). The following graph shows how destabilize uneven demands from the perspective of prospective pupils' universities. I can see here how the age structure reflects the effects of strong and weak years of births. Interestingly, there are shown graphs in Fig. 4.
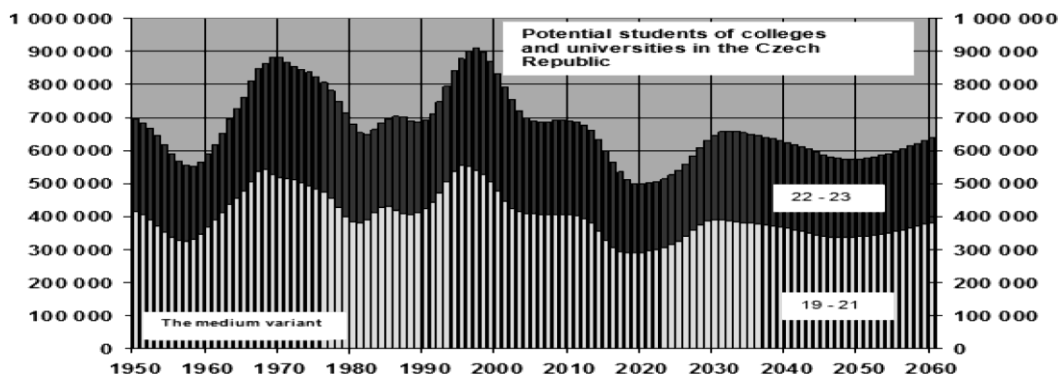
Fig. 4 Potential students of colleges and universities in the CR – the medium variant

Conclusions. As the population is increasing in older persons and the oldest age groups will need more and more attention paid to them. These are the age groups that have specific needs not only in terms of health care, social services, but also a range other services and needs.

In 1950, the proportion of seniors in the population, about 13 %, at the present time is slightly higher than 20 %. Until 2060 to 33-40 % depending on the variant projections.

It is especially seen an increase in the proportion of the oldest age group (85-year-old and older). Share this age group in 1950 amounted to only about 1 %, currently is only slightly higher. In 2060, however, the proportion will reach 85 years and elderly in the total population of 5-10 %, again depending on the variant projections.

People over 70 years of age accounted in 1950 around 40 % of the elderly population, currently it is around 50 %. In 2060, it may already be around 70 %. People over 85 years of age accounted in 1950 less than 2% of the elderly population, currently there are already around 5%. In 2060 their share could be around 20% of the population of seniors in all variants of design.

There is also increasing average age of seniors. In 1950, the average age of my seniors commercially – higher 69 years, currently amounts to about 71 years in 2060 will be moving around 76 to 77 years, depending on the variant projections.

Keywords: *socioeconomic demography; statistical methods in demography; population projections; the age structure of the population of the Czech Republic; component method without migration; component method with migration*

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Virtual War Medicine – A Key Element of Modern Warfare

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Introduction. Until the outbreak of war in Ukraine, the international concept of war medicine was based on principles and practices based on known scenarios of combat and conflict development. However, the current data on the number of wounded and killed obtained so far indicate that war medicine needs to be rapidly transformed, as it has the most critical role. It appears that combat troops are facing levels of casualties not experienced since the Korean War. Moreover, the ubiquity of artillery, air defense, drones, and long-range strike capabilities tends to limit direct medical evacuation options, unlike, for example, previous conflicts. All of this is indicative of the growing role of virtual warfare medicine in modern conflicts. Thus, war medicine requires an immediate response from NATO and individual member states in the form of the introduction of new processes for the provision of medical care, first aid training, and, in particular, the implementation of new procedures for the transmission of information about the wounded, the use of innovative approaches, technology or artificial intelligence.

In this context, the paper focuses on the processes of providing health care to soldiers in wartime environments and civilian life, taking into account the current global trends of warfare and the resulting demands. Emphasis is placed on the current legislation and practical experience of healthcare professionals in the military. Through concrete examples, the challenges associated with war medicine are presented, especially in the context of the need for digital transformation of healthcare for soldiers on the battlefield. On closer examination, it is evident that it is essential to establish a secure process for sharing and transferring patient data at all levels of command and control, particularly through virtual consilia. As a result, efforts are being made to secure this information, including setting up the legal aspects of its evaluation and further processing.

The war in Ukraine reveals the shortcomings and weaknesses of war medicine. Notable is the estimate by Russian specialists that 50% of combat deaths in the Russian army were the result of poor first aid training of the soldiers themselves. In contrast, Ukrainian forces, possessing effectively trained first aid personnel, show a significantly higher survival rate of their wounded compared to their adversaries.

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This paper aims to evaluate the process of acquisition, transmission, storage, and evaluation of soldiers' medical data in the context of the limitations of their rights as patients in the context of virtual warfare medicine and the decision-making power of their superiors. A sub-objective of the paper is also to present a possible solution for the secure transfer of data from the battle line to the physician.

Investigation Results. We are in a situation where the leaders of NATO allied armies, influenced by the experience gained from the conflict in Ukraine, are calling for a rapid and thorough review of the organization and, in particular, the training of military and medical personnel to be able to effectively face new types of high-intensity conflicts. The second pillar of the necessary fundamental change in war medicine is the implementation and development of new technologies. The need to implement the use of new technologies and procedures is based on the published results of recent war games simulating major corps-level engagements facing an adversary such as China or Russia. Using the US Army as an example, its casualties of deployed US Army corps would be as high as 21,000 dead or wounded, half the original numbers, in just seven days of deployment. A significant finding, however, is that evacuation of the wounded, especially during the so-called golden hour (i.e., the 60 minutes critical to the survival of the wounded), is proving much more difficult than in previous conflicts. The ubiquitous air defenses make medical evacuation much more difficult than before, especially for air transport of the wounded. Wounded soldiers can no longer be evacuated and inevitably there are situations where they have to wait hours, days, or even weeks in isolation from medical assistance to be rescued. This puts pressure not only on medical personnel to start using much broader skills than before but especially on the acquisition of information on the health status of the wounded in the field, its transmission, and subsequent evaluation. This will make it possible to assess and subsequently respond to soldiers' injuries on the battlefield, which will help to increase their chances of survival. Military telemedicine, the use of artificial intelligence, or virtual consilia can significantly help to stabilize the wounded soldier. The soldier will then not only be able to wait until the evacuation is possible but will also be able to withstand much longer transits, with medical centers having to be deployed beyond the range of enemy long-range artillery, often several hundred kilometers from the line of contact.

In light of these new challenges, it is necessary to introduce a multidisciplinary approach also to the law of health and the law of war. An essential requirement of modern war medicine is the security requirements for the protection and processing of soldiers' medical data by the applicable legislation. Therefore, the aim of the paper is also to compare the position of the soldier as a patient and the soldier himself in the context of virtual war medicine to propose optimal conditions for the processing and storage of their data and their personalized evaluation for the benefit of the army.

Conclusions. International exercises, but especially the sharing of information on the conflict in Ukraine, have undeniably declared that the processing of soldiers' health data is becoming a key issue in the provision of military health care in the current global situation. Emphasis on the use of big anonymized data and working with it using both classical and artificial intelligence algorithms can provide the military command with personalized health assessment and prediction of future developments, thus contributing to more effective treatment of military patients on the battlefield, but also in the hinterland. By leveraging today's known technologies and their strengths, while introducing them directly to the battlefield (e.g., by acquiring data from sensors placed on the body or equipment of soldiers),

a path can be set not only to more effective treatment of all types of injuries, but also to greater combat effectiveness and success in combat.

The fact remains that, in addition to the necessary adaptation and evolution of medical response to high casualty rates, it is desirable above all to perceive the new reality of high-intensity warfare, for which modern armies, especially in the West, do not seem to be prepared in terms of virtual warfare medicine.

Keywords: *new military technologies; Ukrainian war; patient; data protection; soldier; virtual consilium; health law; cyber security*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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The Need for the Establishment of Forensic Linguistics in Georgian Context

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Introduction Forensic linguistics, a discipline that has gained prominence in recent years, emerges as a crucial component within the framework of sustainable defense practices. Originating in the early 20th century, forensic linguistics has undergone significant evolution, with linguists increasingly assuming roles as expert witnesses in legal proceedings. This paper seeks to explore the pivotal role of forensic linguistics in criminal investigations, emphasizing its contribution to perpetrator identification and crime resolution through the analysis of linguistic features within written documents.

Methodologies such as style analysis, author identification, and text analysis are examined in detail, showcasing their relevance in addressing contemporary challenges such as cybercrime and the gathering of digital evidence. Particularly noteworthy is the contextualization of forensic linguistics within the Georgian landscape, where the proliferation of threatening letters targeting educational institutions and airports underscores the urgency for linguistic analysis in criminal investigations.

In response to this imperative, a team of linguists from Batumi Shota Rustaveli State University (BSU) embarks on an ambitious initiative to establish forensic linguistic practices in Georgia. The endeavor begins with the creation of specialized corpora tailored for analyzing threatening texts, marking the initial steps towards formalizing forensic linguistics within the country's legal framework.

As forensic linguistics is still in its nascent stages in Georgia, this paper underscores the critical need for its formal recognition and integration within the legal system. By shedding light on linguistic nuances and patterns within textual evidence, forensic linguistics offers invaluable insights into criminal behavior, thereby assisting law enforcement agencies in their pursuit of justice.

Overall, this paper advocates for the acknowledgment and incorporation of forensic linguistics as an indispensable tool in the administration of justice within the Georgian context, aligning with the principles of sustainable defense by enhancing the efficiency and effectiveness of criminal investigations.

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Conclusions. In summary, forensic linguistics emerges as a pivotal discipline in the realm of sustainable defense practices, offering crucial insights into criminal investigations. Through methodologies such as style analysis and text analysis, forensic linguistics contributes significantly to perpetrator identification and crime resolution, particularly in addressing contemporary challenges like cybercrime. The contextualization of forensic linguistics within the Georgian landscape highlights its urgency in analyzing threatening texts targeting key institutions. Initiatives by linguists from Batumi Shota Rustaveli State University to establish forensic linguistic practices in Georgia mark essential strides towards formalizing the discipline. However, the nascent stage of forensic linguistics in Georgia necessitates its formal recognition and integration within the legal system. By illuminating linguistic nuances within textual evidence, forensic linguistics aids law enforcement in their pursuit of justice, advocating for its acknowledgment and incorporation to enhance the efficiency of criminal investigations and align with principles of sustainable defense.

Keywords: *Forensic linguistics, sustainable defense, criminal investigations, perpetrator identification, linguistic analysis.*

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Demand Forecasting - Definition, Process Stages, Algorithm and Available Methods, Part 1 - Theoretical Basis

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Introduction. Demand forecasting is the process of estimating future demand for a product or service in a rational manner using scientific methods, based on a detailed analysis of available empirical data. Scientific publications use traditional demand forecasting methods [1], simulation models [2,3], machine learning [4,5], artificial neural networks [6,7] or correlation analyzes [8] taking into account seasonality [9]. Prediction of future phenomena is an important component of managing a given organization [10]. As a consequence, it is intended to prevent unnecessary costs [11-13], promote energy production [14] and reduce its consumption [15,16]. Another set includes works on minimizing fuel consumption [17,18] and environmental pollution [19]. In the field of transport, analyzes of road traffic intensity [20], prediction of the duration of road incidents [21] and evaluation of real road traffic data [22] are used.

Stages of the forecasting process. The forecasting process is sequential and consists of 6 stages. The forecasting process is a structured and sequential approach to predicting future events or trends based on historical data, statistical analysis, and expert judgment. It typically comprises six stages, each of which plays a crucial role in ensuring the accuracy and reliability of the forecast. Below, I provide an extended explanation of each stage:

Identification of Objectives: The first stage involves clearly defining the objectives of the forecasting exercise. This entails determining what specific variables or phenomena are to be forecasted, the time horizon of the forecast, and the level of detail required. For example, in economic forecasting, the objective may be to predict GDP growth rates over the next five years.

Data Collection: Once the objectives are established, the next step is to gather relevant data. This may include historical data on the variables of interest, as well as supplementary information such as economic indicators, demographic trends, or market research findings. The quality and reliability of the data collected are critical factors that can significantly impact the accuracy of the forecast.

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Data Preprocessing: In this stage, the collected data is cleaned, organized, and prepared for analysis. This may involve removing outliers, filling in missing values, standardizing units of measurement, and transforming data to make it suitable for modeling. Data preprocessing is essential for ensuring the consistency and integrity of the dataset.

Model Selection and Development: Once the data is prepared, various forecasting models are evaluated and selected based on their suitability for the specific objectives and characteristics of the data. Common forecasting techniques include time series analysis, regression analysis, and machine learning algorithms. The chosen model is then developed using the historical data to generate forecasts for future periods.

Model Evaluation and Validation: In this stage, the performance of the forecasting model is assessed using validation techniques such as cross-validation or out-of-sample testing. This involves comparing the model's predictions to actual outcomes to determine its accuracy, reliability, and robustness. Model evaluation helps identify any shortcomings or weaknesses that may need to be addressed before finalizing the forecast.

Forecast Generation and Monitoring: Once the model is validated, it can be used to generate forecasts for the desired time horizon. These forecasts are regularly monitored and updated as new data becomes available or as circumstances change. Continuous monitoring allows for adjustments to be made to the forecast in response to evolving conditions, ensuring its relevance and usefulness over time. They are shown in Fig. 1.
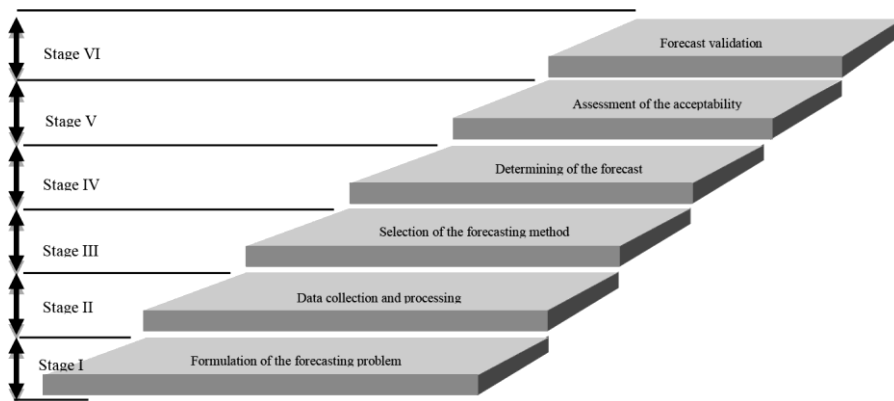
Fig. 1. Stages of the forecasting process

The presented process is sequential, and the individual stages of forecast creation are discussed in detail in the work.

Method of investigation. In practice, almost every forecast is individual, which means that the problems you have to face will also differ when developing a given task. To solve an existing decision-making problem, you need to delve into the data structure and understand the activities and connections occurring in the considered community [23,24].

Forecasting methods include a set of techniques, tools and methods used to process past data with the ability to determine future events or trends. They are basically classified into two subsets: quantitative and qualitative (Fig. 2).

Fig. 2. Classification of demand forecasting methods

At the research stage, it is important to develop an algorithm for the forecasting process, it is shown in Fig. 3.

