

PROPOSAL OF REORGANIZATION IN AIRSPACE STRUCTURE AND OTHER FACILITIES FOR THE NEEDS OF FUTURE UNMANNED AIRCRAFT SERVICES

Magdalena Kobrzyńska¹, Katarzyna Krawczyk¹, Paweł Ostręga¹, Aleksandra Pasich¹

¹The Faculty of Mechanical Engineering and Aeronautics Rzeszów University of Technology, al. Powstańców
Warszawy 12, 35-959 Rzeszów

Abstract

The development of Unmanned Aircraft was another milestone towards the enhancement of transportation sector, especially in highly congested areas. This kind of vehicle offers a wide range of opportunities that might be crucially beneficial for the society, as well as contribute to saving a human life or mitigate the influence of current urban traffic on environment. Apart from visualizing and gathering traffic information that might be useful for future land traffic flow organization, another potential application worth of attention is medical industry: transport of vaccines, blood or organs for transplantation. Unmanned Aircraft might crucially facilitate the whole process by lowering costs and time of transport. However, the complexity of airspace structure over highly populated and congested Polish cities, absence of a clear regulatory framework at European Union, extended waiting time for the approval of Unmanned Aircraft operations in Controlled Airspace boundaries or lack of infrastructure and proper Unmanned Aircraft traffic monitoring systems prevent that sector of transportation from dynamic development of a proper market for Unmanned Aircraft services. The fundamental concept of the article is to examine the present situation regarding the airspace structure over the congested area and in the vicinity of the airport of a highly populated and urbanized city as well as to analyze currently existing facilities for Unmanned Aircraft in that area. For the examination, Warsaw, the most populated and urbanized city in Poland as well as having the most complex airspace structure for unmanned aircraft, was chosen. Additionally, present Polish regulations regarding Unmanned Aircraft Operations were reviewed. The performed analysis and its extrapolation to other highly urbanized areas in Poland indicates, that significant changes in airspace structure and regulations need to be conducted in order to implement Unmanned Aircraft services in the future and fully exploit high potential of that market. Thus, the paper also includes a proposal of solutions regarding airspace reorganization to accommodate Unmanned Aircraft traffic along with manned air vehicles, more efficient flight approval system, potential changes in regulations enabling Unmanned Aircraft to perform their services as well as elements of infrastructure and monitoring systems that would prevent present level of safety from deterioration or even improve it.

Keywords: airspace reorganization, transport infrastructure, Unmanned Aerial Vehicles regulations, urbanized area, Unmanned Traffic Management (UTM)

1. Introduction

The transportation industry has been experiencing dynamic development recently, which significantly contributes to the enhancement of society's life in general. The branch that has one of the biggest shares in this phenomenon is Unmanned Aircraft Vehicles (UAVs) industry. Current operations of this kind of vehicle have already shown that its influence on transportation sector's enhancement process might be crucial in the upcoming years. The UAVs might contribute to significant relief of ground traffic in highly congested areas by taking over the tasks currently conducted by land vehicles - saving a human life by transporting the vaccines, blood or organs for transplantation, delivering packages or food, as well as helping in the urban traffic's optimization process by visualizing and gathering information that is crucial for the organization of traffic flow [1]. Using the UAVs instead of land vehicles might significantly reduce costs and time of the afore-

mentioned operations and the influence of transportation branch on environment, since UAVs are considered as zero emission mean of transport.

In order to fully exploit the potential of the UAVs transportation branch, clear airspace structure for the movement of this kind of air vehicle and regulations unified in all EASA state members are needed. Thus, the fundamental concept of the paper is to analyze present situation regarding the airspace structure in the vicinity of Chopin Airport in Warsaw and regulations concerning the operations of UAVs in Polish airspace as well as to examine the level of unification of these regulations with other EASA state members.

The article also includes proposals of solutions that might contribute to the enhancement of currently existing facilities for UAVs operations.

