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CHALLENGES FOR INTEGRATION OF REMOTELY PILOTED AIRCRAFT SYSTEMS INTO THE EUROPEAN SKY

Summary. Remotely Piloted Aircraft Systems (RPAS) are widely used in the civil sphere. They offer capabilities predisposed them to be employed by state services in ensuring security and public order, as well as in commercial activities. It should be assumed that the number of RPAS users will grow in geometric progression. It also applies to the European Union, where the market of RPAS is considered to be one of the most prospective in the development of small and medium-sized enterprises. This situation generates specific problems that should be solved in order to develop the RPAS' market without limitations as a part of the European aviation system. The final state should be full integration of RPAS into the European aviation system, to conduct flight operations in non-segregated airspace without additional administrative constraints. Some efforts have been made to achieve this ambitious goal in the European Union. The paper summarises the current status of the legal framework and projects connected with the integration of RPAS into the European airspace. It is mainly based on qualitative analysis of source materials. The purpose of the paper is to identify key problem areas, the solution of which will contribute to the integration of RPAS into the European civil aviation system. An analysis of normative

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documents functioning in the European Union (EU) relating to RPAS has been carried out. In particular, the European Commission (EC) documents and regulations related to RPAS proposed by the European Aviation Safety Agency (EASA) have been taken into account. Three crucial areas have been identified as challenges for the integration of RPAS into the European civil aviation system. Firstly, general concepts of integration of Remotely Piloted Aircraft into the European airspace including the development of the U-space concept. Secondly, the field of legal regulations, without which the functioning of RPAS as a part of the European aviation system is impossible. In this context, it is justified to continue the implementation of the Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System proposed by the EC in 2013. Also relevant are the EASA proposals for categorising RPAS and conducting flight operations based on the risk approach which is a new solution. The discussion may be triggered due to by-pass of all regulatory competencies to EASA, without taking into account the specificity of the national systems. Thirdly, the societal field. Full integration of RPAS into the European civil aviation system requires social acceptance for air operations involving RPAS. Despite the undeniable social benefits of RPAS utilisation, in particular in ensuring security and public order, it will be necessary to address issues related to the perception of RPAS by the public, including privacy and data protection, law enforcement associated with the application of RPAS, third-party liability and insurance requirements of RPAS.

Keywords: Remotely Piloted Aircraft Systems (RPAS), U-space concept, categories of UA operations, EASA, ICAO

1. INTRODUCTION

Issues associated with the integration of Remotely Piloted Aircraft Systems (RPAS) with manned aviation in the European airspace include many significant matters. Firstly, the legal regulations enabling the formal functioning of RPAS, intended for various purposes, in the European airspace. Secondly, the general concepts and ideas regarding the integration of unmanned aviation with manned aviation. Thirdly, the social dimension connected with the future use of RPAS. Equally important are modern technologies, which enable and facilitate the future integration of unmanned aviation with manned aviation. The separated areas are complementary in regard to each other and they should be considered as a system, which will ensure the safe functioning of RPAS in the European airspace.

The foundation for discussion regarding the integration of RPAS with the manned aviation system in European airspace should be a terminology base. Many expressions occur in the media space, which described an aircraft without a pilot on board: unmanned aircraft (UA), unmanned aerial vehicle (UAV), remotely piloted aircraft (RPA), pilotless aircraft or drone. In a broader sense, the phrase “system” is added to these terms indicating that an unmanned aircraft constitutes one of many elements enabling the performance of RPAS flight. In a terminological context, it is reasonable to adopt terms developed by the International Civil Aviation Organization (ICAO) [12].

According to ICAO, the most general term is unmanned aircraft (Figure 1), which is understood as “an aircraft which is intended to operate with no pilot on board” [14]. The UA sub-category is RPA defined as “an unmanned aircraft which is piloted from a remote pilot

station” [14]. In a broader sense, the UA as well as the RPA are an element of the system allowing them to perform their flight, defined as unmanned aircraft system (UAS) – “an aircraft and its associated elements which are operated with no pilot on board” [15], and RPAS – “a remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design” [15], respectively.

