

Artificial Intelligence and civil law: liability rules for drones



Artificial Intelligence and civil law: liability rules for drones

STUDY

Abstract

This study – commissioned by the European Parliament’s Policy Department for Citizens’ Rights and Constitutional Affairs at the request of the JURI Committee – analyses existing European and national legislation on the regulation of drones for civil use, discussing how they are defined and classified, whether certification and registration is required, how liability is apportioned between the subjects involved, and if compulsory insurance is provided for. Finally, on the basis of a risk-management approach, the study elaborates recommendations for future policy formulation.

ABOUT THE PUBLICATION

This research paper was requested by the European Parliament's Committee on Legal Affairs and commissioned, overseen and published by the Policy Department for Citizens' Rights and Constitutional Affairs.

Policy Departments provide independent expertise, both in-house and externally, to support European Parliament committees and other parliamentary bodies in shaping legislation and exercising democratic scrutiny over EU external and internal policies.

To contact the Policy Department for Citizens' Rights and Constitutional Affairs or to subscribe to its newsletter please write to: poldep-citizens@europarl.europa.eu

RESPONSIBLE RESEARCH ADMINISTRATOR

Giorgio MUSSA
Policy Department for Citizens' Rights and Constitutional Affairs
European Parliament
B-1047 Brussels
E-mail: poldep-citizens@europarl.europa.eu

AUTHOR

Andrea BERTOLINI, Ph.D., LL.M. (Yale)
Assistant Professor of Private Law, Scuola Superiore Sant'Anna (Pisa)
Adjunct Professor of Private Law, and Law of Robotics and AI, Università di Pisa
Attorney licensed to practice in Italy and New York

Scuola Superiore Sant'Anna
Piazza Martiri della Libertà 33
56127, Pisa (PI)
Italy
andrea.bertolini@santannapisa.it

LINGUISTIC VERSION

Original: EN

Manuscript completed in November 2018
© European Union, 2018

This document is available on the internet at:
<http://www.europarl.europa.eu/supporting-analyses>

DISCLAIMER

The opinions expressed in this document are the sole responsibility of the author and do not necessarily represent the official position of the European Parliament.

Reproduction and translation for non-commercial purposes are authorised, provided the source is acknowledged and the publisher is given prior notice and sent a copy.

CONTENTS

CONTENTS	3
LIST OF ABBREVIATIONS	5
LIST OF TABLES	8
LIST OF MAPS	8
EXECUTIVE SUMMARY	9
GENERAL INFORMATION	13
1 Regulating robotics: methodological considerations	14
1.1. Regulating civil liability for drones: identifying the issues	14
1.1.1 Definitions and criteria for classification	16
1.1.2 Liability, insurance and risk-management	17
1.1.3 The role for Europe	18
2 Definitions and criteria for classification	20
2.1 The European legal framework	21
2.2 Member States' legal framework	24
2.2.1 Spain	24
2.2.2 France	24
2.2.3 Belgium	24
2.2.4 The United Kingdom	25
2.2.5 Italy	25
2.2.6 Denmark	26
2.2.7 Sweden	26
2.2.8 Czech Republic	26
2.2.9 Poland	27
2.2.10 The Netherlands	27
2.2.11 Austria	27
2.2.12 Germany	28
2.2.13 Ireland	28
2.3 The United States legal framework	28
2.4 Discussion and conclusions	34
3 Liability, Insurance and risk-management	36