2. Review of current regulations and facilities in Poland

Current regulations in Poland include the UAV's Maximum Take-Off Weight (MTOW) limitations, thus the ones whose MTOW is not bigger than 25 kilograms will be considered in this paper. Most commercial UAV operations are performed according to Beyond Visual Line of Sight (BVLOS) rules. As stated by the latest Ordinance of the Ministry of Infrastructure [2], the BVLOS operations can no longer be considered as recreational ones and are divided into four main groups, dependant on the characteristics of the specific flight:

- 1) Operational – performed as part of the operation of relevant services, e.g. Customs and Tax Service, medical services);
- 2) Technical – control and protection of society and property);
- 3) Automatic – monitoring and control of society and property, medical supplies;
- 4) Training – aimed to train new UAV operators.

Conducting any of afore-mentioned types of flight is associated with the necessity to meet various requirements.

2.1 UAVs regulations in Poland

Before any operator is allowed to conduct a BVOLS flight, they have to apply for and receive the approval from Polish Civil Aviation Authority. Such approval is valid for 12 months. Apart from the application, the following documents need to be attached [3]:

- 1) Operating Manual;
- 2) The copy of Aviation Personnel Certificate of Qualifications;
- 3) The copy of third party liability insurance.

Once, the operator meets all the requirements, the Civil Aviation authority confirms approval within two working days.

2.2 BVLOS flight regulations

In order to perform a BVLOS operation, such intention including the route and the area of flight, needs to be submitted to the Polish Navigation Services Agency (PANSA) at least 7 days before the actual flight. PANSA publishes the specific flight at least 2 days before the beginning of the operation. For operational, specialized or training flights, the following limits must be respected: altitude not more than 120 m above sea level, speed not exceeding 150 km / h. In the case of automatic flights: a height of 50 m above ground level or 50 m above the highest obstacle within 100 m is not exceeded, at a horizontal distance of less than 100 mm from buildings or with their consent, speed less than 150 km / h. Communication between the aircraft and the operator must be maintained at all times. When flying over the CTR (Control Zone), it is required to comply with the laws of the institution that provides air traffic service. In the ATZ (Aerodrome Traffic Zone), D (Danger Area), MATZ (Military Traffic Zone), R (Restricted Area) or P (Prohibited Area), flight is only possible with permission from the zone administrator and according to rules defined by him

[3]. In the ADIZ (Air Defense Identification Zone), ATS (Air Traffic Services) or AMC (Airspace Management Call) has to be informed.

2.3 UAVs' obligatory equipment and other requirements

Apart from formal requirements, there are various technical aspects that need to be met in order to perform the operation without violating the regulations. First of all, the BVLOS operation can be performed only by UAVs that are entered in the register of Unmanned Air Vehicles run by the Civil Aviation Authority – in result every aircraft has unique registration numbers. Additionally, every UAV has to be equipped with the following components [3]:

- 1) Navigation lights – continuous green light on the right wing, continuous red light on the left wing, a white flashing light on top of the tailplane;
- 2) Telemetry with ongoing monitoring of flight parameters – track, speed, altitude, battery charge or fuel supply;
- 3) Primary localizing device;
- 4) Emergency localizing device – independent from the primary localizing device;
- 5) FAILSAFE – the ability to perform one of the emergency procedures, for instance emergency landing, return to home, etc;
- 6) Flight Data Recorder;
- 7) Camera for observations of the surroundings.

2.4 Present airspace structure over congested area in Warsaw

Figure 1 presents current airspace structure in the vicinity of Chopin Airport. The red colour contributes to complete prohibition of UAV operations (direct vicinity of the airport and the downtown of Warsaw). Other zones visible on the figure contribute to various restrictions, that have to be acknowledged by the operators [4].