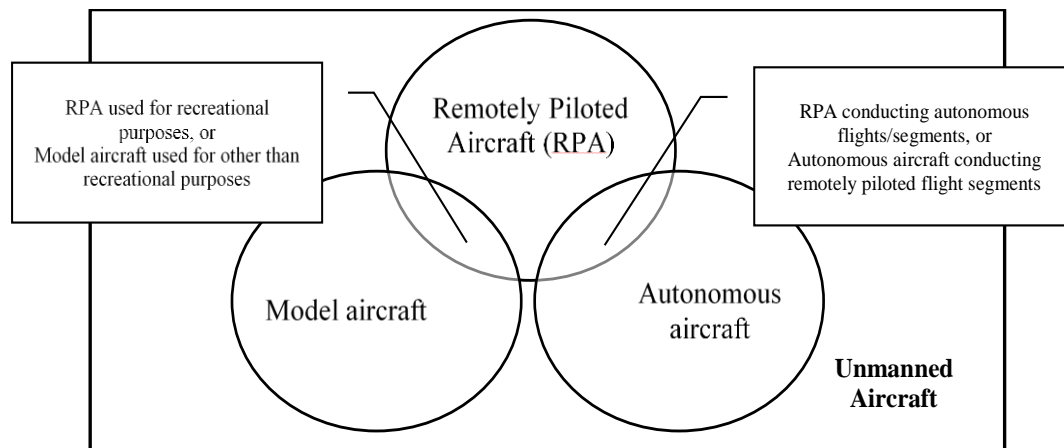


Fig. 1. Unmanned Aircraft according to ICAO rules
Source: [15]

In the context of legal provisions, within the meaning of ICAO, UA (or RPA) – it is an aircraft regardless of the fact whether it is piloted remotely, automatically or autonomously. Therefore, the provisions of article 8 of the Chicago Convention apply to it – “no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorisation by that State and in accordance with the terms of such authorisation. Each contracting State undertakes to ensure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft” [16]. The key phrases in the provisions of article 8 refer to “assuring control” and “obviating danger”. Hence, it should be assumed that the functioning of UA (RPA) in non-segregated airspace, along with the manned aviation, will be possible by meeting certain requirements resulting from the Annexes to the Chicago Convention. Moreover, only the remotely piloted aircraft will be able to be integrated into the scope of the international airspace in the near future. According to ICAO, the RPA is an aircraft piloted by a licensed “remote pilot” located in a “remote pilot station”, which is placed outside the aircraft itself (for example, on the land, ship, another aircraft, in space) that continuously monitors the aircraft in every moment of its actions. On the other hand, the remote pilot has the ability to respond to instructions issued by the Air Traffic Control (ATC) services and communicates by voice or via data link, in accordance with the given class of airspace or given actions, and it is directly responsible for the safe functioning of the aircraft during its flight. To generalise, the RPA may have different types of autopilot technology, but the remote pilot must be able to react at every moment of the flight.

The documents prepared by aviation organisations in the European Union (EU), that is, the European Aviation Safety Agency (EASA), the European Organisation for the Safety of Air Navigation (Eurocontrol), as well as documents of the European Commission, include both terms: UA (UAS) and RPA (RPAS), which are often used interchangeably, although it must be clearly emphasised that the UA (UAS) remains the dominant term. Nevertheless, it is reasonable, in the context of integration of unmanned aviation with manned aviation in

the European airspace, to use the term RPAS, which clearly indicates the need for constant control of remote control over the unmanned aircraft, which is supposed to ensure an appropriate safety level of air operations.

2. GENERAL CONCEPTS OF INTEGRATING REMOTELY PILOTED AIRCRAFT INTO THE EUROPEAN AIRSPACE

The purpose of integration of unmanned aviation (civil and military) into the European airspace is the possibility of a problem-free performance of air operations in all classes of airspace along with the manned aviation. Achieving the target state of integration, according to the assumptions included in the European ATM Master Plan: Roadmap for safe integration of drones into all classes of airspace [25], of the unmanned aviation with manned aviation will be possible through the implementation of two mutually complementary approaches (Figure 2). Firstly, the evolutionary approach associated with the adaptation and integration of large certified RPA with manned aviation. This RPA will operate in the airspace and on the airports in the same way as manned aircraft, considering the limitations resulting from the lack of a pilot on the board. It should be assumed that large RPA will perform air operations in the airspace between 500 and 60,000 ft. Therefore, they will have to be integrated with conventional air traffic with the use of Instrument Flight Rules (IFR), as well as based on the instructions included in the Standards and Recommended Practices (SARPs). It is expected that large RPA will be remotely piloted by a licensed remote pilot in accordance with the IFR's regulations and procedures in a manner similar to the Visual Flight Rules (VFR), just like the manned aviation [13].

