

Drone Regulation and Technology under Aviation Law



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Abstract:

This article offers an in-depth examination of drone regulation in the context of aviation law, addressing important topics like the development of drone technology, safety concerns, and regulatory responses. It explores crucial aspects of drone laws, such as pilot qualification, registration, and operational restrictions. The ramifications for privacy and security are discussed, highlighting the need for a rational balance between personal freedom and security precautions. The paper emphasizes how important it is for States to work together to address the global aspect of drone activities. It also highlights issues and trends for the future, such as integrating cutting-edge technologies like artificial intelligence and urban air mobility. In order to fully utilize drone technology while preserving societal interests, the article underscores the dynamic interaction between innovation and the need to address safety, privacy, and security concerns. It also advocates a cooperative approach among governments, aviation authorities, and industry stakeholders.

Key Words: Drone, Aircraft, Aviation law, Technology, Legal implications.

تنظيم الطائرات بدون طيار والتكنولوجيا بموجب قانون الطيران

ملخص: تقدم هذه المقالة فحصاً متعمقاً لتنظيم الطائرات بدون طيار في سياق قانون الطيران، وتتناول موضوعات مهمة مثل تطوير تكنولوجيا الطائرات بدون طيار، ومخاوف السلامة، والاستجابات التنظيمية. وتستكشف جوانب مهمة من قوانين الطائرات بدون طيار، مثل تأهيل الطيارين والتسجيل والقيود التشغيلية تمت مناقشة التداعيات على الخصوصية والأمن، مع تسليط الضوء على الحاجة إلى توازن عقلاني بين الحريات الشخصية والاحتياجات الأمنية. تؤكد المقالة على مدى أهمية أن تعمل الدول معاً لمعالجة الجانب العالمي لأنشطة الطائرات بدون طيار. كما تسلط الضوء على القضايا والاتجاهات المستقبلية، مثل دمج التقنيات المتطورة مثل الذكاء الاصطناعي والتنقل الجوي في المناطق الحضرية. ومن أجل الاستفادة الكاملة من تكنولوجيا الطائرات بدون طيار مع الحفاظ على المصالح المجتمعية، تؤكد المقالة على التفاعل الديناميكي بين الابتكار والحاجة إلى معالجة المخاوف المتعلقة بالسلامة والخصوصية والأمن. كما تدعو إلى اتباع نهج تعاوني بين الحكومات وسلطات الطيران وأصحاب المصلحة في الصناعة.

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الكلمات المفتاحية: الطائرات بدون طيار، الطائرات، قانون الطيران، التكنولوجيا، الآثار القانونية.

Réglementation et technologie des drones dans le cadre du droit de l'aviation

Résumé: Cet article propose un examen approfondi de la réglementation des drones dans le contexte du droit de l'aviation, abordant des sujets importants tels que le développement de la technologie des drones, les problèmes de sécurité et les réponses réglementaires. Il explore des aspects importants des lois relatives aux drones, tels que la qualification des pilotes, l'enregistrement et les restrictions opérationnelles. Les conséquences sur la vie privée et la sécurité sont également discutées, soulignant la nécessité d'un équilibre judicieux entre les libertés personnelles et les précautions de sécurité. Cet article souligne à quel point il est important que les nations travaillent ensemble pour aborder l'aspect mondial des activités des drones. Il met aussi en évidence les enjeux et tendances d'avenir comme l'intégration de technologies de pointe telles que l'intelligence artificielle et la mobilité aérienne urbaine. Afin d'utiliser pleinement la technologie des drones tout en préservant les intérêts sociétaux, cet article met en évidence l'interaction dynamique entre l'innovation et la nécessité de répondre aux problèmes de sûreté, de confidentialité et de sécurité. Il préconise également une approche coopérative entre les gouvernements, les autorités aéronautiques et les parties prenantes de l'industrie.

Mots Clés : Drone, Aéronef, Droit de l'aviation, Technologie, Implications juridiques.

Introduction:

The regulation of drones falls under the purview of aviation law, a complex and evolving legal framework that regulates all aspects of aviation activities. At the time when unmanned aerial vehicles, or drones, are becoming more popular, the complex relationship between technical advancement and the regulatory framework of aviation laws is crucial.¹ The main objective of the regulatory framework is the protection of third parties, both on the surface and in the air. Drone regulation and technology governed under aviation law encompass a wide range of legal and technical considerations, including licensing requirements, operational limitations, airspace restrictions, and privacy protections. Regulators worldwide are tasked with striking a delicate balance between promoting innovation and ensuring public safety while also addressing the diverse needs and concerns of stakeholders across various sectors. This Article examines the intersection of drone technology and aviation law, exploring the evolution of drone regulations, the technological advancements driving innovation in the drone industry, and the legal framework governing drone operations. By delving into the complexities of drone regulation and technology in the context of aviation law, we aim to provide insight into the status quo, emerging trends, and future challenges facing the regulation of drones in the airspace.

THE FIRST TOPIC:

Definition of Aircraft and Drones

The definition of the drone needs clarification because it is crucially important to know whether it is or is not an aircraft. If it is an aircraft, and operates between States (international flight), it means that the Chicago Convention (1944)² and its 19 Annexes apply. If it is not an aircraft, the national law is applicable. This distinction determines the legal status of the drone as well as its registration, administration and operational aspects. Many of us think that drones are a special category as this technology is based on human intervention remotely from the drone (controlled from the surface or from the air), not on board the vehicle.

¹SCHNITKER, R. and HET, K.D.V., "Drone Law and Policy: Integration into the Legal Order of Civil Aviation". Eleven International Publishing. The Hague, 2021, p. 131.

