Znanja, veštine i sposobnosti neophodni za operatere UAS

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Apstrakt: Upotreba borbenih i komercijalnih dronova je u sve značajnijem porastu. Pored upotrebe vojnih dronova u vojne svrhe i komercijalnih u civilne svrhe, takođe su poslednji sukobi u Nagorno Karabahu i Ukrajini ukazali i na mogućnost upotrebe komercijalnih dronova u vojne svrhe. Profesija operatera drona postaje sve popularnija, među mladim ljudima zaintersovanim za STEM obrazovanje. Za izvršavanje različitih zadataka i aktivnosti potrebne su donekle različite veštine operatera dronova, ali je osnova ista. Cilj ovog rada je da analizira znanja, veštine i sposobnosti za operatere UAS, kako vojne, tako i civilne. Na osnovu analize literature i rezultate diskusije fokus grupe, kreirani su opisi posla sa specifikacijom izvršilaca za vojne i civilne operatere UAS, uz preporuke za budući razvoj operatera UAS u Republici Srbiji.

Ključne reči: UAS, operateri, znanja, veštine i sposobnosti

Knowledge, Skills, and Abilities Needed for UAS Operators

Abstract: The use of combat and commercial drones is on the rise. In addition to the use of military drones for military purposes and commercial drones for civilian purposes, the recent conflicts in Nagorno-Karabakh and Ukraine also indicated the possibility of using commercial drones for military purposes. The profession of drone operator is becoming increasingly popular among young people interested in STEM education. Different tasks and activities require somewhat different drone operator skills, but the basics are the same. The aim of this paper is to analyze the knowledge, skills and abilities for UAS operators, both military and civilian. Based on the analysis of the literature and the results of the focus group discussion, the job descriptions were created with the job specifications for military and civilian UAS operators, along with recommendations for the future development of UAS operators in the Republic of Serbia.

Keywords: UAS, operators, knowledge, skills, and abilities

1. Introduction

Unmanned Aircraft Systems (UAS) are becoming more significant in the last decade, both in military and civil purposes. The expression *Unmanned Aircraft System* was coined in the United States in 2005 by Department of Defense (DoD) and the Federal Aviation Administration (FAA) (Granshaw, 2018).

Undoubtedly, recent conflicts in Nagorno-Karabakh (Ilic, Tomasevic, 2021) and Ukraine (Zabrodskyi, et al. 2022) showed the possibilities of combat implementation of UAS. Furthermore, the war in Ukraine shows that drones are becoming a significant factor in conventional warfare (Eslami, 2022). The scale of their use in the war in Ukraine is unprecedented and exceeds the conflict in Nagorno-Karabakh. The impact of drones on the changing character of warfare is a very important topic for further research, as there are still not enough studies.

However, the possibilities of civil and commercial use of UAS, are endless, and many researchers focused on the topics of non-military use of UAS. UAS can be used in scientific research (biology, archaeology, geography, etc.); education; creative industries; (Skrzypietz, 2012; González-Jorge et al. 2017); health (Restás 2022); 3D mapping; photogrammetry and remote sensing construction (Freimuth and Everaerts, 2008); agriculture, etc. (Rasmussen et al. 2013; Ehmke 2013); delivery and transport (Li, et al. 2022). UAS are seen as a powerful tool in environmental, risk prevention and management, especially in cases of floods, earthquakes, and wildfires (Fernández-Guisuraga et al. 2018; Zormpas et

al. 2018; Wang et al. 2022; Gebrehiwot et al. 2019; Gray, & Weston, 2021). In the area of security (critical infrastructure security, border security, traffic control, manmade disasters, like radiation leaks, etc.), UAS is also becoming very important tool for prevention and monitoring (Li et al. 2018; Kamnik et al. 2020).

The limitless possibilities of UAS application in military and civil purposes require recruitment, hiring and training of greater number of UAS operators with specific set of knowledge, skills, and abilities. An UAS operator can be defined as a person who operates, or controls, or navigates an unmanned aircraft system. The first part of this paper explores existing literature on specific set of knowledge, skills, and abilities needed for UAS operators both for military and civil purposes, the second part presents the results of a focus group discussion and the job descriptions and specifications of civil and military UAS operators alike. Finally, future recommendations for the defence system of the Republic of Serbia are given.

