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## Technological Capabilities of Virtual Reality Laboratories for the Training of Personnel of State Security Entities

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**Abstract:**

**Purpose:** The objective of this article was to present the analyzes of the needs of state security entities in the context of training, with particular emphasis on the analysis of technological possibilities of virtual reality laboratories in line with the paradigm of digital training technologies.

**Design/Methodology/Approach:** Analysis of the well-known literature, the authors' experience of R&D and implementation in the area of security, requirements of state security entities and best practices in the field of digital training technologies were taken into account.

**Findings:** The result of the work is a set of identified features required for training systems for state security entities, in particular for training anti-terrorist and counter-terrorist activities.

**Practical Implications:** Virtual solutions will not replace training on real equipment, however, they enable repetitive training in conditions similar to real ones, reducing training costs and enabling instructors to constantly increase the level of training difficulty. Taking into account the deficiencies in the infrastructure of uniformed and military services and the prevailing trend to develop training facilities and improve the competences of officers and soldiers at every level.

**Originality/value:** It can be concluded that the presented solutions will have a positive impact on the level of interdisciplinary training in the field of planning, preparation, implementation and consequences of actions taken.

**Keywords:** Virtual reality, digital training methods, State Security Entities.

**JEL classification:** F50, F52, I21, I23, I20.

**Paper Type:** Research study.

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## **1. Introduction**

The issue of security concerns every person, and ensuring the safety of people living in a given country is considered the most important duty of State Security Entities. One of the elements of ensuring safety is counteracting and reacting to the occurring threats. Taking effective actions by officers of uniformed services and soldiers in emergency situations requires interdisciplinary training in the field of planning, preparation, implementation and consequences of actions taken.

Training of officers, soldiers, guards and security personnel as representatives of the state security system entities responsible for ensuring public safety, in particular anti-terrorist activities, is a complex and multifaceted process (Al-Daeef, 2017). This process should be carried out at each of the levels of task implementation, which include the intervention, tactical and strategic level, while taking into account the practical experience gained during activities in the country and abroad.

A feature of scientific cognition is the orientation towards areas of the scientific discipline, thanks to which it is possible to identify specific problem issues that create conditions for researchers to actively seek opportunities aimed at improving, changing or developing new solutions in the studied reality. As part of the security science discipline, there are opportunities to explore the area related to counteracting and combating terrorist threats, taking into account the analysis of the existing system solutions which include training processes in the field of decision-making. The inspiration for undertaking scientific inquiries was undoubtedly the complicated situation in the area of variable terrorist threats forcing the evolution of the training process in the field of decision-making taking into account the element of situational awareness (Nawrat, 2017).

The modern world is full of threats to security in the external (international) and internal (national) aspect, at the same time pointing to military and non-military threats that appear on many levels (Mythen, 2018). A series of progressing political, social and economic processes led to the development of globalization, which contributed to the dynamic economic development of the world, as well as cultural and civilization changes. On the one hand, it enables the flow of thoughts, people, capital and technology on a global scale, which has had a positive impact on the development of many areas, including economic ones. On the other hand, globalization has led to the spread of a wide range of negative phenomena (Falk, 1997; Hys, 2010; Zastempowski *et al.*, 2020).

Internal political, economic and financial crises, problems of many countries, international terrorism, cyber threats, organized crime, corruption, trafficking in human beings, money laundering, drug addiction are phenomena that occur more frequently due to the phenomenon of globalization and are transferred from one region to another. For experts in the field, the phenomenon of terrorism is undoubtedly one of the most unpredictable threats to the modern world. This is due

to many factors. The variability of the goals of potential terrorist groups as well as the variability of the methods of carrying out attacks (*modus operandi*) correlate with the interchangeability of the scale and intensity of threats (Ganor, 2009).

U. Beck describes contemporary terrorists as new global actors, devoid of territorial and national roots, non-governmental organizations of violence (Beck, 2002). This also confirms the characteristics of the contemporary categories of terrorists, which are, in a way, tools of terrorist groups defined by experts. They distinguish two categories of bombers: solo terrorism and lone wolf terrorism. Solo terrorism includes terrorists who attack alone, are not members of the organization, but sympathize with it. They are people who seek contact and indoctrinate themselves under the influence of the ideologies proclaimed by the terrorist organization. These people plan, prepare and carry out a terrorist attack based on publicly available information. On the other hand, the category of lone wolf terrorism (Phillips, 2011) includes potential bombers who do not have direct and indirect contacts with any terrorist organization.

