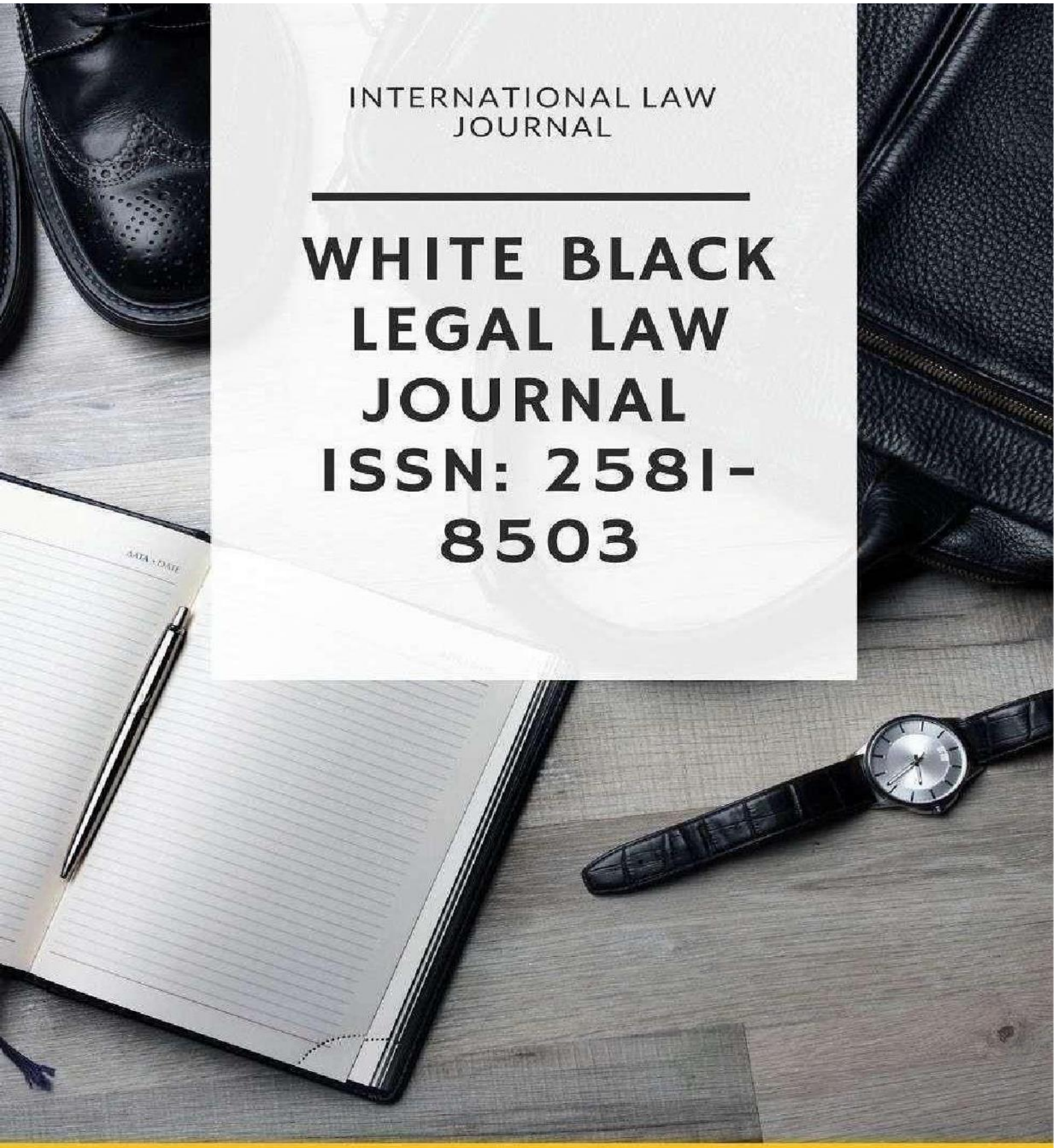


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BALANCING PUBLIC SAFETY AND INNOVATION IN ADMINISTRATIVE CONTROL OF UNMANNED AIRCRAFT SYSTEMS

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ABSTRACT:

The quick spread of aircraft systems ("UAS") into commerce, agriculture, logistics and public safety has moved faster than the administrative systems that were used before to manage manned aviation. This Article analyses how international, regional and national groups that manage aviation like the International Civil Aviation Organization, the European Union Aviation Safety Agency and the U.S. Federal Aviation Administration among others have tried to find a way to make UAS work while keeping it safe. The Article denotes the legal base from the Chicago Convention, the European Unions risk-based categories, U.S. Rules under Part 107 safety research on managing drone traffic and examines how people work with control systems. It says that administrative control of UAS has partly found the right balance. It ends with ideas for a system that uses risk-based categories, special safety plans for drone traffic rules that make control systems easier to use and agreements between countries.

