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THE ERA OF UNMANNED AERIAL VEHICLES IS COMING

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Abstract

The use of UAVs (Unmanned Aerial Vehicles) is constantly increasing due to their technical, operational and economic potential. They are used for recreational and commercial purposes by individuals, companies, organizations and government institutions. Despite the systematic implementation of appropriate safety procedures in air traffic management systems, aviation procedures and safety management systems, it is impossible to completely prevent air accidents. Within 6 months, two air crashes have been reported that involved BEAING 767 Max 8 aircraft. This gives rise to the question whether air accidents involving manned aircraft will become a catalyst for even faster development of UAVs and their greater importance. **Purpose:** The purpose of the article is to present the potential for the use of UAVs and the measures that should be taken in order to make unmanned aviation competitive against manned aviation. **Method:** The scientific methods used in the paper include the review and criticism of the literature on the subject, as well as logical analysis and construction. Article type - Review article. **Results:** The article presents the measures to be implemented in order for unmanned aviation to become competitive against manned aviation and complement other types of transportation services. When introducing new regulations and procedures, the priority should be to ensure the safety of the airspace and other spaces where operations with the use of UAVs will be performed. **Conclusions:** In order to ensure safety, it is important to equip UAVs with anti-collision devices and airspace detectors informing about any approaching aircraft and obstacles on the actual and potential path, as well as with cameras enabling observation of the airspace around UAVs.

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Unmanned aerial vehicles – current state and prospects for development

The use of Unmanned Aerial Vehicles (UAVs) is growing and is likely to continue to do so both in the civil and state aviation sector. Flights with UAVs are made for recreational, sports, scientific and commercial purposes (in such sectors as transportation, construction, agriculture, forestry, stocktaking, energy sector, rescue operations, geodesy and advertising) as well as for operations of national importance (such as by air rescue or security services).

In order to guarantee the effective use of UAVs and ensure safety in the airspace, a full integration of manned and unmanned aviation in the common airspace, based on a transparent legal framework, is required. The process of integration must be carried out in such a way so as to avoid any adverse impact on airspace users, air navigation, air traffic services, aircraft or the operation of ground-based air navigation aids.

The current level of technological advancement of the systems supporting both manned and unmanned flights undoubtedly allows for performing air operations in the common airspace. This is made possible with the use of modern advanced technologies, the knowledge and experience of the people involved in the development of UAV systems and air traffic management systems. The integration of manned and unmanned aviation must be carried out according to a plan, which takes into account the level of technological development, the experience of airspace users as well as the needs and expectations of air carriers and the industry.

In light of the above, it should be noted that commercial flights with passengers on board seem feasible within the next few years. This calculation is not due to technological limitations of aircraft or air traffic management systems, but results from the need to first convince passengers to use UAVs for travel. Currently, all commercial passenger flights in the European airspace are operated by manned aircraft. This gives the passengers the sense of comfort that in the event of any failure of the aircraft, the crew, by following the established procedures, will either manage to land safely or not take off at all in the first place, as the procedures, the equipment on board the aircraft as well as the ground-based systems will prevent it. Due to the increasing intensity of air traffic and the specific scope of ATS (Air Traffic Services), modern passenger planes are well equipped with modern electronics that supports the crew of the aircraft, the Air Traffic Services and other personnel in ensuring the safety of operations on the ground and in the air.

Passengers are usually convinced that the crew controls the aircraft throughout the whole flight. In fact, the flight operation is mostly carried out by automatic systems that

support and replace the crew in the process of controlling the aircraft. These systems that ensure the flight safety have become indispensable in modern air navigation, as safety is the top priority for air traffic management systems, flight crew and aircraft maintenance staff.

Air transport brings economic benefits. Its use makes it possible to introduce new technologies into the air traffic management system. It also drives the development of aviation infrastructure, which translates directly and indirectly into increasing the level of safety for airspace users. However, it should be taken into account that aviation is an area of human activity, where adverse events cannot be excluded. In order for air navigation to be safe, the likelihood of adverse events must be systematically minimized, taking into account increasing air traffic, procedural and equipment modifications, as well as the integration of manned and unmanned aviation into the common airspace. At the same time, it has to be remembered that the complete preclusion of adverse events in aviation is impossible.

