Legal perspectives on the cross- border operations of unmanned aircraft systems

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6 CONCLUSIONS AND RECOMMENDATIONS

6.1 SCOPE OF THIS CHAPTER

The final chapter focuses on how the findings of this study respond to the overall question, 'Is the actual international legal framework adequate to ensure the operation and development of UAS while preserving high levels of safety?' Specifically, this chapter provides answers to the following research questions laid down in the introductory chapter, namely:

1. Do the Chicago Convention 1944 and its SARPs apply to UAS?
2. What are the legal aspects associated with international air navigation and international air transport of UA?
3. Can the current international air transport legal regime support the cross-border operations of UAS?
4. Do the Chicago Convention 1944 and its SARPs require updating to incorporate UAS within the international civil aviation system?

Finally, the author will analyse whether the findings may contribute to the development and evolution of air law, and will propose recommendations for future research on this topic.

6.2 GENERAL CONCLUSIONS

Civil aviation is experiencing a significant change because of the incursion of UAS. The international air transport of passengers, cargo and mail using UA is no longer science fiction. We are at a crucial moment in history in which technological advances are creating disruptions in almost all areas of people's activities, and aviation is not an exception. As per the findings laid down in Chapter One of this research, UAS promise to change the face of civil aviation dramatically, enabling new markets and potentially spurring economic growth and job creation worldwide. It is expected that UAS operations will increase exponentially once they integrate completely with international civil aviation.

Until the 21st century, UAS operated outside of the civil aviation system, mainly as State aircraft. That is no longer the case. We are now seeing new UAS engaging in a myriad of civil functions, while innovation continues to evolve at a fast pace, and more people allow their imaginations to bring new ideas and applications into practice.

It is also unquestionable that the progress of civil aviation depends, to a large extent, on the development of technological innovations that make air transport safer, more efficient and more economically sound. Creating regulations for new technologies is, therefore, a challenging task because regulations need to address not only the technological leaps but also the impact on society at the time they occur, and innovation has been demonstrated to be faster than bureaucracy.

Even though unmanned aviation is a growing industry that renders a range of capabilities and sophistication with ample operational opportunities and economic potential, it is a challenging new frontier for civil aviation that also carries great promise. According to industry reports presented in Chapter One of this research, the UAS market will grow from US $11.45 billion in 2016 to US $51.85 billion by 2025. As an outcome of this fast-developing market, about ten percent of global civil aviation operations will be unmanned in just ten years. This remarkable expansion will be made possible by the active participation of all industry players, including software developers, component suppliers and companies involved in data, communications and onboard systems. Nevertheless, it is difficult to project precisely the full economic impact of UAS on civil aviation until a harmonised international regulatory framework is in place, as uniform rules will facilitate the routine international operations of civil UAS.

The increasing operations of UAS have raised safety and security concerns on manned aviation as confirmed by the incidents that occurred in the UK, USA and UAE in 2018 and 2019, analysed in Chapter Five. Hence, there is an escalating need to adopt a comprehensive regulatory framework for the operation of UAS aimed at facilitating its safe and efficient integration.

The applications of UAS are limitless. They go from recreational flight to cargo delivery. The unmanned aviation market is selling UAS with varying characteristics and features to many, if not the vast majority, of individuals uninformed on how to fly them safely. This scenario signifies a potential threat to manned aircraft, particularly when UAS operations take place close to airports or over populated areas.

ICAO is working to facilitate the cross-border operations of UAS while ensuring they do not represent a hazard to civil aviation users and operators. Once SARPs for UAS are complete, UA will be able to engage in international air transport in synchrony with manned aircraft, using the same airspace, procedures and separation standards, operating from airports and interacting as manned aircraft do with ATC and other pilots safely and seamlessly. This work entails adopting hundreds of new SARPs in the Annexes to the Chicago Convention 1944, in addition to the thousands that have already been adopted.

The new SARPs for UAS will also bring new responsibilities for States. Qualified licensing and certification authority personnel of the CAA will be essential. The more sophisticated UAS shall have the capacity to fly following the rules of the air under IFR, and shall hold all the certifications and licences to be able to operate as safely as manned civil aircraft.

Because the normative regime governing international civil aviation was conceived and built primarily to facilitate the international air navigation of manned aircraft, civil UAS encounter regulatory gaps that prevent them from safely participating in civil aviation.

The purpose of this research is to study the legal and regulatory challenges that civil UAS currently confront when used in cross-border operations. The author has analysed the following issues:

- The legal regimes of the airspace;
- The notion of aircraft;
- The concept of international air navigation concerning international air transport; and
- The regulatory regime of safety.

All of these subjects aim to identify and analyse their applications to the cross-border operations of UAS. In this endeavour, the author has also resorted to the rules of treaty interpretation laid down in the VCLT, to give legal coherence and pragmatism in interpreting and applying international aviation rules to UAS.

While completing this research, the use of civil UA continued to increase. This situation confirmed the need to study further its legal implications from the perspective of air law and, perhaps most importantly, confirmed the lack of sufficient regulations to make UA international operation safe.

The most basic aspect, essential to highlight first to answer the central question of this research, is that UA falls within the definition of aircraft because UA relies on its wings for the lift.[1] Moreover, as concluded by ICAO, all UA, whether remotely piloted, fully autonomous or a combination thereof, are subject to Article 8 on pilotless aircraft of the Chicago Convention 1944.

The principles of air law laid down in the Chicago Convention 1944 apply to the cross-border operations of UAS, namely:

- The principle of State sovereignty in national airspace in conjunction with Article 8 of the Chicago Convention 1944: Because the mentioned convention recognises that every State has complete and exclusive

1 *Aircraft*. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

sovereignty over the airspace above its territory,[2] any UA shall obtain prior authorisation to fly over the airspace or land in the territory of another State.[3]
- Freedom of flight above the high seas: UA are also free to fly over the airspace above the high seas; and,
- Nationality of aircraft: Because UAs have the nationality of the State of registry, such State is responsible for the safe operation of UA.

Article 3 of the Chicago Convention 1944 distinguishes between civil and State aircraft, the latter being excluded from the governance of the Chicago Convention 1944.[4] The function in which the UA engages determines its condition of civil or State aircraft, regardless of its manned or unmanned characteristics.

When the UA engages in civil functions, the international legal regimes of airspace and aircraft laid down in Articles 1, 2, 3, 3*bis* and 4 of the Chicago Convention 1944 apply to the cross-border operations of UAS. UAS shall, therefore, comply not only with those provisions but also with the subsequent ones that govern the flight of aircraft over the territory of contracting States.