KEYWORDS:
Unmanned Aircraft Systems (UAS), Drone Traffic Management, Aviation Regulation, Risk-Based Categories, Drone Traffic Management, Aviation Safety.

I. INTRODUCTION

Unmanned Aircraft Systems ("UAS") have moved quickly from hobbyist uses into important tools for modern business, farming, delivery and keeping people safe. The speed of this change has been faster than the systems that were built over a century to manage planes. This has forced regulators over the world to deal with two main goals that often conflict: keeping the skies safe and letting UAS grow in new ways. Market predictions show how big the challenge

is.[1] The Teal Group expects that non-military UAS production will go from about five billion dollars in 2020 to than eighteen billion dollars by 2029 growing by more than fifteen percent each year. [2]The European Commission says that the drone industry will make than ten billion euros and create one hundred thousand new jobs in ten years. Balancing this growth with a level of risk is really an administrative law problem. It needs agencies like the [3]International Civil Aviation Organization ("ICAO") the U.S. Federal Aviation Administration ("FAA") and the[4] European Union Aviation Safety Agency ("EASA") to create ways to check the safety of these planes manage their flight and handle the growing number of them without making the risk much higher.

This Article examines at how different groups have tried to do this. Part II talks about the base from the Chicago Convention and how ICAO made rules step by step. Part III compares the risk-based rules in the European Union with how the FAA gives permits. Part IV looks at the administrative law perspective from India, including the Drone Rules, 2021, airspace classification and constitutional safeguards. Part V looks at how to manage the safety of drone traffic and the systems that help with that. Part VI discusses the issues with controlling drones from the ground. Part VII checks if the current system really balances safety and new ideas using accidents and research. Part VIII suggests ways to make the system work better.

II. THE INTERNATIONAL LEGAL FOUNDATION: THE CHICAGO CONVENTION AND ICAO

The problem with UAS is not completely new.[5] Article 8 of the Convention on International Civil Aviation known as the Chicago Convention expected the need to control flights without pilots. It says that "No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without authorization by that State." In 2004 ICAO said that Article 8 covers both planes that are controlled from a distance and automatic ones putting UAS under its rules. However, ICAO moved slowly. It had a meeting about UAS in 2006 created a group to study them in 2007 and only gave advice in 2011. Later a group made a book that covers permission, registration and how to control the planes but its not a real rule

[1] Teal Group Corp., *Civil UAS Market Profile and Forecast* (2020).

[2] European Commission, *A Drone Strategy 2.0 for a Smart and Sustainable Unmanned Aircraft Eco-System in Europe*, COM(2022) 652 final (Nov. 29, 2022).

[3]Convention on International Civil Aviation, opened for signature Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 [hereinafter *Chicago Convention*], art. 8.

[5] International Civil Aviation Organization [ICAO], *Working Paper: Civil/Military Cooperation in Air Traffic Management*, AN-Conf/11-WP/11 (2003); *see also* ICAO Assembly Res. A35-14 (Oct. 8, 2004).

and doesn't cover planes that fly on their own.

Some people say ICAOs slow move is wrong. Havel and Mulligan say that [6]ICAOs advice is for planes that will eventually share the sky with regular planes even though most UAS are small and fly low. They say that ICAO can't just ignore the UAS without changing the rules, which would create a new kind of rule that could be risky. This criticism showed the gap that European and American regulators later tried to fix with their rules.

III. Regional and National Regulatory Architectures

A. The European Unions Risk-Based Categorization

The European Union has made the detailed rules so far.[7] The rules from the European Commission split UAS into three groups specific and certified based on how risky they are. The "open" group is for low-risk flights with parts and rules for how much they weigh how close they fly to people and how skilled the person flying is. These flights don't need any permission first. The "specific" group needs permission after checking the risks. The "certified" group covers flights that carry people or dangerous items. These are treated like regular planes. This way of dividing the work is supported by another rule that created EASA and gave it power over how UAS are made and used.

The way the European Union handles this is special because it uses the type of plane and the type of flight to decide. The Specific Operations Risk Assessment ("SORA") asks people who fly to look at the risk in the air and on the ground suggest ways to fix the problem and show that the risk is low. SORA makes the decision-maker choose between ideas and safety.