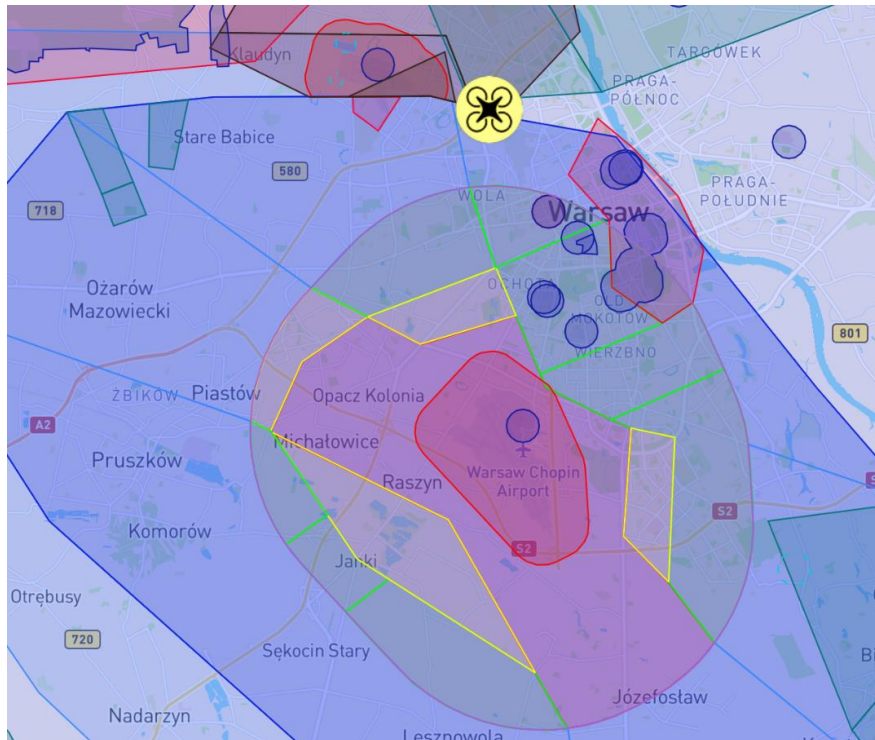


Figure 1 – Present structure of airspace for UAVs in the vicinity of Chopin Airport.

As can be seen, there is a high level of variety in the characteristics of the specific zone and its restrictions. Such variety can easily lead to confusions and misunderstandings, especially among

non-polish operators, who intend to perform commercial flight in Polish airspace.

3. Regulations in other EASA's member states

In order to assess the level of complexity and variety of current regulations concerning UAV operations throughout EASA's member states were analysed. EASA has already published specific regulations that every member state has to follow [5][6]. However, many of the countries have their own unique regulations that need to be checked and acknowledged by every operator intending to perform any UAV operations within the boundaries of that country.

3.1 The variation of EASA's member states regulations

The regulations regarding UAV operations throughout the EASA's member states and concerning the most important aspects every operator needs to be aware of in order to perform a flight in a specific country are summarized and presented in table 1 [7].

Table 1 – UAV operations regulations in EASA's member states.

Country	Commercial/Recreational	Day/Night	Joules limitations	Weight Limitation
Austria	-	-	+	-
Bulgaria	-	-	-	+
Belgium	Classes	+	-	+
Croatia	-	+	-	+
Cyprus	+	+	-	+
Czechia	+	-	-	-
Denmark	+	+	-	+
Estonia	+	-	-	-
Finland	+	-	-	+
France	+	+	-	+
Germany	-	-	-	+
Greece	+	+	-	+
Hungary	-	-	-	-
Ireland	-	-	-	+
Italy	+	+	-	-
Latvia	-	+	-	+
Lithuania	-	-	-	+
Luxembourg	-	-	-	-
Malta	-	-	-	-
Netherlands	+	+	-	+
Poland	+	-	-	+
Portugal	-	+	-	+
Romania	-	-	-	+
Slovakia	-	+	-	-
Slovenia	+	+	-	+
Spain	+	-	-	+
Sweden	-	+	-	+

As can be seen, the law regarding UAV operations may vary in each of the EASA member states, which might often lead to confusions and uncertainties among the foreign operators who intend to perform the UAV operations in a specific country. The table clearly shows, that in order to adapt the UAV traffic into the airspace along with Manned Aircraft, a significant number of changes needs to be implemented. It demands full cooperation of all EASA's member states.