²Chicago Convention on International Civil Aviation (1944). 9th ed., 2006.; ICAO Doc 7300.

First requirement: Definition of Aircraft and Drones Terminology

The aircraft has an international definition rendered by the International Civil Aviation Organization (ICAO) under Annex 7 to the Chicago Convention on Aircraft Nationality and Registration Marks, whereas drones are not defined therein. Although drones belong to pilotless aircraft, which is defined in the Chicago Convention (1944), in modern terminology, they are mentioned as Unmanned Aerial Vehicle (UAV) or Remotely Piloted Aircraft Systems (RPAS); nevertheless, the definition remains on a national level. In the context of the article, the international approach is important as it determines the legal status of the drones.

First section: Aircraft definition according to ICAO

Firstly, we must define aircraft because drones qualify as aircraft in civil aviation terminology. According to ICAO, an aircraft can be defined as “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”. “This definition does not describe the term unmanned, while it does not exclude an unmanned version either”.³

In other words, an aircraft is “any machine supported for flight in the air by the lift or by the dynamic action of air on its surfaces, especially powered airplanes, gliders, and helicopters”.⁴ Furthermore, an aircraft can be a vehicle that is designed for air travel and is capable of flying within the Earth's atmosphere. Aircraft can be classified in several ways, including by category, class, and type:

- 1. Category:** This represents the most general categorization of aircraft, considering their intended purpose and the environment in which they operate. Examples include:
 - 1.1 Airplane:** A heavier-than-air aircraft powered by an engine with fixed wings, which realises flight by interacting with the air through its wings.
 - 1.2 Glider:** These are crafted to soar without an engine, depending on natural air currents, which generate lift.
 - 1.3 Rotorcraft:** These employ spinning blades to create lift; examples include helicopters or gyroplanes.

³*Id.*, p. 33.

⁴Aircraft Definition & Usage Examples. at<www.dictionary.com/browse/aircraft>.

1.4 Lighter-Than-Air: These can hover and remain airborne by utilizing gas lighter than air, which is enclosed within, like airships or balloons.

1.5 Powered Lift: An aircraft in this classification, like the Bell Boeing V-22 Osprey, can perform vertical take-off, landing, and low-speed flight.

1.6 Powered Parachute: A powered parachute is an aircraft with an engine consisting of a flexible wing attached to a fuselage. The wing is not positioned for flight before the aircraft is in motion.

2. Class: This represents a more detailed subdivision within a category, determined by design and performance features, such as whether it is a single-engine or multi-engine aircraft.

3. Type: This pertains to a distinct brand and model of aircraft, like the Boeing 737 or Airbus A320. It is applicable for piloting an aircraft weighing over 12,500 pounds or a jet; pilots require a “type rating” irrespective of its weight.⁵

In broader terms, there are two primary classifications for aircraft:

- **Aerostats:** being significantly lighter than airplanes, rely on lift-like ships to hover through the air.
- **Aerodynes:** are heavier than air and derive their lift from motion.⁶

There are various aircraft types, including airplanes, helicopters, gliders and drones, each with different designs and mechanisms for realising flight. Aircraft can be used for purposes such as transportation of people and goods, military operations, reconnaissance, research, and recreational activities.

Second section: Definition of Drones according to National Law

Drones are modern and widespread systems operated by the technology in the aviation industry. According to the Federal Aviation Administration (FAA),⁷ an aircraft is “any contrivance invented, used or designed to navigate or fly in the air.” As a drone is created, employed, and constructed for aerial navigation, it satisfies the FAA's criteria for being classified as an aircraft. An “unmanned aircraft” refers to a category of aircraft that functions without a human pilot on board; these aircraft are

⁵ Pilot Institute, “The Difference Between Category, Class, and Type of Aircraft”, at <<https://pilotinstitute.com/category-class-and-type-of-aircraft>> accessed 7 November 2024.

⁶What is Aircraft. Classification of Aircrafts. at <<https://mechanicaljungle.com/types-of-aircrafts>>.

⁷Federal Aviation Administration (FAA) in the United States, responsible for implementing aviation regulations, views drones as aircraft and labels them Unmanned Aircraft Systems (UAS).

commonly known as Unmanned Aerial Vehicles (UAVs) or drones.⁸ The drone is defined by the Cambridge Dictionary as “an aircraft that does not have a pilot but is controlled by someone on the surface”.⁹ Instead of being directly controlled by a person in the aircraft, unmanned aircraft are typically remotely controlled or operate autonomously based on pre-programmed instructions.

The technical term of the drone is: “a specific type of unmanned robot, namely, unmanned aerial vehicles (UAV). When armed, drones are also referred to as “unmanned combat aerial vehicles” (UCAV)”.¹⁰

Regarding the definitions mentioned above, we can summarize that a drone (UAV) is an aircraft pursuant to the definition of Annex 7 on Aircraft Nationality and Registration Marks.¹¹ It must be highlighted that all aircraft can be unmanned (as it is technically practicable).

Second requirement : Definition of State and Civil Aircraft

As it is defined in the first requirement drones are aircraft. The status of aircraft is important as this determines the legal status of the flying equipment. The other very important aspect – after the definition of aircraft – is to clearly make distinction between State and civil aircraft. The treaty-makers of the Chicago Convention regulated that the “Convention shall be applicable only to civil aircraft, and shall not be applicable to State aircraft”.¹² Therefore, the clear distinction between civil and State aircraft has significance. This means that the civil aircraft (e.g., airplanes, helicopters, drones, etc.) operate internationally under the Chicago Convention while State aircraft operate internationally under national laws (internal rules). Both operations on the domestic level (within the national airspaces) are under national laws. Another main aspect of the distinction is the difference proceeding from legal and administrative requirements, which manifests itself in different licensing and operational procedures.