Under Article 8 of the Chicago Convention 1944, States must ensure that UA flying in regions open to the air navigation of civil aircraft shall be controlled in a manner as to obviate danger for other aircraft. Because pilotless aircraft can engage in myriad purposes, Article 8 neither affects nor prohibits UA from engaging in civil functions because the provision relates to the type of aircraft (that is, unmanned aircraft) rather than the type of use, which when flying in airspace open to civil aircraft shall take measures to make the flight safe.

Different regulatory regimes, including but not limited to public air law conventions, such as the Chicago Convention 1944 and its Annexes, criminal air law conventions and bilateral and multilateral Air Services Agreements govern international aviation. These treaties and agreements also interact with each other. Hence, when a UA engages in international air transport, the UA must follow the applicable regimes regulating the use of airspace, aircraft and international air navigation and safety laid down in these legal documents.

Finally, because the unmanned industry continues to grow, so will the numbers of aircraft operating simultaneously. This scenario is a tremendous challenge for States, ICAO and airspace planners, which will require inno-

2 See Article 1 Sovereignty of the Chicago Convention 1944.
3 See Article 8 Pilotless aircraft of the Chicago Convention 1944.
4 See Article 3 Civil and State aircraft of the Chicago Convention 1944.

vative approaches to the management of air traffic, safety and security of UAS.

6.3 WHAT ARE THE LEGAL ASPECTS OF THE INTERNATIONAL AIR NAVIGATION AND INTERNATIONAL AIR TRANSPORT OF UA, AND CAN THE CURRENT AIR TRANSPORT LEGAL REGIME SUPPORT THE CROSS-BORDER OPERATION OF UAS?

The regulatory framework of international civil aviation would be meaningless without man first being able to discover how to defy gravity and that machines heavier than air can sustain themselves safely. Accordingly, the rules governing flight first have the purpose of promoting safety, and second, support the economics resulting from the commercial and market interactions provoked by the use of aircraft. Insatiable human curiosity subsequently made UAS possible, while UA integration into civil aviation challenges the current regulatory framework that mainly governs the operation of aircraft that have pilots on board.

Both *international air navigation* and *international air transport* are terms that refer to the cross-border operation of aircraft, but each has different legal connotations. That is, as per the finding in Chapters Three and Four of this research, the cross-border operations of UAS deal with rules for the international air navigation of UA and the international air transport by UA.

The author of this research has analysed the main provisions of the Chicago Convention 1944 that apply to the cross-border operations of UAS when engaged in civil functions and has interpreted them following international rules on the interpretation of treaty provisions. He has done the same with other international treaties, such as the *International Air Services Transit Agreement*, the *International Air Transport Agreement* and the rules generally contained in the Bilateral/Multilateral ASAs, which govern only international air transport.

The findings for international air navigation and international air transport by UA are the following:

- The Chicago Convention 1944 and its Annexes provide the regulatory framework for the international air navigation of UA, whereas the rules for the international air transport are also subject to Chapter Two on *Flight over Territory of Contracting States* of the Chicago Convention 1944 and bilateral and multilateral agreements between States.
- The international air navigation of UA pertains to the technical and safety aspects of the flight and shall follow the SARPs adopted from time to time by ICAO's Council.
- For a UA to engage in the operation of international services, its operators shall follow Articles 5, 6, 7 and 8 of the Chicago Convention 1944,

the provisions of the *International Air Services Transit Agreement* and ASAs.

- The term *prior authorisation* is a common element in Articles 5, 6, 7 and 8 of the Chicago Convention 1944 since they pertain to flights over foreign airspaces, but this term is expressed and fine-tuned in each of the referred Articles, causing different legal implications in law and practice.
- The term 'authorisation' used in Articles 5, 6 and 7 refers mainly to economic features of an air service, with the exception of Article 5, which also addresses safety-related aspects when an aircraft flies to inaccessible regions or without air navigation facilities, whereas the special authorisation in Article 8 is of a technical nature, aimed at addressing aspects like characteristics of the aircraft, equipment on board, communications, ATC, operations speeds, remote pilot licences and certificates of airworthiness, to name a few. Section 3.1 of Appendix 4 of Annex 2 on Rules of the Air of the Chicago Convention 1944 governs the content of the authorisation found in Article 8, which may also be in the form of agreements between the States involved.
- Article 5 lays out operational rights for non-scheduled flights, though restricted by regulations, conditions or limitations as the underlying State may deem appropriate.
- Article 6 prohibits scheduled international flights over the territory of a State, except with the special permission of that State and under the terms of such authorisation. UA willing to engage in scheduled international air services will always require prior special permission' to fly to another country and per the mandate of Article 6 of the Chicago Convention 1944, but also because Article 8 demands it. The authorisation of Article 6 may take the form of ASAs, whereas the prior authorisation of Article 8 may take the form of a 'Request for Authorisation Form'. Nevertheless, nothing impedes that States may agree mutually on simpler procedures through bilateral or multilateral agreements or arrangements for UAS operations. In other words, for States to grant or exchange the authorisation for scheduled international flights for UA, they shall invoke not only Article 8 but also the traffic rights exchange through the ASAs.
- Likewise, a foreign UA with intentions to conduct cabotage operations in another State will require both the prior permission of Article 7 and that stipulated in Article 8. The authorisation of Article 7 addresses economic aspects of cabotage and may be granted, provided that such State may not seek or agree to give authorisation on an exclusive basis.
- Because Article 8 is *lex specialis*, it prevails over Articles 5, 6 and 7. For instance, UA engaged in non-scheduled air transport shall have the privilege of taking on or discharging passengers, cargo or mail, subject to the right of any State where such embarkation or discharge takes place, to impose such regulations, conditions or limitations as it may consider desirable. States, therefore, may regulate international non-

scheduled flights unilaterally and a UA shall follow the rules of the State of destination. However, the author considers that because Article 8, being *lex specialis*, prevails over Article 5, a UA will always require special permission to fly or land over the airspace of another State but, at the same time, it shall be able, *mutatis mutandis*, to comply with the other elements of Article 5 for non-scheduled flights.

- It is not strange that the cross-border operations of UAS always requires prior authorisation for all types of flights because this prior authorisation has also always been present for the operations of manned aircraft since the adoption of the Chicago Convention 1944. In other words, the authorisation requirements in Articles 5, 6 and 7 always apply to manned aircraft.