So moving to the new rules has been hard. The old rules were for future use, so the EU had to let old planes keep flying with old rules for a while. The fact that old and new rules are still in use shows a problem in rules: it's hard to apply new strict rules to old planes that are different from each other.

B. The United States: Certification Through Part 107

The FAA has taken an approach using one main rule14 C.F.R. Part 107 to let small UAS fly for businesses. This rule helps businesses grow but still limits how high they can go, where they can fly and who can fly them. The main problem is that the rule stops flights that're not in

[6] ICAO Secretariat, *Unmanned Aircraft Systems (UAS) Study Group (UASSG)*, Terms of Reference and Work Programme (2007).

[7] International Civil Aviation Organization, *Unmanned Aircraft Systems (UAS)*, ICAO Circular 328-AN/190 (2011).

view of the person flying. These flights could help with delivery checking things and farming. They also make it harder to avoid other planes and keep communication. Getting permission for these flights is an issue in the U.S. When it comes to making sure UAS are safe.

C. Harmonization Gaps

Because flying planes doesn't stop at borders, the different rules from ICAO, EASA and the FAA cause problems. Companies that want to use UAS in places face different rules on how heavy the planes can be what skills pilots need and if their certificates are accepted. Some ideas to fix this include meetings where rules are made together research on how to manage drone traffic and agreements that're like those for regular planes. Without these the cost of following rules stops the growth that the rules are meant to help.

IV. The Indian Administrative Law Perspective on UAV Regulation

India offers a further comparative case study in balancing safety and innovation, illustrating how a large and rapidly growing UAS market has approached administrative control from outside the ICAO-EASA-FAA triad discussed above. As drone use in India has expanded into agriculture, aerial photography, surveying, delivery and infrastructure inspection, the government has had to develop a regulatory architecture that manages aviation, security and privacy risk without needlessly slowing commercial adoption. Because these functions are carried out mainly through statutory rules and specialised regulatory bodies rather than through primary legislation, India's UAS regime is best understood as an exercise in administrative law as much as aviation law.

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A. The Drone Rules, 2021 and Delegated Administrative Rulemaking

The core framework is the Drone Rules, 2021. These rules lay out the licensing, registration and airspace requirements for civilian drone operations. The main body responsible for enforcing these rules is the Directorate General of Civil Aviation also known as DGCA. This agency handles certification, remote-pilot licensing and checks, on compliance. [8]It works with the Digital Sky platform, a system that processes registrations, permissions and airspace clearances. This model, in which the executive is given power to fill in the operational detail of a fast-changing technology, is a familiar example of delegated legislation. As with the

[8] International Civil Aviation Organization, *Manual on Remotely Piloted Aircraft Systems (RPAS)*, ICAO Doc 10019, AN/507 (1st ed. 2015).

European Union's specific-certified categorisation and the FAA's Part 107 permitting process discussed in Part III, the underlying administrative-law concern is the same: authorities exercising delegated rulemaking and licensing power must stay within the limits set by law and may not act arbitrarily in granting or refusing permissions.

B. Airspace Classification and the Principle of Proportionality

India's approach to airspace management is built around a colour-coded zoning system that divides the country into green, yellow and red zones, permitting, restricting or prohibiting drone flight according to the sensitivity of the area below. This is functionally similar to the European Union's open-specific-certified risk tiers and to the geofencing tools discussed later in this Article, but it is administered directly by the executive rather than left to a case-by-case risk assessment such as SORA. Because a blanket restriction can be just as damaging to legitimate[9] commercial and technological use as an inadequate one, the zoning system raises a recurring administrative-law question: whether a given restriction bears a reasonable connection to the safety, security or privacy interest it is meant to protect. A framework that is too restrictive risks discouraging the growth that the Drone Rules, 2021 were designed to enable, while one that is too permissive risks the safety and security gaps documented elsewhere in this Article.

C. Constitutional Constraints: Articles 14, 19 and 21

UAV regulation in India also operates against the backdrop of the Fundamental Rights under the Constitution. Article 14 requires that administrative decisions on registration, certification and airspace permission be applied consistently and without arbitrary distinctions between similarly placed operators. Article 19(1)(g) protects the right to run drone-based businesses in agriculture, photography, surveying and logistics long as the restrictions set by Article 19(6) are reasonable and serve public safety and the public. Many drones have cameras and sensors that can watch people, homes and private activity without needing to be physically present. When government agencies use drones for surveillance or law enforcement they also touch on the privacy right protected by Article 21. Therefore, such use must have a legal basis and cannot be done in an arbitrary or unfair way. Taken together these rules guide Indias drone regulators toward a standard to the proportionality approach used in the European Union. Restrictions should match the risk of a specific operation considering the type of drone, where it is used and

[9] Brian F. Havel & John Q. Mulligan, *Unmanned Aircraft Systems: A Challenge to Global Regulators*, 65 DePaul L. Rev. 107 (2015).

the possible outcomes instead of applying the same limits, to every operator.