⁸ CIOBANU, Elizabeth, “Is a Drone Always Considered an Aircraft?”. 16 July 2021. at <www.droneblog.com/drone-considered-aircraft>.

⁹ Cambridge Dictionary (2019). at <<https://dictionary.cambridge.org/dictionary/english/drone>>.

¹⁰ MELZER, Niles, “Human rights implication of the use of drones and unmanned robots warfare. European Parliament”. Policy Department, 2013, p. 6. at <[www.europarl.europa.eu/thinktank/en/document/EXPO-DROI_ET\(2013\)410220](http://www.europarl.europa.eu/thinktank/en/document/EXPO-DROI_ET(2013)410220)>.

¹¹ ICAO Annex 7 on Aircraft Nationality and Registration Marks. 6th ed., July 2012.

¹² Chicago Convention on International Civil Aviation (1944). 9th ed., 2006, Article 3.

First section: Definition of State Aircraft

The Chicago Convention enumerates the examples of what qualifies as State aircraft during attendance to the functions of the State executive power(*acta iure imperii*): “Aircraft used in military, customs and police services shall be deemed to be State aircraft”.¹³ With regard to the fact that this enumeration is not exhaustive, the category of State aircraft also encompasses aircraft engaged in search and rescue operations, humanitarian aid shipment, attendance to the national aerial survey-cartographic tasks and special tasks (e.g., shipping prisoners, refugees, etc.).

Second section: Definition of Civil Aircraft

Despite the importance of the distinction, the concept of civil aircraft is not defined distinctly under the Chicago Convention. Therefore, the exact activities of the flight need to be taken into account. It seems what is State aircraft is not a civil one, as State aircraft is defined, other activities are supposed to be civil ones. But this is not valid in each case. The reason is that State aircraft can be engaged in a civil mission, which determines the flight and the aircraft itself as civil, and vice-versa: a civil airline’s airplane can be engaged in a mission which is under the supervision of the State, and in this mission the aircraft is deemed to be a State aircraft.

In conclusion, all aircraft (including drones) must be considered based on their function. Several aspects need to be examined: what is the objective of the flight; what kind of crew (civilian or military) carries out the flight operation; based on what flight plan and licences the flight is carried out by the crew and what is transported by the aircraft?

THE SECOND TOPIC: Historical Evolution of Drones

Significant technological advancements and a shift from military-focused applications to a broader range of uses have marked the historical evolution of drones. This evolution demonstrates that technical development was permanent and outstanding, while the regulatory context was lagging behind and not uniform. The

¹³Chicago Convention on International Civil Aviation (1944). 9th ed., 2006, Article 3 b).

following brief overview illustrates the key stages in the historical evolution of drones from technological, commercial, and regulatory viewpoints.

First requirement: Evolution of Drones

The evolution of drones reflects progress from early experimental concepts to their widespread application across the military, commercial, and civilian sectors, driven by advancements in technology and expanding applications. It must be noted here that the Chicago Convention of 1944 regulated pilotless aircraft precisely 80 years ago as the treaty-makers realized the potential and importance of this technology.

First section: Historical Periods

1. **Conceptualization and Early Ideas** (Early 20th Century): The idea of unmanned aerial vehicles (UAVs) started to take shape in the early 20th century. Nikola Tesla introduced the concept of a "teleautomaton" in 1898,¹⁴ envisioning a remotely controlled flying machine.
2. **World War II – Target Drones** (1930s – 1940s): Various countries developed target drones for military training during World War II. These early UAVs were used as flying targets for anti-aircraft gunnery practice.
3. **Post-World-War-II Reconnaissance Drones** (1950s – 1970s): The post-World-War-II era saw the development of reconnaissance drones, such as the Ryan Firebee Series¹⁵. These UAVs were used for surveillance purposes, especially during the Vietnam War.
4. **Emergence of Cruise Missiles**¹⁶ (1970s – 1980s): The development of cruise missiles influenced the evolution of UAVs. Cruise missiles share similarities with drones in terms of remote control and autonomous navigation.
5. **Predator and Global Hawk**¹⁷ (1990s): The 1990s was marked by a significant turning point with the advent of the General Atomics MQ-1 Predator. This drone was a pioneer in armed reconnaissance and paved the way for the use of armed

¹⁴THOMPSON, K. M., "I, Robot: Nikola Tesla's Telautomaton". UCLA, 2015. p. 2., ProQuest ID: Thompson_ucla_0031D_13965. Merritt ID: ark:/13030/m5mw5c45. at <<https://escholarship.org/uc/item/4xr9r7rm>> accessed 7 November 2024.

¹⁵FIREBEE, Ryan – Wikipedia. at <https://en.wikipedia.org/wiki/Ryan_Firebee>.

¹⁶TIRU, Wilson, "The Evolution of Drones and Cruise Missiles: A Tale of Innovation". 24 November 2023. at <www.procurabl.com/blogs/the-evolution-of-drones-and-cruise-missiles%3A-a-tale-of-innovation>. accessed 7 November 2024.

¹⁷<https://en.wikipedia.org/wiki/General_Atomics_MQ-1_Predator>.

drones. The Northrop Grumman RQ-4 Global Hawk, introduced simultaneously, exemplified the extended duration of UAVs for surveillance at high altitudes.