Another important element for the international air transport of passengers, cargo or mail, is the exchange of traffic rights accorded between States under ASAs which also apply, *mutatis mutandis*, to the cross-border operations of UAS.

Subject to several proposed changes designed to adapt the special nature of UA to the operation of international air services and the applicability of global safety and security rules, the author considers that current ASAs' provisions can apply to undertakings operating UA engaged in international air transportation. Thus, States may need to redefine specific Articles, namely:

- Instead of *airlines*, the author used the term *undertakings operating UA* to avoid that only airlines operate UA. The definitions in ASAs, licensing conditions and Freedoms of the Air must be adapted to accommodate this expression.
- The provision on definitions as UAS is a new entrant to civil aviation and soon, once all SARPs are adopted, UAS will be capable of performing international air transport services routinely;
- The provision on *designation and authorisation* as a third State may have jurisdiction over the UAS on safety and security-related aspects, among others and therefore such State must be part of the chain process of international air transportation. Moreover, the new ASA shall materialise the special authorisation described in Article 8 of the Chicago Convention 1944, which is technical;
- The provision on *the application of laws*, as the remote pilot station of the UA, could be in different States and therefore be subject to multiple jurisdictions;
- The provision on *recognition of certificates* in the sense of facilitating the recognition of licences of remote pilots in a third State; and
- The provisions on safety and security associated with the particular nature and risk of UAS activities and guided by the SARPs adopted by ICAO.

Finally, the economic regulations for international air transport using manned aviation is the benchmark for the future development of economic regulations for international air transport operated by UA. Regulations for fair competition between manned and unmanned aviation will also be needed, as both will have to compete in a market that has been developed mainly for manned aviation.

6.4 DO THE CHICAGO CONVENTION 1944 AND ITS ANNEXES APPLY TO UAS?

Under the Chicago Convention 1944, any aircraft that flies without a pilot on board is a UA. Those UA that will engage in international air transport shall operate following the rules of the air under IFR, and will require the same certificates, licences and equipment as manned civil aircraft. Because UA are aircraft, when engaged in civil functions, the Chicago Convention 1944 applies. However, the emergence of UAS as an innovative technology has outpaced the ability of ICAO's Council and other ICAO bodies to produce a complete set of SARPs that address risk-related aspects to make the operations of UAS safe. For instance, as per the findings laid down in Chapter Five of this research, recently adopted SARPs do not regulate certification, registration, safety and security management, airworthiness, flight planning, use of aerodromes and handovers, among others. Because of the current lack of a complete set of SARPs, a UAS operator based in one State might find it challenging to obtain approval to engage in international air transport in another State.

According to Article 12 of the Chicago Convention 1944, States will have to make their regulations on UAS uniform with the international ones as ICAO adopts them. The already-achieved high levels of safety and security for the whole civil aviation system shall not decrease when integrating UAS.

UAS also pose new types of safety and other risks to manned aircraft, aerodromes and populations on the ground, which UAS must overcome first. Safety and security concerns, such as the possibility of collision with manned aircraft, the use of unapproved communications spectrum, the misuse of UAS and the potential for unlawful interference are all of great concern at national and international levels.

There are also aspects that ICAO and its member States shall address, such as the functional interoperability with traditional ATC, airspace design and rules of the air, and the location and types of operations relevant to UTM. For instance, the emergence of a new range of aviation operations conducted in low-level airspaces by small UAS, such as urban or suburban environments, is creating new challenges to civil aviation. The airspace segment from ground-level to upwards of 1,000 feet is already a crucial

operating environment for many low-flying helicopters and other manned aircraft. These are critical components that any effective UTM system shall take into account. The UTM concept, which ICAO is now developing, attempts to tackle this challenge. UTM, therefore, shall have the capacity to support high-density aircraft operations and a myriad of manned and UA and flight operations simultaneously. As unnamed aviation continues its integration into international civil and UTM operations continue to evolve, multiple challenges will still need to be identified and addressed.

Finally, as the number of incidents involving UAS increase and threats grow more complex, a range of countermeasures are necessary to mitigate risk and preserve public trust in the operations of UAS. New SARPs and PANS to prevent incidents involving UAS must, therefore, be pragmatic, realistic and effective. Security measures must be risk-based and produce specific results.

6.5 DO THE CHICAGO CONVENTION 1944 AND ITS SARPS REQUIRE MODERNISATION FOR INCORPORATING UAS TO THE INTERNATIONAL CIVIL AVIATION SYSTEM?

6.5.1 APPLICABILITY OF SARPS

Unmanned aviation tests the current legal and regulatory regimes of international civil aviation, as the absence of a pilot on board, or no pilot at all, defy the applications of the provisions of the Chicago Convention1944 and its SARPs designed explicitly for manned aircraft and the 'see and avoid' technology to obviate danger to civil aircraft.

Besides the Rules of the Air of Annex 2 to the Chicago Convention 1944, there are other rules and obligations that, under the Chicago Convention 1944 and its SARPs, UAS shall follow when engaged in cross-border operations, such as minimum safe distances, heights or cruising levels, particularly over cities, aerodromes or persons. This situation creates safety concerns because of the lack of a complete set of SARPs specifically applicable to UAS.

The Rules of the Air of Annex 2 also mandate that aircraft engaged in international air navigation shall fly under either VFR or IFR which, among other specifications, require separations standards. Because current SARPs do not address these scenarios specifically for UAS, it is difficult or perhaps impossible for UAS to comply with rules that do not yet exist. It is most likely that ICAO's Council will adopt new SARPs for UAS once the technology is reliable and safe enough to use UAS in civil functions.

ICAO's goal to ensure adequate global alignment of UAS regulations has

already produced the amendments in the following Annexes to the Chicago Convention 1944:

- Annex 1 on Personnel Licensing;
- Annex 2 on the Rules of the Air;
- Annex 7 on Aircraft Nationality and Registration Marks; and,
- Annex 13 on Aircraft Accident and Incident Investigation.

These already amended Annexes are not enough to address all the aspects that UAS require to operate safely. Thus, the complete integration of UAS into international civil aviation will definitively cause the development of more specific SARPs for UAS in order to supplement the existing ones.

There are also concerns about UAS operations over the high seas, increasingly carried out in activities such as oil platforms, fisheries resource monitoring, search and rescue and surveillance operations. Questions remain unanswered by the current SARPs, such as how can non-certified UAS comply with the Chicago Convention 1944? Will they require possessing and carrying a certificate of airworthiness? Will they purposefully avoid the water surface or human-made structures?