3.1	The European legal framework	39
3.1.1	Liability for defective products	41
3.1.2	Insurance regime for air carriers and aircraft operators	44
3.2	Member States' legal framework	46
3.2.1	Spain	46
3.2.2	France	46
3.2.3	Belgium	46
3.2.4	The United Kingdom	47
3.2.5	Italy	47
3.2.6	Denmark	48
3.2.7	Sweden	48
3.2.8	Czech Republic	48
3.2.9	Poland	49
3.2.10	The Netherlands	49
3.2.11	Austria	49
3.2.12	Germany	50
3.2.13	Ireland	50
3.3	The United States federal regulation	50
3.4	Discussion and conclusions	55
3.4.1	The EU and MSs' legal framework: an assessment	55
3.4.2	The US legal framework: comparative considerations	58
3.4.3	The optimal choice of liability rules	58
3.4.4	Compulsory insurance schemes and compensation funds	60
3.4.5	A Risk-Management Approach	61
3.4.6	The role for Europe	63
4	Conclusions and Recommendations	65
4.1	Conclusions	65
4.1.1	Definitions and classification requirements	65
4.1.2	Liability, insurance & risk management	66
4.1.3	The role for Europe	68
4.2	Policy recommendations	68
	REFERENCES	70

LIST OF ABBREVIATIONS

- AA** Autonomous Aircraft
- AI** Artificial Intelligence
- AICOM** Artificial Intelligence for Europe Communication from the Commission
- BGB** German Civil Code
- BVLOS** Beyond Visual Line Of Sight
- CFR** Code of Federal Regulations
- CJEU** Court of Justice of the European Union
- CLRR** 2017 European Parliament Resolution on Civil Law Rules on Robotics
- DCIR** Draft Commission Implementing Regulation on Rules and Procedures for the Operation of Unmanned Aircraft
- EASA** European Aviation Safety Agency
- EDR** Event Data Recorder
- EEA** European Economic Area
- EGTL** European Group on Tort Law
- ENAC** Italian Civilian Aviation National Body
- EU** European Union
- FAA** Federal Aviation Authority
- FAR** Federal Aviation Regulations
- FCLRR** Follow-Up to the European Parliament Resolution on Civilian Law Rules on Robotics

FMRA	FAA Modernization and Reform Act
GARA	General Aviation Revitalization Act
GDPR	General Data Protection Regulation
GPS	Global Positioning System
IoT	Internet of Things
IR	Regulation 2004/785 on insurance requirements for air carriers and air operators
JORF	French Official Bulletin
LFG	German Aviation Law
LUC	Light UAS Operator Certificate
LuftVG	German Air Traffic Law
LuftVO	German Aviation Regulation
MOTD	Motor Directive
MS	Member State
MTOM	Maximum Take Off Mass
OJ	Official Journal of the European Union
PETL	Principles of European Tort Law
PLD	Directive 89/374 concerning liability for defective products
RCA	Regulation 2018/1139 on common rules for civil aviation
RMA	Risk Management Approach
RPAS	Remotely Piloted Aircraft System
RPAV	Remotely Piloted Aerial Vehicle

- SAE** Society of Automotive Engineers
- S&R** Search and Rescue
- SDR** Special Drawing Rights
- SUA** Small Unmanned Aircraft
- SUAS** Small Unmanned Aircraft System
- SURPAS** 2015 European Parliament Resolution on the Safe Use of RPAS
- SWDE** Staff Working Document on the Evaluation of Council Directive 85/374/EEC
- TSFS** Swedish Transport Agency Regulation
- UA** Unmanned Aircraft
- UAS** Unmanned Aircraft System
- UAV** Unmanned Aerial Vehicle
- UK** United Kingdom
- US** United States of America
- VLOS** Visual Line Of Sight

LIST OF TABLES

TABLE 1

Definitions and classification criteria by country.....30

TABLE 2

Civil liability rules by country.....52

LIST OF MAPS

MAP 1

Map of civil liability rules by country (fault-based or strict).....56

EXECUTIVE SUMMARY

Background

Advanced robotics and Artificial Intelligence (AI) applications raise many legal challenges, among which the regulation of civil liability is of fundamental, pre-emptive, importance.

Both the European Parliament resolution with Recommendation to the Commission on Civil Law Rules on Robotics (CLRR)¹, and the Follow-up provided by the Commission (FCLRR)², expressed the need to determine whether existent rules ensure high product safety *ex ante*, prompt victims' compensation *ex post*, allowing the proliferation of a European industry³.