Fig. 3. Forecast development algorithm

Due to the complexity of forecasting tasks, using the presented scheme ensures work organization and certainty that all important elements needed to complete the forecast have been implemented. Skipping any of the stages may lead

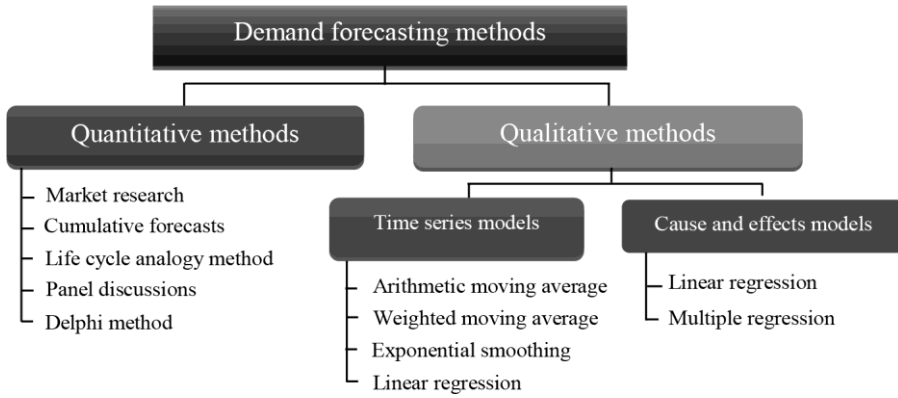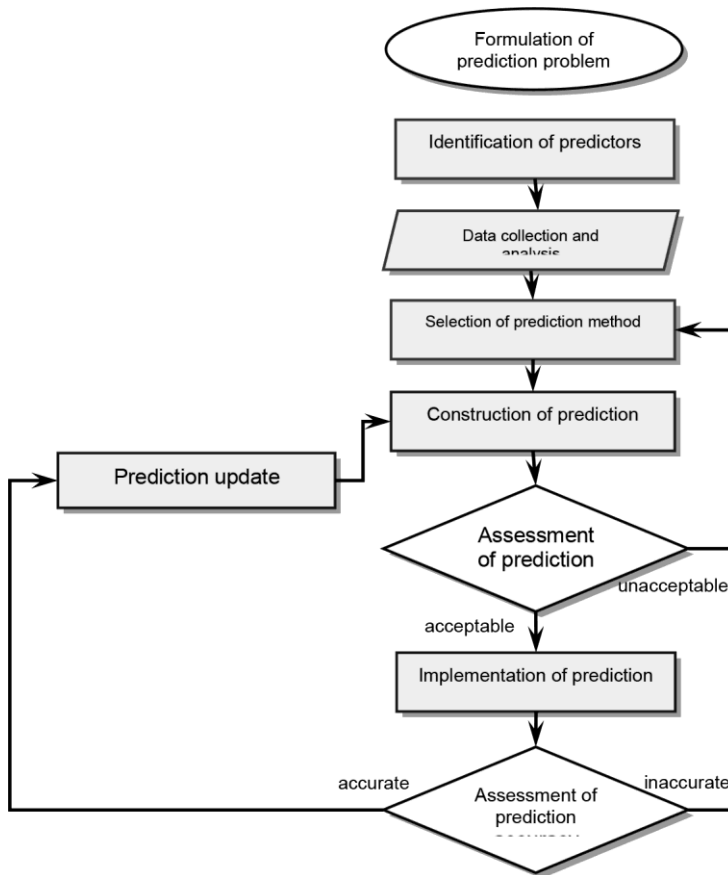to the selection of the wrong forecasting method and, as a result, an inaccurate analysis, which results in a waste of time and money.

Summary. Forecasting is a key component of the activities of many companies due to its irregular nature and fluctuations in demand over time. Incorrect prediction of the demand volume leads to inappropriate decisions, which result in negative consequences. Underestimating demand may generate opportunity costs, while overestimating it may result in increased storage costs. Predicting future phenomena has always been a sought-after skill that can bring benefits. To sum up, it should be said that in reality there is no universal method of forecasting the level of demand, which is conditioned by the existence of too many random factors. According to the laws of forecasting, short-term forecasts are the most accurate. Quantitative statistical models are helpful in predicting future values of variables based on historical data using statistical techniques. Such models should be considered objective due to the observance of specific rules of conduct when determining the value of forecasts.

Keywords: *forecasting, stages of the forecasting process, algorithm of the forecasting process, forecasting methods.*

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Forecasting demand and optimizing total costs in the transport network, Part 2 Case Study form Poland

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Outline of the problem - assumptions for the example. In the example under study, a company producing semiconductors for automotive vehicles is preparing a production plan for October 2023. The company has a total of ten strategic customers (C_1-C_{10}), of which demand is known for seven of them, and for the remaining three there is no information on demand, as presented in Table 1. Empirical data is available from August 2021. until May 2023 for C_1, C_2 and C_3 customers. Our task is to determine the demand for October 2023 for customers C_1, C_2 and C_3.

Table 1. Number of expected transports C_1-C_{10}

C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
-	-	-	23	70	35	9	50	38	65

The research problem is: firstly, forecasting the appropriate demand values for customers C_1-C_3 (see Table 1); secondly, minimizing total transportation costs. In the case of the second problem, i.e. total transport costs, it should be mentioned that they consist of two calculation stages, i.e. transport from the production plant to the manufacturer's warehouses (W_1, W_2 and W_3), and then transport from the warehouses to ten customers (C_1-C_{10}). The goods are transported using a fleet of trucks with a „Mega" type curtain trailer with dimensions of 13.6 [m] in length, 2.45 [m] in width, 2.95 [m] in height from the production plant to three reloading warehouses in a shuttle system. This means that the means of transport regularly makes trips between the point of shipment and the point of collection of the cargo. Shuttle services are used to transport bulk cargo, and in the examined example, one vehicle is able to transport 100 pieces of product. The cost of transport in the Factory-Warehouse relationship and the capacity of these warehouses are presented in Table 2. Unit transport costs are summarized in Table 3.

Table 2. Unit transport cost from Factory to Warehouse [PLN] and storage capacities [pcs.]

Warehouse number	Unit transport cost from Factory to Warehouse [PLN]	Storage Capacities [pcs.]
W_1	220	23000
W_2	180	14000
W_3	150	12000

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Table 3. Unit transport costs in the Warehouse-Customer relationship [PLN]

Warehouse/ Customer	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
W_1	95	84	157	59	105	141	58	116	145	47
W_2	30	60	81	114	43	86	94	64	83	85
W_3	117	103	69	135	109	40	133	97	58	168

Analyzing the empirical data, it should be stated that they had different characteristics for individual customers C_1-C_3 (summarized in Fig. 1-Fig.3).
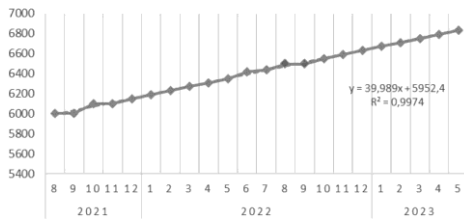
Fig. 1. Customer demand C_1 after eliminating outliers
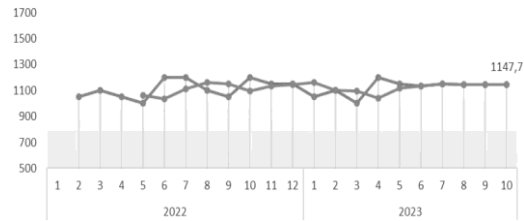
Fig. 2. Comparison of empirical data with the forecast for C2 customer
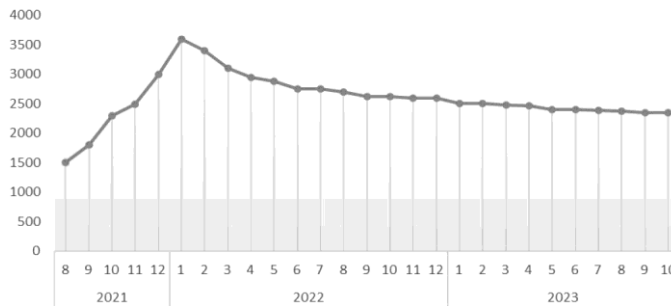
Fig. 3. Customer C_3 demand

A forecast was determined for each client using a different method. The results for the months from June to October 2023 are summarized.

Based on the cost data (Table 3) and the number of cruises in a given warehouse-customer relationship, an additional 3x10 matrix was created in an MS Excel spreadsheet. It reflects potential transports from individual warehouses to a specific customer. To solve the problem, the Solver add-in was used, in which the direction of optimization (aiming at minimization) of the objective function was determined. Moreover, the following limiting conditions were written in mathematical form:

1. The number of transports to the warehouse should be equal to the number of transports from the warehouse to the final recipient;

2. The total number of shipments should be equal to the demand of all customers;

3. Each warehouse has a limited capacity, i.e.: W_1 = 230 trucks, W_2 = 140 trucks, W_3 = 130 trucks.

The obtained results are presented in Table 4.

Table 4. Optimal transport matrix reflecting the minimization of transport costs

Transport W/C	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	Total number of flights from the warehouse
W_1	71	0	0	0	0	0	0	0	1	65	137
W_2	0	0	0	9	0	35	9	50	37	0	140
W_3	0	12	24	14	70	0	0	0	0	0	120
Total number of flights to the Customer	71	12	24	23	70	35	9	50	38	65	397

In order to calculate the total transport costs, it was necessary to multiply the number of required cruises by the unit transport cost and then sum the obtained partial results. Using our data the total transport cost was calculated, consisting of the sum of the products of routes in the Factory - Warehouse relationship and in the Warehouse - Customer relationship as:

$$K_C = K_{FW} + K_{WC} \tag{1}$$

where: K_C – total transport cost; K_{FW} – total cost of the Factory – Warehouse relationship; K_{WC} – total cost of the Warehouse - Customers relationship. The total transport cost is therefore:

$$K_C = 73340 + 89545 = 162885 \text{ [PLN]}$$

The received amount of 162,885 [PLN] means the minimum value that the production company will pay for the transport itself in the numerical example examined. Without prior forecasting, the cost of transportation would likely be much higher due to the lack of data and the shortened time needed to plan the route.

Summary This work covers issues related to real decision-making problems in the areas of forecasting and process optimization. It presents basically two aspects, the first one concerns the practical application of selected demand forecasting methods. The second one was related to the optimization (minimization) of the total costs related to the considered transport network, which included two basic stages of transport, i.e. the first one covering the movement of goods from the factory warehouse to three warehouses with their own locations and the second one containing the structure of transport from the mentioned warehouses to customers, in accordance with their needs. In the first part, based on empirical (historical) data, a demand forecast was prepared for three customers C_1 - C_3 using the linear regression method, a weighted moving average and reducing a non-linear function of an exponential nature to a linear form. The calculated demand volumes constituting the C_1 - C_3 forecast were included in the collective matrix of transport volumes of all customers forming a given network. In the next stage, a mathematical model was developed covering the minimization of total transport costs carried out in two stages: **Stage 1** involved transporting products from the factory to three warehouses; **Stage 2** took into account the optimal structure of transporting goods from the mentioned warehouses to individual customers C_1 - C_{10}, in accordance with their needs.

In the analyzed example, an accurate forecast of demand for production allowed the company to plan transport in advance, which in turn made it possible to reduce the total transport costs to a minimum, i.e. to the level of PLN 162885.

Keywords: *forecasting, optimization, transport, transportation network.*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

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Challenges to Senior Level Professional Military Education. Observations from the Baltic Defence College

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Introduction: The 2018 National Defense Strategy instigated a contentious debate regarding the state of professional military education within the United States, critically evaluating how well it could achieve its stated goals in practice. In this recent discussion on professional military education, a spectrum of perspectives, opinions, and recommendations has been offered, all aimed at enhancing the quality of graduates' preparation for subsequent assignments, refining the scope and methods of educating officers at subsequent levels of development, and assessing student performance. Numerous stakeholders have engaged in discussions concerning the structure and effectiveness of military educational institutions. Within these discussions, a plethora of evaluations and suggestions have been put forth, focusing on intricate aspects such as curriculum content, teaching methodologies, assessment techniques, and more. While much attention has been devoted to scrutinizing the structure and efficacy of US military educational institutions, there exists a notable dearth of contemporary research on European equivalents, often relying on outdated sources. This study seeks to address this gap by critically examining the current landscape of professional military education in Europe.

The ongoing debate pertains specifically to senior-level professional military education, which aims to equip senior officers and their civilian counterparts with the skills necessary for strategic-level responsibilities. The complexity of challenges inherent at this level has been acknowledged by politicians and government officials cooperating with the military. In the United States, congressional representatives have noted a gap in professional military education, observing that while it effectively prepares officers for joint operations, it falls short in fostering cooperation at the strategic level with politicians who often lack historical context and cultural insight. While recent institutional efforts have been made to enhance synergy senior-level professional military education and and lower-tier levels of education within individual branches of armed forces, tangible outcomes are likely to materialize only in the foreseeable future.

The renewed emphasis on NATO's fundamental mission of collective defense and deterrence underscores the heightened significance of adequately preparing officers at all levels of professional military education. This imperative pertains to both to quantity and quality of graduates at every tier of professional military education. Given the diminishing expertise in high-intensity warfare within Allied militaries over recent decades, there exists a clear requirement to realign professional military education to better address the evolving security

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environment. This necessity extends beyond the United States and encompasses Allied nations in Europe as well.

Method of investigation. The qualitative research employed analysis of official documents, academic research, and ongoing debate surrounding senior-level professional military education. It seeks to bridge insights from this discourse with solutions implemented at the Baltic Defence College. Key focus was on comparing and contrasting observations and recommendations from the Western educational community, particularly the U.S. military educational community, with those specific to the Baltic Defence College. The study's retrospective scope is confined to the past decade, although earlier data was utilized to contextualize assessments related to the researched period.

Investigation Results. Addressing the contemporary challenges encountered in senior- level professional military education demands sustained commitment from stakeholders and the flexibility of educational institutions. While solutions proposed in the ongoing debate on professional military education are largely pertinent, their implementation may face obstacles such as bureaucratic hurdles, time constraints, or resource availability. The Baltic Defence College, functioning as an international medium-sized professional military education institution, benefits from a degree of agility in both development and delivery of senior-level education. This enables the College to prepare officers from Framework Nations, Allied and Partner countries for executive responsibilities at strategic levels. Enhancements to senior-level professional military education at BALTDEFCOL are deliberately incremental and balanced, leveraging the institution's strengths while mitigating potential risks. This intentional approach ensures that the-senior level education programme remains responsive to the evolving requirements of the Framework Nations while meeting NATO accreditation standards.

Conclusions. The topic of senior-level professional military education warrants heightened consideration, especially in the European PME community. While senior-level education is predominantly a national responsibility, it is also facilitated by international educational institutions. Sharing insights on challenges and best practices associated with preparing senior officers and their civilian counterparts for executive roles at strategic levels directly enhances the relevance and responsiveness of professional military education to evolving security dynamics.

Limitations. The research draws upon data extracted from publicly available documents, academic research, and inputs shared within communities of practice. The author explicitly states that the views expressed in the article are strictly their own and do not reflect the official positions of BALTDEFCOL or the Framework Nations.

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024), 11 – 13 September 2024, Brno, Czech Republic

Teaching Defence Management to Senior-Level Professional Military Education at the Baltic Defence College

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Introduction. The Baltic Defence College (BALTDEFCOL) was founded by Estonia, Latvia and Lithuania (*framework nations*) in 1999. The College is a modern, future-oriented, attractive training and education institution with a regional focus and Euro-Atlantic scope to meet the defence and security needs of the framework nations. It provides the best academic practices and remains a Professional Military Education (PME) institution constantly evolving strategically. The BALTDEFCOL delivers a core PME programme consisting of different residence courses, including the Higher Command Studies Course (HCSC). This program equips senior-level officers and governmental officials with the knowledge and skills to navigate the strategic complexities of the 21st century when resources are limited and strategic guidance is often insufficient.

The research was carried out within the HCSC. The investigation aimed to understand the current learning environment and defence management concept. Both encourage reflection, reinforce critical thinking and require the development of strategic decision-making skills. Based on the theoretical results of the investigation, the essay addressed a set of steps. First, the question *'What to teach?'* It is imperative to create not just an ideal learning environment but also a culture of the class, encouraging interaction with one another. The second step was understanding the reality (*What do we teach at the senior level?*): Assessing the current status of training and education and potential outcomes. At the same time, the last step was focused on '*continuous improvement*': identifying areas for enhancement and striving for excellence.

Method of investigation. The research critically analyses the education documents related to PME in the Baltic Defence College, NATO and the EU. The development of the senior level is essential to the three Baltic countries. Senior-level development is a multifaceted process that takes place over an entire career. The development occurs through several steps of PME. The research was limited to teaching defence management to senior-level PMEs. Therefore, the article explains the following: 1) What is the senior-level PME in the BALTDEFCOL? Also, it underlines the importance of 2) What do we teach to the senior level? and 3) How do we plan to deliver teaching? It elaborates on the reality of training and education 3) What do we do in the class? And 4) What can we achieve? Ultimately, the research explores possible improvements and the way ahead.

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Investigation Results. The study suggests that dynamic and rapid changes in the security environment and war in Ukraine have influenced education and training. The BALTDEFCOL is an international and NATO-accredited education and training institution providing PME for senior leaders (*militaries and civilians*). The PME of framework nations divided officer education into four development levels. The analysis is focused only on the HCSC, the fourth level of military education. The paper discussed and elaborated an even narrower focus on teaching defence management to senior leaders, equipping them with the necessary instruments to investigate, assess, and formulate defence management strategies and planning. Despite the agreed level of education among the three Baltic nations, the NATO curriculum harmonisation does not explicitly recognise the fourth level of PME.

The current security landscape, especially in the Eastern flank, necessitated a unified NATO approach. Standardisation of operations, interoperability and interchangeability among allied forces becomes paramount. To achieve this, the College employed a comprehensive educational approach combining lectures, seminars, syndicate works, individual learning, case studies, exercises, and field study trips. These methods empowered senior-level participants to confront complex systems and hostile environments effectively.