6. **Commercial and Civilian Applications** (2000s): In the early 2000s, there was a shift towards developing drones for commercial and civilian purposes. Small consumer drones became popular for recreational use, aerial photography, and various industries, such as agriculture.
7. **Technological Advancements** (2010s – present): Rapid advancements in technology, including improvements in miniaturization, sensor capabilities and battery life have contributed to the development of highly sophisticated and versatile drones. This has expanded their applications in fields like search and rescue, environmental monitoring and infrastructure inspection.
8. **Integration of AI and Autonomy** (2010s – present): Integrating artificial intelligence (AI) and autonomous technologies has played a crucial role in enhancing drone capabilities. Drones are now capable of autonomous flight, obstacle avoidance and advanced mission planning.
9. **Regulatory Challenges and Global Integration** (2010s – present): The growing use of drones has led to regulatory challenges related to safety, privacy and airspace management. Governments worldwide are working to establish regulations to ensure responsible drone use.¹⁸

Second section: Latest Challenges

As introduced in the evolution of drones, the technology has become increasingly widespread and sophisticated. These unmanned aerial vehicles (UAVs), in need of aerodynamic forces for their flight, utilisable once or several times, have reached the level of development where they can carry out certain tasks more efficiently and safely than traditional airplanes. Aerial robots with remote control, programmed self-control or combined control have been transplanted from military application into civil use in manifold ways. Currently, they already control motorway traffic and monitor water levels and borders, but they also provide help in plant conservation and archaeological research. As a result of the spectacular spread of UAVs, detailed international and national regulation has become inevitable.¹⁹

¹⁸GROSS, Richard J., “Complete Evolution & History of Drones: From 1800s to 2024”. 11 May 2023. at <<https://www.propelrc.com/history-of-drones>> accessed 7 November 2024.

¹⁹ Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft. C/2019/3824, OJ L 152, 11.6.2019, pp. 45–71.

Second requirement: Development of Technology and Aviation Law

The requirement is to analyse the relationship between technology and law. In the second stage, the technological impact and the lack of legislation, regulations and procedures must be considered. The achievements of the legislator (on the national level) and also of the treaty-makers (on the international level) need to be analysed. The establishment of the regulatory framework was usually delayed. Technological innovation always precedes the lawmaker, but this is not always negative, as in these cases, when the lawmaker has time to gain a better understanding of the effect of the new technology on society and everyday life. It needs time to put in place firm and effective regulations.

First section: Evolution of the Regulations of Drones

The rapid advancement of aviation technology and the increasing complexity of air traffic have driven the development of aviation law and regulations. International cooperation has played a crucial role in ensuring the safety, security and efficiency of global air travel. Legal frameworks established from the early 20th century to the present day have governed various aspects of civil and commercial aviation.

Drones' legal evolution has been a complex process, adapting to the rapid advancement in drone technology. Here's a brief overview below to understand why the treaty-maker (international level) and the legislator (national level) missed providing an appropriate legal framework for drones after a long period:

1. **Early Drones:** The initial drones were balloons propelled by gas or air and radio-controlled planes. They were first used for surveillance and later, armed with missiles, deployed to strike targets during combat.²⁰
2. **Regulation Emergence:** as drone technology became popular, governments faced the need to regulate drones. Organizations such as the Academy of Model Aeronautics (AMA) were among the first to initiate the launch of training programs for drone pilots.²¹

²⁰O'CONNELL, Mary Ellen, "The International Law of Drones". ASIL, Volume 14, Issue 37. 12 November 2010. at<www.asil.org/insights/volume/14/issue/37/international-law-drones>. accessed 7 November 2024. Introduction.

²¹<www.modelaircraft.org>.

3. **Commercial Restrictions:** In the mid-2000s, certain aviation authorities declared it illegal to use drones for commercial purposes. However, they permitted non-commercial flights with specific operating standards if drone pilots adhered to the requirements.
Moreover, even with commercial limitations, drones were occasionally employed for commercial purposes, leading to conflicts between aviation authorities and drone pilots.
4. **Drone Laws Change:** As hobby drones with the capability to reach significant altitudes became more widespread and popular, aviation authorities were bound to adopt stricter measures.
5. **Three Phases of Drone Laws:** the development of drone regulations can essentially be summarized in three phases:
 - establishing simple flight rules with some exemptions,
 - simplifying those one-off authorizations,
 - standardizing risk assessment and certification.²²
6. **International Drone Rules and Standards:** the first steps towards standard certifications were completed by the end of 2015.²³

Monitoring the Evolution of International Drone Regulations: observing the progress of global drone regulations, coupled with trends in technology and instances of security and safety issues in the analysed nations in the forthcoming years, will offer insights into the effects of gradual versus all-or-nothing regulatory approaches to technology adoption. Additionally, it will help determine whether the gradual introduction of untested technology mitigates potential hazards.²⁴

The Chicago Convention (1944)²⁵ was shaped in anticipation of the establishment of ICAO, dedicated to coordinating and facilitating the extensive international collaboration necessary to develop the worldwide air transportation network. The primary purpose of ICAO is to emphasise its role as a specialized agency that encourages the development and safe regulation of international civil aviation. The Chicago Convention circumscribes the organization's responsibilities, which include fostering the development of international air transport, ensuring the

²²<www.linkedin.com/pulse/drone-laws-101-three-phases-drone-industry-insights>.

²³ Manual on Remotely Piloted Aircraft Systems (RPAS), AN/507, 1st ed., 2015.; ICAO Doc 10019.

²⁴JONES, Therese Marie, "International Commercial Drone Regulation and Drone Delivery Services". 05 December 2017. at <www.rand.org/pubs/research_reports/RR1718z3.html> accessed 3 November 2024.