Despite the implementation of appropriate safety measures in air traffic management systems and aviation procedures, it is impossible to successfully eliminate the risk of air accidents (Annex 13 to the Convention on International Civil Aviation, 2010, p. 16).

Within 6 months, two air crashes involving BEAING 767 Max 8 aircraft occurred:

- On October 29, 2018, a Boeing 737 Max 8 took off from Jakarta Soekarno-Hatta Airport (Indonesia). It crashed just 13 minutes later, likely into the Java Sea, with 189 people on board.
- On March 10, 2019, a Boeing 737 Max 8 crashed shortly after take-off from the airport in Addis Ababa (Ethiopia). All 157 people on board were killed. The 737 Max 8 aircraft was delivered a few months earlier and put into service in August 2018. The captain of the tragic flight was Bhavye Suneja, while the first officer was named as Harvino. Both were experienced pilots - the captain had over 6,000 hours of flying experience and the first officer - about 5,000 hours.

Boeing 737 Max 8 with an MCAS (Maneuvering Characteristics Augmentation System) is a completely different model from the existing aircraft. It features a new twin-engine design, as well as structural and aerodynamic modifications and changes to the electronics, control system and other installations of the aircraft. Compared to previous models, Boeing 737 Max 8 was much more modern, economical and durable, as well as easier to control by the crew. However, what was extremely significant, it had different parameters of aerodynamic lift.

According to the preliminary report by the Ethiopian authorities on the ET302 flight crash, although the flight crew were the emergency procedures prescribed by Boeing, they were unable to control the aircraft. A representative of Boeing admitted that during both fatal flights there occurred some problems with the software. Most likely, the anti-stall system was automatically activated and caused the plane to lose lift and nosedive.

Errors in the software responsible for controlling the aircraft (MCAS) are thought to have been the direct cause of the crash, which led to the death of a total of 346 passengers and crew members.

Is it, therefore, reasonable to expect that the popularity of air transport will decrease? Certainly not, as air transport is considered to be the safest mode of travel. However, what is likely is that the public, as well as institutions responsible for the safety of air navigation, will press the demands for increased safety of new aircraft, as well as for the certification process to be clear, transparent and supervised by independent accredited and notified bodies.

This raises the question of whether air accidents, such as the examples presented above, will allow for a green light for unmanned aviation and whether they will have an impact on the acceleration of the process of the integration of manned and unmanned aviation, thus allowing for the successful introduction of UAVs on the air transport market. In order to answer that question, several factors need to be considered.

The fact is that the demand for the services provided by UAVs is enormous and the potential of such vehicles is so great that they may become highly competitive against manned aviation in the future. Manned aircraft manufacturers, including Boeing and Airbus, are likely to be most threatened by such competition, due to the size and importance of these giants in the global aviation market.

Boeing is an American aerospace corporation based in Chicago. It has two major divisions. Boeing Commercial Airplanes, with its headquarters in Renton (Washington), is the world's largest manufacturer of passenger planes. The main production plants are located in Everett, Washington (Models 747, 767, 777 and 787 Dreamliner) - 60 km north of Seattle, and in Renton (737 family) - 21 km south of Seattle. Boeing Defense, Space & Security (until 2010 known as Integrated Defense Systems), with its headquarters in Saint Louis, Missouri, is responsible for aerospace and defence products and services. Its production plants are located in: St. Louis – (F-15 and F/A-18), Philadelphia (Pennsylvania) – (CH-47, V-22), Long Beach – (C-17), Mesa (Arizona) – (AH-64). Boeing Phantom Works department focuses, in turn, on R&D. The corporation employs approximately 165,500 people and manufactures various types of aircraft and helicopters for both military and civil use. It also participates in space

research programs, producing units and components for launch vehicles, artificial satellites and spacecraft.

Airbus, with its headquarters in Amsterdam, the Netherlands, is a European manufacturer of aircraft and a subsidiary of the Airbus Group (formerly EADS). Airbus employs approximately 50,000 people in various European countries: Germany (Hamburg), France (Toulouse), Great Britain (Bristol) and Spain (Seville), and since 2009 also in China (Tianjin). The company's subsidiaries are located in the United States, Japan, China and India.