Alternative regimes – objective and absolute liability rules, compulsory insurance schemes, compensation funds, risk-management and a one-stop-shop approach⁴ – have been considered to efficiently achieve the said objectives. However, given the relevant differences⁵, no one-fits-all solution is possible; rather, classes of applications need to be identified, according to similarities displayed in their design and functioning.

The Commission referred to a sound regulatory framework – especially concerning product safety and liability – as one of the pillars of its AI-strategy in its Communication of 25 April 2018⁶ (AICOM), and is working towards that direction by assessing relevant EU rules, including the Product Liability Directive (PLD)⁷, also by appointing two expert groups, with the aim of issuing guidance by mid-2019.

Objectives

Since the CLRR, drones have been identified as deserving specific regulation, and an adequate reflection on the matter is urgently called for, given their increasing diffusion.

This study (i) offers an overview of the different definitions and classifications of drones available across Member States (MSs) and in European Union (EU) legislation, to discuss which criteria ought to influence liability and insurance regulation. Pursuant to a Risk-Management Approach (RMA), (ii) it analyses liability rules applicable to drones at EU and MSs level, to (iii) assess whether such frameworks

¹ European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)) See <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2017-0051+0+DOC+XML+V0//EN> (last access 2.11.2018).

² See European Commission, *Follow up to the European Parliament Resolution of 16 February 2017 on Civil Law Rules on Robotics* (Bruxelles: 2017), http://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/JURI/DV/2017/11-20/A8-0005-2017_EN.pdf (last access 2.11.2018).

³ Paragraph 22, CLRR.

⁴ CLRR, esp. paragraphs 49 and ff., and FCLRR, p. 2.

⁵ Andrea Bertolini, "Robots as Products: The Case for a Realistic Analysis of Robotic Applications and Liability Rules," *Law Innovation and Technology* 5, no. 2 (2013); Andrea Bertolini and Erica Palmerini, *Regulating Robotics: A Challenge for Europe* (Bruxelles: 2014).

⁶ Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, *Artificial Intelligence for Europe*, SWD(2018) 137 final, <https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe> (last access 2.11.2018). See esp. p. 15.

⁷ Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, in OJ L 210, of 7.8.1985.

provide adequate incentives or whether intervention at EU level is advisable, and towards which direction, eventually (iv) formulating policy recommendation on the matter.

Methodology

The present study is based on desk research, building on the most recent data. It encompasses legislative instruments, academic work, publicly available documents, including those of the MSs' Authorities responsible for implementing and/or enforcing rules on civil use of drones.

Findings

The study found that the Regulation on Civil Aviation 2018/1139 (RCA)⁸ – which addresses issues of registration, certification and general rules of conduct for operators, but does not regulate civil liability directly – defines «unmanned aircraft» (UA) as any aircraft «operating or designed to operate autonomously or to be piloted remotely without a pilot on board», and classifies them according to the overall degree of danger they create.

On the contrary, the Insurance Regulation 785/2004 (IR)⁹ – setting insurance requirements for aircraft operators and air carriers – does not provide any definition of drone, and adopts a mass-based classification applicable to all aircrafts.

Meanwhile, MSs provide different definitions for UA, sometimes including and other times excluding autonomously operated aircraft, and generally classify them according to their weight.

The RCA does not set any specific liability rule, but merely states that the operator is liable for failing to ensure the safety of drones' operations, pursuant to criteria to be further specified by the Commission through delegated and implementing acts, which are now at a non-adopted and non-endorsed draft stage.

The IR sets compulsory insurance requirements on the operator, according to the above mentioned mass-based classification, where light devices employed for leisure or non-commercial purposes are exempted, and thus subject to non-uniform MSs laws.