²⁵Chicago Convention on International Civil Aviation (1944). 9th ed., 2006.; ICAO Doc 7300.

safe and orderly growth of civil aviation, and promoting cooperation among nations for achieving these objectives, furthermore, it provides the foundational basis for the establishment and functions of ICAO, setting the stage for international collaboration in matters of civil aviation and for the creation of standardized regulations to govern air travel globally. The Chicago Convention extends ICAO's responsibility beyond safety and navigation to “foster the planning and development of international air transport”.²⁶ Nevertheless, the main challenge for ICAO is collaborating to create strategic guidance documents to steer the regulatory development. These documents must be used as the foundation for developing regulations by many States and Organizations.²⁷

The aviation regulations aim to find a balance between encouraging innovation and ensuring the safe and responsible use of drone technology. As the drone industry evolves, the regulatory framework continues to adapt in order to address new challenges and technological advancements.

The legal approach to drones involves developing and implementing regulations and laws governing their operation and use. This legal framework addresses various aspects such as safety, privacy, and airspace management, as well as the rights and obligations of drone operators. As drone technology continues to advance, legal approaches are adapting to balance innovation with societal concerns and potential risks. The legal landscape for drones varies among countries and regions, reflecting the need for tailored regulations that consider local and global considerations. Additionally, the legal framework often encompasses issues like certification, registration, and enforcement measures to ensure responsible and safe drone use.

The popularity of drone use is rising, prompting countries globally to frame rules and regulations for safety measures and privacy protection. While regulations concerning drones can differ based on a country's legislation, there are standard regulations in most countries pertaining to the registration of drones and their owners, requirements for drone operators and certifications, limitations on the highest-flying altitude and distance from the operator, prohibition of flights in designated GEO Zones like airports,²⁸ densely populated regions, and restricted areas.

²⁶DEMPSEY, Paul S., “Public International Air Law”, William S. Hein & Company, Incorporated for the Centre for Research of Air and Space Law, McGill University, 2nd ed., Montreal, 2017, p. 65.

²⁷SCHNITKER, R. and HET, K.D.V. “Drone Law and Policy: Integration into the Legal Order of Civil Aviation”. Eleven International Publishing, The Hague, 2021, p. 42.

²⁸<www.dji.com/ae/flysafe/introduction>.

The primary need is a well-crafted legal framework that strikes a balance between embracing technological progress and effectively safeguarding human rights and confidentiality. For this reason, air law governing the use of drones includes profuse agreements and we abound in organizations that frame and arrange activities for the use of modern aircraft types and advanced smart uses.

Second section: Regulations at the International and National Level

Unmanned aircraft, whether operated remotely or fully autonomous, maybe combinations of both, are regulated in the part of "Pilotless Aircraft," in the Chicago Convention (1944). The treaty-makers stipulated that "No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of each authorization".²⁹ In modern phrasing, pilotless aircraft is considered to be a drone, nowadays more technically referred to as Remotely Piloted Aircraft System (RPAS).³⁰ Within this, concerning remotely piloted aircraft systems (RPAS), widespread in civil use, it must be required regourous regulations for safe operations, which mean, these aircraft are marking, registering, and licencing. The RPAS's operation required special qualification for the operator, and also take into acoount the issues of liability and insurance.³¹

The general overview of drone regulations on both the national and international levels shows the complexity of this challenge from a legal viewpoint as follows:

1. Operational Requirements

²⁹Chicago Convention on International Civil Aviation (1944). 9th ed., 2006,Article 8.

³⁰ABEYRATNE, Ruwantissa, "Convention on International Civil Aviation – A Commentary". Springer, Cham, Heidelberg, New York, Dordrecht, London, 2014, p. 117.

³¹ Palik,Mátyás: 'A pilótanélkülilégijárművek hazaiszabályozóikörnyezetefejlesztésreirányuló K+F projekt bemutatása'. (Introduction of the R&D Project Targeting the Development of the Domestic Regulatory Environment of Unmanned Aerial Vehicles), RepüléstudományiKözlemények, Ludovika, 24, No. 2, 2012, p. 486.

In many States, drone registration is mandatory.³² Operators must register their drones, and the devices may need to display registration numbers, for instance, in the United States, the Federal Aviation Administration (FAA) requires drone owners to obtain an FAA identification number if their drone weighs more than 8.8 ounces (250 grams). The cost is a nominal \$USD 5, and the assigned identification number should be visibly placed on the exterior of the drone. Some lightweight drones (e.g., the Autel Nano and DJI Mini-series) are exempt from registration due to their 249 g take-off weight.³³ The drones can also be registered as personal property in a number of jurisdictions nationally, or internationally (in the international registry of mobile assets). The aim of this registration is to safeguard security interests or establish unencumbered ownership rights”.³⁴

1.1 Operator Licensing

Certain countries regulate the licensing or certification requirements for drone operators. This process may involve passing a knowledge test or undergoing training. In the United States if somebody plans to use a drone for commercial purposes (such as taking photos, videos or for sale), this person will obtain a Part 107 certification after passing a rigorous exam.³⁵

1.2 Flight Restrictions

National regulations define where drones can and cannot fly. These restrictions help ensure safety and prevent conflicts; common rules provide flying at or below 122 meters (400 feet) to avoid manned aircraft, maintaining visual line of sight with the drone during flight, avoiding restricted airspace, such as no-fly zones around airports and sensitive areas, not flying over groups of people, stadiums, or emergency response efforts (like fires) and staying sober while operating a drone.

1.3 Altitude Limits

To prevent conflicts with manned aircraft, most countries impose altitude limits on drones. These limits vary but are typically well below commercial flight altitudes.

³²See, Federal Decree by Law No. 26/2022 (UAE). Concerning the Regulation of the Civil Use of Unmanned Aircraft and Related Activities. Issued on 26 September 2022.

³³FISHER, Jim, “Drone Regulations: What You Need to Know. Want to fly a quadcopter? Here's what the FAA expects you to know”. 23 December 2015. at <<https://me.pcmag.com/en/drones/21205/drone-regulations-what-you-need-to-know>> accessed 3 November 2024.