Conclusions. The desired qualities to prepare the 21st Century Warrior have required high- quality, trained senior leaders. The rapid changes in the security environment require a solid and effective teaching of defence management to senior-level professionals. The PME system in BALTDEFCOL consists of four development levels. The HCSC is the fourth level of military education. Teaching defence management is part of the HCSC curricula, focused on instruments, assessment and formulation of defence management and planning at the strategic level.

However, the BALTDEFCOL, in response to technological development and rapid changes, has embraced innovative teaching methods for senior-level training. The ambition was to cultivate critical and creative thinkers who tackle complex problems and confront the unknown. These approaches are crucial for shaping strategic thinking, fostering better collaboration, and addressing regional security challenges properly. Without educated people, even advanced military systems, platforms and ammunition hold little value. Education remains the most powerful tool and process for transforming senior-level preparation and maintaining advanced technological expertise and warfighting skills.

Limitations. The data used in this research have been extracted from publicly available government documents, NATO publications, BALTDEFCOL materials, PME news, defence management, and experiences from allies and partner countries.

Keywords: *BALTDEFCOL, PME, defence management, teaching senior-level and NATO.*

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Constructive Simulation Tools in the Armed Forces of the Slovak Republic

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Introduction. Modelling and simulation tools have been used in the military since ancient times. Throughout history, they performed essential cognitive and military functions. Modelling and simulation participated in the overall development of the military, especially in the military art, military tactics, the construction of the army and the training of commanders. Modelling and simulation were used in the period of preparation for wars as well as during the war. In the 1960s, simulation was an increasingly common phenomenon, especially in the armies of more technically advanced countries. Different types of simulators were created, which reduced the financial expenses and time required for training. At the same time, they increased safety and efficiency with the possibility of better analysis and evaluation of the overall activity. The performance of computers could have improved the quality of simulators. Therefore, the development itself was conditioned mainly by the improvement and modernization of computer technology. Over time, more and more modern and realistic simulators began to be developed, which became an integral part of the training of all advanced armies of the world.

The entry of the Slovak Republic into the North Atlantic Alliance brought with it increased requirements for the training of units and the ability to effectively cooperate with the armies of other countries. To achieve these requirements, using simulators and trainers is a rational choice. This initiated the building of simulation centres on the territory of the Slovak Republic. The participation of the Slovak Republic in the Partnership for Peace program enabled the provision of financial, material and personnel assistance in the field of modelling and simulation.

Method of investigation. The main aim of this paper is to describe and assess the use of constructive simulators used by the Armed Forces of the Slovak Republic. In this paper, the author analyzes the use of simulation technologies in the training and education of the land and air forces of the Slovak Republic. This paper also analyses the advantages and disadvantages of using constructive simulators for military training. The paper structure respects the general principles of simulation technology and crisis management. The intersection of these two specific areas makes it possible to streamline the preparation of the security community that participates in solving crises at the national and international levels.

Investigation Results. Most military operations are physical activities. These are performed in a specific space containing many variants of the terrain surface, objects, natural obstacles, forests, watercourses, buildings and objects. All these elements in the real world also

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have their physical, chemical and biological properties. These must be taken into account when creating the most realistic model possible. Creating the most identical virtual three-dimensional space, showing the most significant possible identity with the original, is time-consuming. The subsequent simulation process may need to be more accurate in low model similarity and bring the desired benefits. Powerful and modern computers are needed to calculate and process this vast information flow, especially if it is a real-time simulation. Then the fastest possible response of the computer is needed to ensure the smoothness of the simulation process. If the computing technology's capacities are insufficient, errors and a too-long response of the simulation to a specific action of the subject may occur during significant interaction of the subject with the environment. The financial costs of building a high-quality simulation centre are also directly related to this.

The main aim of simulation technologies is to provide the armed forces (and other components) through simulations with the most realistic environment for dealing with combat and non-combat situations on the modern battlefield. This contributes to the training of units and the education of leaders. The Armed Forces of the Slovak Republic are no exception. The exercises performed by the following virtual simulators are unique in their preparation and execution phases. A systematic approach was established for the organization of joint exercises using simulation tools, shown in Fig. 1.
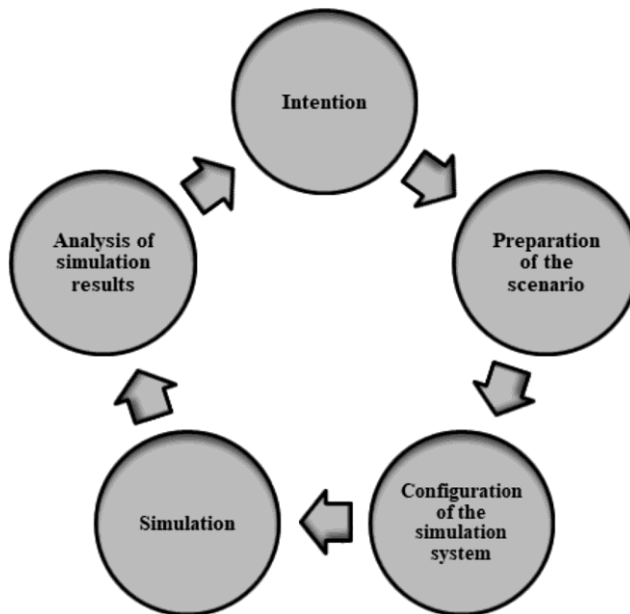

Fig. 1 Scheme of the use of workplaces for the training of the Armed Forces of the Slovak Republic

Conclusions. By studying this topic, virtual flight simulators are more affordable for the Armed Forces of the Slovak Republic than the training itself. Another advantage of simulators is their safety and the possibility of creating an almost real environment. In this way, the trainee can master the control of the machines and prepare for various critical situations during regular training and combat deployments. An important question is how the Armed Forces of the Slovak Republic will solve the gradual modernization of military equipment. Modernization should occur not only on the equipment but also on individual simulators. In the future, the

training requirements in the Armed Forces of the Slovak Republic should reflect the changing training requirements within NATO. Individual training weapon systems are integrated into a unified, centrally controlled evaluation system. This will subsequently be part of the overall training strategy of the advanced armies of the world. Means of live simulation will become part of combat and support means and equipment of the soldier of the 21st century.

Limitations. The paper deals exclusively with constructive simulation tools in the Armed Forces of the Slovak Republic. It does not solve or compare the issue in question within other countries.

Keywords: *modelling; simulation; virtual simulator; Armed Forces of the Slovak Republic.*

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Differences in Second Language Learning Motivation

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Introduction. The aim of the paper is to provide a detailed view on motivation for learning second languages in the Czech Armed Forces. As an important prerequisite of interoperability, foreign language proficiency represents an integral part of competences necessary for the personnel serving in modern western militaries. Therefore, language education belongs to significant components of professional military education. As in any other human activity, motivation represents one of the key factors influencing language learning effectiveness. Complexity and diversity of motivation with focus on language learning motivation rather than language classroom motivation have been considered alongside with striving for higher effectiveness of the second language learning process. Motivational factors include respondents' goals, attitudes and efforts. Awareness of the fact which motivational factor is the driving force behind students' willingness to study second language and their success will definitely contribute not only to the production of tailor-made courses, but also to the qualitatively improved overall approach towards the second language learning process within the Czech Department of Defence.

The presented research focuses on examining validity of the following hypotheses:

1. Czech Armed Forces, personnel, serving in a largely directive-managed organization with strictly defined language and career requirements, are motivated to learn second language dominantly based on extrinsic rather than intrinsic factors.

2. There are no significant differences in relative importance of different motivation factors among male and female learners.

3. For younger learners, internal motivational factors are more prevalent than for older learners.

Method of investigation. The paper examines the hypotheses above and therefore, different factors of motivation for second language learning among 454 participants of 2022/2023 language courses at the Czech University of Defence Language Centre who represent different categories of both military and civilian personnel of the Czech Armed Forces and the Ministry of Defence of the Czech Republic. Data on motivational factors were gathered within a questionnaire survey enabling to rank relative significance of individual language learning motivational factors as well as to examine language learners´ perception of these factors as either intrinsic or extrinsic. Survey has been designed to enable data classification based on different groups of learners (e.g. by gender, age, military rank, military service duration or education). Data gathered were analyzed using basic statistical methods, especially descriptive statistics and the test of equal proportions, see for example.

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Investigation Results. Results of the submitted analysis enabled to confirm validity of two of the three initially formulated hypotheses. First, unlike expected, results show that motivational factors perceived intrinsic prevail over extrinsic ones (indicated by responders to be app. three times more important). Second, the hypothesis of no significant differences in perception of relative importance of different motivational factors between men and women has been confirmed. Finally, the assumption that intrinsic motivation would play a more important role for younger learners compared to older learners was not confirmed.

Table 1. Survey results by gender of respondent

Males	Mean	Median	Rank	Motivation			Females	Mean	Median	Rank	Motivation		
				Extrinsic	Intrinsic	Both					Extrinsic	Intrinsic	Both
Q1	2.52	2	6	27.0%	32.6%	40.5%	Q1	2.00	2	2	25.4%	13.6%	61.0%
Q2	2.55	3	7	35.5%	30.6%	33.9%	Q2	2.19	2	6	40.7%	15.3%	44.1%
Q3	2.42	2	3	14.5%	49.5%	36.0%	Q3	2.10	2	3.5	13.6%	49.2%	37.3%
Q4	2.51	2	5	23.9%	42.9%	33.2%	Q4	2.10	2	3.5	20.3%	33.9%	45.8%
Q5	3.10	3	10	19.1%	46.4%	34.5%	Q5	3.29	4	9	25.0%	48.2%	26.8%
Q6	3.07	3	9	20.3%	46.4%	33.2%	Q6	3.42	4	10	25.9%	40.7%	33.3%
Q7	1.91	2	1	5.3%	70.1%	24.7%	Q7	1.69	2	1	1.7%	78.0%	20.3%
Q8	2.46	2	4	7.3%	69.9%	22.8%	Q8	2.24	2	7	1.7%	74.1%	24.1%
Q9	2.37	2	2	8.0%	64.8%	27.2%	Q9	2.10	2	5	0.0%	70.7%	29.3%
Q10	2.91	3	8	8.6%	71.1%	20.3%	Q10	2.78	3	8	3.4%	75.9%	20.7%
Q11	3.31	3	11	17.9%	41.9%	40.2%	Q11	3.46	4	11	15.5%	43.1%	41.4%
Q12	3.42	4	12	18.1%	48.8%	33.1%	Q12	3.59	4	12	21.1%	50.9%	28.1%

Discussion. In spite of the fact that the armed forces represent an organization characterized by directive style of management, incl. strict language requirements policy obligations to fulfill them, survey results show that intrinsic factors play more significant role in foreign language learners´ motivation. Confirmation of the expected no significant differences in perception of second language learning motivational factors between men and women probably reflects the fact that in the Czech Armed Forces conditions for military service, career system and therefore also language requirements and learning opportunities are set and implemented as equal for both genders. Not confirming the expectation that the motivation of younger learners will be different from that of older learners can be partially explained by the fact that learners understand added value of second language competences not just with regards to their current and prospective career requirements in the military but also in the context of their future second career after they retire from the military or in their private life. Partially, this result can be connected with the fact that generally higher ranks, i.e. older military personnel serve at positions with higher language requirements.

Conclusion. Results of the research indicate that there is an opportunity for the HR policy- makers to enhance language learning effectiveness by adjusting the language education system in the Czech military. Such an adjustment should lead to a more informal and voluntary education model, which would utilize the intrinsic will of the learners to "learn something new" on one hand, on the other hand would establish conditions (time frame,

instructors, consultation, learning materials etc.). Similar perception of motivation across different groups of learners makes reasonable implementation of similar or equal treatment with regards to different personnel categories.

Limitations. Research presented covers second foreign learners of their learning motivation just within one academic year at the University of Defence Language Centre. Subsequent repeated surveys aimed to confirm results gained and/or identify trends in perception of second language learning seems to be useful for forming impartial and more comprehensive picture of the issue examined. Similarly, comparison with results of similar research in other countries represents a great potential added value for future research.

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Preferred Leadership Styles: Mid-Career Professionals in the Czech Military

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Introduction. Today´s global and interconnected world poses new challenges and tasks for leaders at all leadership positions and in all spheres of society, including the field of national security and defense. One of the crucial leadership skills is to choose an appropriate leadership style for achieving expected goals and tasks [1]. Currently, in institutions and organizations, we encounter increasing requirements for the ability to cooperate and connect with the individual components of these organizations, which requires the use of new methods from their leaders [2]. Even traditional complex hierarchical organizations [3], such as the military and police, must adopt new leadership and management practices in times of rapid technological development and social change, practices that focus on sharing power and fostering cooperation. One such procedure is the use of the connective leadership method. The aim of the paper is to present findings drawn from the ASI questionnaires collected at the mid-career officer courses during the 2018 – 2022 period.

Method of investigation. As part of the curriculum of the leadership section of senior officer courses at the University of Defence, participants worked on identifying the leadership styles used in their current work positions.

The Individual Achieving Styles Inventory (ASI) was used to assess leadership styles used in connection with achieving participants' work tasks. The connective leadership method [2] was created on the basis of the growing need of complex organizations where it is necessary to lead different groups that are nevertheless dependent on each other and must cooperate on a common task. The connective leadership method includes nine behavioral strategies that individual leaders use in different contexts and is designed to help them discover and develop strategies that they would not normally use. This method thus develops both the leadership potential of individuals and the effective functioning of entire complex organizations and their different structures.

Investigation Results. The findings show a consistent pattern of almost equally balanced use of all leadership styles in all groups with two less preferred styles: competitive and entrusting. The findings reflect the fact that at their leadership level, the mid-career officers are expected to suppress possible competitive tendencies while cooperating with other teams and groups in order to achieve their tasks. On the other hand, they are expected to perform many of their tasks themselves, which prevents them from using entrusting leadership style more often. The paper will also comment on differences between male and female military leaders' preferred styles, though the number of female leaders in the cohort was significantly lower than that of the male leaders.

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Incorporating the internationally proven connective leadership method into the training of commanders at the level of organizational leadership would significantly enrich not only the content of the training but, above all, the course participants themselves. It would help them manage difficult situations in their own practice of leading people to accomplish a task.

The very important fact that emerges from the long-term work with the participants of career education courses is that they themselves perceive the need to improve their leadership skills [4]; they welcome the feedback that is provided to them during the courses. They are open to new knowledge and want to learn new methods of working with a team so that it is possible to effectively achieve goals even in challenging, non-standard conditions with people whose selection they cannot completely influence.

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COVID-19 Restrictions´ Effect on Physical Fitness: A Comparative Study of First-Year Students in Pre, During, and Post-Pandemic Eras

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Introduction. Physical fitness plays a crucial role in fostering effective and self-reliant behavior among individuals. On a broader scale, a community composed of physically fit members demonstrates higher productivity, overall health, and greater resilience to challenges of all types – from economic pressures to cultural, medical, and natural disasters, as well as conflicts. The gradual but steady decline in population fitness over the past decades is acknowledged, and various measures are being implemented by governments to counter this trend, emphasizing an active lifestyle and suggesting reductions in time spent on digital media. However, the very essence of promoting physical fitness advice was overshadowed by a more immediate threat—the coronavirus disease (COVID-19) pandemic. Countermeasures adopted varied across countries globally, but social distancing emerged as a universal response. Home-office, distance learning, or even lockdowns have led to an increase in unhealthy lifestyles, consequently contributing to a decline in physical fitness.

While the exact timeline of the COVID-19 pandemic remains undefined, the most severe countermeasures were implemented during the years 2020 and 2021. Scientific exploration and documentation of physical fitness changes have been conducted; however, a broader time window is often absent as studies predominantly focused on the acute responses to lockdown without follow-up trend inquiries. Therefore, the presented study aims to investigate how physical fitness varied among first-year university students over a 5-year span to encompass the influence of the COVID-19 era. This investigation includes an examination of students in all combinations, whether they were accepted before, during, or after COVID-19 restrictions, and under various circumstances of their study.

Method of investigation. Data for the analysis were collected from the results of the first two semesters of physical education credit disciplines at the University of Defence, achieved by 1196 males and 253 females, over five consecutive school years, from 2018 to 2022. The first- semester disciplines included the 10 x 10 m shuttle run, 1000 m run, and pull-ups for men, and pull-up hold for women. The second semesters comprised the 12-minute run and pull- ups for men, and pull-up hold for women. All tests were administered by a physical education teacher with a minimum of 6 years of experience. All students were familiar with the tests and underwent training for the disciplines or received a training plan during distance schooling.