MSs' legislation is articulated and results from the extension of civil aviation rules. Most countries adopt at least one strict liability rule, burdening primarily either the operator, or the owner, or the pilot. Few countries resort to standards of care, the majority adopts stricter rules, coupled with liability caps. Most MSs establish a duty to acquire third-party liability insurance, at times differentiating between commercial and non-commercial use.

Alongside with the said framework, other rules may apply. Most significantly, being «products», drones may fall within the scope of application of the PLD, whenever the accident is caused by their defectiveness.

⁸ 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, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91, in OJ L 212/1 of 22.8.2018.

⁹ Regulation (EC) No 785/2004 of the European Parliament and of the Council of 21 April 2004 on insurance requirements for air carriers and aircraft operators, in OJ L 138, 30.4.2004.

Recommendations

Pursuant to a RMA, liability should not be attributed on the basis of considerations of fault, rather on the party that is best positioned to minimize risks and acquire insurance, thus decoupling *ex ante* deterrence – to be achieved via safety regulation – and *ex post* compensation. Therefore, the RMA would suggest the drone's operator – who is best positioned to manage risks – shall be held strictly and objectively responsible, as to limit litigation costs, provide clear criteria for the ascertainment of liability, ease access to justice. Given the small awaited economic consequences, liability caps would not be appropriate.

Criteria that increase the overall potential risk of the single application, and diversify its importance, nature and size, may justify the imposition of specific requirements with respect to certification and insurance; on the contrary, this may not justify the need for a different liability scheme, identifying another subject as the ideal responsible party, whereas it might be sensible to differentiate liability depending on the use (commercial or recreational).

Both the RCA and the majority of MSs' regulations should be deemed adequate pursuant to a RMA, when they burden the party who may best identify and manage risks efficiently. However, overlap with other liability regimes may compromise compensation. Indeed, the PLD semi-strict liability for defective products regime is problematic, especially when advanced technologies are involved, because the difficulty in establishing the causal nexus, as well as the defective nature of the products, and problems of informational asymmetry, as well as the availability of the so-called development risk defence, make the ascertainment and apportionment of liability particularly complex and burdensome.

Furthermore, as of now, victims of accidents caused by drones don't easily obtain compensation, due to lack of insurance and identification, or insolvency on the side of insurers.

The in-depth study suggests that adoption of uniform rules, as initiated through the RCA, is the best option for regulating civil liability for civil use of drones. Indeed, intervention at EU level would be necessary to avoid market fragmentation as well as the diverging technical solutions, which may derive from the latter.

The definition of drones provided by the RCA is found to be adequate. Classifications should be used to determine certification and insurance requirements, which shall be dependent on the general level of risks associated with the use of the aircraft.

Liability should aim at ensuring easy compensation to the victim, through clear rules on the apportionment of liability and reduced litigation costs. Thus, liability rules should be strict, not fault-based, burden the only one party who is best positioned to manage risks, and acquire insurance, pursuant to a one-stop-shop approach. Being the party who is best positioned to and manage risks, and acquire insurance – the operator shall be held liable. However, in the case of non-commercial use of drones, the owner might be more easily identifiable and thence be held responsible as opposed to the operator, or jointly and severally obliged with him. Liability should also cover damages deriving from a defect in the device or human errors in the operation of the drone. However, the said party should be allowed to sue in recourse the manufacturer and the pilot respectively. If more party were held liable they should be jointly and severally liable for the same damages.

All drones should be covered by third-party insurance for damages deriving from their operation, and the latter should be made dependent exclusively on the different level of risks the single device poses in light of its intrinsic characteristics. For this reason, exceptions may be provided for model aircraft and toy drones, which – due to their specific purpose and context of use – would bring about very limited risks.

Given this peculiar significance of classification for the purpose of regulating civil use of drones, coordination between the RCA and the IR in this respect should be sought.

A compensation fund should be established to cover damages in all cases where the drone is not insured, and the pilot and/or owner and/or operator cannot be identified.

Such compensation fund could be financed through taxation or fees to be paid when the product is sold or manufactured.