D. Judicial Review as an Administrative Safeguard

Finally administrative decisions made under the Drone Rules, 2021. Such as rejections of registration or certification the cancellation of permissions or the setting of zone-based restrictions. Are still open to review by the courts under Articles 32 and 226 of the Constitution. Courts that have this power can investigate whether the DGCA or another organization has gone beyond the powers given by law has acted in a way has broken a fundamental right or has not followed a proper process. [10]This kind of court review does a job to the international harmonisation and certification-recognition systems that were talked about in Part III: it offers an outside protection, against the misuse of the rulemaking and licensing power that a quickly changing technology forces regulators to use. As UAV technology continues to develop, Indian administrative law will need to extend this safeguard to newer concerns such as automated decision-making in drone-traffic clearance, expanded surveillance use and accountability for UTM-style service providers, so that the regulatory system remains, in keeping with the aims of this Article, safe, transparent and supportive of innovation.

V. Extending Safety Management to Unmanned Traffic Management

Managing safety for planes is done with a system that finds risks deals with them and keeps track of how well things are working. Applying this to UAS and the new systems that help manage drones has been one of the hardest tasks, in the past decade.

Research done at the University Politehnica of Bucharest shows three areas that need management: adapting current ATM-focused SMS elements—like risk-management processes, safety-performance monitoring and safety reporting—to handle UAS-specific dangers; creating new "indicative" SMS rules that fit UTM service providers, who are usually private companies rather than traditional air navigation service providers; and changing the oversight role of National Supervisory Authorities, which now have to manage not only air navigation service providers but also UTM operators, UAS operators and UAS manufacturers. [11]Commission Implementing Regulation (EU) 2021/664 which sets up the rules for U-Space extends the ATM-focused SMS rules from Regulation (EU) 2017/373 to UTM providers.

[10] Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the Rules and Procedures for the Operation of Unmanned Aircraft, 2019 O.J. (L 152) 45.
[11] Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on Unmanned Aircraft Systems and on Third-Country Operators of Unmanned Aircraft Systems, 2019 O.J. (L 152) 1.

Researchers warn that these general rules are "a necessary but not enough" basis for good UTM safety without extra UTM-specific rules that handle things like fatigue in highly automated operations and cooperation between different UTM service providers in the same airspace.

The real-world problems of this management gap are clear from incident data. Reports of UAS entering controlled airports rose quickly between 2014 and 2018 in both the United Kingdom and the United States and confirmed crashes between[12] UAS and commercial airplanes have been reported in Mexico, Canada and Argentina. Measures like geofencing have helped reduce the risk but not fully especially when operators turn off geofencing on purpose or when systems don't have it all. In short, the task is to create a UTM oversight system that can grow with the increase in low-altitude UAS traffic before it causes safety issues people won't accept in shared airspace.

VI. Human Factors as an Administrative Blind Spot

Another issue for management is that UAS safety mostly depends on ground-based operators, whose performance is hard to make the same through equipment certification alone. Looking at two U.S. UAS accident datasets shows how big the problem is: human factors caused twenty-four percent of accident causes in the Hunter RQ-5 fleet with outside-pilot landing error alone responsible for forty-seven percent of those accidents and for nineteen percent of accident causes in the Shadow RQ-7 fleet, which uses an automated takeoff and landing system to take human error out of the most dangerous parts of flying. A separate look at sixty-eight U.S. Navy UAS accidents from 2011 to 2014 found that judgment and decision-making errors made up fifty-three percent of factor-related causes more than either skill-based errors or perception errors. These results follow a pattern in manned aviation, where pilot mistakes are still a common cause of accidents but they are especially important for UAS because the remote pilot doesn't have the same sensory cues as an onboard pilot and because the design of ground control stations like screen layout and alert systems is not yet subject to the same strict consistent human-factors standards as for manned flight decks.