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The best results achieved by each student were used for the study. The statistical program R was used for data analysis.

Investigation Results. In the first-semester disciplines, the school class of 2020/21 distinguished itself with poorer results in all three disciplines for both men and women. Among men, the class of 2018/19 achieved the best results, demonstrating statistically significantly better performance in pull-ups compared to all other classes, a superior 1000 m run result in all years except 2019/20, and a better 10 x 10 m shuttle run result compared to 2020/21. For women, the class of 2019/20 showcased the best results, with a pull-up hold performance superior to that of 2020/2021 and 2021/22. Differences in the 1000 m run and 10 x 10 m shuttle run with other classes were statistically insignificant. In the second-semester disciplines, the class of 2019/20 exhibited the lowest results for men in both disciplines, while for women, the class of 2020/21 had the poorest performance. The best results for men in the 12-minute run were observed in the class of 2021/22, and for pull-ups, in the class of 2018/19. Among women, the class of 2018/19 achieved the best results in the 12-minute run, and for pull-up hold, the class of 2022/23 demonstrated superior performance. Comparing pull-ups between the first and second semesters of the same classes revealed identical performances for 2018/19 and 2019/20, and an increase in the second semesters for 2020/21, 2021/22, and 2022/23. Differences between semesters in pull-up hold were statistically significant in all years, with decreased performances in 2018/19 and 2019/20, and increased performances in 2020/21, 2021/22, and 2022/23.

Conclusions. This study analyzes the physical performance of university students in their first year of study before, during, and after COVID-19 pandemic-related restrictions, providing insightful observations on how physical capabilities varied during this period. The notably poor first-semester performances in 2020/21 suggest a significant impact of COVID-19 restrictions on physical performance. The class of 2020/21 is characterized by students who did not undergo physical entrance exams for the university and experienced a partial lockdown and a distant-schooling system throughout the semester. Interestingly, the class of 2021/22, who also did not undergo physical entrance exams but were required to be present at the residence hall during distant-schooling, achieved better results. The second semester followed the same pattern for women but not for men. The class with the most substantial decline in physical performance in the second semester was 2019/20, who experienced lockdown and distant-schooling but underwent physical entrance exams. The observed decrements in physical performance during lockdown and distant-schooling align with the findings of previous researches.

Keywords: *physical fitness, longitudinal study, distant schooling, COVID-19 restrictions, impact assessment.*

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Military Versus Civilian University Online Education

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Introduction. In this paper we compare three independent questionnaire surveys conducted between 2021 and 2022 at the Faculty of Military Leadership of the University of Defence and the Faculty of Business and Economics of the Mendel University, both in Brno, Czech Republic. The main objective was to assess the contribution of online teaching during the Covid-19 pandemic, to evaluate it subsequently with face-to-face teaching and, above all, to compare the results obtained at military and civilian universities.

In the Faculty of Military Leadership, the science subjects Mathematical Methods and the humanities subjects Military History and English Language were chosen, all taught in the first year of a five-year master's degree program. Only science courses were monitored at the Faculty of Business and Economics, namely three courses of Mathematics in the 1st year of the bachelor's degree and the course of Operational Research in the 1st year of the follow-up master's degree. A total of 437 respondents took part in these surveys. The majority of military students were male, whereas the selected civilian field had a more balanced representation of men and women, even in the chosen civilian follow-up master's degree, women predominate.

Methodology. The questionnaires were created in Google Forms for data collection. The content and number of questions varied across the datasets, and most of them used a 5-point Likert scale for evaluation. In all three cases, the respondents rated the advantages and disadvantages of online learning, its quality and were asked which type of learning they preferred. The collected data was processed using descriptive statistics, followed by cluster analysis and K-means method. In the processing, the division into two homogeneous clusters was always used.

Results. When evaluating the benefits of online learning, the military students most valued the time savings and not having to commute. The civilian university students were most appreciative of the video recordings provided and flexibility. When comparing the disadvantages of online learning, the lack of social contact appeared to be the most significant for both types of students. They were also bothered by technical problems. The civilian bachelor's students reported lower concentration during online learning and a poorer understanding of the material discussed in this way in contrast to other master's students.

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From the evaluation of online learning by military and civilian students, it is clear that civilian bachelor's students rate online learning worse, as shown in Fig. 1, where 1 indicates very good, 2 rather good, 3 average, 4 rather poor and 5 very poor quality of online learning. In terms of preference for online or face-to-face instruction, military students prefer online instruction more, whereas the distribution of preferences is more even for the civilian students surveyed.
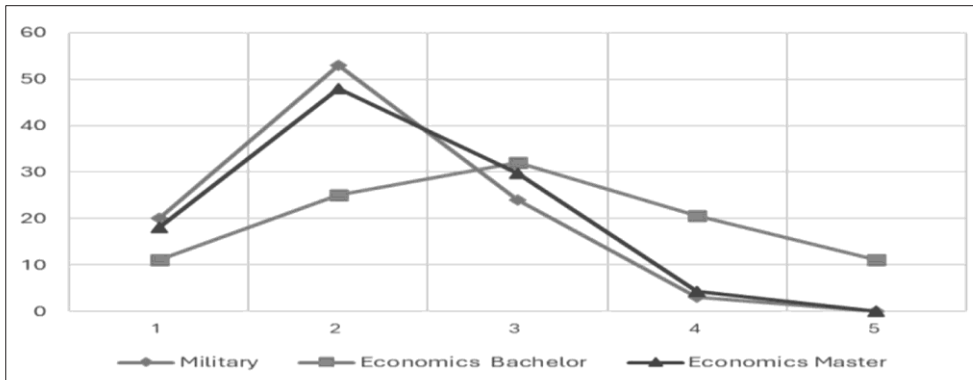

Fig. 1 Quality assessment of online learning by military (green),
civilian bachelor (orange) and master (blue) students.

When the students were divided into two clusters based on their responses to the selected questions, these clusters were identical in terms of number of students in the case of the military university and the civilian master's program. For the students of civilian bachelor's program, the second cluster was more numerous. These two resulting groups can be interpreted as follows, cluster 1 corresponds to respondents who prefer online learning, cluster 2 to those who prefer face-to-face learning.

Conclusions. The observed surveys show that online instruction was accepted by military students as a suitable substitute for face-to-face instruction and was even more preferred. Compared to civilian courses, its preference was slightly higher. The quality of online teaching in the military studies was then rated comparably to that of online teaching in the civilian follow-up master's courses. Thus, online learning and its use in military university studies can be recommended.

Limitations. Online teaching at the military university was compared with only one civilian university, and that of the economics major. The chosen courses were similar in focus but did not cover the full range of courses of the study under review. The aforementioned questionnaire surveys were not identical and differed on some questions.

Keywords: *military education, online teaching, questionnaire surveys, cluster analysis, descriptive statistics.*

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11 – 13 September 2024, Brno, Czech Republic

Analysis of Students Results and Form of Physics Teaching at the Faculty of Military Technology of the University of Defence

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Introduction. This contribution deals with the form of teaching physics at the Department of Mathematics and Physics, Faculty of Military Technology, University of Defence. The Department of Mathematics and Physics educates future officers in technical fields, as well as civilian experts for the national security system and the defence industry. Physics is taught in almost all specializations, especially in the military-technical field of mechanical and electrical engineering [1]. Students from various types of secondary schools come to our faculty. This means that students' knowledge of physics is very different. At the beginning of the study, we try to balance the level of knowledge of physics with an individual approach. Accredited fields of study for master's, bachelor's and follow-up master's studies have a decent number of hours subsidized in physics. This takes place in the form of lectures, theoretical and laboratory exercises. We strive to innovate teaching methods by introducing modernized textbooks and new laboratory tasks while using information technologies [2]. Whether our efforts have positive results can be judged from the results of students in physics exams over the past five years.

Method of investigation. We used data from the last five years of students' results in physics exams to analyse their learning achievement in teaching physics. We studied the impact of the individual approach to students [3-4], the gradual introduction of innovative methods in teaching using new laboratory equipment, the modernization of study materials and the use of information technologies.

Investigation Results. Analysis of physics exam results over the past five years shows a positive effect on student achievement in relation to dividing them into smaller groups in laboratory and computational exercises. Individual approach to students, especially mentoring at the beginning of physics studies, also plays an important role.

Conclusions. Teaching students in physical subjects consists of lectures, theoretical and laboratory exercises. Analysis of learning outcomes confirmed that mentoring, including individual care of students, helps to achieve better exam scores and a better understanding of physics topics.

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
11 – 13 September 2024, Brno, Czech Republic

Possible Approaches to Increasing Fitness in the Military in the Context of the Current Level of Fitness in the Population

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Introduction. In the field of health physical education, i.e. aspects of fitness and the level of motor skills, we as a society encounter a decrease in performance, which can be described as an undesirable phenomenon. This fact manifests itself in many areas and at different levels, and it is therefore not surprising that this negative phenomenon became evident in the military surroundings. Army environment is specific in the variability of stimuli arriving during different time periods throughout the year and their nature. The physical preparation and readiness of the soldier, which is influenced by climatic conditions, equipment and armament as well as limited regeneration time must lead to the ability to use capabilities under difficult conditions and immediately when needed. The aim of physical fitness is to be prepared for potential operational deployment. Currently, there is a trend towards decreased physical activity throughout the day, which also affects professional soldiers. An increased proportion of work activities that do not directly demand fitness is leading to a decline in performance. The absence of comprehensive exercise, replaced by unilateral physical activity, appears to be a cause, along with a lack of respect for the principles of adapting the body to stress over longer periods. According to authors Boyle and Kraemer, Zatsiorski, it is crucial to create a training program from actions that occur in the given aktivity.

Results. In our contribution to this fact, we reflect on the issue and substantiate the claim based on the data acquired. On the basis of data obtained from recent years during laboratory tests, many years of personal experience and the results of similarly conducted studies, it can be stated that when measuring force (expressed by anaerobic capacity) and aerobic reactions there is a decrease and at the same time (possibly related to that) there is a decrease in the muscle component and an increase in the fat component with respect to the body composition. Next, we deal with means that we believe can effectively avert or possibly slow down this phenomenon. We want to draw attention to both health aspects in the context of body composition and fitness components, namely aerobic and anaerobic capacity and their sustainable development. For these purposes, we present exercise programs based on long term systematic work with load and rest intervals, while the HIIT method is used and workout is based on basic multi-joint exercises that serve not only to increase fitness, but also to prevent injuries.

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In connection with the composition of HIIT programs, their manipulation and subsequent application, we refer in particular to the findings of the authors Laursen and Buchheit, our own research activities focused on evaluating the effectiveness of programs when changing one of the variables in the most used HIIT system in the commercial sphere, the so called Tabata, and meta-analyses by Ramos and Milanovič.

Conclusions. In the given meta-analyses, in addition to the effectiveness of the HIIT program for fitness development, the health aspect was monitored and interval method was compared with continuous method. The effect of HIIT on changing body composition is mainly attributed to EPOC (excess post oxygen contribution), which was explained and confirmed in subsequent studies by Olson, as well as factors at the hormonal and enzymatic level.

Keywords: *physical fitness, HIIT – High Intensity Interval Training, anaerobic and aerobic capacity.*

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Survival Analysis of the Military Students Drop Out Rate

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Introduction. The military-economic-political situation in the world in recent years has not been as stable as most people would have imagined. This is reflected in the increase in military conflicts, which in some way affect the lives of more and more people. In this situation, the armies of the respective countries play a key role. It is important to have educated people in command positions who serve the democratic principles of their country. In the Czech Republic, the University of Defence is responsible for educating and training military officers. Three faculties, two institutions and three centres are involved in the bachelor's, master's and doctoral studies in military leadership, technical and medical fields [1].

During the existence of the University of Defence, the study programmes have undergone minor or major changes in order to meet the requirements of a modern army and to respond to the military-political situation in the world. The length and content of the studies have therefore naturally changed. One of the logical consequences was the transition to a five-year master's programme with an emphasis on the formation of the military professional's personality, physical fitness and language skills.

Military students – future commanders – have been enrolled in newly accredited five-year study programmes. During their studies, the students have to fulfil not only their academic obligations, but also a demanding military training. Not every student can cope with this successfully. In this contribution, we compare the dropout rate from the five-year study programme at the Faculty of Military Leadership and the Faculty of Military Technology, as well as the dropout rate for each year of study.

Limitations. The study is limited to the students of two faculties of the University of Defence, Brno, Czech Republic, which started the new study programme at the same year. The availability of data is our main limiting factor, but we have finally completed all five years. Nevertheless, for each leaving student only the official date of their leaving is known, but not the reasons that led to this decision.

Method of investigation. In this study, several scientific methods were employed to assess the dropout rate of the military students. First, the data were cleaned and scaled, followed by a statistical description of the main characteristics. Parametric and non-parametric methods of survival analysis were then used to assess and compare the dropout rate of each faculty and each class [2,3].

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Results. The dropout rate, as shown in Fig. 1(a), is similar for both faculties. The first year is the most critical, with a survival rate of around 65%, after which the slope of the survival curve decreases. As for the classes, Fig. 1(b) shows a similar pattern to that of the faculties, with the first year being the most critical. In particular, for the classes of 2016 and 2017 (yellow and violet, respectively), one can observe a large drop after the first semester. This visual comparison is supported by the Gehan-Breslow-Wilcoxon test, which shows that there are statistically significant differences between the survival curves for both the faculties and classes.

(a) KM estimates - Faculty   **(b)** KM estimates - Class
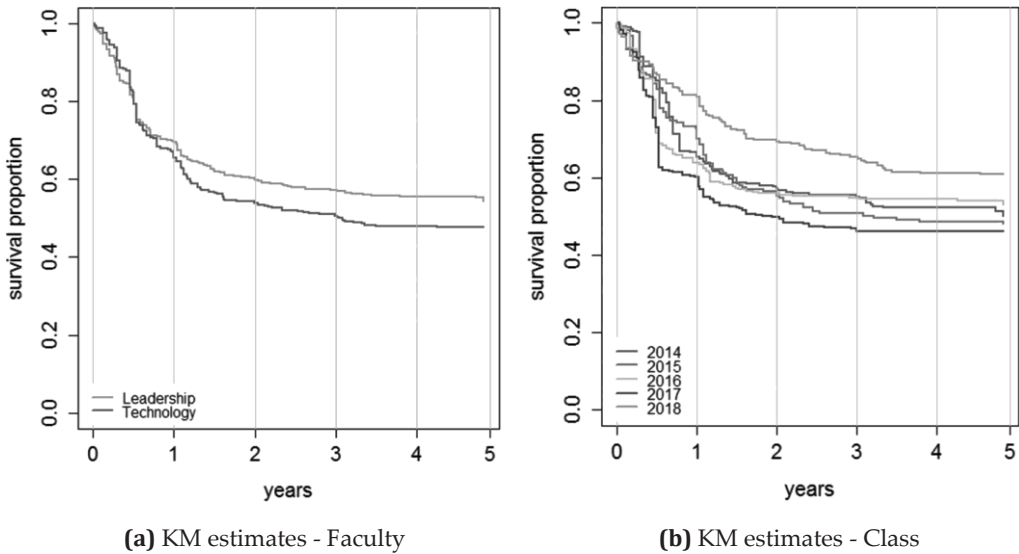
Fig. 1 The Kaplan-Meier estimates of the dropout rate stratified by (a) faculty and by (b) class

Conclusions. The outcomes of this study show that the first year is critical for the students of both faculties. Although the reasons for dropping out are not known, we can conjecture that the high dropout rate after the first semester is influenced by the discrepancy between the students' perceptions and the reality of the university studies [4]. After the first year, however, the dropout rate decreases substantially. The class of 2018, as far as we know, was influenced by the creation of mathematics support groups, which resulted in a more gradual dropout rate in the first three years compared to the other classes. From a pedagogical point of view, it is important to pay more attention to the students during this critical period and to motivate them more to study.

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Multicriteria Comparison and Evaluation of Vestibular Apparatus Training Methods for Pilots

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Introduction. Balance, regulation of position, body movements in space, the perception of gravity, and angular and linear acceleration are significant for every pilot because their processing with possible suppression of false sensations is one of the basic conditions for a successful flight. The vestibular apparatus is involved in the above. This critical apparatus generates sensory perceptions. If not corrected by vision, it may generate perceptions that may not correspond to the real position of the pilot-aircraft system. The reactions of the apparatus, mostly of an unconditionally reflexive nature, may also induce various unusual sensations, unwanted emotions, and illusions, which may be fatal for the pilot. This is because the human body is adapted only for movement on the ground, and its senses cannot properly evaluate the sensations during flight in an aircraft. For this reason, every aircraft is equipped with flight and navigation instruments that indicate the aircraft's actual position in space, regardless of the dynamic forces acting on it. Their use helps pilots to overcome the imperfections of human perception. [1],[2],[3],[4],[5]

As part of the preparation of a student of the University of Defence (UoD), specialization military pilot, physical training takes place during the first three semesters before the start of practical flight training. This physical training takes place in the scope of four lessons per week and focuses on:

● basic physical training (development of physical abilities and movement skills);

● special physical exercise to increase the body's resistance to the adverse physical factors of flight.