GENERAL INFORMATION

KEY FINDINGS

- Regulation 2018/1139 (RCA) defines drones as unmanned aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board, and classifies them according to the overall degree of danger they create.
- MSs provide a different range of definition for UA, sometimes including and other times excluding autonomously operated aircraft; the majority of MSs classify drones according to their weight.
- Under the RCA, the operator is liable for failing to ensure the safety of drones' operation, pursuant to criteria to be further specified by the Commission. The Insurance Regulation 785/2004 (IR) sets compulsory insurance, according to a mass-based classification exempting light devices employed for non-commercial purposes.
- MSs have different and diverging rules. The majority adopt at least one strict liability rule, burdening primarily the operator (or the owner), provide liability caps, and establish compulsory insurance for third-party liability, at times differentiating between commercial and non-commercial uses.
- Pursuant to a RMA, liability should be attributed on the party that is best positioned to minimize risks and acquire insurance, decoupling compensation from deterrence, to be achieved via safety regulation.
- Thus, the operator shall be strictly and objectively liable, as to limit litigation costs, provide clear criteria for the ascertainment of liability, and ease access to justice. Given the small awaited economic losses, liability caps would not be needed.
- Criteria increasing the drones' overall potential risk might justify specific certification and registration requirements, and compulsory third party insurance.
- Compensation funds could help securing compensation.
- Both the RCA and the majority of MSs' regulations are adequate in a Risk Management perspective, when they burden the party who may best identify and manage risks efficiently, but overlap with the Product Liability Directive (PLD) and other liability regimes may compromise compensation.
- The adoption of uniform rules on the matter of civil liability and insurance requirements for drones at EU level, as initiated through the RCA, is the best option for regulating civil liability for civil use of drones.

1 REGULATING ROBOTICS: METHODOLOGICAL CONSIDERATIONS

KEY FINDINGS

- Various policy documents highlight the need to address how drones for civil use are developed and operated, and suggest different options for their regulation.
- Liability and insurance are fundamental, since they serve both the purpose of deterrence and compensation, ultimately affecting the development of a technological application, its market, as well as that of related services.
- To identify the best regulatory solution, it is necessary to analyse the initiatives adopted at MSs and EU level, to assess whether they create the right incentives, and to consider whether EU intervention is advisable, and – if so – how it should be elaborated. A brief description of the US system will be provided on the same matter in a comparative perspective, focussing on regulation applicable at federal level.
- In such analysis, attention shall be paid to the legal definitions and classification criteria used (e.g. size, place of deployment, type of use etc.), and how they affect the adequacy of the rule with respect to its underlying rationale, differentiate the solution adopted, and thus contribute in determining the optimal set of liability rules.

1.1. Regulating civil liability for drones: identifying the issues

The EU Commission in its 2014 Communication¹⁰ on sustainable development of remotely piloted aircraft systems (RPAS) stated that

«the progressive integration of RPAS into the airspace from 2016 onwards must be accompanied by adequate public debate on the development of measures which address societal concerns including safety [...] third party liability and insurance».

More recently, the EU Commission – in the Communication on Artificial Intelligence for Europe (AICOM)¹¹ – mentions drones as a noteworthy example of artificial intelligence (AI) embedded in a hardware device.

Indeed, the European Parliament in its Resolution of 16 February 2017¹², with recommendations to the Commission on Civil Law Rules on Robotics (CLRR) includes drones in the analysis of «Remotely piloted, automated, connected, and autonomous ways of road, rail, waterborne and air transport»¹³, and it

¹⁰ European Commission (2014). Communication from the Commission to the European Parliament and the Council: A new era for aviation. Opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner, COM (2014) 207 final, Bruxelles. <http://eurlex.europa.eu/legal-content/EN/TEXT/?uri=CELEX%3A52014DC0207> (last access 2.11.2018).

¹¹ Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Artificial Intelligence for Europe, SWD(2018) 137 final, <https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe> (last access 2.11.2018).