Secondly, the innovative approach requiring the development of new services and procedures associated with the implementation of the U-space concept, ensuring access of smaller RPAs to the airspace in a large quantity, especially in urban areas. This concept will be based on a high level of automation of activities and communication systems. "U-space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to the airspace for large numbers of drones. As such, U-space is an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and all types of environment, even the most congested, while addressing an appropriate interface with manned aviation and air traffic control (ATC)" [24]. The U-space framework encompasses a wide and scalable range of services relying on agreed EU standards and disseminated by service providers. Increasingly wider scope of application of the unmanned aircraft requires their access to non-segregated airspace, particularly within the Very Low Level (VLL) operations. In this context, in a special way, the U-space concept will be addressed to urbanised areas and VLL operations, that is, below 500 ft [6]. Taking into account the need to develop new framework allowing for safe and efficient use of RPA, it will be reasonable to use the latest developments in the scope of such technology areas as artificial intelligence, Internet of Things or 5G networks, bearing in mind the requirements relating to cybersecurity, as well as security and protection of privacy of the citizens and environmental protection. The gradual distribution of U-space is linked to the growing accessibility of blocks of services and enabling technologies. It should be the evolution of automation of the RPA increases, and cutting-edge methods of interaction with the operating environment (including manned and unmanned aircraft) mainly through digital information and data exchange [18].