In particular, the specialized training prepares students for initial flight training, which places increased demands on spatial orientation [6]. The flight training takes place in an intensive form of 2 to 3 flights per day in a briefing-flight-debriefing format with progressively more demanding individual flights. This training aims to provide primary flight training and test future pilots' individual competencies. For this reason, aerobatic flights are included in the flight training after 30 hours to test spatial orientation skills and organism endurance as prerequisites for the possibility of becoming a fighter pilot [7]. In the context of the current increasing expenditure on armaments and the acquisition of new modern equipment by the Air Force [8], a high emphasis is placed on the training of personnel.

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This article aims to analyze and compare, using multicriteria analysis, the different methods for training the resistance of the vestibular apparatus at the UoD. Thanks to regular training, students of the military pilot specialization prepare for adverse effects, such as kinetosis caused by irritation of the vestibular apparatus, learning to recognize flight illusions and to react adequately to them. In the special physical training classes, students perform physical exercise with changes in body position, such as various agility exercise, basic gymnastics, and exercise on gymnastic equipment (trampoline, rings, trapeze, etc.). In order to strengthen the resistance of the vestibular apparatus of future pilots of the Czech Air Force to undesirable phenomena of motion sickness and vestibular illusions, the UoD has a training simulator 360Swing, Gyroscope by company Ad-Libitum, Poland, and rotation cage.

Method of investigation. At the beginning of the study, the analytical hierarchy process [9] was performed to identify the individual criteria according to which each training method is compared. In total, nine criteria for comparison were identified within the expert team:

C_1 Maximum acceleration values

C_2 Similarity to flying in an airplane

C_3 Simultaneous irritation of multiple semicircular canals

C_4 Variability of training

C_5 Involvement of cognitive functions

C_6 Necessity of mastering the technique

C_7 Current health status

C_8 Possibility of leisure training

C_9 Equipment maintenance needs

The individual criteria are discussed in more detail, e.g., C_2 Similarity to flight in an aircraft was assessed by measuring the acceleration vectors during flight, as shown in Fig. 1. Weights were then determined for each criterion using the Saaty matrix.

Investigation Results. The result of the comparison is a table of the individual criteria, scored and compared according to the criteria weights. Devices and methods currently available in the UoD environment were included as alternatives:

A_1 Gyroscope

A_2 Rotation Cage passive

A_3 Rotation Cage active

A_4 Basic Gymnastics

A_5 360 Swing

The best rating was achieved by the passive double circle variant, which was close in rating to the fifth wheel and gyroscope. In contrast, the elementary exercise received the lowest score.
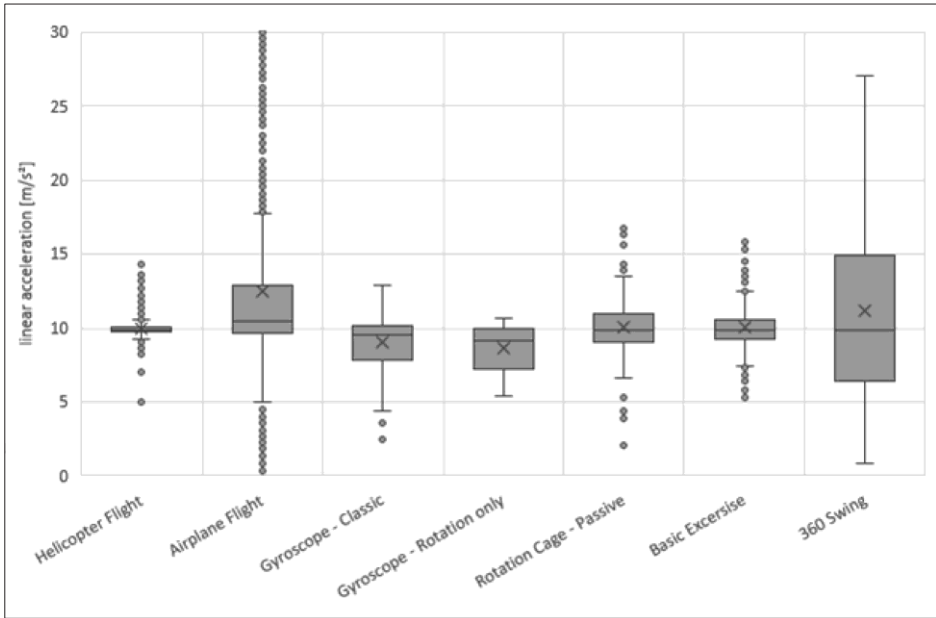
Fig. 1 Measuring of acceleration vector

Conclusions. Despite the above evaluation, none of the alternatives overwhelmingly outweighed the others in absolute numbers and individual criteria. This fact is illustrated in the spider diagram, see Fig. 2, which shows the distribution of the scores in each criterion not including the weights that would distort the resulting area. In conclusion, the best training results can be achieved by appropriately combining all the above methods. Finding a suitable combination of methods is also a direction for future research.
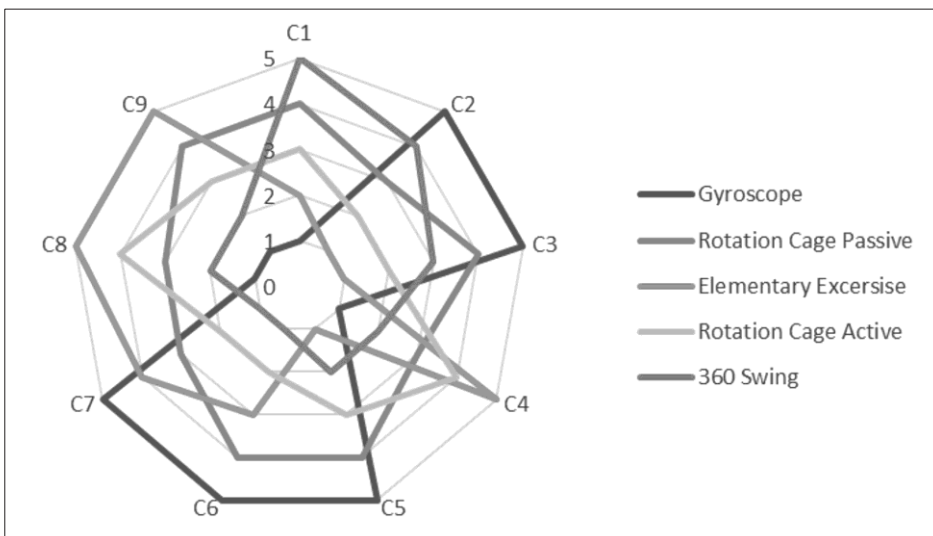
Fig. 2 Spider diagram of results

Limitations. This study's limitation is the limited selection of alternatives, which is, however, defined by the environment of the UoD and its material facilities.

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Statistical Analysis of Youth Physical Fitness as an Important Factor for the Defence of the Czech Republic

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Introduction. The Army of the Czech Republic replenishes its ranks with adult citizens of the Czech Republic with appropriate education, skills, age and health. Post-entry training requires the use of methods and means that are adequate to the level of the entering soldiers and ensure the achievement of a minimum level of their overall readiness.

The Czech Republic, like other European countries, faces the problem of declining physical fitness of youths not only in the context of the COVID-19 pandemic in 2020-2021 [1–4]. The Army must respond to this situation by adjusting its approach. In order to make this change systemic and to respond to the current state of society, the BODY project (*Physical fitness of the population as a risk factor for ensuring defensive capacity of the Czech Republic*) included, among other things, testing the physical fitness and body composition of adolescents as potential candidates for entry into the army. The aim of this study is to determine the level of physical fitness of youths and to assess their current status in strength and endurance disciplines. This knowledge can be used to prepare adequate recruitment conditions, including the content and limits of relevant tests, as well as to modernise recruitment policies.

Method of investigation. The BODY project tested the physical fitness of 1486 Czech secondary school students (923 males, 563 females) aged 15-18 years between 2021 and 2023. The project included 15 civilians and one military high school in a systematic way to cover all regions of the Czech Republic. Physical testing consisted, among other things, of endurance (W170/kg test, 4x10m shuttle run) and strength disciplines (standing long jump, handgrip strength). The physical testing also included a body composition analysis where the parameters measured included body height, weight, body fat and muscle mass. Individuals participated in this study voluntarily and signed an informed consent form if they were 18 years old. For the minors, the consent was signed by their legal representative. Respondents were also assured of the confidentiality of the information obtained.

Investigation Results. In endurance disciplines the respondents performed significantly better than in strength disciplines. Women performed better than men in both endurance disciplines. As can be seen in Figure 1, the sum of very good and excellent results exceeds 50% in the W170/kg test in most cases for all years and age categories.

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In 2023, there is an improvement in performance (reduction in the proportion of poor performers) in this discipline for all male age categories compared to 2021, and for females only in the 17 and 18 age categories. Women performed better in handgrip strength. For both females and males in the 17 and 18 age categories, the proportion of insufficient grip strength was highest.

Looking at performance by year, regardless of age, the best results in handgrip strength were achieved by both men and women in 2021. In the W170/kg stress test, men improved slightly each year, while women performed slightly better in 2022 than in 2023. Percentage of total body fat was measured highest in both men and women in 2021 and has been gradually decreasing.
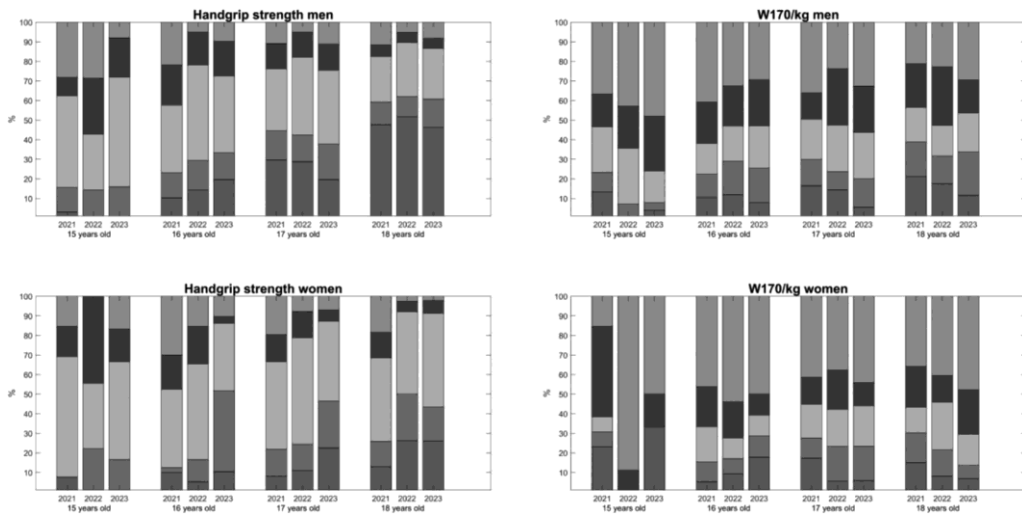
Fig. 1 Performance evaluation of the W170/kg test (right graph) and handgrip strength (left graph) for men (first row) and women (second row). Performance categories: poor-blue, medium-red, good-yellow, very good-purple, excellent-green

Conclusions. Motivated, competent, well-trained and therefore qualified military personnel are essential to the success of any army. For planning and management of training, it is therefore essential to have information on the status of selected target groups from among the citizens of the Czech Republic, so that the training system is prepared for the expectations of future participants and, if necessary, supplemented with new elements. Within the framework of European standards [5,6], an assessment of 15-18 year old students in the Czech Republic was carried out and percentiles for the most commonly used tests of physical fitness and body composition were determined.

Limitations. It is important to note that these data have methodological limitations. Respondents completed other measurements as part of the BODY project, including questionnaire surveys, so fatigue from these parts of the project may have played a role in the physical testing results. It should also be noted that some events, particularly the long jump from a standing position, require professional supervision and training. If students have not encountered this discipline before, they may perform significantly worse.

objective: Personnel Preparation (project OYUOB20200001, 2021).

Keywords: *fitness testing; body composition analysis; adolescents; statistical evaluation*

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Alpha-Fit Test Battery Norms for Children and Adolescents from 5 to 18 years of Age Obtained by a Linear Interpolation of Existing European Physical Fitness References

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1   The W170 Stress Test determines the power (W) the test subject is capable of achieving at a heart rate of 170 beats/min. For interpersonal data comparisons, power is converted to kilograms of weight (W/kg).

Analysis of Physical Performance of University of Defence Students Using Exploratory Factor Analysis

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Introduction: In some countries, there is a noticeable decrease in endurance capabilities among military recruits at the beginning of their military service, accompanied by an increase in body weight [1]. Lower levels of physical ability in soldiers reduce the likelihood of successfully completing basic training and, conversely, increase the risk of musculoskeletal injuries [2]. Conversely, a high level of general endurance can positively affect the handling of physical demands during basic training and may be associated with its successful completion [3]. When assessing military readiness, the level of strength and endurance capabilities are considered key performance factors [4]. Some studies [5, 7] have examined the level of physical ability among Czech soldiers, including recruits. The general trend of deteriorating health and decreasing physical ability among the population including soldiers, leads to an increase in body weight and percentage of body fat. Some foreign studies [8, 9] have explored the relationship between body composition and physical ability. Combined strength and endurance training is an optimal training method to increase the overall physical performance of soldiers [10]. Soldiers engaged in combat situations, however, also require an appropriate level of anaerobic capacity to fulfill high-intensity tasks in rapidly changing life- threatening situations [11]. Large differences in the initial physical performance of recruits have led military units to create safer and more effective training programs [12]. The physical ability of soldiers is often tested using tests designed for a wide population, such as the 12-minute run test and push-ups, as well as specific military tests [13, 14]. In some similar studies, exploratory (EFA) or confirmatory (CFA) factor analysis has been used to assess the correlation structure of variables [15, 16]. There is no unified approach worldwide to the content of physical tests, and individual NATO states have their own test batteries. Typically, the level of strength (sit-ups, push-ups, pull-ups, and endurance in pull-ups) and endurance (running at various distances) capabilities are verified. Training and testing of Czech military students at the University of Defence primarily focus on developing strength, speed, speed-coordination, and endurance capabilities. The aim of the research was to analyze the physical performance of University of Defence (UD) students, explain the correlation structure of observed variables using exploratory factor analysis, and identify and name individual latent factors.

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Method of Investigation: A total of 89 male students from UD (age: 21.1 ± 1.26 years; body height: 180.3±6.69 cm; body weight: 80.6±9.32 kg) were tested as part of mandatory physical tests. Ethical approval was obtained from the Human Subjects Ethics Committee of the University of Defence. The measurements and tests were focused on two areas (Table 1): body size and composition (6 tests), motor performance (12 tests). All tests were conducted by physical education professionals at the University of Defence, each possessing a minimum of five years of teaching experience. Participants were explicitly instructed to exert their best effort during each testing session. Testing of students took place at UD sports facilities and occurred over the course of one week. Descriptive statistical methods (mean, standard deviation; minimum value, maximum value; coefficient of variation; Pearson correlation coefficient) were used for statistical data analysis. The correlation structure of observed variables and identification of individual factors were examined using exploratory factor analysis (maximum likelihood method, varimax rotation). The effect size of the correlation coefficient r was evaluated as follows (Cohen, 1988): r=0.1 (small); r=0.3 (medium); r=0.5 (large). The significance level was set at $p < 0.05$.

Investigation Results: For the examined group of UD students (n = 89), basic statistical characteristics were calculated for individual variables (n=18), and a seven-factor correlation structure of observed variables was identified through exploratory factor analysis (EFA). The values of the correlation coefficient *r* between individual variables and factors F1–F7 are provided in Tab. 1.