¹² P8_TA (2017) 0051 ((2015/2103(INL)). See <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2017-0051+0+DOC+XML+V0//EN> (last access 2.11.2018).

¹³ Paragraph 24, CLRR.

identifies safety, security and privacy as the main issues, related to drones, that Union law needs to protect¹⁴.

In the aforementioned document, the European Parliament urges the Commission to have safety assessments carried out, and to evaluate the benefits of introducing a compulsory system capable of providing identification and tracking of drones. Moreover, it is stated that

«homogeneity and safety of unmanned aircraft should be ensured by the measures set out in Regulation (EC) No 216/2008 of the European Parliament and of the Council»¹⁵.

Finally, reference is made to another European Parliament resolution, of 29 October 2015, on safe use of remotely piloted aircraft systems (RPAS), commonly known as unmanned aerial vehicles (UAVs), in the field of civil aviation¹⁶ (SURPAS). This document, indeed, fosters a class-based and risk-based approach, and includes drone classification, liability and insurance among the key issues. Indeed, the European Parliament:

«considers the question of identifying drones, of whatever size, to be crucial; underlines that solutions should be found which take into account the recreational or commercial use to which drones are put».

More broadly, the CLRR addresses the issue of liability as being of primary relevance, whenever the regulation of emerging technologies is concerned. Indeed, by determining the party who is going to bear the economic consequences of an accident, responsibility shapes the incentives for all players involved, influencing the market for that given product, as well as for relevant services – among which insurance –, also determining – under certain conditions – the kind of technical solution that will prevail among viable alternatives.

In such a perspective, the CLRR consider the possibility of adopting alternative approaches, encompassing solutions such as compulsory insurance schemes, automatic compensation funds, and the so called risk-management approach¹⁷.

So conceived, the issue of civil liability arising from the use of drones requires a complex assessment, starting with the identification of existing applicable norms regulating that very aspect, as well as tightly connected ones, primarily – for the matters at hand – insurance requirements. Both the national – Member States' – and the European levels need to be considered, in a comparative perspective (see Chapter 3 below), but reference will also be made to the United States, primarily at federal level, when relevant (see Section 2.3).

¹⁴ Paragraph 30, CLRR. Drones, moreover, are mentioned – especially with reference to identification and sensing and avoiding capabilities, in the Commission's reply to CLRR. See Follow up to the European Parliament resolution of 16 February 2017 on civil law rules on robotics 2015/2103 (FCLRR),

http://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/JURI/DV/2017/11-20/A8-0005-2017_EN.pdf, last access 2.11.2018.

¹⁵ This 2008 regulation (see *infra*) is no longer in force, since it was repealed by Regulation 2018/1139, for which see *infra*.

¹⁶ P8_TA (2015)0390 ((2014/2243(INI)). See <http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A8-2015-0261&format=XML&language=EN> (last access 2.11.2018).

¹⁷ Erica Palmerini and Andrea Bertolini, "Liability and Risk Management in Robotics," in *Digital Revolution: Challenges for Contract Law in Practice*, ed. Reiner Schulze and Dirk Staudenmayer (Baden-Baden: Nomos, 2016); Andrea Bertolini, "Insurance and Risk Management for Robotic Devices: Identifying the Problems," *Global Jurist*, no. 2 (2016).

To that end, the legal definitions and the corresponding classification criteria need to be taken into account, so as to identify differences and similarities among legal systems in describing the object – the technological application – they intend to regulate, and to determine which of those distinctions could have a bearing on the choice of the optimal set of liability rules (see Chapter 2 below).

Once the broader picture is depicted, it will be possible to discuss whether existent rules are adequate, in as much as they provide correct and desirable incentives to all subjects involved, and more specifically whether EU intervention is advisable, along which lines, and according to what criteria (see Chapter 3 below).

Before proceeding with the analysis, however, a more detailed discussion of the single issues this report is going to address in each of the following chapters will be provided, to further highlight the intimate connection between each part in the perspective of a functional analysis¹⁸.