All information radicalizing his views, along with the methods of operation, he obtains from the mass media, and mainly from the Internet. The subjective scope of terrorist attacks is characterized by a catalog with a wide range of unpredictable activities, characterized by complexity and dynamism. Terrorist threats change their nature and cannot be confined within the rigid framework of trends and tendencies. They do not freeze in time, but undergo constant, varied and chaotic changes. The historian W. Laqueur (Laqueur, 2017) believes that there is no phenomenon of pure and unchanging terrorism, arguing that there are many different terrorisms. These are the main reasons why, for the purposes of this study on technological possibilities of training uniformed services officers, emphasis was placed on terrorist threats (Laskowski, 2021).

Effective counteracting and combating terrorist threats requires appropriate preparation of state security system entities performing tasks in the field of five elements of activity, which should be understood as follows:

- Counteracting – all initiatives aimed at preventing individual or groups of people from undertaking any terrorist activities.
- Combating – a range of actions aimed directly at terrorist structures in order to gather the necessary information to neutralize and punish them. The aim of combating it is also to make it impossible to rebuild structures.
- Protection – all activities aimed at effective protection of persons and objects as well as elements of the state infrastructure.
- Responding – a series of activities and undertakings aimed at minimizing the effects of a possible terrorist attack.
- Forecasting – a series of activities covering the analysis of reality as well as potential goals of selecting methods and forms of action in relation to the

scale of the threat. It is an element that creates a link between the four elements mentioned above, taking into account the mini-interactions taking place between them.

The above-mentioned elements of activities fall into two areas within which the entities of the state security system perform tasks in the field of counteracting and combating terrorist threats. The first area is anti-terrorist actions – proactive, which should be understood as pre-emptive actions aimed at reacting to planned terrorist attacks (Frey, 2018). They include obtaining information by secret services on:

- obtaining information by using informants, secret collaborators for this purpose,
- analyzing and processing obtained information on potential terrorist threats,
- using information on terrorist threats in order to develop recommendations for entities of the state security system responsible for security,
- collecting information for building databases that may in the future be used to prepare recommendations or forecasts of potential threats to state security.

The scope of proactive activities also covers organizational activities aimed at ensuring the protection of important persons from the point of view of state security, their places of stay, and securing places threatened by terrorist attacks. The second area is counter-terrorist activities – reactive, which should be understood as activities related to reacting to a terrorist attack (Todsén, 1990). Their scope includes:

- carrying out activities as part of the rescue operation related to the release of hostages,
- carrying out activities within the scope of detaining persons suspected of terrorist activity,
- carrying out activities related to the neutralization of terrorists.

In view of such defined terrorist threats occurring in every part of the world, it is necessary to create effective systems for preventing and combating threats of this nature. With such a scale and variety of contemporary threats, effective counteracting them is not possible with the participation of individual entities of the state security system. Cooperation on many levels is required, one of these levels is to conduct a training system (Avveduto, 2017) preparing for collision-free cooperation of entities in the implementation of entrusted tasks related to effective counteracting and combating the phenomenon of terrorism, which requires cooperation covering all levels of cooperation of security system entities performing tasks within the indicated range.

The training process in the area of cooperation, as well as in the area of individual elements of activities of entities, requires the introduction of situational awareness by simulating real places including weather conditions and time of day and virtual

avatars (Figure 1), thus increasing the effectiveness of the training process, and thus greater effectiveness of the entities of the state security system during the actual taking of actions to counteract and combating terrorist threats.

Training of officers, soldiers, guards and security personnel as representatives of the state security system entities responsible for counteracting and combating terrorist threats is a complex and multifaceted process. Each organization of the state security system is subject to evaluation. The most common source of evaluation is public opinion. In the case of uniformed services, the evaluation criteria may be different.

**Figure 1.** Examples of mapping real places including weather conditions and time of day and virtual avatars for situational awareness training.



*Source:* Akademia WSB, VRTechnology.

Formation can be assessed, for example, through the prism of proper action, i.e. providing help, combating violations of the law and arresting their perpetrators, carrying out tasks in accordance with the needs of citizens and respecting their rights, ensuring a sense of security. However, the formations can also be assessed by adopting completely different assumptions, assigning the organization "patches": brutality, unlawful actions, violations of human rights, wrong decisions, abuse of powers, improperly conducted interventions. Two extremes and two ways of looking at one organization.

The evaluation of the formation influences the evaluation of an individual officer in the same way as the attitude of the officer affects the evaluation of the entire formation. This situation indicates that any diagnosis should be made at the level of a single unit of the organization - an officer. The investment in the employee is important and essential for the functioning of the organization (Shaw, 2009). Every money spent on training returns many times (Lovreglio, 2021). It is a multi-faceted turn.