Tab. 1 Structure matrix coefficienfts for observed variables (*n* = 18)

	Variables	F1	F2	F3	F4	F5	F6	F7
1	Body height (BH)	*-0.195*		0.591		0.479		
2	Body mass (BM)	0.423		0.806	0.329			
3	Waist hip ratio (WHR)	0.933						
4	Body fat (BF)	**0.973**						
5	Muscle mass (MM)	-0.971						
6	Fat free mass (FFM)			**0.898**	0.363			
7	Handgrip strength right (SR)				0.818			
8	Handgrip strength left (SL)				**0.903**			
9	Forced expiratory volume 1 s (REV1)					**0.837**		
10	Forced vital capacity (FVVC)					0.772		
11	Physical Working Capacity-170 (PWC)		0.480					
12	Sit-ups (SU, 120 s)		0.430					
13	Push-ups (PU, 60 s)		**0.782**					
14	Triple jump (TJ)							0.433
15	Throw a hand grenade (THG)							**0.630**
16	Running 5 km (R5)		-0.437					-0.356
17	Swimming 100 m (S100)						**0.975**	
18	Swimming 300 m (S300)						0.756	

Notes: For $\alpha = 0{,}05$ is $r_{krit} = 0{,}206$. Factor loadings <0.3 (ES small) are suppressed. Variables with the highest loadings for each factor are in bold.

The individual latent factors can be designated as follows: F1 = "body size and composition" (highest loadings found in body fat, .973), F2 = "strength endurance" (highest loadings

found in push-ups, .782), F3 = "body size" (highest loadings found in fat-free mass, .898), F4 = "muscle strength" (highest loadings found in HGS left, .903), F5 = "vital lung capacity" (highest loadings found in forced expiratory volume, .837), F6 = "swimming skill" (highest loadings found in swimming 100 m, .975), F7 = "explosive strength" (highest loadings found in throw a hand grenade, .630). Based on the results of EFA, the reduction of the number of measurements and tests to a total of seven can be considered, using variables with the highest loadings.

Conclusions: The analysis of physical performance of University of Defence students using exploratory factor analysis demonstrated a seven-factor structure of observed variables. The individual latent factors can be identified as "body size and composition, strength endurance, body size, muscle strength, vital capacity, swimming skill, explosive strength." The reduction of the original eighteen measurements and tests to a total of seven can be considered.

Limitations: Although there are methods for determining the optimal number of factors when using EFA, the interpretation of factors may depend on the researcher's subjective assessment and knowledge. Selecting inappropriate methods for analysis (e.g., incorrect type of factor analysis) can lead to incorrect results. If too many factors are selected, it may lead to excessive model complexity and difficulties in interpretation.

Keywords: body composition, body size, exploratory factor analysis, military students, motor test battery, physical performance factors

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Teaching the Subject of Operations Research at Military Universities (not only) of NATO Countries

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Introduction. In recent decades, there have been significant changes in the economic and political situation in the world. It is crucial that commanding officers are properly educated. The only military college that educates military professionals for the Army of the Czech Republic is the University of Defence based in Brno.

The university training of future officers of the Army of the Czech Republic takes place in accredited study programs in the field of management and resource management applied to the sphere of defence and security. Military study programs combine a broadly oriented theoretical foundation with more narrowly focused study subjects. In our contribution, we will focus on Operational Research (OR), which is taught by the Department of Quantitative Methods at the Faculty of Military Leadership. As part of completing the course, students learn to solve optimization problems, improve their logical thinking and correct judgment.

Operational research is intended for all students of the faculty. The teaching takes place in the second semester of the first year, with a time allocation of 56 hours (28 hours of lectures and 28 hours of exercises). The subject is completed with a credit and an exam. The content of the subject is an introduction to linear programming (production planning problem, mixing problem, distribution problem, graphical method, simplex method, artificial base method, duality), transport problems, multi-criteria evaluation of variants, multi-criteria linear programming, matrix games. This information is available on the website of our university, see [1].

We are interested in a comparison with the teaching of operational research at military colleges in other European countries and especially NATO countries. The goal of our research was to find out at which schools OR is taught, what topics, in which year/semester, the size of the teaching time allowance and the number of credits.

Method of investigation. It is not easy to obtain the necessary information (whether OV is taught at a given school, in which year, subject plan, time allowance for OV teaching, etc.). We searched on the websites of the selected universities. We started with the university addresses from the document Partner Institutions of the University of Defence in Brno, see [2]. From the selected 26 universities, we found the necessary data for only four of them. At the same time, we approached 26 students who studied at our faculty within the ERASMUS+ program. We received answers (and other information) from only two Slovak students. We obtained information from Ukraine using known personal contacts.

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Investigation Results. We obtained information from universities in six states. The websites of these universities are listed in [1, 3, 4, 5, 6, 7]. In Table 1. are the names of states, the names of universities where OR is taught and names of the subject. The symbol * means that there are more schools (faculties or branches) in the given state (school) where OR is taught. We always chose one school, one faculty or one field of study for each country. In such cases, the data were mostly similar.

Table 1. Countries, university names and subject names

Country	University	Name of subject
Bulgaria	Vasil Levski National Military University	Operations Research
Czech Rep.	University of Defence	Operations Research
Slovakia	Armed Forces Academy of General Milan Rastislav Štefánik*	Operations Analysis
Slovenia	University of Ljubljana	Operations Research
Ukraine*	Kharkiv National University of the Air Force named after Ivan Kozhedub*	Mathematical problems of operations research in electrical engineering
USA	University of Michigan	Operations Research

Table 1. Information about the teaching of OR, i.e. topics, year, semester, hours and credits

Country	Topics of Operations Research								Year	Semester	Hours	Credits
	LP	TP	Duality	MEV	MP	MG	NA	Queue				
Bulgaria	Y	Y						Y		W or S	30	3
Czech Rep.	Y	Y	Y	Y	Y	Y			1.	S	56	4
Slovakia*	Y	Y					Y	Y	1.	W	42	4
Slovenia	Y		Y	Y	Y			Y	2.	S	45	
Ukraine*												4
USA												

Notes: Y=yes, i.e. the topic is taught at the school.

Table 2 contains the OR topics (LP = Linear Programming, TP = Transportation Problems, MEV = Multicriteria Evaluation of Variants, MP = Multicriteria Programming, MG = Matrix Games, Theory of Games, NA = Network Analysis, Graph Theory, Queue = Queue Theory, Models of Mass Service), year, semester, hours and number of credits. Symbol Y means yes, i.e. the topic is taught at the school.

Conclusions. Obviously, there is little data. For an explanation, see the Limitations paragraph. Data for Ukraine and the USA are almost completely missing, not available on the Internet; we did not find them. We can only base it on the subject name, see Tab. 1. It is likely that many of the mentioned OR research topics are also taught at the respective universities of Ukraine and the USA.

In all these countries Linear Programming is taught, and almost everywhere the Transportation Problem. Some schools teach some topics, other schools teach other topics. Very often the OR is taught in the first year and usually the subject is evaluated with four credits. Considering the teaching of the OR subject in one semester, the time allocation is similar, 42 to 56 hours.

Limitations. The lack of information available from public websites is a big problem. When we do get some information, it is often not complete, it is a different type of information than that of another school.

We are trying to obtain additional necessary data for the article by directly addressing representatives of schools or faculties, typically the vice dean for studies. We want to reach out to other schools as well.

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Educating Soldiers' Competencies Through Battlefield Simulation Systems

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Introduction. Military operations in complex and dynamic environments require special skills and training [1]. In this context, it becomes essential to provide advanced and specialized courses to prepare soldiers to operate effectively in a variety of combat situations. In this context, battlefield simulation systems are becoming an invaluable tool, providing soldiers with a virtual platform on which they can participate in realistic and intense exercises [2].
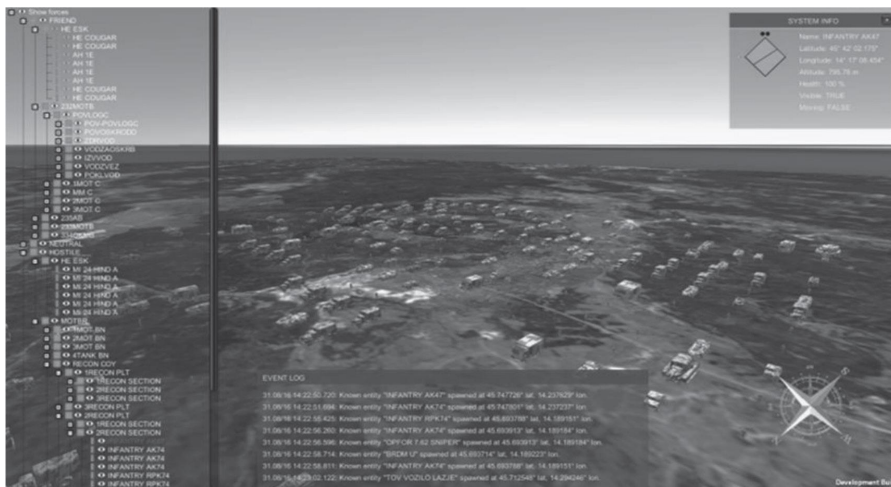
Fig. 1. The Joint Conflict and Tactical Simulation (JCATS) system [3].

One of the main challenges of complex military operations is that command personnel need to be competent and ready to take decisions and formulate strategy. Their role is decisive in combat situations and their training and preparation is therefore of paramount importance. The Joint Conflict and Tactical Simulation (JCATS) system is one way to strengthen the capabilities of command staff (see Fig. 1). It is designed to ensure that command personnel are well prepared to deal with the complexities and challenges of modern warfare [3-5].

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The use of simulation technologies in military training represents a significant shift towards more innovative and effective training methods. These systems provide the ability to simulate complex combat scenarios, allowing soldiers to practice decision-making skills and leadership qualities in a safe and controlled environment. This not only improves their readiness for real operations, but also helps to ensure that they are well prepared to lead and make critical decisions even under high pressure.

However, simulation systems need to be implemented and used appropriately in order to make their maximum contribution to the training of soldiers. It is essential to ensure that troops are provided with a quality training program and that systems are continuously updated and improved to take account of changing combat situations and technology.

In the final assessment, battlefield simulation systems are becoming an integral part of the training of military forces, providing a safe and effective environment for soldiers to develop their skills and readiness for a wide range of operations. They allow soldiers to practice decision-making and leadership qualities in realistic combat situations, giving them the confidence and readiness to act in any challenge.

Method of investigation. Quantitative data collection involved gathering numerical data related to various aspects of military training, such as participant performance metrics, training outcomes, and system utilization statistics. This data was obtained through structured surveys, performance evaluations, and system logs, among other sources. By collecting quantitative data, researchers were able to capture precise measurements and objective indicators of the impact of JCATS systems on training effectiveness.

Quantitative data collection involved gathering numerical data related to various aspects of military training, such as participant performance metrics, training outcomes, and system utilization statistics. This data was obtained through structured surveys, performance evaluations, and system logs, among other sources. By collecting quantitative data, researchers were able to capture precise measurements and objective indicators of the impact of JCATS systems on training effectiveness.

Quantitative analysis techniques were then employed to analyze the collected data and identify patterns, trends, and correlations. Statistical methods, such as regression analysis, correlation analysis, and descriptive statistics, were used to interpret the data and draw meaningful conclusions. These analytical approaches allowed researchers to quantitatively assess the relationship between the use of JCATS systems and various training outcomes, such as skill acquisition, decision-making proficiency, and operational readiness.

Investigation Results. Foremost, the study unearthed that technological proficiency stands as the foremost determinant of JCATS efficacy, underscoring the critical role of adeptness with simulation technology. Concurrently, strategic acumen emerged as another significant driver, showcasing its substantial positive impact on JCATS performance. Given their noteworthy coefficients and statistical significance, these variables demand prioritization within training frameworks and enhancement endeavors, guiding the design of targeted interventions aimed at bolstering proficiency in these areas.

Secondarily, the analysis underscored the paramount importance of exercise duration, pinpointing a notable correlation between time invested in exercises and the enhancement of soldiers' competencies. This correlation underscores the imperative of continual learning and the cultivation of practical experience, highlighting the intrinsic value of immersive training scenarios in augmenting soldiers' skill sets.

Lastly, the study illuminated the salience of leadership competencies, particularly in intricate leadership scenarios. The discernible impact of leadership skills underscores their pivotal role in fostering effective command and control structures within military operations. This finding accentuates the significance of integrating leadership development initiatives into training regimens, ensuring that military personnel are equipped to navigate multifaceted leadership challenges with adeptness and efficacy.

Conclusions. The study shows that there is a clear link between strategic thinking, tactical planning, technological knowledge and their impact on JCATS performance and feedback. These relationships show the importance of integrating strategic thinking, tactical planning and technological knowledge to ensure high JCATS efficiency and effective feedback. The results of the linear regression analysis offer valuable insights into the multifaceted determinants of JCATS effectiveness. By elucidating the pivotal role of technological proficiency, strategic acumen, exercise duration, and leadership competencies, this study furnishes actionable intelligence for refining training programs and fortifying military readiness in an increasingly complex operational landscape.

Keywords: *training of military personnel; soldiers' competencies; JCATS systems; simulated combat scenarios; realistic and immersive training environment.*

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Enhancing Collective Military Training: Integrating the Laser Battlefield System for the Lithuanian Land Forces

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Introduction. Global political transformations and the emergence of unconventional threats have fundamentally altered the landscape of national defense, ushering in a new era characterized by unprecedented challenges and complexities. In response to these dynamic shifts, national defence strategies must undergo rapid adaptation to effectively counter evolving threats and safeguard national security interests. Central to this imperative is the recognition that learning, encompassing the continuous upgrading and development of skills, constitutes a pivotal component of military service in the contemporary era [1-5].

The traditional paradigms of warfare and security have been supplanted by an array of non-traditional threats, ranging from cyber warfare and terrorism to hybrid warfare tactics employed by state and non-state actors alike. These unconventional threats operate outside the bounds of conventional warfare, transcending geographical boundaries and exploiting vulnerabilities in interconnected global systems. In the face of such multifaceted challenges, the static and rigid doctrines of yesteryears prove inadequate, necessitating a paradigm shift towards dynamic and adaptive defence strategies.

Learning, in this context, assumes paramount importance as a means of fostering agility, resilience, and innovation within military organizations. By prioritizing the continuous upgrading and development of skills, military personnel are better equipped to confront the evolving nature of modern warfare and effectively respond to emergent threats. This entails not only the acquisition of technical proficiencies and tactical competencies but also the cultivation of critical thinking abilities, adaptability, and cross-cultural understanding [1-5].

Moreover, learning serves as a catalyst for organizational evolution and institutional transformation within national defence establishments. As military institutions embrace a culture of lifelong learning and knowledge sharing, they become more agile and responsive to changing operational environments. This entails the adoption of innovative training methodologies, leveraging emerging technologies, and fostering interdisciplinary collaboration to enhance operational effectiveness and strategic agility [6-8].

Furthermore, learning extends beyond individual skill development to encompass broader strategic imperatives such as doctrine development, capability enhancement, and interoperability among allied forces. Through collaborative learning initiatives and

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multinational exercises, nations can leverage collective expertise and pool resources to address common security challenges effectively. This collaborative approach not only fosters mutual trust and cooperation but also enhances the resilience and effectiveness of coalition operations in an increasingly interconnected world.

Collective military training lies at the heart of preparing armed forces for the myriad challenges they may face in the field [4,5]. As the nature of warfare evolves and becomes increasingly complex, the need for innovative training methodologies becomes more apparent [5-8]. One such innovation that has garnered attention in recent years is the integration of the Laser Battlefield System (LBS) into military training exercises.

The Laser Battlefield System is a cutting-edge technology that simulates battlefield scenarios using laser-based simulation devices. These devices are worn by military personnel and simulate the effects of weapons fire, allowing soldiers to engage in realistic combat scenarios without the risks associated with live-fire exercises. By integrating the LBS into collective military training, armed forces can enhance the realism and effectiveness of their training exercises while minimizing safety concerns. These investigations focused on assessing how a data-driven approach to training enables armed forces to continually refine their tactics, techniques, and procedures, ensuring that they remain at the forefront of military readiness.

Method of investigation. The efficiency of Laser Battlefield System (LBS) usage was evaluated through a comprehensive approach that involved both quantitative and qualitative data collection methodologies. This multifaceted assessment aimed to gather data pertaining to various dimensions of military training, providing a comprehensive understanding of the system's impact on training outcomes.

Quantitative data collection involved the systematic gathering of numerical data related to the usage and effectiveness of the LBS. This included metrics such as the number of training exercises conducted using the system, the duration of each exercise, participant performance metrics, and system utilization statistics. By quantifying these aspects, researchers were able to analyze the frequency and intensity of LBS usage, as well as its direct impact on training outcomes.

In addition to quantitative data, qualitative data collection methods were employed to capture the nuanced aspects of LBS usage and its effects on military training. Qualitative data was gathered through methods such as participant observations, interviews with training personnel, and surveys assessing subjective perceptions of the system's effectiveness. These qualitative insights provided valuable context and depth to the quantitative findings, offering insights into the practical challenges, benefits, and limitations of LBS integration into military training.