1.1.1 Definitions and criteria for classification

The term «drone», also used by the European Parliament in its recommendations and in the title of the current study, is a-technical¹⁹, despite commonly used in the public sphere to refer to an aircraft, either

«controlled manually by means of a remote controller requiring a highly skilled operator [...] or precisely controlled from the remotely spaced programmable computers using the on-board autopilot and global positioning system (GPS)»²⁰.

Typically, both engineering and social science literature – including legal one – refers to such kind of applications as Autonomous Aircraft (AA), Unmanned Aircraft (UA), Unmanned Aircraft Systems (UAS), Unmanned Aerial Vehicles (UAV), Small Unmanned Aircraft (SUA), Remotely Piloted Aerial Vehicle (RPAV), Remotely Piloted Aircraft Systems (RPAS).

Among these, the name choices mentioning the concept of remote control, such as RPAS, and the ones referring to the idea of automation, such as AA, provide a closer description of the respective piloting technique employed, while the general reference to the absence of an inboard pilot (such as in UAS) aims at encompassing all the range of drones, regardless of their degree of automation²¹.

Moreover, words related to the idea of system (such as UAS) provide more comprehensive a view than similar descriptors that simply recall the vehicle in itself (such as UAV. A RPAV device is part of a RPAS environment, the latter is an accurate descriptor, since it provides exact reference to the non-fully-autonomous piloting technique, and to the interaction of a vehicle, a link and an operating infrastructure. In turn, the RPAS sub-class is a component of the broader UAS class²².

¹⁸ On the importance of a functional approach to the regulation of robotics, please do allow reference to Bertolini, "Robots as Products: The Case for a Realistic Analysis of Robotic Applications and Liability Rules.", as well as Ronald Leenes et al., "Regulatory Challenges of Robotics: Some Guidelines for Addressing Legal and Ethical Issues," *Law Innovation and Technology* (2017), and Erica Palmerini et al., "Robolaw: Towards a European Framework for Robotics Regulation," *Robotics and Autonomous Systems* 86 (2016).

¹⁹ Indeed, the word «drone» was initially meant to describe unmanned target aircraft in military aviation. A «drone» (in the mid-20th century military aviation), just like a «drone» (understood as the male of the honey bee) «has one happy flight and then dies». See A. H. Taylor, *Radio Reminiscences: A Half Century*. (Washington, D.C.: US Naval Research Laboratory, 1948).

²⁰ Kazi Mahmud Hasan, S. H. Shah Newaz, and Md. Shamim Ahsan, "Design and Development of an Aircraft Type Portable Drone for Surveillance and Disaster Management," *International Journal of Intelligent Unmanned Systems* 6, no. 3 (2018).

²¹ Stuart I. Granshaw, "Rpv, Uav, Uas, Rpas... Or Just Drone?," *The Photogrammetric Record* 162, no. 33 (2018). See esp. p. 165.

²² *Ibidem*.

The current study, however, will use both relevant technical terms, as indicated above, together with their widely diffused corresponding acronyms, as well as the word «drone», indistinctively, unless a specific – technical or legal – reason requires otherwise.

Legal definitions are essential to exactly identify what kind of application a specific norm regulates, and thence to determine its rationale – the outcome it intends to achieve – against which its efficiency and effectiveness needs to be assessed. In such a perspective, similar rules, enacted by single MS, if referring to different applications, might justify opposite conclusions about their adequacy, as well as contribute to describing an overall more fragmented picture than the one that would otherwise appear.

More specifically, when drones are considered, classifying criteria play a relevant role. Regulations typically differentiate machines according to size, place where the drones need to be deployed, and use – professional or not –, their ability to operate autonomously – or with higher levels of automation –, the amount of energy they might develop, the possibility to record images.