The success of the implementation of anti-terrorist activities is a consequence of properly conducted training on each of these levels (Carlson, 2018). All these issues function in the minds of the instructors, however, undoubtedly the greatest attention is paid to perfect physical skills and the safe and effective use of firearms and means of direct coercion. The reason for this state of affairs is the lack of tools enabling the instructors to make officers aware of the importance and consequences of the

planning stage (Daniec, 2013) and the stage of preparation for combat operations during the implementation of the task (Jeźdrasiak, 2018). Currently, most of the competences of officers and soldiers are improved independently, which is not realistic and narrow specialization may occur, e.g. the most accurate shooters may not be able to quickly identify targets or work in situations of increased stress or provide first aid.

## **2. Methodology**

For the purposes of this article, an analysis of the existing solutions and literature was carried out. The analyzed solution was presented on the basis of expert knowledge and an internet review of solutions available on the market. Literature databases were analyzed, as well as patent databases. The results from the indicated patent search engines and literature databases on the basis of the knowledge conducting the analysis and knowledge of the subject of the study, the materials were assessed in terms of convergence with the scope of the analysis. The subject of the notification and the description of the technical solution were subject to the convergence assessment.

The literature review in this article was conducted in a semi-systematic manner. The semi-systematic or narrative review approach is designed for topics that have been conceptualized and explored differently by different research groups from different disciplines and that hinder the full systematic review process (Wong *et al.*, 2013). This means that it is simply impossible to review every article that may be related to the topic, so a different strategy should be devised. As part of the review for this article, the following steps have been taken: 1. designing the review, 2. conducting the review, 3. analysis, 4. writing up the review.

This process was developed from practical experience and is a synthesis of and influenced by various standards and guidelines suggested for literature reviews (Snyder, 2019).

## **3. Needs in Relation to Training Tools**

As a result of the conducted research, a number of requirements for training tools were identified in order to effectively implement the training process of the personnel of state security entities. The main need is defined as enabling work experience in a given occupation, development of professional skills and competences. Moreover, enabling the officers to be equipped with specific professional qualifications. Training tools should also build appropriate attitudes, including the attitude of lifelong learning. An exemplary training tool should meet the following identified needs:

- education and career counseling taking into account the required competences, interests and predispositions (Shimada, 2019);

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- support in the selection of a specialization profile;
  - building awareness of cyberbullying, preventing hate and promoting attitudes of mutual respect and tolerance;
  - effective use of trends in the labor market and training of skills necessary for future professional work;
  - generating detailed data on the relationship between the professional development of people and their chosen career paths, and their subsequent compliance with the rule of law.

The use of virtual reality in training replaces traditional learning methods thanks to numerous advantages, such as e.g., virtual avatars powered by artificial intelligence algorithms, which consist in studying books and instructions (Nawrat, 2016). Research shows that the best methods of learning are based on multi-sensory communication, involving sight, hearing, touch, smell and taste at the same time. Many of the results of the analyzes carried out show the advantages of using virtual reality in education. The first one is definitely immersion in the learning process and the elimination of external distracting stimuli.

In the case of using virtual goggles, the officer separates himself from the outside world and focuses on activities in VR (Silic, 2020). This immersion also promotes greater involvement. Calling training scenarios in virtual reality experiences emphasizes the experiential character, which is stronger here than in other media (Zahabi, 2020). Another positive aspect of using VR simulation in the education process is the possibility of analyzing and correcting the behavior of officers on a current basis through an appropriately developed scenario. In VR, the entire learning process is very transparent. The applications not only allow you to track where the officer is looking, how he is gesturing, but also allow you to analyze the voice (speech pace, timbre), and even allow you to catch unnecessary interruptions and repetitions.

Thanks to these solutions, it is possible to prepare personalized feedback on students' progress, as well as areas requiring further work. Virtual reality also brings benefits in the form of a decrease in training costs, as well as in the function of time. According to the analyzes, the costs of education decrease, depending on the chosen profession, they can drop by as much as 63 to 92%, and the training time from 2.7 to 12 times (Nawrat, 2016). Taking into account the above data, there is no doubt that in the future, vocational training will take place using virtual reality.

The introduction of the state of the epidemic related to the spread of the COVID-19 virus caused / accelerated the already natural process of the need to transfer the training of many skills to the virtual space. However, such solutions are still imperfect today (no support for group work and group management, and accountability of classes hierarchically and geographically) and unavailable - no VR goggle sets in state security entities. The need for a coherent educational platform and a network of virtual reality laboratories, thanks to which it will be possible to

improve the training process, but also enable a real assessment of the skills and shortages of officers who want to work in a specific specialization. Virtual reality tools will be used to conduct research on the level of preparation for a specific profession, and through a series of substantive trainings on selected professional qualifications for the most important specializations for the formation. The tools should allow for the use of prototypes in two ways: for cyclical tests (at each stage of training) and allow the officer to direct the choice of a specific career path.