Again, considering the difficulty for UAS to comply with the current regulatory framework of international civil aviation, the question arises of the best method to resolve these issues. To achieve the routine safe cross-border operations of UAS, all nineteen Annexes to the Chicago Convention 1944 will necessitate amendments to incorporate new SARPs. The new SARPs shall aim not only at facilitating UAS integration but also at securing the continued safety of international air navigation.

SARPs, procedures, policies and infrastructures of the current international civil aviation system will give rise to adjustments that will support the full spectrum of new capabilities and features of UAS within the international civil aviation system without compromising aviation safety.

ICAO and its contracting States must continue working together on the framework of the RPASP[5] and Unmanned Aircraft Systems Advisory Group (UAS-AG)[6] to secure and craft a regulatory framework flexible enough to keep pace with UAS technological developments, support their safe and

5 The Remotely Piloted Aircraft Systems Panel (RPASP) coordinates and develops ICAO Standards and Recommended Practices (SARPs), Procedures and Guidance material for remotely piloted aircraft systems (RPAS), to facilitate a safe, secure and efficient integration of remotely piloted aircraft (RPA) into non-segregated airspace and aerodromes.

6 The Unmanned Aircraft Systems Advisory Group (UAS-AG), established in 2015 to support the Secretariat in developing guidance material and expedite the development of provisions to be used by States to regulate unmanned aircraft systems (UAS), with its industry and international partners, as well as the Member States, has been instrumental in providing support to the global aviation safety collaboration.

efficient integration into the international civil aviation system and focus on better-defined issues, whether technical, operational or legal. This approach may maximise the socio-economic benefits of unmanned aviation while addressing the legal, safety and sustainability concerns. Also, because UAS technology is in continuous development, States and regional aviation organisations must cooperate permanently to achieve the highest uniformity of regulations and procedures aimed at facilitating and improving the cross-border operations of UAS.

6.5.2 MANAGEMENT OF UAS BY ARTIFICIAL INTELLIGENCE

As for the Chicago Convention 1944, the author puts forward that its provisions are robust enough to support the current challenges that remotely piloted UAS require to integrate with international civil aviation. ICAO shall focus, therefore, on adopting new SARPs rather than amending the Convention. This does not mean, however, that there is no space for improvements. As UAS technology evolves, new challenges arise that will require action, particularly when autonomous aircraft UAS, with no pilot intervention at all but only controlled by artificial intelligence (AI), are developed enough to dabble in international civil aviation.

The incursion of AI requires attention not only by the aviation industry but also by States. By 2050, AI will be present in almost all daily activities, and it is likely that autonomous aircraft will be sufficiently developed to carry out routine flight operations. Accordingly, the incursion of autonomous aircraft with AI raises not only legal but also ethical questions, which will require rethinking the Chicago Convention 1944 to address the challenges they may present. For instance, can autonomous aircraft engage safely in international air navigation following the rules laid down in the Chicago Convention 1944 and its Annexes? Do the foundations of the current civil aviation regime on safety apply to the operation of autonomous aircraft to guarantee they do not represent a hazard to other airspace users? How can the current legal and regulatory regimes apply to a device that has AI but no artificial consciousness at all? Perhaps the answers require not only legal but also ethical analysis.

Under ICAO 's views, Article 8 of the Chicago Convention 1944 governs the three types of UA: RPA, fully autonomous aircraft and a combination thereof. A fully autonomous aircraft does not require pilot intervention. Because of their transversal application, the provisions laid down in the Chicago Convention 1944 dealing with the principles of air law addressed in Articles 1 to 4 and the access to international airspace in Articles 5 to 8 also apply to autonomous aircraft. Nevertheless, the following provisions may not apply as they relate to the role of persons such as pilots and crews who manipulate the flight controls of an aircraft during flight or whose duties are essential to the operation of an aircraft:

Article 12 Rules of the air
"…each contracting State undertakes to insure the prosecution of all persons violating the regulations applicable."

According to this provision, a State may prosecute all persons violating the Rules of the Air. However, as AI is not a person but a set of algorithms that make AI work and make decisions while airborne, they are not subject to prosecution if it violates the Rules of the Air. It is, therefore, necessary to adopt a set of rules that address the consequences in which the AI controlling the autonomous aircraft violates the rules of the air.

6.5.3 REQUIREMENTS FOR ADMISSION TO FOREIGN AIRSPACE

Article 13 of the Chicago Convention 1944 regulates entry and clearance conditions for access by aircraft to foreign airspace. It reads as follows:

"The laws and regulations of a contracting State as to the admission to or departure from its territory of passengers, crew or cargo of aircraft, such as regulations relating to entry, clearance, immigration, passports, customs, and quarantine shall be complied with by or on behalf of such passengers, crew or cargo upon entrance into or departure from, or while within the territory of that State."

As an autonomous aircraft does not have a flight crew but a set of algorithms that controls the aircraft, Article 13 does not apply to this type of UA. Nevertheless, it can be redefined to address the autonomous aircraft clearance when entering or departing from the territory of a contracting State.

Article 29 Documents carried in aircraft

"Every aircraft of a contracting State, engaged in international navigation, shall carry the following documents in conformity with the conditions prescribed in this Convention:
a. Its certificate of registration;
b. Its certificate of airworthiness;
c. The appropriate licences for each member of the crew;
d. Its journey logbook;
e. If it is equipped with radio apparatus, the aircraft radio station licence;
f. If it carries passengers, a list of their names and places of embarkation and destination;
g. If it carries cargo, a manifest and detailed declarations of the cargo."

An autonomous aircraft may carry the electronic versions of all documents listed in Article 29, but does not carry licences for each member of the crew, as it does not have a flight crew. Perhaps, an amendment that also incorporates a certification or licence of the AI system that operates the autonomous aircraft may complement this obligation.

Article 32 Licences of personnel

"a. The pilot of every aircraft and the other members of the operating crew of every aircraft engaged in international navigation shall be provided with certificates of competency and licences issued or rendered valid by the State in which the aircraft is registered.
b. Each contracting State reserves the right to refuse to recognise, for the purpose of flight above its own territory, certificates of competency and licences granted to any of its nationals by another contracting State."

This provision does not address the scenario of autonomous aircraft. Neither the issuing State nor the overflown State may recognise licences for AI that control an autonomous aircraft when engaged in international air navigation. Perhaps, the solution is to certify the system, software and hardware of the AI that enables the flight control of autonomous aircraft.