³⁴HODGKINSON, D., and JOHNSTON, R., “Aviation Law and Drones: Unmanned Aircraft and the Future of Aviation”, 1st ed., Routledge, 2018, 2.3.5.

³⁵*Id.*

1.4 Visual Line of Sight (VLOS)

Many countries require drone operators to maintain a clear visual line of sight with their drones during flight. This enhances safety and prevents collisions.

1.5 Remote Identification

Some countries stipulate the implementation of remote identification requirements. This technology enhances airspace security by allowing authorities to identify and track drones remotely.

1.6 Payload Restrictions

Drone operators need to observe limits on the weight and type of payloads their drones can carry. These restrictions are in place to ensure safety and privacy, for example, some drones are equipped with cameras for aerial photography, while others may carry scientific instruments or delivery packages. Compliance with payload restrictions is crucial to prevent accidents and protect privacy.

1.7 Insurance Requirements

In certain regions, drone operators are required to carry liability insurance. This insurance covers potential damages resulting from drone-related incidents, having insurance provides financial protection and ensures that any harm caused by the drone is adequately compensated.

1.8 Privacy Considerations

Drone regulations often address privacy concerns. They specify how and where drones can capture images or record videos of individuals and private property. Operators should be mindful of privacy rights and avoid intrusive or unauthorized surveillance.

1.9 Night Flying Restrictions

Some countries impose restrictions on, or require special permissions for, flying drones at night. Safety concerns drive these regulations, night flying introduces additional challenges, such as reduced visibility and increased collision risks. Operators must follow guidelines to mitigate these risks.

1.10 Emergency Procedures

Regulations specify procedures for dealing with emergencies during drone flights. These procedures cover scenarios like equipment failures, unexpected events, or sudden weather changes, being ready for such unforeseen situations ensures rapid and secure reaction, minimizing potential harm.

1.11 Educational Outreach

National authorities often engage in educational efforts to inform the public about drone regulations and safe flying practices.

International regulations may influence drone activities across borders, and operators need to be mindful of any agreements or limitations existing between adjacent countries and comply with them to ensure safe and responsible drone operations. As drone technology continues to evolve, regulations are likely to be updated to address new challenges and opportunities.

2. The Relation Between National and International Law

In certain cases, discrepancies may arise between a State's national laws and its commitments under international law. The International Court of Justice (ICJ)³⁶ and other courts assert that contradictions in domestic law cannot serve as a justification for avoiding compliance with international law.³⁷ Regardless of any disparities that may emerge between a State's international commitments and its domestic obligations, the State must still adhere to its international obligations.³⁸

In some States, the connection between domestic and international law may not be straightforward or easily defined, and because of the arising contradictions, the International Civil Aviation Organisation urged the implementation of international standards and procedures as stipulated in the Chicago Convention: "Each contracting State undertakes to collaborate in securing the highest practicable degree of uniformity in regulations, standards, procedures, and organisation in relation to

³⁶ The International Court of Justice (ICJ) in The Hague is the Supreme Judicial Organ of the UN, the only permanent international judicial forum of universal character. The duty of the International Court of Justice is the adjudication of cases submitted thereto within the purview of international law. Article 92 of Charter of the United Nations. 26 June 1945.

³⁷ HODGKINSON, D. and JOHNSTON, *supra* note 34, R.4.3.1

³⁸ In the event of a conflict between the obligations of the Members of the United Nations under the UN Charter and their obligations under any other international agreement, their obligations under the United Nations Charter (1945) shall prevail, Article 103 of Charter of the United Nations. 26 June 1945.

aircraft, personnel, airways and auxiliary services in all matters in which such uniformity will facilitate and improve air navigation.”.³⁹ The collaboration among contracting States is conducive to achieve consistency in regulations, standards, procedures, and organization related to various aspects of aviation. The rule above places emphasis on cooperation among nations to harmonize aviation regulations and practices, ultimately benefitting air travellers and the aviation industry worldwide.

THE THIRD TOPIC: Safety and Security Implications

The widespread application of drone technology has resulted in notable consequences as to safety and security. These implications raise concerns about the potential misuse of drone technology. Drone users and operators can give rise to serious safety and security issues which can jeopardise the aviation stakeholders' operations and can cause danger to the general public (third parties). The drones can be used for illegal activities such as reconnaissance, remote sensing, escorting, etc. Without the permission of third parties, these are forbidden activities; at the same time, they conflict with the purposes of civil aviation stipulated by the Chicago Convention.⁴⁰

First requirement: Guaranteeing Privacy Rights

In surveillance concerns, drones equipped with cameras have the capability to capture images and record videos, potentially encroaching on the privacy rights of individuals.⁴¹ Drones flying over sensitive locations, such as private properties, can lead to heightened privacy concerns, especially if conducted without proper authorization. Drones can also be used for unauthorized surveillance, posing security risks to individuals, organizations and critical infrastructure. In addition, drones can collect vast amounts of data, including images, videos, and location information, raising questions about how these data are stored, processed, and used. Drones can invade personal spaces and record videos without consent, and the data collected,

³⁹Chicago Convention on International Civil Aviation (1944). 9th ed., 2006, Article 37.

⁴⁰Chicago Convention on International Civil Aviation (1944). 9th ed., 2006, Article 4.

⁴¹ KISTERS, Salomon, “The Ethical Concerns in Drone Technology”. 30 June 2023. at <<https://originstamp.com/blog/the-ethical-concerns-in-drone-technology>> accessed 5 November 2024.

whether intentionally or inadvertently, is subject to security regulations.⁴² Unauthorized access to drone data can lead to privacy breaches.