The intensive development of ICT technologies allows for the development of digital technologies for training officers and soldiers in an ever wider range of competences. The concept of classic trainers enabling learning certain manual activities is more and more often replaced by a comprehensive approach enabling the preparation of an officer for service in difficult conditions at every stage of work, starting from the planning phase, through the phase of preparation, implementation and analysis of activities. Digital Training Technologies (DTT) can enable training of individual officers' skills as well as cooperation and command skills. The main advantages of using DTT in the training process are:

- the possibility of conducting a multimedia introduction to the issue using virtual reality,
- the possibility of conducting exercises based on scenarios limited only by the instructor's imagination - no need to incur costs related to the rental of facilities and the risk of damaging them during exercises,
- the possibility of practicing cases that cannot be trained in any other way,
- ease of reuse of training materials and exercise scenarios once prepared,
- the ability to monitor the course of training and analyze after the end of the exercise,
- the possibility of conducting exercises in the field of evacuation and providing first aid,
- the possibility of collecting individual progress of training participants,
- the ability to collect information about the way participants move,
- the possibility of using the training personalization methodology,
- support for instructors by automating routine activities,
- no need to incur logistic costs,
- reduction of operating costs,
- the possibility of developing new training methodologies using new DTT capabilities,
- ensuring the objectivity and accountability of the training process.

The analysis of Polish digital training technologies confirmed the benefits of using new technologies of Polish production in the training process, showed that:

- training with the use of DTT is not characterized by an unjustified level of risk, it results in the development of knowledge and skills that can be



- transferred to the environment of operational activities,
- the possibility of dynamic modification of the simulation environment by the instructor translates into the psychological context of the trainees who have to face the stress resulting from a critical assessment of the situation and the need to act immediately in an environment with limited access to information,
  - realism of training translates into proficiency in the skills required to effectively perform operational activities,
  - conducting training not only in the implementation phase, but also in planning, preparation and analysis, translates into effective professionalisation of training.

The conducted analysis showed the following disadvantages of using the simulation systems: simplification of reality, time-consuming preparation, high cost of preparation, the risk of an inadequate level of detail of the model, difficulties in assessing the adequacy of the model.

The implementation of training with the use of simulations may be associated with the following risks:

- in the case of an incorrectly prepared simulation, erroneous habits may be instilled in the person participating in the training,
- the phenomenon of simulator sickness may occur.

#### **4. Virtual Reality Laboratories as an Example of the Use of Digital Training Technologies**

The creation of virtual reality laboratories as part of the training process in an institutionalized system (uniformed formations) requires the design and evaluation of teaching programs and training processes carried out with the use of modern virtualized learning tools. Designing educational classes and training scenarios implemented in virtual reality is carried out in cooperation with specialists in various fields: substantive experts who will prepare substantive materials, hybrid teaching methodologists, process designers (instructional design), media educators, IT specialists, scriptwriters, 3D graphic designers and the use of different areas of knowledge: pedagogy, psychology, didactics, andragogy, ergonomics, usability, cognitive science, sociology, computer science and specialist knowledge.

Preparation of virtualized content attractive and effective in terms of didactics requires the development of a didactically effective model of teaching and learning by shaping learning competences at the minimum:

- according to constructivism (in a four-stage process the learner takes responsibility for his own learning) (Bryceson, 2007);

- neurodidactics, in the four-stage Learning Model (from unconscious incompetence to unconscious competence) (Kaźmierczak, 2017);
- based on the cognitive optimism strategy (Seligman, 2012);
- using brain-friendly techniques and tools of teaching, activating methods (polysensory, hemispheric and multi-intelligent), ensuring deep mastery of the acquired knowledge and skills using the natural predispositions of the learner (eg in terms of learning time);
- based on learning by doing, learning by doing, learning here and now in a Solution-Focused Approach (SFA) (Kvarme, 2010);
- with the use of personalized Bloom's four objects of change to drive learning in Adaptive Instructional Systems (Betts, 2021).

In order for virtual laboratories to be able to implement the above assumptions of effective learning, they should be designed at least in accordance with the Kolb cycle (Harb, 1993), Cathy Moore's Action Mapping method (Lowry, 2011) and RM Gagné's theory (Buscombe, 2013) of 9 steps in the 4-phase pedagogical model of Palloff (Palloff, 1999) and Keith Pratt e-course construction (community building, building cooperation, cooperation, partnership) (Mao, 2005).