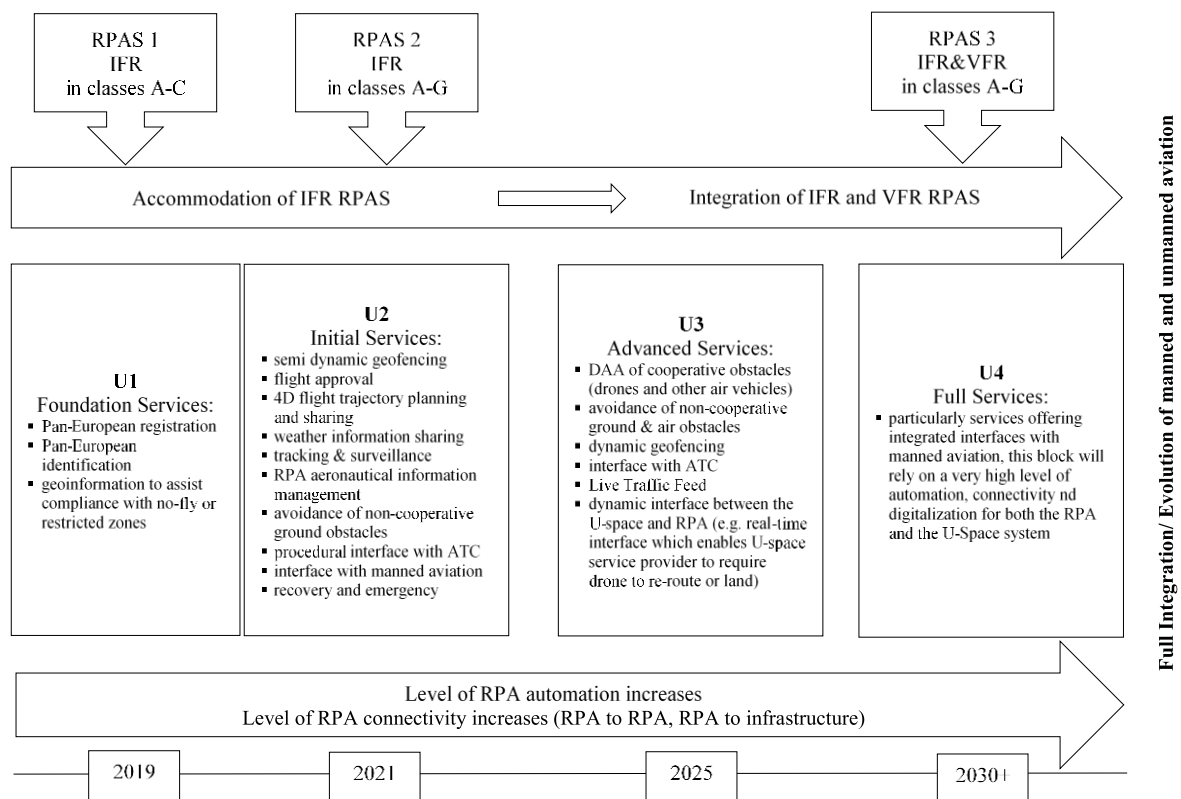


Fig. 2. Integration of unmanned and manned aviation
Source: based on [25]

The first block of services (U1) provides foundation services (e-registration, e-identification and pre-tactical geo-fencing). The main purposes of these services are to identify RPA and operators and to inform operators about known restricted areas. With the deployment of the U1 foundation services, more RPA operations are enabled, especially in areas where the density of manned traffic is very low. The administrative procedures for approval to fly and the permissions for some specific missions will be simplified. The range of Visual Line Of Sight (VLOS) routine operations will be extended and will support extended VLOS flights, including VLOS operations in an urban environment. Beyond Visual Line of Sight (BVLOS) operations will still be constrained, but they will become more and more possible [25].

The second block of services (U2) refers to an initial set of services that support the safe management of RPA operations and the first level of interface and connection with ATM/ATC and manned aviation. Where appropriate, U2 will make use of existing infrastructure from ATM, but new opportunities for RPA operations will be enabled through the exploitation of technologies from other sectors. The range of operations at low levels will be increased, including some operations in controlled airspace. RPA flights will no longer be necessarily considered on a case-by-case basis, and some examples of BVLOS operations will become routine (albeit with some constraints) [25].

The third block of services (U3) will build on the experience gained in U2 and will unlock new and enhanced applications and mission types in high density and high complexity areas. New technologies, Automated Detect and Avoid (DAA) functionalities and more reliable means of communication will enable a significant increase of operations in all environments

and will reinforce interfaces with ATM/ATC and manned aviation. This is where the most significant growth of RPA operations is expected to occur, especially in urban areas, with the initiation of new types of operations, such as air urban mobility [25].

The fourth block of services (U4) focuses on services offering integrated interfaces with ATM/ATC and manned aviation and supports the full operational capability of U-space based on a very high level of automation. It is expected that the need for new services will arise during the roll-out of U3 [25].

Integration of unmanned aviation with manned aviation is a continuous process. Along with the implementation of more and more services and operations, the RPA will be gradually integrated into all airspace classes until the achievement of full integration [1]. Through the entire duration of this process, the unmanned and manned aviation will develop by using new technologies that facilitate the integration process. In the technological context, two technologies will have crucial meaning for the development and integration of unmanned aviation into the European airspace: DAA and C2 Link and Communications [22].

3. OVERVIEW OF PROPOSED EUROPEAN LEGAL REGULATIONS IN RELATION TO REMOTELY PILOTED AIRCRAFT SYSTEMS

The European Union perceives the use of RPAS as an important element of economic development of the Member States, particularly in the sector of small and medium-sized enterprises [23]. The legal regulations existing so far required the certification of RPAS with Maximum Take-off Mass (MTOM) from 150 kg (with the exception of state aviation aircraft), which at the European level is implemented by the EASA. Legal provisions regarding smaller RPAS are designed and implemented by the national aviation authorities. Increasing access to the UA and the potential threats associated with their use prompted the need to design legal regulations at the global level (ICAO) and regional level (European Commission, EASA, Eurocontrol). As a result of the work of expert teams, the following resolution was developed at the European level: European Parliament legislative resolution of 12 June 2018 on the proposal for a regulation of the European Parliament and of the Council on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and repealing Regulation (EC) No 216/2008 of the European Parliament and of the Council (COM(2015)0613 – C8-0389/2015 – 2015/0277(COD)), which regulates the essential requirements for the UA. The proposed solutions apply to all UA regardless of the MTOM size. At the same time, the basic factor taken into account in the scope of the safety of the air operations performance is considered to be the risk, therefore the provisions should be proportional to the risk associated with a specific operation or type of operation [2]. Contents of the subject Resolution also drew attention to the need of including in the legislation, the specific conditions in a given country, associated with, for example, population density, which should be taken into account in order to ensure the flexibility of the designed regulations.