Ensuring encryption, secure storage and controlled access to drone data is crucial. As an issue of the Invasion of Personal Space, drones flying near private properties can infringe personal space and privacy boundaries. Drones also present threat concerns that include cybersecurity and terrorism. In terms of cybersecurity,⁴³ exposure to hacking poses risks of unauthorized control and potential misuse, compromising the security of collected data and the systems that govern it. On the other hand, the potential weaponization of drones and their use to carry explosive devices poses a growing terrorist threat, especially in densely populated areas or during public events. The convergence of these issues underscores the need for comprehensive measures to address cybersecurity vulnerabilities and the potential for the misuse of drones for malicious purposes.

Many methods are used in a negative way, violating the privacy and security of individuals using drones. As technology continues to advance, ongoing efforts to balance the benefits of drone use and the protection of privacy rights are essential. Policymakers and regulatory bodies play a crucial role in establishing guidelines that ensure responsible drone operations and safeguard individuals' privacy.

Second requirement: Counter-Drone Activities

Counter-drone measures, also known as Counter-Unmanned Aircraft Systems (C-UAS), are systems designed to detect, track, identify and mitigate threats posed by unauthorized or nefarious drones. These systems have become an essential part of airspace security as the use of drones has grown in popularity; it they aimsaim to detect, disrupt and respond to activities that pose risks to privacy, security, and public safety.

Counter-UAS measures can be divided into two types of procedures:

⁴² Asia Pacific, “Data Protection, Privacy and Drones”, at <<https://www.clydeco.com/en/insights/2022/2/data-protection-privacy-and-drones>> accessed 5 November 2024.

⁴³FERRINGER, Megan, “Cybersecurity Threats from Above: How Drones Put Our Sensitive Data at Risk”. at <<https://www.navisite.com/blog/insights/how-drones-put-our-sensitive-data-at-risk>> accessed 7 November 2024.

1. **Drone Detection:** This technology functions to identify unmanned aircraft systems (UAS) or drones present in the airspace. Drone detection systems include radar, RF sensors, and PTZ cameras.⁴⁴
2. **Drone Mitigation or Interception:** These are active countermeasures that attempt to disrupt drone communications, bring down unmanned aircraft, or disable/damage drones in flight. Examples include jamming devices, missile interception systems, high-power lasers, and kinetic systems.⁴⁵

The legality of Counter-UAS systems is guaranteed by regulations which apply to all three components of a modern UAS: the controller, the link, and the vehicle. With the increasing affordability, widespread adoption, regulation, and deployment of drones, organizations and agencies worldwide encounter fresh security challenges in managing their lower airspace.⁴⁶ Therefore, Counter-UAS solutions must be practical and legal; the specifics of counter-drone measures can vary based on the jurisdiction and the specific application.

First section: The Legal and Technological Regulatory Challenges of the Drone Industry

The rapid advancement of drone technology poses several challenges, and the laws and regulations surrounding drones are continually evolving to address these issues.

Drone technology and laws face several challenges:

1. **Safety and liability:** the deployment of drones in the technology sector raises notable safety issues, mainly when operating them in densely populated zones or in proximity to critical infrastructure. Potential hazards include the risk of collisions with other aircraft, structures or individuals on the ground. In case of accidents, establishing accountability can be intricate, with potential legal liabilities extending to the operator, manufacturer, or even the software developer in the event of malfunctions. It is imperative to address these risks by emphasizing the importance of adequate training and certification for drone operators.

⁴⁴ Counter-Drone Technology, “Counter-Drone Technology. Can drones be stopped with technology?”. at <www.airsight.com> accessed 7 November 2024.

⁴⁵ NENE, Vidi, “Kinetic Systems as Drone Countermeasures”. 14 August 2018. at <<https://dronebelow.com/2018/08/14/kinetic-systems-as-drone-countermeasures>> accessed 1 November 2024.

⁴⁶ Counter-Drone: “The Comprehensive Guide to Counter-UAS/C-UAS/CUAS”, at <www.dedrone.com> accessed 3 November 2024.

2. **Intellectual property:** drones equipped with cameras and sensors serve as valuable instruments for acquiring aerial images and data. Nevertheless, this gives rise to intellectual property issues as individuals or businesses might unintentionally capture copyrighted material or encroach upon someone's privacy during aerial surveillance. Businesses utilizing drones must navigate through copyright laws and guarantee compliance by obtaining proper permissions or licenses for capturing and utilising images or data acquired through drones.
3. **Regulation compliance:** the speedy evolution of drone technology has posed difficulties for regulators in staying abreast of emerging advancements and formulating all-encompassing regulations. Divergent rules exist among countries concerning drone operations, encompassing aspects such as flight constraints, altitude thresholds, and licensing prerequisites. Global tech enterprises must adeptly navigate this array of regulatory frameworks to guarantee adherence to guidelines across various jurisdictions.

Addressing these challenges requires collaboration involving technology experts, legal professionals, regulatory bodies, and the drone industry to develop comprehensive and adaptable legal frameworks that promote innovation while ensuring public safety, privacy, and security.

Third requirement: The Future of Drones

Drones are becoming an increasingly affordable mode of transportation due to their miniaturization and enhanced efficiency; the future of drones holds significant promise and is likely to be characterized by continued technological advancements, increased integration into various industries, and the development of new applications.