2. Literature review on knowledge, skills, and abilities needed for UAS operators

Every job position is defined by its *job description*, which could be defined as a list of job's duties, responsibilities, reporting relationships, working conditions, and supervisory responsibilities and its job specification (required knowledge, skills, and abilities). A list of responsibilities, chain of accountability, job conditions, etc. is often called *job description* in its narrow sense. A list of a job's "human requirements," that is, the necessary education, skills, and personality is often termed *job specification* (Dessler, 2013). Both categories are products of a process called job analysis (Siddique, 2004; Prien, et al. 2009). It can be stated that the process of job analysis is a foundation of all future human resources management processes. Development of KSAO's (knowledge, skills, abilities and other characteristics) is also occasionally defined in scientific and professional research as competency modelling, but with an addition to job analysis – inclusion and accentuation of job performance (Campion, et al. 2011).

Knowledge, skills, and abilities requirements for military UAS operators have to be developed in a more complex manner because their responsibilities include, not only drone operating knowledge, skills, and abilities, but military skills, too - firearms operating skills, military tactics knowledge, etc. (Žnidaršič, et al. 2020). In developing job descriptions for military UAS operators, one of the crucial factors that should be taken into the account is psychological dimension, which is to perform under combat circumstances and the ability to manage psychological effects of loss of lives (Chappelle, 2014; Hijazi, et al. 2019; Saini, et al. 2021; Voice, 2022; Richardson, 2022). Kirkpatrick, (2015) analyzed risk management and courage of operators of combat UAS.

Schmidt, et al. 2022, emphasised development of UAS operators' competencies and the importance of training programs for achieving required level of competencies. Some authors propose training programs for developing future drone operating skills through gamification, using various web and other IT based platforms and virtual reality, both for military and civil UAS operators that can be offered through higher, and even secondary STEM education (Bartholomew & Mayo, 2018; Cardona Reyes, et al. 2021). Lamb, et al. (2022) emphasized perception of risk of UAS operators as an important competence and Pena (2014) stressed out the accountability as a key factor of UAS operators' competencies. Adams (2020) focused on UAS operators' skills in online journalism as a specific category of UAS operating, similarly Borowik, et al. (2022) paid attention to the skills of UAS operators needed for filming.

3. Development of set of knowledge, skills and abilities needed for UAS operators

One of the most important components of UAS operations are their operators' qualifications (Marshall, et al. 2012). Development of job descriptions for military and commercial UAS operators is a multifaceted process that is different for each of these groups, so both processes should be approached with special thoughtfulness. As there are not a significant number of UAS operators in the Republic of Serbia, a focus group is organized instead of research through survey and statistical analysis. Expert focus groups as a method of a qualitative study are common research method. Focus groups are often defined as a group interview with a moderator, usually consisted of experts (Albanesi, 2014). The

academics and experts in a certain field debate on a defined issue following questions set by semi-structured interviews (Van Audenhove, Donders, 2019; Li, 2019). In newer studies, focus grpup interview is considered very informative and important method of researching many subjects in varipus social sciences (Van Soest, 2022).

The focus group included the experts in security, risk management, strategic management, environmental studies and a UAS operator. A Zoom focus group session is organized on September 10, 2022. The author was a moderator, and a transcriber of the answers. This focus group was organized as an unstructured discussion on wide range of subjects related to development of knowledge, skills, and abilities of military and civil UAS operators.

Table 1. Expert focus group composition (Source: author)

Code	Field	Expertise	Position
Expert 1	Higher education	Security and military studies	Full professor
Expert 2	Higher education	Strategic management	Research fellow
Expert 3	Higher education	Human resources management	Associate professor
Expert 4	Information technologies	Information technologies	Project manager
Expert 5	Risk management	UAS operations	UAS operator
Expert 6	Higher education	Environmental studies	Research fellow

4. Results

In a discussion, several main topics emerged. Expert 1 emphasized the importance of various combat skills needed for military UAS operators, which has not any significance for civil UAS operators, nevertheless, future military UAS operators can be recruited from the pool of civil operators and UAS enthusiasts and could receive proper military training through military academy or other forms of military training. Expert 4 stressed out the importance of information technologies education and constant learning of the students who engage in operating civil UAS who in the future would participate in various activities that require the involvement of UAS, expert 1 added that it is the basis for both, military and civil operators.

Expert 2 emphasized the importance of development of government strategy on UAS implementation in various fields and the inclusion of UAS in local governments' strategy on the adoption of smart cities, especially for the city of Belgrade. Those strategies would be a framework of the process of development of competencies needed for UAS operators. Expert 6 gave emphasis on the promoting the awareness of various fields in which UAS can already be involved (environmental protection, firefighting, flooding prevention and monitoring, deforestation monitoring, agriculture, etc.).