The presented Resolution establishes the essential requirements concerning: a) design, production, technical service and exploitation of the UA, b) environmental protection, c) registration of the UA, their operators and designation of the UA. In relation to section (a), the most important arrangements require the operator and the UA pilot to be familiar with the national regulations and EU regulations regarding the planning of operations, especially in relation to the security, privacy, data protection, responsibility, insurance, protection and environmental protection. This is associated with the knowledge of the manufacturer's

operating instructions, as well as safe and environmentally-friendly use of UA in the airspace, in accordance with the rules and procedures of air traffic. Moreover, the airworthiness requirements must be met and organisations participating in the design, production, technical service, operations of the UA, related services and training must meet the conditions specified in the Resolutions. On the other hand, the UA's operator is responsible for its exploitation and the flight performed by such operator must be conducted in accordance with the procedures for carrying out the duties of operators, defined for the given area, airspace, airports or places, which are planned to be used, and in relevant cases the appropriate air traffic management systems. Operations with the use of UA must be carried out in a manner ensuring the safety of third parties on the ground and other airspace users, as well as minimising the risks resulting from unfavourable external and internal conditions. The UA's operator is responsible for its necessary equipment for navigation, communication, surveillance, detection and avoidance of obstacles, as well as other equipment considered to be necessary for the safety of the intended flight, taking into account the nature of given operation, as well as regulations and rules of air traffic applicable in each phase of the flight [8].

With regard to the section (b), the emphasis is put on the need to minimise noise, various emissions and the release of liquids by the UA. Therefore, their systems and equipment required for the reasons of environmental protection must be designed, manufactured and maintained to function in accordance with their intended use in all foreseeable conditions of exploitation [10].

With reference to the section (c), the Regulations introduced a requirement for the establishment of digital harmonised and interoperable national registration systems, in which information regarding the UA and their registered operators should be stored. The national registration systems should be consistent with the EU legislation, considering the matters of security, privacy, personal data protection and environmental protection [10, 21].

In the context of legal regulations, it is reasonable to focus on EASA's proposals due to the fact that it is the main organisation presenting solutions for the integration of RPA with manned aviation in the European airspace. It is necessary to note that the EASA's proposals are the result of previous activities undertaken in the EU in relation to the use of the potential of the unmanned aircraft. A good example is a report developed in 2013 by the European RPAS Steering Group – Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System, which is an outcome of several years of consultations ordered by the European Commission. The Roadmap identifies all the issues to be addressed and establishes a step-by-step approach to address them. The complete document includes 3 annexes, entitled: A Regulatory Approach, A Strategic Research Plan, A Study on the Societal Impact [9]. However, EASA is the main actor creating new rules for the future utilisation of UAS in the European sky. The idea is to cover the regulation of all civil unmanned aircraft systems, regardless of their MTOM. Three categories of UA operations have been established as follows [3]:

- open (low risk) is a UAS operation category that, considering the risks involved, does not require prior authorisation by the competent authority before the operation takes place.
- specific (medium risk) is a UAS operation category that, considering the risks involved, requires authorisation by the competent authority before the operation takes place and takes into account the mitigation measures identified in an operational risk assessment, except for certain standard scenarios where a declaration by the operator is sufficient.
- certified (high risk) is a UAS operation category that, considering the risks involved, requires the certification of the UAS, a licensed remote pilot and an operator approved by the competent authority, in order to ensure an appropriate level of safety.

Proposals regarding the open and specific categories have been included to Opinion No 01/2018 Introduction of a regulatory framework for the operation of unmanned aircraft systems in the “open” and “specific” categories.