First section: Drone activities in different areas

1. **Miniaturization:** “refers to the scaling down of the physical size of a drone”,⁴⁷ reducing the size will enable quicker navigation through confined spaces and a greater level of manoeuvrability.
2. **Outer Space Exploration:** Drones are being used for space exploration (for instance, NASA’s Perseverance Rover carried a drone named Percy to Mars).⁴⁸

⁴⁷ HODGKINSON, D. and JOHNSTON, *supra* note 3134, R. 6.2.1

3. **Urban Landscapes and Business Tasks:** Drones are anticipated to have a substantial impact in urban landscapes and business tasks. They are being used to deliver goods, monitor traffic, and perform inspections. The concept of Urban Air Mobility (UAM) is also being explored, which could help alleviate traffic congestion.⁴⁹
4. **Artificial Intelligence (AI):** AI is powering the future of drones. It can assist drones to operate in environments inaccessible to humans, analyse data in real-time, and modify flight telemetry according to terrain and navigation.
5. **Technological Advancements:** Ongoing innovation in drone technology is expected to lead to improved performance, longer flight times, enhanced payload capacities, and more sophisticated sensors and cameras.
6. **Delivery Services:** Drones are increasingly being explored for delivery services, especially in the e-commerce sector. Fast and efficient delivery of packages to remote or urban locations is a potential application.⁵⁰

Future developments of drones will need to consider the safety of shared airspace and the current air traffic control system. While the future of drones holds immense potential, it also comes with challenges related to safety, privacy, and regulatory frameworks. Continued collaboration between technology developers, regulatory bodies, and industries will be essential to unlock the full benefits of drone technology in a responsible and sustainable manner. Governments are likely to refine and update drone regulations to accommodate new technologies and applications. Striking a balance between innovation and ensuring safety and privacy will be a crucial aspect of future regulations.

⁴⁸STRICKLAND, Ashley, "CNN, Perseverance Rover has successfully landed on Mars and sent back its first images". 18 February 2021. at <<https://edition.cnn.com/2021/02/18/world/mars-perseverance-rover-landing-scen-trnd/index.html>> accessed 7 November 2024.

⁴⁹REAGAN, Jason, "Joby Aviation Inks Major Deal to Snag Parking Spots for Urban Air Taxis". 11 June 2021. at <<https://dronelife.com/2021/06/11/joby-aviation-inks-major-deal-to-snap-parking-spots-for-urban-air-taxis>> accessed 7 November 2024.

⁵⁰SAMET, Alexandra, "Drone Delivery: What it is and what it means for retailers". 24 October 2023. at <<https://www.insiderintelligence.com/insights/drone-delivery-services>> accessed 7 November 2024.

Conclusion

The authors conclude that a subtle stability between innovation and regulatory protection is to be preserved. The legal environment needs to change as the drone industry continues to soar to new heights. Regulatory bodies (legislators) ought to launch campaigns to educate the public about the advantages, dangers of and laws pertaining to drone use. What is essential: the ethical and sustainable integration of drones into global airspace requires an intricate balance between strict rules, technological innovation and international cooperation. Legal frameworks that prioritize safety and societal concerns must permit innovation and the consideration of the rapidly changing drone world. Furthermore, the authors think that stakeholders must cooperate to create precise rules and laws controlling drone privacy to allay these worries. A multifaceted strategy is needed to strike a balance between protecting individual privacy rights and the legal uses of drone technology. Drone integration offers unprecedented growth chances across a range of businesses; nevertheless, because of the possibility of a privacy violation, caution must be exercised.

The authors tend to think that drone technology presents new legal concerns that the changing legal landscape must meet head-on to preserve individual rights without further problems. Drones are becoming more and more common in the sky, thus, navigating the delicate line between privacy protection and technological growth will require careful consideration and teamwork. For the most part, the development of drone technology calls for a flexible and sophisticated legal framework, especially on an international level in the field of aviation law. We can see many national regulations⁵¹ on drone activities, but these must be harmonized and complied with much more in the international field. Therefore, Governments, aviation authorities, and industry performers⁵² must work together to strike a balance between innovation

⁵¹ See, Federal Decree by Law No. 26/2022 (UAE). Concerning the Regulation of the Civil Use of Unmanned Aircraft and Related Activities. Issued on 26 September 2022.

⁵² The main industrial performers of civil aviation industry are the air carriers, airports, and air navigation service providers (ANSPs), furthermore, the States' civil aviation authorities (CAA), aircraft manufacturers, maintenance, repair, and overhaul companies (MROs), travel, telecommunication, and consignment service providers, and last but not least, the passengers themselves. In the performance of the activity of air transport, insurance, aircraft financing and ground handling service providers have important roles. SIPOS, A., "International Aviation Law – Regulations in Three Dimensions". Springer Nature Switzerland, Cham, September 2024, p. 355.

and safety, privacy and security concerns. Only if we take a cooperative and progressive approach can drones be fully utilized and the interests of society protected.

The authors believe that promoting enhanced global cooperation towards uniform drone laws enables smooth cross-border operations and guarantees a cohesive strategy for safety and security. To address concerns about unintentional privacy violations during drone operations, it would be ideal to ensure there are improved geofencing and robust encryption methods.

Also, our opinion is that promoting flexible regulations that change with drone technology and carrying out routine evaluations to tackle new issues guarantee a progressive and safe regulatory landscape. Fostering responsibility among drone operators requires supporting training about public understanding about privacy concerns, responsible drone use, and following regulations. Furthermore, we think that staying ahead of possible security risks requires encouraging more investment in research and development for counter-drone technologies.

Governmental and non-governmental organizations, as well as lawmakers and drone industry stakeholders, may work together to create policies that positively integrate drones into various industries while addressing safety and security concerns. Moreover, encouraging compliance with drone regulations can be achieved by proposing incentive packages, such as tax benefits or licensing advantages. Ensuring fair and uniform execution of the rules while serving as deterrence can be achieved by advocating open enforcement procedures. By accepting these suggestions, we may appropriately integrate drones into the future while balancing innovation with privacy, security and public safety concerns.

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