By combining quantitative and qualitative data collection methods, researchers were able to triangulate findings and obtain a holistic understanding of the efficiency of LBS usage. Quantitative data provided objective measurements of system performance and usage patterns, while qualitative data offered rich insights into the experiential and perceptual dimensions of LBS integration. Together, these complementary approaches facilitated a comprehensive assessment of the system's efficacy in enhancing collective military training.

Investigation Results. In summary of the findings derived from the expert opinion

poll, it can be concluded that the viewpoints articulated regarding the efficacy of the Laser Battlefield System in educating soldiers' preparedness for actual military engagements and fostering teamwork skills, as determined by Kendall's coefficient, hold statistical significance. The convergence of opinions among experts has been affirmed, thereby facilitating a thorough examination of the nuances inherent to the subject of investigation. Consequently, this enabled a more in-depth exploration of the intricacies surrounding the object of study and facilitated the identification of problematic areas based on the mean importance of criteria estimates.

In order to assess the potential contribution of LBS technological solutions to the effective development of soldiers' teamwork skills, a regression analysis was conducted. The model revealed that the ease of system use, increased soldier involvement, and risk reduction during exercises collectively account for 99.4% of the realistic exercise perception fostered during the teamwork skills development process. This underscores the criticality of promptly adapting to available equipment and its efficient deployment on the battlefield during collective training endeavors. Furthermore,

Conclusions. The results of the study unequivocally confirmed that the development of soldiers' teamwork skills during the exercise is positively correlated with faster and better mastery of the Laser Battlefield System (LBS). This correlation indicates that soldiers are simultaneously improving their LBS skills by engaging in cooperative activities aimed at improving teamwork. This type of exercise not only accelerates the acquisition of the system, but also contributes to a more engaging and authentic training environment. Furthermore, it has been confirmed that LBS provides a sense of realistic exercises, which leads to a higher level of engagement of the soldiers in their military tasks. By actively participating in a teamwork-oriented exercise, soldiers become more immersed in the training process. Therefore, the dynamic environment that LBS systems can create not only enhances soldiers' competences, but also fosters a more cohesive and effective team dynamic, ultimately facilitating the development of better teamwork skills necessary for success in real military operations.

Keywords: *collective military training, soldiers' competencies, laser battlefield system, realistic combat scenarios*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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The Role of Training in Strengthening Individual and Collective Resilience

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Introduction. Developing emotional resilience requires two categories of resources: organisational resources, such as autonomy, peer support, and professional development opportunities; and individual resources, which are determined by personal characteristics [1]. These two categories of resources, professional and personal, determine individual and collective resilience.

Identifying which personal and professional resources to enhance in individual resilience training can be challenging. Previous research has identified several resources that can be developed through resilience training programmes. However, due to the limited scope and duration of these programmes, it is crucial to prioritize the resources that would benefit most from training. Therefore, the aim of this study was to identify the essential elements that should be included in the training programme to have the greatest impact on building resilience in soldiers.

To achieve this, a review of the competencies included in the Master Resilience Training (MRT) programme was conducted. The MRT programme is coached by senior soldiers who support junior soldiers in developing a set of competencies. Each competency is developed through a series of preventative interventions. For example, to develop self-awareness, senior soldiers encourage junior soldiers to reflect on their own experiences, both positive and negative, provide feedback and encourage them to seek feedback from others.

Method of investigation. The research focused on identifying key competencies for enhancing soldiers' mental resilience by using data obtained during research project (project agreement No S-LU-22-9 funded by the Research Council of Lithuania) consulting 16 experts from diverse military backgrounds [2]. These experts were selected based on their experience in mental resilience training and military service. The study utilized a pairwise comparison questionnaire to analyze differences in opinions among experts, employing six Master Resilience Training (MRT) competencies [3,4,5]. This approach aimed to understand the varying perspectives on resilience-building across different military contexts.

Investigation Results. The research narrowed down the list of competencies to three that need to be included in training programmes: self-regulation, mental agility, and strength of character. The importance of each competence depends on the specific context. When defending their own country, the strength of character becomes a crucial factor in enhancing the mental resilience of individual soldiers and the collective resilience of the army. Self-

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regulation is also a key factor in promoting psychological resilience during military operations. The study suggests that these three core competencies form a 'cluster of causes' that also impact other resilience-related competencies.

Conclusions. This study advances the understanding of resilience training in military contexts by pinpointing three critical competencies: self-regulation, mental agility, and strengths of character, highlighting their variable significance across different military environments. The research highlights the contextual nature of resilience and provides insights to improve training programs for soldiers in domestic and international military operations. The nuanced approach offers a valuable framework to tailor resilience training to meet specific needs.

Limitations. The study's use of an analytical method to understand resilience competencies has limitations due to the inherent complexities of measuring such competencies. Furthermore, the focus on senior soldiers as trainers may not fully encapsulate the broader experiences and needs of all military personnel. Future research could benefit from exploring a wider range of perspectives and using diverse methodologies to comprehensively capture the nature of resilience in military settings.

Keywords: *cognitive skills; resilience training; personal and collective training; military*

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Importance of Physics Entrance
Test for Individual Mentoring

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Introduction. This paper deals with the description of the entrance testing of students at the beginning of physics teaching at the Department of Mathematics and Physics of the Faculty of Military Technology of the University of Defence. In the entrance test, students are given questions to determine what their basic knowledge of physics is. The students will also state in the entrance test their experience with physics, at which type of high school they studied and how long they have been involved in physics. The level of readiness of students is often very different. Some students pursued physics throughout their time in high school, while some pursued physics for only one year. With the entrance test [1-2], teachers get detailed information about students not only in terms of up-to-date knowledge of physics, but also the type and duration of physics studies in secondary school. This allows teachers to focus on individual areas of physics in the first few weeks of their studies at the university, given the individual abilities of individual students.

Method of investigation. Based on the results of the entrance test, teachers focus on individual students and as part of their mentoring, attend to them individually as needed [3-5]. After five to six weeks of physics lessons there follows a control test, which allows us to get information on how the students have mastered the introduction to physics with respect to their initial physical knowledge.

Investigation Results. By comparing the initial physics test and the next test after five to six weeks of instruction, teachers get an overview of student improvement and progress. It is thus possible to continue individual mentoring in the future. The results of the follow-up tests clearly demonstrate a gradual improvement in learning outcomes.

Conclusions. The comparison of the results of the physics entrance test with the control test confirms the essential contribution to individual work with students at the beginning of their studies. The first weeks of physics teaching are crucial for a proper understanding of basic physical principles and for further successful study.

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Teaching in Software Applications: A Single Robust Built-In Command Versus Sequence of More Elementary Commands

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Introduction. We teach applied mathematics, especially numerical analysis and statistics. We dare to say that these mathematical disciplines are essential for a large number of university technical fields, the education process for national defence in not an exception, see [9] for an idea of what is included; however, we don't say that technicians are proficient in these disciplines. According to our experience, even long-solved fundamental problems are constantly being solved all over due to the lack of connection between abstract results and procedures used in practice. This may stem from the inappropriate approach of us, the teachers of these disciplines, to teaching.

Numerical analysis and statistics inherently need suitable software for teaching, but, and this is often forgotten, students need to have mastered the basics of the relevant "non-numerical" discipline of mathematics (the fact that students first pass some basic course does not often guarantee this).

In this text, however, we only focus on how to perform some fundamental methods of numerical analysis and statistics in software applications (in the teaching process). Simply put, we are trying to explore the advantages and disadvantages of using pre-prepared functions (robust built-in commands) for fundamental methods of given disciplines over custom "programming" of these methods (just by using sequences of fundamental commands). Depending on which way of solution we lean towards, it is more or less important, which application we use and also it is more or less important, if we use such application, which then professionals in that given technical field using. A related topic is already addressed in the older article [1], which notes the shift in the role of the computer in teaching mathematics: from an instructional tool (e.g. displaying graphic outputs; see also [4]) to a programming tool. Let us also note that we dealt with the categorization of the way software applications are used in the teaching process in our texts [2] and [6]. Further, let us emphasize that by pre-prepared functions we always mean functions built into an application, not finished user-made functions (scripts). Given this, we will also consider how important it is that we know exactly what the pre-prepared function calculates, i.e., we could program it by hand in any suitable software if needed, but we don't need to know precise implementation to the used application.

Method of investigation. We focus on pre-prepared functions in the applications Maple (for numerical analysis) and MATLAB (for statistics). We examine what a specific built-in

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function actually calculates; moreover, we will see how difficult it is, or it is not, to figure it out. Note that in [7] it is examined how Maple calculates the sum of an infinite series and how this can be useful for students. Finally, we will also provide an alternative to the pre-prepared built-in functions: the hand-written code to obtain the same result that the built-in functions provide. In fact, programming the method by hand is often the only practical way to find out what a built-in function actually calculates.

We can look at the matter from another point of view (more global), in which writing scripts goes hand in hand with the use of pre-prepared functions (both built-in and user-made). When solving a more comprehensive problem in practice (for students, for example, when writing a final thesis), it is inevitable that the student will look for solutions (user-made functions, a solution of the problem using built-in functions, etc.) on various web forums. He either find some existing solution or he directly asks. The ability to find and correctly adopt (modify) a solution is absolutely essential today, but be careful, we must not confuse this ability with being educated in the subject. If the student does not orient himself in the subject and only throws one found foreign solution after another, he will easily make a mistake and come to a completely meaningless conclusion, see, e.g., the section "Wrong interpretation of results" from [5]. Unfortunately, due to the its described secondary nature, there is no time left for teaching how to find and apply foreign solutions (the student has to learn this ability himself). Materials (textbooks) with prepared code sequences, on the basis of which students create their code, can be a certain starting point for teaching, see [8]. We do not deal with the just-described problem of adopting user-made solutions from the Internet in this text, however, it is an important topic that is now even more relevant than before thanks to the rapidly growing capabilities of AI. Help from AI could even replace to a certain extent the simple search for solutions on the Internet – the question is whether AI is not an even more dangerous source of nonsense than the pure internet searching.

Investigation Results. Let us give a simple exercise from Maple. For the approximate numerical calculation of definite integrals, so-called quadrature formulas are used. Maple has the robust command `Quadrature` in the package `Student[NumericalAnalysis]`. The command returns the approximate value of the integral corresponding to the selected formula type and other selected parameters if different `output` is not set. Students should know from the lecture that, for example, in the special case of Newton–Cotes formulas, the interpolation polynomial is integrated, and they should therefore obtain the same result by manually entering the integration of the interpolation polynomial.

The solution in Fig. 1 a) is more concise and easier for students to implement than the one in b). However, there may be a problem with setting the parameter **view**, more precisely, an explanation of why we set it in presented way (the command **Quadrature** itself would set the range on the y-axis from the minimum to the maximum value of the function **f** on the given interval). With the solution in Fig. 1 b), there will be no doubt about the meaning of the value 1.475730582 and what the orange line in the picture is, but even here it will be difficult to tell how the value 1.475730582 relates to the plotted graphs – in b) however, it will be "only" for ignorance of the basics of integral calculus, in a) for ignorance of the numerical integration. Note that if we wanted to numerically estimate the given integral as accurately as possible, we would use the command **evalf(If)**, which uses a very good numerical method.

It should be added, that the code produced in Fig. 1 b) is specific to the quadrature formula used. As a consequence, the code presented in Fig. 1 b) would be diametrically different

for other quadrature formulas. In general, we need to know how to determine the nodes and how to calculate the coefficients of the quadrature formula from them. So, it is up for consideration whether we require this level of knowledge from students. Additionally, the more code students write, the more it depends on how proficient they are with the application; common student mistakes in Maple and how to avoid them can be found in [3].
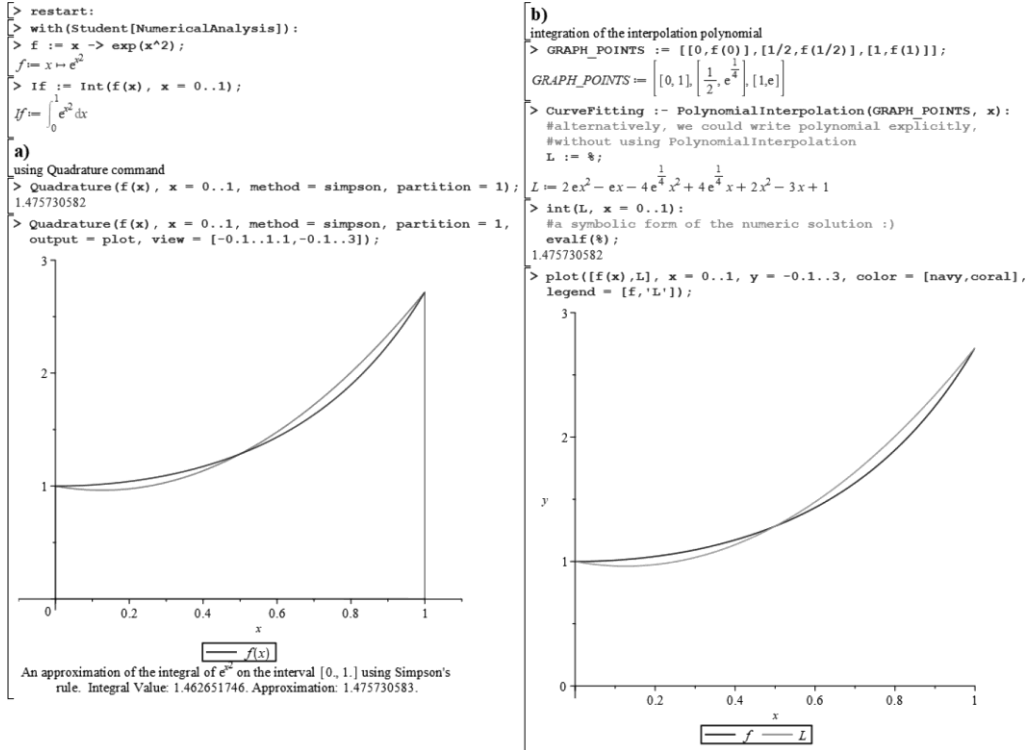

Fig.1. Comparison of the two ways of solution using a one method of numerical integration

Conclusions. We solved several exercises in two ways (but using the same method), one way of solving usually relied on one robust built-in command for the used method, and in the other way the method was applied more explicitly by using several elementary commands. Based on these two methods, two corresponding directions of teaching can be distinguished. It could be beneficial to examine how teachers of these and related mathematical disciplines approach these directions. The easiest implementation would probably be using a questionnaire (a survey). The respondents (teachers) would first familiarize themselves with the given exercises in order to have a good understanding of what is involved. Then they would be asked several questions in which it would find out how they teach and which of the partial options (from both ways of solution) seems more appropriate or correct to them.

Keywords: *built-in command; Maple; MATLAB; teaching applied mathematics; programming mathematical methods*

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Challenges to Nacional Defence in Contemporary Geopolitical Situation (CNDCGS'2024),
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STEM Teaching in Contemporary Education

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Introduction The education system serves as the primary producer of human capital, responsible for training competent personnel essential for the country's economic progress and rapid technological and economic development. Therefore, the educational standard aims to equip students with knowledge and skills necessary to capitalize on humanity's rapid progress, utilize modern achievements, and become active members of society. Moving beyond passive recipients of knowledge, students should transform into active learners capable of applying acquired knowledge for professional success and societal benefit.

This paper explores the objectives of technical and science education, effectively implemented through STEM (Science, Technology, Engineering, and Mathematics), an interdisciplinary practical teaching approach. STEM education empowers children to engage in experiments, make mistakes, and draw conclusions based on personal experiences rather than solely relying on textbook information.

This approach fosters active student participation and cultivates competencies such as creative and critical thinking, independent information processing, imagination, and interpretation skills. Moreover, STEM education plays a crucial role in shaping future professions that contribute to national development. While important projects have been implemented within the framework of the Millennium Program of the General Education School of Georgia to train STEM specialists, further efforts are needed. Effective school education and professional personnel training require a conducive school culture, qualified teachers, and abundant educational resources.

To address this issue, our research utilized quantitative and qualitative methods, including questionnaire development, literature review, and analysis of international and local projects and training programs. These efforts aim to lay the groundwork for the preparation of STEM specialists. This paper seeks to answer key questions: Who should teach STEM, and how should STEM be taught? By ensuring the education of future generations capable of contributing to the country's economic development, political stability, and security, we aim to foster a prosperous and sustainable society.

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Conclusions. In summary, this document highlights the crucial role of STEM education in fostering economic development, promoting innovation and preparing individuals for the challenges of the future. By examining the objectives and implementation of STEM education, we have highlighted its transformative potential in shaping the skills and competences of the next generation.