Expert 3 highlighted the importance of multi-team cooperation in development of knowledge, skills, and abilities for UAS operators that would include expert UAS operators, experts in human resources with the expertise in job analysis and in development of job descriptions and job specifications. Expert 5 stated the importance of continual updating of existing job descriptions and job specifications because of fast changes in the field of UAS operations and their application.

According to the literature review and the focus group discussion results, following job descriptions and job specification for military and civil UAS operators can be proposed:

a. Military UAS operators

Job description
- General UAS operations performance (Technical skill, take-off, climb, cruise, landing and recovery, emergency disposal);
- Following appropriate safety procedures;
- Implementing appropriate operations procedures;
- Mission planning;
- Instruments monitoring;

- Map reading;
- Risk estimation;
- Emergency procedures performing;
- Specific UAS operations performance (combat performance).

Job specification
- Knowledge of UAS components;
- Knowledge of ergonomics;
- Visual ability (high level);
- Attention to detail;
- Hand-eye coordination;
- Motor skills;
- Spatial orientation;
- Information technologies proficiency;
- Teamwork skills;
- Independent thinking skills;
- Leadership skills;
- Communication skills;
- English language proficiency;
- Knowledge of UAS regulation;
- Analytical skills;
- Problem solving kills;
- Active listening skills;
- Prioritization skills;
- Multitasking skills;
- Risk management skills;
- Time management skills;
- The ability of performance under extreme stress;
- The ability to perform under extreme pressure;
- Judgement and decision making skills;
- Knowledge of military strategies and tactics;
- Combat capabilities.

b. Commercial UAS operators

Job description
- General UAS operations performance (take-off, climb, cruise, landing and recovery, emergency disposal);
- Specific UAS operations performance (3D mapping; photogrammetry and remote sensing; delivery and transport, firefighting; crops spraying; scientific research; etc.);
- Following appropriate safety procedures;
- Mission planning;
- Instruments monitoring;
- Map reading;
- Risk estimation;
- Emergency procedures performing;
- Implementing appropriate operations procedures

Job specification
- Knowledge of UAS components;
- Knowledge of ergonomics;
- Visual ability (high level);
- Attention to detail;
- Hand-eye coordination;
- Motor skills;
- Spatial orientation;
- Information technologies proficiency;

- Communication skills;
- Teamwork skills;
- Independent thinking skills;
- Leadership skills;
- English language proficiency;
- Knowledge of UAS regulation;
- Analytical skills;
- Problem solving kills;
- Active listening skills;
- Prioritization skills;
- Multitasking skills;
- Risk management skills;
- Time management skills;
- Stress management skills;
- Judgement and decision making skills;
- General knowledge of a particular field (archaeology, traffic, transportation, agriculture, entertainment industry, etc.).

5. Recommendations for the defence system of the Republic of Serbia

The first recommendation is to develop more STEM programs and awareness of STEM sciences significance, not only through secondary and higher education, but to begin with the programs in elementary education through courses and workshops that include programs adjusted to the younger population and appropriate educational levels. One of the prerequisites of developing future UAS operators is development secondary and higher education programs in: maths, physics, engineering, computer science, programming, data analytics, data visualisation, data mapping, etc. (Hoagland, 2013). The second recommendation is to include gamification as a tool for developing future UAS operators (both civilian and military).

It is important to understand that both civil and military UAS operators are needed in the future job market, because there is often not a clear line between the need for engagement of civil or military UAS operators, for example in cases of ecological or man-made accidents, disasters (fires, earthquakes, floods, etc.), when knowledge, skills, and abilities of both civil and military UAS operators would be of crucial importance.

6. Limitations and further study

As technologies' development is very rapid, research of knowledge, skills, and abilities required of any job position that includes fast changing information technologies needs to be instigated on regular basis, because some of the conclusions may become obsolete very quickly. Future studies should be focused on further development of UAS technologies and changes in requirements for UAS operators both in military and civil sector.

7. Conclusion

The aim of this paper was to analyse the knowledge, skills and abilities for UAS operators, both military and civilian. Based on the analysis of the literature and the results of the focus group discussion, the job descriptions and job specifications for military and civilian UAS operators were proposed, along with recommendations for the future development of UAS operators in the Republic of Serbia. The most important step would be promotion of STEM sciences, especially information technologies and education of generations that could be educated for military and civil UAS operators.

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