3.2 Airspace complexity's minimization

Another issue that needs to be addressed is the level of complexity of the airspace structure for UAVs in many countries – the Polish airspace in Warsaw is the best example. In order to mitigate this problem, potential airspace restructuring needs to be reconsidered and it does not need to be

a revolutionary concept. The problem of complexity could be solved by creating one bigger zone with clear information about ongoing restrictions within it. A good example of such solution is the zone in the vicinity on Vienna Airport presented on figure 2.

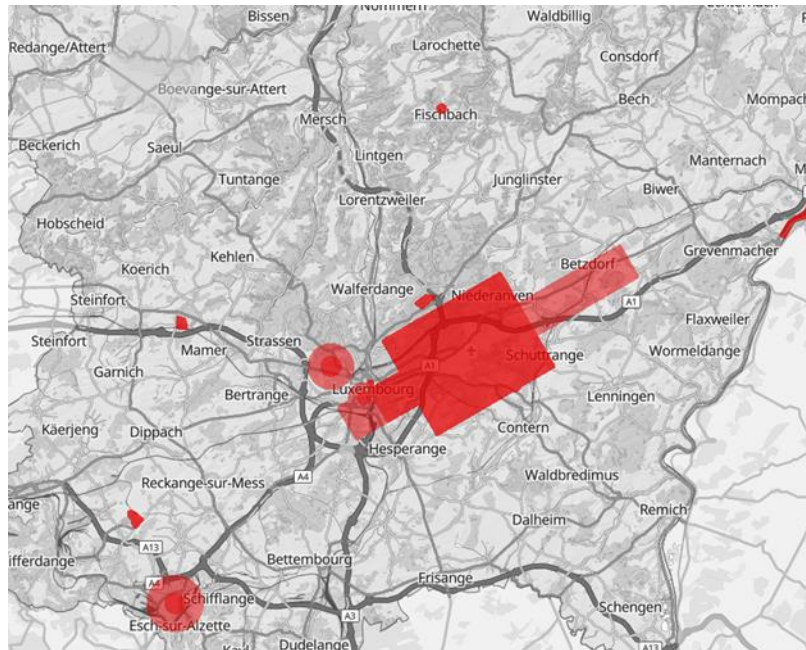


Figure 2 – Airspace structure for UAV operators in the vicinity of Vienna Airport.

4. Conclusions and future work

To summarize the analysis conducted in the paper, the law regarding UAV operations may vary in each of the EASA member states. There is a group of laws that was published by EASA and all member states are obliged to follow them. On the other hand, some rules are unique to a specific country and the operators have to look up for the proper information every time they are going to perform the UAV flight abroad in order to avoid any misunderstandings. Some of the regulations, like weight limitations or heights and distances from objects that UAVs may operate, are adapted in several countries and they do not differ from each other. In order to fully exploit the potential of UAVs applications in society's future lives, the regulations need to be unified in each EASA member state. Countries, like Republic of Poland, should reconsider the reduction of current rules to minimum canceling the unnecessary limitations and start the process of adjustment to the European limitations and advices. The second issue is amount of no-fly, restricted or other types of zones and organizations whose permission is required to perform a flight. This problem could be solved by creating one greater zone not including full restricted zones, with upper limit of maximum flight altitude, and organization which would work in cooperation with actual managing organizations and was in favor to give permissions or not. To minimize risk of damage caused by UAVs and their operators, the following solution could be introduced. All UAV operations divided into two groups: commercial and recreational. According to zones mentioned before, recreational flights would be restricted and only commercial operations would have a required permission. Following that, commercial flights would must have an insurance, report region of planned flight and altitude. If those three requirements were fulfilled, the organization would give the permission to an operator and inform the rest of actual organizations that the flight would be performed. The advantage of such solution is that the operator has only one organization to contact with and he/she knows he/she wouldn't fly into other zone without permission and map of zones would be much more readable. Recreational flights would be possible only beyond zones' boundaries.