Considering the importance of the above-mentioned corporations, it is doubtful that such aircraft manufacturing giants would be able to afford losing their customers to drone manufacturers. Both Boeing and Airbus are analysing the situation on the market and areas, where manned aircraft cannot be used, but where such gaps in the market can be filled by UAV manufacturers and related companies.

Although the prospects for UAV manufacturing giants are quite optimistic, there are certain issues that remain to be resolved. First of all, what has to be introduced is new legal regulations, which will allow for air operations in all classes of airspace without any restrictions, as well as identical, transparent certification procedures. In addition, there is also the problem of convincing people to switch to travelling by UAVs.

From the economic and practical point of view, it is important to launch passenger flights by UAVs. However, currently drone flights with passengers on board are extremely rare and are carried out only for testing, demonstration or advertising purposes.

At the CES 2016 trade show in Las Vegas, Ehang 184 - a passenger, fully automatic quadrocopter was presented, which relies only on information from its sensors during the flight. Ehang co-founder boasted the aircraft can reach a maximum height of 3,500 meters, and its optimal flight speed is around 100 km/h. The price of the vehicle ranges from $200,000 to $300,000. It may seem high, but if serial production is launched, it can become much cheaper.

The drone market is developing steadily, but at the same time quite spontaneously. Although drone flights with passengers on board have already been carried out, such instances cannot be considered as regular air transport. The mentioned innovative air operations and the idea of air taxis are still at the testing stage. In order for the technology to become widespread, it is necessary to develop or adapt and implement appropriate rules and regulations in order to enable UAVs to perform air operations without restrictions.

The main difficulties related to UAV flights, apart from the economic factor, lie in the fact that there are currently no legal regulations for such flights. Most European countries

have their own regulations for UAV flights with MTOW up to 150 kg. In order to standardise the regulations for flights with the use of UAVs the weight of which exceeds 150 kg, the European Commission has appointed EASA (the European Aviation Safety Agency). The new legal regulations must, as soon as possible, allow UAVs to access all classes of airspace and cover their entire weight category.

The European Commission has announced the entry into force of the Regulation of the European Parliament and of the Council No. 2018/1139 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations of the European Parliament and of the Council (EC) No. 211/2005, (EC) No. 1008/2008, (EU) No 996/2010, (EU) No 376/2014, Directive 214/30 EU and 2014/53/EU of the European Parliament and of the Council, repealing Regulation (EC) 552/2014 of the European Parliament and of the Council 2014 and (EC) No 216/2008, and Council Regulation (EEC) No 3922/91.

This new regulatory approach is a breakthrough in the EU aviation law. Pursuant to this document, UAVs with an MTOM (maximum take-off mass, including fuel, batteries, payload, etc.) below 150 kg will no longer be subject to the regulations adopted by individual member states, but will become standardised for all EU countries. What is of great importance, the new regulation covers the entire weight category of UAVs. This will solve the problem of differences in terms of airworthiness standards or technical and operational regulations between individual EU Member States and will significantly accelerate the process of integrating manned and unmanned aviation in the common airspace.

The development and ratification of legal regulations, however, does not mean that unmanned aviation will automatically partly replace manned aviation. In order to make it possible, several requirements must be met and the entities that meet them first will be able to ensure for themselves a lion's share of the air transportation market, as well as provide other services with the use of unmanned aerial vehicles. The main factors that will have a significant impact on the popularity of UAVs include:

- Safety. The operations performed by "drone air taxis" must be carried out safely with unlimited access to all classes of airspace. Flights, take-offs and landings will have to be performed both in areas with a low population density as well as in urban agglomerations. Due to the limited range of the UAV, unlimited access to electricity or other types of fuel will have to be provided at the landing sites.
- Travel safety and comfort. Passengers on board must feel safe and travel in comfortable conditions. As Unmanned Aerial Vehicle Operators (UAVO) will be able

to control UAVs from a remote location (including on other continents), the cooperation between the UAVO and the crew on board the UAV will be of great importance.