The effectiveness of teaching in a virtual laboratory should be verified at the stage of evaluation with the use of methodological tools supporting the measurement of the effectiveness of education, which will allow, *inter alia*, to assess the quality of methods and the effectiveness of content transmission and to determine the leading factors for the 3rd and 4th level of evaluation according to the Kirkpatrick New Model (Panchenko, 2013).

Adaptability is one of the key competences of the future (Figure 2). A world that is becoming more and more complex requires proficiency in solving problems, finding solutions and answers beyond the usual patterns. Today, uniformed formations expect officers to be more flexible in attitudes and skills, and to respond comprehensively to changing requirements and circumstances. The use of the simulation environment allows you to gain simulated experience in various working conditions, e.g. at the airport, in the office, in the workshop, in warehouse spaces, etc. Adaptability is a competence that reacts directly to the world defined by the acronym VUCA (Volatility, Uncertainty, Complexity, Ambiguity), i.e. variable, uncertain, complex and ambiguous (Bennett, 2014).

It is assumed that the ability to adapt to new conditions depends on the development of self-organization features and the knowledge of one's own identity. Adaptability is not automatic, thoughtless (if it is to be permanent and effective). It is a complicated process consisting of several elements: scanning multiple data, aggregating and collecting verified information (determining a specific change); interpretation, that is, giving them meaning; choosing (giving weight to certain meanings) and adapting through learning, i.e., taking action.

**Figure 2.** Examples of mapping real situations in real places.



*Source: Moto-Profil, Akademia WSB, VRTechnology.*

Adaptability is related to flexibility. The condition for both reacting and introducing changes is flexibility, i.e. the ability to adapt to new conditions and requirements, both internal and external. Having well-developed adaptive skills allows you not only to better manage the impact of change on yourself, but also to develop very valuable change management skills, including the ability to analyze and synthesize.

In summary, the following main advantages of using Virtual Reality Laboratories as an example of the use of Digital Training Technologies in the training of officers of state security entities have been identified:

- accountability;
- standardization of procedures;
- improving procedures;
- verification of competences;
- monitoring of competences;
- improving security;
- awareness test;
- process optimization;
- cost optimization;
- more Instructing time for students thanks to relieving them of the routine accountability of learning outcomes,
- building empathy by providing the experience of a person who is radically different from each other or new phenomena or situations, eg by simulating diseases;
- safe remote or stationary work;
- (automatic) analysis and drawing conclusions;
- realistic representation of reality.

The conducted analysis allowed for the identification of the following drawbacks and threats to the use of Virtual Reality Laboratories in the training of officers of state security authorities: time-consuming preparation, the phenomenon of simulator sickness may occur, high cost of preparation, requires a team of specialists with various competences, such as: programmer, 3D graphic designer, sound engineer,

animator, motion actor, voice actor, editor.

## **5. Summary**

This article contains the results of the analyzes of the needs of state security entities in the context of training, with particular emphasis on the analysis of the technological possibilities of virtual reality laboratories in accordance with the paradigm of digital training technologies. The considerations carried out in this study allowed for the definition of a set of functional requirements for tools supporting Instructors during training for officers of uniformed services in the field of anti-terrorist activities.

The study presents solutions that can be proposed by the Polish defense industry, state and commercial research and development centers and research institutes in the field of using existing domestic digital technologies for training operational troops and Territorial Defense. The research focused on the following challenges faced by the training systems of uniformed services: system interactivity, methodological correctness of the training scenario, realistic work environment, legal conditions and consequences of actions, first aid.

The conducted analysis made it possible to achieve the goal and define the following needs in the field of VR-based technologies:

- personalization of training;
- realistic representation of reality;
- interdisciplinary group exercises;
- the possibility of making mistakes and observing their consequences;
- ongoing instructor supervision with the possibility of modifying the simulation environment;
- post-exercise analysis.

Summing up the research process carried out, it should be stated that the Polish defense industry is able to offer solutions that meet the defined requirements both in the field of training uniformed services, as well as these solutions may constitute a complementary element of the system of organizing military training. Of course, virtual solutions will not replace training on real equipment, but they allow repetitive training in conditions similar to real ones, reducing training costs and enabling instructors to constantly increase the level of training difficulty.

Taking into account the deficiencies in the infrastructure of uniformed and military services and the prevailing trend to develop training facilities and improve the competences of officers and soldiers at every level, it can be concluded that the presented solutions will have a positive impact on the level of interdisciplinary training in the field of planning, preparation, implementation and the consequences

of actions taken.

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