Current guidelines are not complete. The FAA has made a human-factors design standard for off-the-shelf systems; the U.S. Department of Defenses Military Handbook 759C and Military Standard 1472F cover the human-engineering design of military equipment in general; and NATOs STANAG 4586 sets the data architecture and message formats for mission-control

[12] Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on Common Rules in the Field of Civil Aviation and Establishing a European Union Aviation Safety Agency, 2018 O.J. (L 212) 1.

interfaces. None of these however is a UAS-specific certification rule like the ones for manned transport aircraft flight decks. Proposed management responses include requiring backup systems for example double-workstation ground control stations that let a second operator take over without stopping and skill-based training that uses real accident data instead of fixed training hours.

A recent study of over five thousand publications on factors in UAS operations shows the urgency of this gap: research in the field increased a lot after 2018 classic texts on human error and aviation safety are still widely cited but the research still lacks a full look at long-term effects of mental workload on UAS operators or standard operation-specific guidelines for ergonomics showing that the safety science available to rulemakers is still incomplete even as UAS use grows.

VII. Has the Balance Been Struck? Evidence from Incident and Growth Data

The test of any management system is whether it allows the innovation that justifies UAS use while keeping the risk within an acceptable level. The evidence is cautiously positive. Even though the production of aircraft is growing at a rate of nearly 14 percent a year the European Central Repository recorded a big drop in reported UAS incidents at airports in 2020 compared to 2018–2019 and Eurocontrols Voluntary ATM Incident Reporting also found fewer drone-related events in 2019 than the year before despite the growing number of UAS. Experts say this drop in incidents compared to the number of UAS is because of rules like registration, geofencing and training for remote pilots and because operators are learning more about safety. That said the same data warns against being too sure. Fifteen percent of UAS encounters in the Eurocontrol report were serious and national reports like Polands Central Reporting Database and the FAAs own data show that reported drone events went up ten times between 2011 and 2019 before dropping a pattern that seems more like better detection and reporting than a real reduction in risk. Havel and Mulligans point that regulators focused too much on large remote-piloted aircraft meant for future integration into non-segregated airspace while the real and documented risk came from small UAS in segregated low-altitude areas still fits with where the rules were focused compared to where the data showed the need was. [13]The later development of category-based EU rules and SORA-based risk assessments is a fix but the fact

[13] Joint Authorities for Rulemaking on Unmanned Systems [JARUS], *JARUS Guidelines on Specific Operations Risk Assessment (SORA)*, Doc. No. JAR-DEL-WG6-D.04 (rev. 2.0, 2019).

that old rules still exist and UTM safety rules are not complete shows that the fix isn't complete yet.

VIII. Toward a More Coherent Administrative Model

Based on the analysis a management system that supports public safety and continued innovation should include at least six parts.

First certification processes should be based on risk like the EASAs specific-certified system, with weight- and distance-based limits that are checked and updated regularly instead of being fixed when rules are first made.

Second UTM and U-Space service providers should have safety rules that are adapted than just copied from ATM practices dealing with things like tiredness in highly automated monitoring jobs and working together between different UTM service providers sharing the same air navigation service providers airspace.

Third BVLOS authorization should follow set detect-and-avoid and communication standards of being decided on a case-by-case basis because BVLOS flights offer the most efficiency and therefore the biggest push for innovation.

Fourth human-factors design standards for ground control stations should be made mandatory of just optional based on the accident data from military UAS fleets.

Fifth regulators should work to make UAS certifications and remote-pilot qualifications recognized internationally through ICAO-led rules, which would lower the cost of following rules for -border operators without a real safety gain.

Finally, agencies should do more to teach the public and share incident reports because public tolerance for UAS risk like for any aviation risk depends a lot on believing that the management system is both good and responsible.

IX. Conclusion

[14]Managing aircraft systems is, at its heart about finding the right balance between risk and safety in a time of fast-changing technology. ICAOs gradual guidance, the European Unions risk-based rules and the FAAs certification-based Part 107 system are all attempts to find that balance and the available incident data shows that these efforts have kept up with the big growth in the global UAS fleet so far. There are still big gaps in UTM-specific safety management in

[14] Operation and Certification of Small Unmanned Aircraft Systems, 81 Fed. Reg. 42064 (June 28, 2016) (codified at 14 C.F.R. pt. 107).

strict human-factors design rules and in international agreement that mean the balance between safety and innovation is not fully reached. Fixing these gaps will mean that management groups see UAS regulation not as a change from rules for regular planes but as a separate and permanent part of aviation law needing the same level of care support from data and global teamwork that a century of regular flight has made standard.

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