The issue covered in this paper also suggests some tasks and challenges for the future analysis. The potential cases yet to be analyzed are:

- The analysis and simulation of the possibility to integrate autonomous UAVs with Manned Aircraft in the same airspace, especially in the vicinity of the airport and the examination of

facilities and systems needed to adapt all the traffic into the specific airspace. The research would also require the assessment and proposal of regulation's amendments in order to clarify all their aspects to the UAV operators as well as the crews of Manned Aircraft;

- Separate research would concern the design of modern collision avoidance system, which would inform the crews of Manned Aircraft about the Unmanned Traffic and advice the most effective and safest way to avoid potential collision;
- The analysis of the scenario, where UAVs take over part of the tasks currently conducted by land vehicles or Manned Aircraft and how it would mitigate the negative impact of transportation branch on the environment by reducing CO₂ emissions.

5. Contact Author Email Address

In case of any questions, please feel free to contact the authors:

kobrzynskamagdalena@gmail.com, katarzyna.krawczyk@euroavia.eu,
pawel.ostrega123@gmail.com, aleksandra.pasich.1996@gmail.com.

6. Copyright Statement

The authors confirm that they, and/or their company or organization, hold copyright on all of the original material included in this paper. The authors also confirm that they have obtained permission, from the copyright holder of any third party material included in this paper, to publish it as part of their paper. The authors confirm that they give permission, or have obtained permission from the copyright holder of this paper, for the publication and distribution of this paper as part of the AEC proceedings or as individual off-prints from the proceedings.

References

- [1] Rise Above. *UAV Applications and Uses*. (online), retrieved by: <https://www.riseabove.com.au/drone-services/uav-applications-and-uses/> [accessed: 21st September 2021];
- [2] Ministerstwo Infrastruktury. *ROZPORZĄDZENIE MINISTRA INFRASTRUKTURY z dnia 20 grudnia 2018 r. zmieniające rozporządzenie w sprawie wyłączenia zastosowania niektórych przepisów ustawy – Prawo lotnicze do niektórych rodzajów statków powietrznych oraz określenia warunków i wymagań dotyczących używania tych statków*. Dziennik Ustaw Rzeczypospolitej Polskiej, Warszawa, 19 stycznia 2019r.;
- [3] Drones' World *Loty BVLOS według nowego rozporządzenia*. (online), retrieved by: <http://www.swiatdronow.pl/loty-bvlos-wedlug-nowego-rozporzadzenia> [accessed: 21st September 2021];
- [4] Polish Air Navigation Services Agency. *Zasady wykonywania lotów bezzałogowymi statkami powietrznymi (BSP) w kategorii szczególnej*. (online), retrieved by: <https://www.pansa.pl/uas-specific/> [accessed: 19th September 2021];
- [5] European Commission. *COMMISSION IMPLEMENTING REGULATION (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft*., Brussels, 24th May 2019;
- [6] European Commission. *COMMISSION DELEGATED REGULATION (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems*., Brussels 12th March 2019;
- [7] DroneRules. *Drone Operations Regulations in EASA's member states*. (online), retrieved by: <https://dronerules.eu/en/professional/regulations/> [accessed: 21st September 2021];
- [8] Austro Control. *Operation of Drones in Austria*. (online), retrieved by: https://www.austrocontrol.at/en/aviation_agency/licenses__permissions/flight_permissions/rpas [accessed: 15th September 2021];
- [9] Beard R.W., McLain W.T. *Small Unmanned Aircraft: Theory and Practice*., Princeton University Press, 2012;
- [10] Polish Civil Aviation Authority. *Unmanned Aircraft – General Information*. (online), retrieved by: <https://ulc.gov.pl/en/unmanned-aircraft/5688-general-information> [accessed: 14th September 2021].