While significant progress has been made in STEM education initiatives, there is still room for improvement. Our research has identified key areas for improvement, including the recruitment and training of qualified STEM educators, the development of innovative teaching methodologies and the provision of adequate resources and infrastructure.

Close collaboration between policy makers, educators and stakeholders is essential to ensure the continued success of STEM education initiatives. By investing in the education of future STEM professionals, we can create a workforce that is ready to drive innovation, stimulate economic growth and meet the complex challenges of society.

Ultimately, the success of STEM education depends on its ability to empower people to think critically, to solve problems creatively and to contribute meaningfully to society. By prioritizing STEM education, we can create a brighter future for generations to come.

Keywords: *Education, STEM, Science, Technology, Engineering, Mathematics, Human Capital, Competencies, Active Learning, School Culture, Teacher Training, Educational Resources, Economic Development, Political Stability, Sustainable Society.*

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Stress Coping Strategies of the Young Soldiers in the Context of the Deteriorating Security Situation

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Introduction. In February 2022, the Russia-Ukraine conflict (RUC) erupted, plunging Europe into a war-torn state after many decades of peace. The security situation in NATO countries, particularly those in Eastern Europe, has significantly deteriorated. Consequently, the insecurity among the entire population has heightened, resulting in increased stress levels. In this paper, the authors focus on a specific target group directly impacted by this threat – soldiers, specifically students of the Czech Republic's sole military school, the University of Defence. The paper aims to identify and describe their coping responses and strategies connected with RUC. The research questions are as follows:

● How do young military students perceive the deteriorating security situation and its potential impact on their future careers?

● What coping strategies do young military students utilize to navigate the security situation within the context of the RUC?

According to Carver [1], specific coping strategies can be assigned to any of the following groups - self-distraction, active coping, denial, substance use, use of emotional or instrumental support, behavioral disengagement, venting, positive reframing, planning, humor, acceptance, religion, or self-blame. Among military personnel, Morgan et al. [2] found that the most common coping behaviors involved problem-solving, talking to friends, hobbies and physical activity.

A study conducted by Kurapov et al. [3] examined the psychological effects of RUC on Ukrainian university students and staff. 97.8% of participants experienced worsened mental and emotional states, marked by increased levels of depression, loneliness, nervousness, and anger. These findings align with those of Stadnik et al. [4], who observed similar trends among students and cadets of Ukrainian universities, indicating that proximity to the conflict zone intensified negative mental health outcomes, including somatic symptoms, anxiety, insomnia, social dysfunction, and severe depression. Additionally, Gilreath et al. [5] investigated stressors impacting the academic performance and well-being of youth in wartime, noting risks such as suicidal tendencies and substance abuse in both short and long terms. Although the psychological impact of the conflict primarily affected individuals within the war zones, those ideologically aligned with the conflict in central Europe and beyond also experienced repercussions. Stressors and increased anxiety were observed globally [6]. For

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instance, Kimhi et al. [7] examined resilience and coping mechanisms among samples from Ukraine and neighboring countries during the conflict, highlighting differences in coping indicators such as hope, well-being, perceived threats, distress symptoms, and sense of danger. The Czech Republic exhibited the highest level of well-being but reported the lowest level of hope.

Method of investigation. Data from two sources are analyzed. One consisted of a semi- structured questionnaire aimed at understanding respondents' perceptions of the current security situation and its impact on their motivation. The second source comprised an unstructured questionnaire designed to identify specific strategies and responses to stress related to the increased threat of war. The samples included 150 and 50 first and second-year military students of the University of Defence. The chosen research design is qualitative; a basic framework is a multiple-case study. The authors employed the principles of Grounded Theory in data processing. This method involves organizing qualitative data through open coding (identification and categorization) and axial coding – a process aimed at revealing relationships among (sub)categories. The outcome of the Grounded Theory approach is the formulation of a theory expressed through the Paradigmatic model.

Investigation Results. Results indicate that young soldiers are predominantly coping positively with the situation in Ukraine. Approximately 50% of them stated that the RUC supported their decision to join the Army. Around 40% mentioned that the situation did not affect it, while only 10% admitted to perceiving the situation rather negatively, considering it a demotivating factor. Students reveal their adeptness at coping with the threat of war. They demonstrate awareness of their mission and role in the event of an imminent threat.

Conclusions. Drawing from Carver's typology of coping strategies (1997), it can be preliminarily concluded that students primarily employ the following strategies in response to escalating war threats: active coping, positive reframing, planning, and acceptance. They often view the impending conflict as validation of their decision to join the army.

Limitations. The survey results are valid for the specific sample used. Qualitative investigations should then undergo validation through quantitative or subsequent qualitative research. Further research could focus on examining stress reactions and coping strategies in a representative sample, specifically targeting military professionals with experience in the Czech Armed Forces or other NATO countries.

Keywords: S*tress coping strategies; Military; Soldiers; Russia-Ukraine conflict.*

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Effects of Physical and Psychological Stress on Cognitive Performance in Czech Army Students

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Introduction. Appropriate physical activity is associated with cognitive enhancement [1], while excessive physical activity and/or physical exercise in extreme conditions usually lead to significant decrease in cognitive performance [2]. Cognitive changes also occur due to acute and chronic stress, affecting individual performance at various levels [3]. In addition, we know that cognition performance depends on individually perceived levels of distress [4]. Military service inherently involves high levels of physical, psychological, and environmental distress [5], necessitating an understanding and management of coping strategies and cognitive performance concerning distress among military personnel, especially command staff. Understanding one's own stress reactions and their impact on cognition is one of the goals that is pursued in the preparation and education of future commanders at the University of Defence. However, in the Czech Republic, we lack validated and standardized tools for these purposes. Therefore, we present a pilot study and preliminary data in this area.

Method of investigation. As part of the curriculum at the University of Defence, students undergo field training where they are exposed to simulated combat conditions while performing assigned tasks. During this training, psychological characteristics of soldier- students are evaluated for their feedback, development, and research purposes – involving testing of cognition and stress coping strategies.

The Coping Strategies Questionnaire (SVF-78) was used to assess coping strategies. It is a widely used questionnaire method for assessing coping strategies across different populations. This tool captures individual variability in processing and coping with stressful situations, comprising 13 scales reflecting positive, negative, and "neutral" coping mechanisms [6]. The Short Neuropsychological Battery (KNB) was used to measure cognitive abilities, offering a screening assessment of the entire cognitive profile with sufficient sensitivity and comparable parallel forms [7].

The testing schedule was as follows:

Day one: pre-test of cognitive abilities (KNB version A); coping strategies test (SVF-78).

Day two: post-test of cognition (KNB version B). Training in the field (approx. 20-30 hours) was conducted between the testing periods, exposing soldiers to sleep deprivation, physical strain, and distress.

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Investigation Results. In this investigation, we present preliminary findings and partial analyses concerning the cognitive abilities and coping mechanisms of military students engaged in simulated combat scenarios. Our initial data suggest that cognitive performance varies among individual students, although certain patterns emerge. Significant statistical variances were detected between pre-test and post-test assessments across nearly all cognitive domains, including attention, language, visuo-spatial aptitude, and executive functions. Notably, attention tended to improve in the post-test phase, alongside enhancements in executive functioning. Immediate (short-term) memory exhibited no discernible alterations between the two timepoints, whereas long-term memory (delayed recall), exhibited the most statistically significant difference. Within the army student sample, adaptive coping strategies predominantly outweighed maladaptive ones, with prevalent techniques encompassing situation control, response control, and positive self-instruction. Also, recommendation for future testing and evaluation is discussed.

Acknowledgements.

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Other Central Administrative Authorities in the Crisis Management System

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Introduction. The Act on Crisis Management [1] defines categories of crisis management authorities (the government, ministries and other central administrative authorities, the Czech National Bank, regional authorities and other authorities with competence in the territory of the region, authorities of municipalities with extended competence and municipal authorities). All these authorities are part of the state security system.

There are established 17 other central administrative authorities with the national competence in the Czech Republic. Their activities are focused on specialized sections of the state administration and they have a certain degree of independence, which is why in some cases they are not associated with tasks and activities in the field of crisis management. This category of other central administrative authorities is the least mapped and published group of crisis management authorities, although they must fulfil the requirements of normative legal acts [1], [2] and be ready and able to respond to differentiated risks. Based on the above, the article examines the scope of fulfilling activities related to ensuring preparedness and dealing with non-military crisis situations according to the requirements of the Crisis Management Act [1].

Method of investigation. Due to the issue under research, qualitative research was carried out based on semi-structured interviews or written questionnaires. The semi-structured interview was chosen in order to allow more flexibility in the conversation. For the semi- structured interviews, priority has been given to officials responsible for crisis management in the relevant other central administrative authority. Due to the low interest of the representatives of other central administrative authorities to answer during the interview, written questionnaires were also used, either on the official emails of the authority or in accordance with Act No. 106/1999 Coll., on free access to information [3]. The reason for the chosen data collection was the fact that information on the researched issue is not freely available on the official websites of other central administrative authorities. On the basis of the data collection, a comparison was made focusing on the fulfilment of the tasks established by the Act on Crisis Management, involvement in exercises of crisis management bodies and crisis management.

Investigation Results. The results of the survey show that the requirements of the Act on Crisis Management [1] are fulfilled for each of the other central administrative authorities.

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However, the level of detail and quality of crisis management is varied depending on the scope of their activities.

On the basis of the comparison, other central administrative authorities in relation to crisis management or ensuring state security can be divided into two categories. The first category of other central administrative authorities has a link to crisis management or security in one or more of its relevant competences defined by the founding normative legal act (e.g. the State Material Reserves Administration, the National Cyber and Information Security Agency, the State Office for Nuclear Safety). The second category is without such a direct link (e.g. National Sports Agency, Office for the Protection of Competition, Czech Statistical Office, Czech Geodetic and Cadastral Office).

This classification also indicates that the first category is more proactive in crisis preparedness activities, as it is related to their scope of activities. Their crisis management units are more numerous, with more table positions created. They regularly participate in or organize exercises (e.g. Resources, Zone).

In the second category of other central administrative authorities, there were problems with a lack of staff dedicated to crisis management issues. The work of the crisis management unit is carried out by a single staff member, who combines functions from other areas. In the case of security, this includes personnel, administration, physical, information and communication systems, health and safety at work, fire safety and cryptographic protection. The departments thus comprehensively cover the security issues of the other central administrative authorities concerned. The accumulation of tasks may result in reduced crisis preparedness of the office concerned.

Conclusions. Other central administrative authorities are classified as elements of the executive power and are also crisis management authorities. Normative legal acts [1], [2] show that their role is in all phases of crisis management, increasing in the case of a large- scale crisis situation and requiring a coordinated approach of management from the national level. An example is the COVID-19 disease pandemic, which demonstrated the necessity of increasing crisis preparedness in all sectors of society, and at the same time was the first crisis situation for some other central administrative authorities to address.

The article helped to fill a gap in information about other central administrative authorities in national crisis management contexts. It provided a division of other central administrative authorities according to their competences in relation to crisis management. It identified the problems that are more frequent in the second category of other central administrative authorities.

Limitations. The research was focused only on the determination of crisis preparedness in relation to the application of the Crisis Act [1] and dealing with non-military crisis situations. Dealing with military crisis situations according to the Act on ensuring the defence of the Czech Republic was not included due to classification of information and the principles of the Crisis Management Act [1] would have to be followed when activating them. Considering the qualitative research and the low level of willingness to cooperate with representatives of other central administrative authorities, there were uncertainties in the accuracy of the data collection due to the non-complexity of the responses, the potential falsity of the answers and the inability to verify the answers independently. The Digital and Information Agency

was not included in the survey as it was established on 1 January 2023 and did not have fully staffed positions at the time of the survey (first half of 2023).

Keywords: *crisis management; other central administrative authorities; exercises; crisis management units; crisis preparedness; crisis plan; crisis management authorities.*

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The Multi-Domain Approach to Military Operations and its Challenges to Intelligence and Intelligence, Surveillance, Reconnaissance

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Introduction. A multi-domain approach to military operations refers to a strategy that integrates capabilities and operations across the battlespace to achieve military objectives. Traditionally, the battlespace was categorized into physical domains, such as land, air, sea, and space. Nevertheless, with advancements in technology and changes in warfare tactics, additional non-physical domains and environments have been recognized, including cyberspace, electromagnetic environment and information environment. In a multi-domain approach, these domains are interconnected and interdependent, with capabilities in one domain supporting and enhancing operations in others. [1] Responding to challenges posed by contemporary and emerging security threats, this approach recognizes that modern conflicts are not limited to a single domain and require coordinated efforts across multiple domains to effectively project power, maintain superiority, and achieve mission success.

Over the last decade, the North Atlantic Treaty Organisation (NATO) and most of its member states have been gradually considering challenges, opportunities and possibilities related to potential implementation of a multi-domain approach. Several concepts have been developed by various nations so far, however, they are often inconsistent or even misunderstood with regard to terminology, scope and policies. [2]

Method of investigation. There are several methods combined in this research. The article firstly compares different perspectives of the most prominent proponents of a multi-domain approach, such as the United States of America, the United Kingdom or NATO, with the aim to identify and clarify differing and similar aspects of the concepts explored. The comparative research was focused predominantly on the most recent doctrinal documents related to multi- domain operations (MDO) released by the abovementioned countries and organization. The authors also performed systematic a literature review in order to analyze how the Western multi-domain approach is perceived and interpreted by peer adversaries/competitors, namely the Russian Federation and the People's Republic of China, and how a multi-domain mindset is reflected in military strategies of both countries. The challenges presented by the multi- domain character of the contemporary and future operating environment (OE) to intelligence and intelligence, surveillance, reconnaissance (ISR) were identified through a case study of the multi-domain interrelation in the conflict in Ukraine and analysis of semi-structured interviews conducted within the Czech Armed Forces intelligence and ISR community.

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Investigation Results. The interpretation of the multi-domain approach to the OE is nonuniform, and its doctrinal concepts vary extensively depending on multiple factors such as the country, level of command and control, involvement of military and non-military actors, etc. There is a general consensus that the pivotal paradigm of the multi-domain approach to military operations is the simultaneous and integrated application of capabilities across multiple domains to create interacting effects in physical, non-physical and cognitive domains [3]. Nevertheless, the terms such as MDO, multi-domain integration or joint all-domain operations are not interchangeable. [4].

The approach of NATO peer adversaries/competitors to multi-domain integration is characterized by a combination of technological innovation, jointness and interoperability, information warfare, grey zone tactics, global power projection, and anti-access/area denial strategy aimed at denying adversary forces access to key areas and preventing them from operating freely in contested environments. Unlike the People's Republic of China, which structures its military to gain informational dominance over its adversaries, Russia seems primarily guided by the pursuit of both dominance and asymmetry through firepower superiority. [5] In addition, the ongoing conflict in Ukraine has proved that cyber capabilities, and electromagnetic warfare are also essential to gain an advantage in the battlespace.

With regard to above mentioned, the role of intelligence and ISR will be of the paramount importance, because commanders must be provided with timely information they need to make informed decisions and effectively employ forces across various domains., including information overload, cross-domain integration of data and intelligence obtained from multiple domains, or complex synchronization of ISR assets in the diverse and contested OE. This will not be possible without implementation of new technologies, such as artificial intelligence and big data processing to enable effective intelligence processing and analysis.

Conclusions. Multi-domain operations represent a holistic approach to modern warfare, recognizing the interconnected nature of conflicts and the need for integrated, flexible, and adaptive responses to emerging threats. In this respect, intelligence and ISR staffs will be required to counter numerous challenges ensuing from the dynamic character of the OE and the rapid development of technologies. The authors conclude that despite advances in technology, human factors remain crucial in intelligence operations. This includes the recruitment, training, and retention of skilled intelligence analysts, as well as ensuring effective collaboration and communication among intelligence personnel and with operational commanders.

Limitations. Researching multi-domain approach to military operations presents several limitations, highlighted by:

• Limited Public Information: While some information about military operations is publicly available, much of it is often restricted or sanitized for security reasons. This limitation sometimes hinders the depth of the research.

• Changing Nature of Warfare: Warfare and military strategies are constantly evolving in response to technological advancements, geopolitical shifts, and changes in tactics. Keeping up with the latest developments and trends in multi-domain operations can be challenging.

• Limited Academic Literature: While there is increasing interest in multi-domain operations, academic literature on the topic may still be relatively limited compared to more established fields. Finding scholarly sources to support this research requires thorough searching and critical evaluation of available literature.

Keywords: *multi-domain operations; NATO; Russia; China; Intelligence Surveillance Reconnaissance, threat, doctrine*

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ABSTRACTS OF THE 4th INTERNATIONAL SCIENTIFIC CONFERENCE

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