- A clear advantage of air transport, including with the use of unmanned aerial vehicles, over other modes of transport. Air transport must be the optimal mode of transport and its advantage over land (road and rail) or water transport (sea and river) must be evident. Factors that need to be taken into account include: accessibility to remote places, travel time, fees and comfort, as well as environmental impact.
- Mobile services. It must be possible to purchase a ticket, check-in and download flight information (regarding any delays, change of terminal, gate no., baggage claim, weather conditions, current and planned seat etc.) using a mobile phone. Airlines already offer such services and they must also be implemented for UAV transportation.
- Travel efficiency. Drone passengers will expect the comfort of travel. In a possible scenario, the passengers could reach the airport using smaller drones (air taxis) and then exit onto the appropriate terminal and board a larger manned or unmanned aerial vehicle.
- The first stage of implementation. For safety reasons, the first air routes to be covered by UAVs must be planned in airspaces with little air traffic and the lowest population density. Such spaces should be determined on the basis of analyses conducted by air carriers, air traffic services, as well as civil and military aviation authorities.
- Technology. The technical equipment of UAVs must guarantee the safety of flights. Anti-collision systems should be programmed in such a way so as to give priority in the use of airspace to aircraft with passengers on board. The systems used by UAVs must be compatible with civil air traffic management systems, as well as military aviation command systems.
- Flexible and smooth takeover of manned aviation tasks. Due to modern solutions and lower operating costs compared to manned aviation, UAVs have the potential to quickly adapt to the current and changing demand for air services. At the same time, in order to ensure a high standard of services, they must be able to perform the tasks of manned aviation, as well as those that manned aviation cannot carry out due to economic and operational limitations of aircraft or crew.
- Environmental protection. The development of unmanned aerial systems cannot compromise the environment. A hybrid power solution should be implemented, where

the airframe and other aircraft parts could make use of solar energy, in order to increase flight range. The structure of UAVs should be designed in such a way so as to make them aerodynamic and allow for the use of solar energy when performing air operations.

- Security of the state and citizens. The introduction of new regulations on UAVs will allow for their use in international airspaces. On the other hand, UAVs could also be used for criminal purposes and violate the security of states, with the use of the equipment installed on board. In order to effectively counteract it, it will be necessary to strengthen the cooperation between the civil and military services responsible for the security of the airspace (Krawczyk, 2018, p. 5).
- Economic and social development. The introduction of UAVs into the common airspace must enable the development of new business models. This will allow small, medium-sized and large enterprises to create new jobs through the development of automation and digitization solutions and their implementation in people's everyday activities.
- Global economic and social development. The development of a new type of aviation - unmanned aviation - should have a positive impact on both the global economy, as well as domestic and regional economies of individual countries and their citizens. Also, the existing manufacturers of manned aircraft and air carriers should not suffer losses due to the appearance of a new participant in the aviation market. The priorities should be: economic growth, environmental protection and provision of the widest range of services, while maintaining a high level of safety.

CONCLUSIONS

The introduction of new services and modern technologies in the field of unmanned aviation will generate new jobs in the civil and state sector. Currently, a growing interest in the services provided with the use of UAVs in the civil sector is observed. The main economic areas, where UAVs are used, include transportation, construction, agriculture, forestry, stocktaking, energy sector, rescue operations, geodesy and advertising. They are also widely used for military purposes, such as conducting reconnaissance, finding ground or water targets, signal transmission and destruction of ground, water or air targets.

Due to their operational potential, UAVs are widely used in the Polish Medical Air Rescue, as well as the Search and Rescue Service, where they often support the already old manned aircraft.

In the above-mentioned areas, what is extremely important, is the ability to react fast and perform long air operations both in normal and difficult weather conditions. Compared to manned aircraft, UAVs have greater operational potential, as they are not limited by the restrictions applicable to the crew on board. However, in order to make flights with the use of UAVs possible , it is required to fully integrate manned and unmanned aviation in the common airspace with unlimited access to all classes of airspace granted to UAVs.

These changes must be accompanied by the introduction of new technologies that will convince potential users of air services to switch to unmanned air transport. However, factors such as comfort, economy, environmental protection and the smoothness of air navigation should not have priority over the safety of airspace users and the population living in the vicinity of air operations.

In the near future, UAVs are expected to become increasingly important not only in the sector of transportation, but also in other economic areas. There is no doubt that the development of unmanned aviation will drive economic and social development and will also have a positive impact on the development of science, technology and environmental protection, while ensuring safety and profitability due to the implementation of new technologies.

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