Article 34: Journey logbook

"There shall be maintained in respect of every aircraft engaged in international navigation a journey logbook in which shall be entered particulars of the aircraft, its crew and of each journey, in such form as may be prescribed from time to time pursuant to this Convention."

An amendment to this provision should mandate that the journey logbook may be electronic to register all the details of the operation of autonomous aircraft when engaged in international air navigation.

The provisions and situations analysed above are minor challenges in the prospective operations of autonomous aircraft in international airspace. How to ensure the safe operations of autonomous aircraft should be the essence and scope of a new set of rules under the Chicago Convention 1944 and its Annexes. ICAO is studying this subject and will make proposals for such new rules.

6.5.4 CAN ROBOTS PILOT AIRCRAFT?

Because pilots, whether on board or remotely, have consciousness, they can follow the Rules of Air of Annex 2 of the Chicago Convention 1944 and make decisions aimed at not endangering persons or property. However, it is more challenging for autonomous aircraft because how may a non-human entity take decisions aimed at ensuring the safety of persons or guarantee AI will not be a threat to persons and property? Perhaps the rules of robotics of the science fiction author Isaac Asimov may guide what the algorithms of the AI that operate the autonomous aircraft shall contain to address this situation:

a) A robot may not injure a human being or, through inaction, allow a human being to come to harm;
b) A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law; and,
c) A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.[7]

Isaac Asimov also added a fourth law in a later novel to lead the others:

d) A robot may not harm humanity or, by inaction, allow humanity to come to harm.

How can these norms apply to the operation of autonomous aircraft? Article 8 of the Chicago Convention 1944 might meet Asimov's first law of robotics:

> Article 8: Pilotless aircraft
> "...Each contracting State undertakes to insure 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."

Undoubtedly, because the essence of this second portion of Article 8 is to secure safety in the operation of pilotless aircraft, it shall not fly in such proximity to other aircraft as to create a hazard that could lead to the injury of persons.

If the AI of an autonomous aircraft follows the orders of authorised personnel, such as operators, UTM, ATS and possibly the network manager, it may satisfy the obligations under the second law of robotics.

Asimov's third law of robotics refers to a situation in which the AI should avoid any danger threatening the existence of the autonomous aircraft itself. Nevertheless, a controlled crash of an autonomous aircraft could be acceptable if it is essential to minimise or eliminate a threat to persons and property.

The principle that 'a threat to aviation safety is a threat to life' and 'to protect aviation safety is to protect the right to life' [8] is consistent with Asimov's last law of robotics. The assurance of the safety of humans shall be at all cost the obligation of any AI that operates an autonomous aircraft. This view may also imply that an autonomous aircraft should not fly in a

7 Paul P. Tottenham, *"What Are Isaac Asimov's Three Laws of Robotics? Are They Purely Fictitious or Is There Scientific Credence to Them?"* The Guardian (Guardian News and Media), accessed May 28, 2019, https://www.theguardian.com/notesandqueries/query/0,5753,-21259,00.html.

8 Jiefang Huang. General Conclusions. In *Aviation Safety and ICAO* (Alphen aan den Rijn: Kluwer Law International, 2009, 241.

way that decreases the current global performance on safety achieved by manned aviation.

Also, the following additional rules of robotics may apply, *mutatis mutandis*, to the operations of autonomous aircraft, in which case the word 'robot' may be substituted with the words 'autonomous aircraft':

(a) A robot must establish its identity as a robot in all cases;[9]
(b) A robot must know it is a robot;[10]
(c) A robot will obey the orders of authorised personnel;[11] and,
(d) A robot must refrain from damaging human homes or tools, including other robots.[12]

There are also real case initiatives aimed at creating rules that govern the functioning of robots. For instance, the most relevant initiative on robotics is the 'Robot Ethics Charter' from South Korea, which describes the rights and responsibilities for robots, based on Asimov's laws but also the rights and responsibilities of manufacturers, users and owners.[13] In April 2007, Japan published recommendations to 'secure the safe performance of the next generation of robots'.[14] Moreover, the European Robotics Research Network (EURON) has proposed the initiative, *European Union's Convention on Roboethics 2025,*[15] aimed at establishing standards committees to determine the technical and legal standards for commercial robots. If adopted, the Convention will mandate all European Union member States to incorporate the following standards:

1. *Safety:* Design of all robots must include provisions for control of the robot's autonomy. Operators should be able to limit a robot's autonomy in scenarios where the robot's behaviour cannot be guaranteed.
2. *Security:* Design of all robots must include, as a minimum standard, the hardware and software keys to avoid illegal use of the robot.
3. *Traceability:* Design of all robots must include provisions for the complete traceability of the robots' actions, as in an aircraft's black-box system.

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9 L. Dilov, L. *Icarus's Way,* 1974.

10 N. Kesarovski. *The Fifth Law of Robotics,* 1983.

11 David Langford, *"Three Laws of Robotics (Applications to future technology)"*, accessed May 29, 2019, https://www.cs.mcgill.ca/~rwest/wikispeedia/wpcd/wp/t/Three_Laws_of_Robotics.htm

12 'Japan's *"Ten Principles of Robot Law,"* Enlightenment of an Anchorwoman, September 29, 2010, https://akikok012um1.wordpress.com/japans-ten-principles-of-robot-law/

13 *"South Korean Robot Ethics Charter 2012,"* Enlightenment of an Anchorwoman, October 3, 2010, https://akikok012um1.wordpress.com/south-korean-robot-ethics-charter-2012/

14 *"Japan Drafting New Advanced Robotics Rules, Asimov's Laws of Robotics Becoming a Reality?"* Gearfuse, April 7, 2007, https://www.gearfuse.com/japan-drafting-new-advanced-robotics-rules-asimovs-laws-of-robotics-becoming-a-reality/

15 *"European Union's Convention on Roboethics 2025,"* Enlightenment of an Anchorwoman, September 29, 2010, https://akikok012um1.wordpress.com/european-union's-convention-on-roboethics-2025/.

4. *Identifiability:* All robots must be designed with protected serial and identification numbers.
5. *Privacy:* Design of all robots potentially dealing with sensitive personal information must be equipped with hardware and software systems to encrypt and store this private data securely.