This Opinion addresses UAS operations in the open and specific categories only, and it introduces: an operation-centric approach (the consequences of an accident or incident with a UAS that does not carry people on board are highly dependent on the environment where the accident or incident takes place), a risk-based approach (in the open category, this is illustrated by introducing subcategories, and in the specific category, by laying down the general principle for a risk assessment to be conducted by the operator before starting an operation), and a performance-based approach (the main requirements in the draft regulation identify the requested performance, and related standards describe acceptable ways to comply with the rules).

The open category will cater for most leisure operations but also relatively simple commercial applications. As a general rule, the open category has been defined as operations conducted with a UAS with an MTOM of less than 25 kg, below a height of 120 m, and in VLOS. The conditions above already provide some initial mitigation, especially for air risks, complemented by the competency of the remote pilot. It was decided to further subdivide operations in the open category into three subcategories to allow different types of operations without the need for authorisation. The subcategories were defined according to the risks posed to people and objects on the ground, keeping in mind that the operations would all be below 120 m in height and far from aerodromes. These subcategories are: A1 – flights over people but not over open-air assemblies of people, A2 – flights close to people, while keeping a safe distance from them, A3 – flights far from people. UAS will be divided into five classes in the context of technical requirements with MTOM as a main criterion of division: from C0 to C4 [5].

The specific category is applicable to all operations that do not comply with the restrictions of the open category. The specific category is a very promising category to cater for the expected high growth of commercial UA applications due to the fact that BVLOS is certainly an important enabler and BVLOS operations will not be allowed in the open category [5]. The category is centred on the concept of operational authorisation based on a risk assessment process. In order to obtain the authorisation, the operator shall give evidence of risk mitigation factors that have been put in place to mitigate the risk of the specific operation. In order to identify the necessary mitigation factors, the operation is analysed by means of a risk assessment model that will be adopted by the EASA and developed by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS) as the JARUS SORA (Specific Operation Risk Assessment). The SORA identifies the necessary risk mitigation factors in terms of harm barriers and threat barriers necessary to reduce both the air risk class and ground risk class to a level deemed acceptable. There will be a concept of standard scenarios adapted to facilitate the task of operators and promote operations in the specific category. If the operator elects to carry out an operation already covered by one of the adopted standard scenarios, he/she will find the mitigation means to be put in place (harm barriers and threat barriers) already identified in the documentation published with that standard scenario, as well as the precise concept of operations within which the operation is permitted. There will be “low risk” and “high risk” standard scenarios addressed. The operator of the UAS is responsible for staying within the operational and technical limits defined by the standard scenario [17, 26].

For the UAS operations in the certified category, EASA will develop amendments to the existing regulations applicable to manned aviation. Peculiar elements of high-risk UAS operations are: the certification and continuing airworthiness of UAS and related products,

parts and appliances, the approval of the design, production and maintenance organisations, air operator certificates, operation of UA, and licences of personnel [19]. The certified category will host operations with higher risk, such as, large or complex UAS operating on congested populated areas, large or complex UAS operating BVLOS in high -density airspace, UAS used for transport of people, UAS used for the carriage of dangerous goods that create high risks for third parties [4].

4. SOCIETAL ISSUES OF INTEGRATION OF REMOTELY PILOTED AIRCRAFT SYSTEMS INTO THE EUROPEAN AIRSPACE

There is no doubt that the full integration of unmanned and manned aviation in the European airspace will also require taking into account the social aspects for activities undertaken by the users of RPA. In a report of 2013, entitled Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System, the authors place emphasis on three important issues. The first relates to the legal responsibility of users of the RPA for causing an accident (in the air, on the ground), enforcing responsibility and using insurance. The second issue focuses on the protection against abuses associated with the use of RPA: maintaining privacy, personal data protection and security of third parties. The third issue raises the social acceptance of the use of RPA in everyday activities, for example, benefits for the citizens or the acceptable risk of performing operations with the use of RPA [11].