In the context of civil aviation and based on Asimov's law of robotics, Thomas Dubot has proposed a set of rules and rights for the operation of autonomous aircraft, namely:[16]

1. An autonomous aircraft must not operate in such a way that it could injure a human being or let a human being be injured without activating controls or functions identified to avoid or attenuate this incident;
2. An autonomous aircraft should always maintain continuous communication with pre-defined interfaces to obey orders of authorised personnel (UAS operator, ATS or Network Manager) except if such actions conflict with the first law;
3. An autonomous aircraft must operate in such a way that it could protect its own existence and any other human property, on the ground or in the air, including other UAS, except if such operations conflict with the first or second law;
4. An autonomous aircraft must always have a predictable behaviour based on its route but also alternative pre-programmed scenarios, except if all forecast options conflict with the first, second or third law;
5. An autonomous aircraft shall interact with surrounding traffic (separation, communication) according to the requirements of the operating airspace, general priority rules and emergency and interception procedures except if such actions conflict with the first, second or third law;
6. An autonomous aircraft must always know it is a pilotless aircraft identity and shall show it honestly when requested or when deemed necessary;
7. As any airspace user, an autonomous aircraft should not operate to decrease the global performance of current civil aviation systems in terms of safety, security, environment, cost-effectiveness, capacity and quality of service (efficiency, flexibility and predictability) except if the first, second or third law requires such operation; and,
8. An autonomous aircraft must ensure complete traceability of all its actions.

In addition to these rules and due to the current state of development of technology, the author proposes an additional rule for the operation of autonomous aircraft:

16 "Integrating Civil Unmanned Aircraft Operating Autonomously ...," accessed May 29, 2019, http://ceur-ws.org/Vol-885/paper2.pdf

9. An autonomous aircraft must report potential cyberattacks to its system and take counter-actions to mitigate such threats, except if such actions conflict with the first or second law.

Any autonomous aircraft manufacturer should, therefore, establish the necessary algorithms in the AI system that allows these aircraft to comply with the rules proposed above.

6.5.5 REMAINING QUESTIONS AND CONCLUDING OBSERVATIONS

A question that remains open is, who will be liable for the breach of these rules? Should the system manufacturer take responsibility or the person who created the algorithms? Is the world on the verge where the creation of artificial consciousness becomes necessary to facilitate the incursion of autonomous aircraft into international civil aviation? The answers to these questions require further research, analysis and debate.

Although the above rules have no legal value, they can serve as a reference to introduce a discussion on the rules that should be adopted in the framework of international civil aviation for the operation of autonomous aircraft in the interest of safety. There is still a long way to go; however, given the rapid pace at which info-technology advances, especially AI, these debates should begin as soon as possible.

Finally, in the same way as the development of AI challenges the current fundamental ethical values and the legal framework of international civil aviation, a future study on autonomous aircraft could consider new approaches for the interaction of autonomous aircraft with manned aircraft. Further research in the field may lead to introducing new concepts of operations, the refinement of current rules and establishing a new set of algorithms for the AI that operate the autonomous aircraft, aimed at securing a safer civil aviation system for all airspace users.

6.6 RECOMMENDATIONS

Given how dynamic moreover, innovative UAS activities have become and the likelihood that their applications will only increase as they become more common, it is essential for ICAO, member States and industry stakeholders to build closer relationships with a shared vision of the future of civil aviation aimed at enabling, but not impeding, UAS innovations. They must find a way for unmanned and manned aviation to coexist in shared airspaces and fully understand this relationship to secure the development of a cohesive regulatory framework serving both unmanned and unmanned aviation. This implies the need to identify and agree on the following:

1. *A shared vision of future operations*
A shared vision includes not only a safe and orderly growth of manned and unmanned international civil aviation throughout the world but also a vision that implies triggering and stimulating civil UAS operations in every possible way while satisfying the growing demands of the users and industry.

2. *Regulatory, oversight and enforcement challenges faced by States and operators*
When a UA engages in international air navigation, the absence of a pilot on board the aircraft challenges the ability to see and avoid traffic or hazardous situations: for instance, potential collisions with other airspace users or obstacles and adverse weather conditions.[17]

To make the operation of UAS safe, a set of rules identified in Chapter Five of this research include the following:
- SMS rules specific for UAS;
- Security Management Systems rules specific for UAS;
- Rules on DAA and separation assurance technology to enable the safe international air navigation of UA;
- UTM rules on UA flight operation levels;
- UTM rules for flight separation between manned aircraft and UA;
- Rules for the interactions in the traffic management for UA between both UTM and ATM;
- Rules on access to the cockpit/compartment of the remote pilot stations;
- Rules on the access of pilots and technical personnel to the locations of remote pilot stations and related infrastructure;
- Rules to prevent hacking, spoofing or other forms of interference of the C2 link;
- Rules on human factors specific to the operation and nature of UAS;
- Rules for the flight planning particular to UAS;
- Rules for the use of aerodromes by UAS along with manned aircraft;
- Rules for safe handover process of UAS airborne;
- Rules for the simultaneous operations of UA; and
- Procedures for UAS in emergencies.

Because remote pilots cannot see and avoid in a way similar to pilots on board an aircraft, eventually the UAS will need to carry equipment capable of detecting and avoiding other aircraft and threats while the UA is airborne. As the UA may have one or several remote pilot stations located across different States, the safety management and safety oversight of the remote pilot station and the remote pilots flying the UA will challenge both the operator and its regulator. Defining the legal aspects of jurisdic-

17 *"Remotely Piloted Aircraft System (RPAS) Concept of Operations (CONOPS) for International IFR Operations,"* accessed February 9, 2019, https://www.icao.int/safety/ua/documents/rpas conops.pdf

tion and enforcement are also new topics that will require deliberation and agreement between States if the goal is to achieve robust, efficient and safe unmanned aviation.[18]

3. *Airspace and aerodrome integration issues*
States shall agree on whether it is appropriate to establish aerodromes that would be open only to the cross-border operations of UAS, rather than combined aerodromes for both manned aircraft and UA operations. Also, UAS must meet the requirements of the airspace in which they intend to fly, which include the ability to operate BVLOS under IFR. The development of separate and specialised procedures at aerodromes will require agreement between the aerodrome operator and the CAA having jurisdiction over the aerodrome. Moreover, UA should be able to manoeuvre on the ground and the air safely and shall conform not only SARPs but also PANS specific for UAS. This situation also includes the capability of detecting and responding to visual signs and markings.

4. *Future constraints pertaining to the Chicago Convention 1944 and its Annexes*
The findings of this research reveal that the constraints for the cross-border operations of UAS, under the Chicago Convention 1944, are mainly regulatory rather than legal. States and ICAO are currently focusing their efforts on adopting new SARPs specific to UAS. As noted above, the author believes that the Chicago Convention 1944 provides, for now, the necessary legal framework to facilitate integration with international civil aviation of UAS controlled by remote pilots, but its Annexes do require amendments to incorporate new specific SARPs to make their operations safe. Nevertheless, the incursion of autonomous aircraft, a type of UA, will require not only rethinking SARPs but also the Chicago Convention 1944 to tackle the challenges of non-human intervention in the flight. Concerning the access of UA to international airspace, States must agree whether it is convenient to establish expeditious mechanisms through bilateral/multilateral arrangements, for the granting of the authorisation referred to in Article 8 on pilotless aircraft of the Chicago Convention 1944. Likewise, States should determine whether the current ASAs render the essential norms aimed at promoting and facilitating the exchange of traffic rights for the international air transport of passengers, cargo or mail using UA.

The safe integration of UAS will require innovative and holistic thinking to understand better where new regulations could support the safety, security and international harmonisation of unmanned aviation operations.

Manned aviation has a more significant human element included in its

18 *"Remotely Piloted Aircraft System (RPAS) Concept of Operations (CONOPS) for International IFR Operations,"* accessed February 9, 2019, https://www.icao.int/safety/ua/documents/rpas conops.pdf

processes than unmanned aviation does, which also has more automated management techniques; some of which will use AI and other advanced capabilities. Machine learning and robotics will change almost every line of work we know. Forecasting the change and its imminence is difficult. One scenario is that within a decade or two, billions of people will become economically redundant. Another scenario is that, even in the long run, automation will keep generating new jobs and greater prosperity to all.

Presently, pilots need recurrent training to be up to date with international civil aviation regulations. For instance, in a scenario where two manned aircraft approach on the same flight level or to an airport at the same time, the pilots and ATC may miscommunicate their intentions, and the aircraft may collide. This scenario has happened in the past in manned aviation.[19] However, since autonomous aircraft may all be connected, when two such aircraft approach to the same injunction, they may not be two separate entities because they will be part of a single algorithm and network. The chances that they miscommunicate will be, therefore, far smaller. Moreover, if ICAO or the national CAA change their policies and regulations, all autonomous aircraft can be updated at the same moment and they will able to follow the new regulations immediately.

Despite the great promises that AI may bring, the aviation accidents of Ethiopian Airlines[20] and Lion Air,[21] which killed hundreds of people involving the aircraft 737 Max 8, have put to the test whether greater freedom in applying AI to air transport operations makes air transport safer. In both cases, preliminary reports suggest that computers intervened in controlling the aircraft, overriding the capacity of pilots to react. Are we perhaps in a scenario where aviation has become more reliant on computerised systems, causing the pilots to diminish their skills to fly the planes themselves and decrease their capacity to respond when things go wrong? Alternatively, are we in a scenario where AI has sufficient freedom to make decisions on life and death and many other complicated ones?

Nonetheless, first things first. States, ICAO and the unmanned aviation industry, such as UAS manufacturers, UAS software and hardware manufacturers, UAS operators and UAS service providers, to name a few, should focus on resolving the current technological and regulatory challenges to complete UAS integration into international civil aviation. The accumulated

19 '*Brazil Upholds U.S. Pilots' Convictions in 2006 Air Disaster.*" Reuters. Thomson Reuters, October 16, 2012. https://www.reuters.com/article/uk-brazil-crash-retrial/brazil-upholds-u-s-pilots-convictions-in-2006-air-disaster-idUSLNE89F01420121016.

20 On 10 March 2019, the Boeing 737 MAX 8 aircraft which operated the flight crashed near the town of Bishoftu six minutes after takeoff, killing all 157 people aboard.

21 On 29 October 2018, the Boeing 737 MAX 8 operating the route crashed into the Java Sea 12 minutes after takeoff, killing all 189 passengers and crew.

experience in this process will allow new technological developments, such as enabling autonomous aircraft to follow a path of integration similar to that of the RPAS, ensuring that autonomous aircraft do not increase the risk to the safety of the people infrastructure. Using autonomous aircraft shall, therefore, fit within the purpose of the Chicago Convention 1944 which is that international civil aviation may be developed in a safe and orderly manner, and that international air transport services may be established based on equality of opportunity and operated soundly and economically[22] while encouraging and supporting the arts of aircraft design and operation for peaceful purposes.[23]

To prevent ICAO to slow down the development of SARPs in a moment where the industry requires timely regulations to expedite the take-off of UAS cross-border operations, financial, technical and personnel assistance from States and industry are essential.

States should invite stakeholders in the aviation industry to gather and examine their available data, which will encourage the creation and adoption of new SARPs consistent with State and aviation industry requirements. They should also share the technical information on UAS operations with ICAO to help in the evolution of new provisions on ASAs and PANS for UAS. States and ICAO shall focus their work in integrating rather than accommodating UAS to the civil aviation system.[24]

The challenge that international aviation faces is that it is almost impossible to forecast all misuses and threats that could involve UA. Thus, the enacting of regulations on this subject can be a complex task. Nevertheless, the following actions may contribute to prevent or mitigate the misuse of UAS:

- All contracting States need to ensure that UAS are not employed for any purpose inconsistent with the Chicago Convention 1944 and therefore, they must amend or embrace in their national legislations rules aimed at holding accountable and castigating those that misuse UAS, including those responsible for authoring these acts or for assisting or protecting the offenders. In this effort, the States may establish partnerships aimed at assisting each other in investigating, apprehending and prosecuting the offenders.

22 See the Preamble of the Chicago Convention 1944.

23 See Article 44 b) Objectives of the Chicago Convention 1944.

24 Accommodation describes the condition when an UAS can operate in airspace using some level of adaptation or support that compensates for its inability to comply within existing operational constructs. Integration refers to a future when UA may be expected to enter the airspace system routinely, without requiring special procedures from air traffic control. Integration will require advances in UAS technology and the development and implementation of harmonized SARPs and PANS. See Thirteenth Air Navigation Conference – icao.int. https://www.icao.int/Meetings/anconf13/Documents/WP/wp_006_en.pdf

- Contracting States may agree on special funding to support ICAO's task, specifically for unmanned aviation security, and encourage ICAO's Council to prioritise the development of SARPs concerning UAS security. The contracting States must undertake adequate security actions within their territories to prevent and eliminate terrorist attacks involving UAS.

- The role of ICAO's Council in adopting SARPs on security for UAS is not sufficient. An audit programme to ensure the implementation of SARPs will be essential.