It seems reasonable that issues associated with legal responsibility for causing an accident with the use of RPA should be regulated at the national level, taking into account the applicable legal acts of the global and regional (European) level. The appropriate changes to the provisions of Annex 13 to the Chicago Convention (Aircraft Accident and Incident Investigation), bearing in mind the use of RPA, have already been introduced. There is no doubt that in matters associated with the legal responsibility and insurance, with regard to the use of RPA, two situations must be distinguished, application of RPA for commercial purposes by operators and application of RPA for sports and recreational purposes. In the first case, in Europe, the users of RPA flying over the territory of one of the EU countries for commercial purposes are required to comply with the Regulation (EC) No 785/2004 on insurance requirements for air carriers and aircraft operators. Article 4 of this Regulation provides that “[...] air carriers and aircraft operators [...] shall be insured in accordance with this Regulation as regards their aviation-specific liability in respect of [...] third parties” [8]. The main purpose of this regulation is to guarantee the people injured in the accident access to adequate compensation by specifying the minimum level of insurance. Regulation (EC) No 785/2004 also defines a minimum level of insurance towards third parties for each RPA, depending on its MTOM. The minimum amount corresponds to 1 million EUR per accident. If the RPA is used for recreational and sports purposes, the user individually assesses the risk and purchases the appropriate policy. In many European countries, the possession of such insurance is obligatory [7].

Privacy and personal data protection are recognised in Europe as fundamental human rights. European legislation, as well as national legislation, protect citizens against cases of privacy violations by considering them illegal, also in the case of using RPA, regardless of the fact whether it is used for commercial, recreational or sports purposes. RPAs often carry devices that allow recording and storing of data, which is often published on social media without the consent of the data subjects. The performance of RPA flights creates a high

probability of unintentional collection and/or processing of personal data. All types of usage of RPA that entail the collection of personal data must be lawful [20]. In Europe, the collection, storage and processing of personal data is legally regulated. European Directive on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, as well as the national regulations, set out rules in the scope of the collection, storage and processing of personal data [9]. Moreover, the use of RPA with respect to the right to privacy, including ethical aspects, is guaranteed within EU in the provisions of Article 7 (Respect for private life) and Article 8 (Data protection) of the Charter of Fundamental Rights of the European Union, by the right to respect for private life of Article 8 European Convention on Human Rights, which obliged the Member States to comply with them.

The third issue is directly associated with the benefits of using the RPA for citizens, with simultaneous acceptance of the resulting risks. The capabilities of RPA technology in civil applications, both commercial and non-commercial, contribute to the stimulation of, increase in competitiveness, promotion of entrepreneurship and creation of new jobs, particularly in the sector of small and medium-sized enterprises. Despite the undisputed advantages and abilities possessed by RPA, there is a lack of knowledge in the society about their possible applications. Most often, their use is associated with support for state authorities (for example, police, fire brigade, border control, etc.) in the scope of crisis management. Therefore, there is a need to inform the societies via the media about opportunities, but also threats associated with the functioning of RPA. It should be emphasised that the full integration of unmanned and manned aviation will also enable the performance of passenger communication flights, also in the global dimension. This means that there is a need to educate the public opinion that flights without pilots on board are equally safe as in the manned aircraft [21].

Conclusively, the social dimension of integration of the unmanned and manned aviation requires closer cooperation between regulating entities and citizens of the EU Member States. New legal regulations in the scope of use of RPA in non-separated airspace should take into account the concerns and proposals of the citizens, while the legislators should be informed about the risks associated with the use of RPA in a reliable manner.

5. CONCLUSION

In the near future, the integration of unmanned aviation with manned aviation will become a fact. This will mean the possibility of performing simultaneous UA and manned aircraft operations in the common European airspace.

Activities undertaken at the European level, mainly including those related to legal regulations, seem to be correct and they are basically aimed at ensuring the safety of all airspace users, as well as on the ground, including the ensuring of privacy and personal data protection. Classification of the UAs and operations based on risk assessment, which was proposed by EASA, will allow for their extensive application in many areas, both commercial and non-commercial, contributing to the economic development of the European Union.

Ensuring the joint performance of operations of the unmanned and manned aviation in single European airspace will require the implementation of modern technologies, levelling the lack of a pilot on board of the aircraft, as well as ensuring safe control of the aircraft. Safety issues associated with the use of UA, both small and large ones, should be the main factor taken into consideration during the development of the concept of integration of the

unmanned aviation with manned aviation. At the same time, the regulations should be balanced in a manner enabling access to the UA to as many interested parties as possible.

To summarise, due to the activities undertaken in the sphere of the functioning of the unmanned aircraft, the European Union may become a global leader in the scope of use of unmanned aviation.

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