- ICAO's Assembly, Council and Secretary-General must address the potential misuse of UAS as a new threat to civil aviation and should assess and determine the applicability of existing aviation security treaties to UAS. Also, it is necessary to revise ICAO's aviation security programme, including Annex 17 on Security to the Chicago Convention 1944 and to consider any other action necessary to mitigate or avoid potential misuse of UAS.

Everything is perfectible and, therefore, there is room to make improvements, which have been addressed in this research and that allow the UAS integration into the airspace and fly together with manned aircraft. However, it is crucial to include aviation stakeholders, whether familiar or not with UA operations, when developing the UAS regulations because their early involvement will ensure that the new SARPs appropriately address the needs of these groups. ICAO and its member States have the tools to continue developing safe and practical foundations for the cross-border operations of UAS regulations and to help CAA understand the safety oversight responsibilities that will apply. These tools include the institutional framework of ICAO, such as the powers and duties of the Assembly,[25] the mandatory and permissive functions of the Council[26] and the duties of the ANC.[27] Because contracting States are sovereign, they possess full control over affairs within their territories and may adopt laws on the operation of UAS.[28]

In the area of safety and security, and also the protection of the environment, the most crucial tool, under the Chicago Convention 1944, to facilitate the cross-border operations of UAS is the standard-setting. Article 54 subparagraph (l) vests ICAO's Council with competence to adopt SARPs; to designate them, for convenience, as Annexes to the Chicago Convention

25 See Article 49, *Powers and Duties of the Assembly of the Chicago Convention 1944.*
26 See Article 54, *Mandatory functions of the Council* and Article 55 on Permissive functions of the Council of the Chicago Convention 1944.
27 See Article 57, *Duties of the Commission of the Chicago Convention 1944.*
28 See Article 1, *Sovereignty of the Chicago Convention 1944.*

1944; and to notify, in each such case, all contracting States of the action taken.[29] Article 54 (m) empowers ICAO's Council to consider recommendations of the ANC for amendment of the Annexes and to take action following Chapter XX of the Chicago Convention 1944.

Even though the Chicago Convention 1944 does not explicitly mention any competence of ICAO for the development and adoption of treaties in air law, it has been a long-standing practice of ICAO to be actively involved in preparing air law instruments. Assembly Resolution A1-46 created the ICAO Legal Committee as a permanent body, which gives legal advice to ICAO's bodies and the development of air law.[30]

This perspective also seeks to adopt specific provisions for the international air transport performed by UA, suggested in Chapter Four of this research. Industry and operators must identify how they can work with governments to ensure and meet their needs and expectations to the fullest extent possible. As proven in the past, international aviation can achieve the best possible results when working together, and UAS shall not be the exception to this rule in which bold thinking will be necessary. In this endeavour, it is unavoidable not to ignore the existing aviation regulatory framework, given its proven model safety record for manned cross-border operations.

6.7 FINAL REMARKS

The potential for the routine cross-border operations of UAS is significant. Nevertheless, it is not an easy task because it requires collective efforts to ensure that unmanned aviation yields its full benefits. Notwithstanding ICAO's leadership role in assuring the safe, secure and orderly development of unmanned aviation globally, it should not withstand this burden alone. Contributions to speed and enrich the process shall also come from States, specialised agencies, academia, air lawyers, operators, manufacturers, pilot representatives and civil society in general.

Air law has developed and grown along with the aviation industry and, over the years, it has kept pace with the evolution of aviation technology. Undoubtedly, air law will continue to evolve further as technological innovations emerge. The author hopes to contribute to the legal thinking and continuing progress of air law through the findings laid down in this

29 Article 54 l) should be read in conjunction with Articles 37 Adoption of international standards and procedures and 38 Departures from international standards and procedures of the Chicago Convention 1944.

30 See *'Legal Committee-Constitution-Procedure for Approval of Draft Conventions-Rules of Procedure.* Doc 7669 5th ed. 1998.

research, which has attempted to address not only the legal aspects of the cross-border operations of UAS but also its safety and security challenges.

The topics analysed herein do not exhaust all aspects for the safe and routine cross-border operations of UAS. Since UAS is an activity in which the regulatory development is at an early stage, there is still room for more debate and legal reflections. Therefore, the future of this fascinating and promising new field in civil aviation relies upon continuous analysis and in-depth research, which will play a significant role in defining the course of the unmanned aviation industry.

The policy and rule-making process for UAS operations have been gradual and is expected to be a long-term activity. Efforts to produce regulations and harmonise the aviation legal regimes for the civil uses of UAS are moving forward but remain at an early stage. More work is still to be done. These aspects justify more in-depth research in the field of air law, in areas such as UAS financing, civil liability for damage caused by civil UAS undertakings under international air law, economic regulations for international air transport using UA, aviation insurance for UAS and the incursion of autonomous aircraft with AI in civil uses, among others.

Similar to manned civil aircraft, international air transport using UA will be a reality not only through adopting new SARPs but also by improving the current bilateral/multilateral ASAs between States, for which it is necessary to establish benchmarks and criteria to address the economic and legal aspects of such operations. Without a doubt, aviation has entered a new era. An innovative and flexible approach is fundamental, meaning that there is a need to think outside the box while considering safety as a priority to facilitate the development and expansion of UAS operations.

In closing, it is likely that in the coming years, when all the safety and regulatory challenges of UAS have been overcome, unmanned aviation operations will be as normal as the manned aviation ones. However, the world is in a moment of extraordinary technological disruptions where AI is surpassing humans in cognitive capabilities. This scenario raises new questions, not only in the legal field but also in the philosophical field.

Are we, therefore, on the verge of a terrifying disruption because AI will be a real player in the aviation industry? Can autonomous aircraft provide better and safer air transport services than UAS controlled by remote pilots and, in particular, reduce the mortality in aviation accidents? Are the Chicago Convention 1944 and ASAs ready for automation? Are the current legal and regulatory regimes ready to address scenarios where AI replace human pilots completely? How can AI contribute to the development of international civil aviation? Will human-AI cooperation character-

ise the scenario of civil aviation in the next years rather than competition? Seeking answers to these questions may lead to future research on the topic.

Without a doubt, the challenge is much greater than that of integrating UAS into international civil aviation. The answers to these questions will require creative thinking based on the impact of the info-technology disruptions to society, and whether it will be a catalyst to make international air transport services more economically sound and efficient but, most importantly, if UAS can make international civil aviation safer.