Briefly discussing the alternative criteria adopted to classify drones across the EU and the many MSs that enacted ad-hoc legislation is essential in order to define the broader picture and subsequently assessing the adequacy of existent civil liability rules. Comparison with the US will allow to observe how the same issues are tackled in a different legal system, where the use of drones is widely diffused (see Section 2.3). Indeed, some but not all the distinctions operated by ad-hoc legislation could play a role in the identification of the optimal liability rule, thence justifying a – partially – different treatment.

1.1.2 Liability, insurance and risk-management

Civil liability rules have a threefold effect.

Ex ante they are intended to induce the optimal behaviour on the side of the user, serving a function typically referred to as deterrence. In the law and economics literature, it is clearly stated that liability rules do commonly not intend to prevent all possible harm, for as to do so would require to radically ban certain activities or disincentivize them to a point that is not socially desirable.

In order to eradicate all lethal car accidents, road transportation ought to be radically prohibited, or safety requirements determined according to such criteria that automobiles would resemble tanks, increasing fuel consumption, reducing speed, as well as the possibility to maneuver on many roads. Overall, both such choices would entail too high social costs that are simply impossible to bear.

In such a perspective, liability concurs with product safety regulations, which directly define the minimal standards of quality and safety a single product needs to meet in order to be distributed onto the European market.

Ex post they are intended to ensure compensation to the victim, once the accident actually occurs. Compensation does not necessarily abide identical criteria as deterrence. Indeed, one party might be the one involved in performing a given activity – e.g. driver – and thence the one whose behaviour needs to be influenced in order to determine the optimal conduct, yet another party might be better positioned to bear the economic consequences of the accident – e.g. owner –, for they might possess larger economic resources or might more easily acquire insurance.

Typically, liability rules aim at addressing both functions simultaneously. At times, however, they primarily abide only one rationale. Under Italian law, for instance, both the driver and the owner of the vehicle are responsible for damages arising from circulation. Only the former, however, might choose the level of care to put in the activity, and the latter is bound to compensate any harm suffered by the

victim on merely objective grounds²³. The liability of the owner thence primarily serves the purpose of ensuring compensation.

When considering a single rule, it is therefore necessary to determine what function it pursues. Such an assessment shall not occur merely on theoretical grounds, rather it should involve a more articulated ascertainment of how rules are materially applied before courts. Said level of detail might not be met with respect to all MSs' legislations within the constraints of the current study. Empirical considerations will be drawn instead with respect to EU legislation, primarily relying on studies recently released by the EU Commission, namely a Staff Working Document (SWDE)²⁴ and an Evaluation-Final Report²⁵, in particular discussing the application of the Product Liability Directive (PLD)²⁶.

A comparative assessment of US legislation on the matter will complement the analysis (see Section 3.3).

Considerations about these two functions will guide the discussion with respect to the need to adopt alternative approaches, such as those mentioned by the Recommendations of the EU Parliament, namely compulsory insurance, automatic compensation funds, and/or a Risk Management Approach (RMA).

The third effect of liability rules further stems from the two mentioned above, and is a consequence of both, and more specifically of the final choice in terms of allocation, operated by the legislator. The way liability rules play out, ultimately reverberate upon the very design of the single device²⁷ for, among possible technical alternatives, a rational agent will opt in favour of the one that minimizes the risks associated with the application of all rules, including those distributing responsibility.

1.1.3 The role for Europe

The impact of liability rules on technological development is one of the considerations that could justify an intervention at EU level, and therefore it will be discussed. Indeed, if liability rules caused

²³ Art. 2054, Italian Civil Code states that «The driver of a non-railed vehicle is obliged to compensate for damage to persons or property caused by the vehicle if he does not prove that he has done everything possible to avoid the damage. [...] The owner of the vehicle, [...] is jointly and severally liable with the driver, if he does not prove that the vehicle has been driven against his will». See Massimo Franzoni, "L'illecito," in *Trattato Della Responsabilità Civile*, ed. Massimo Franzoni (Milano: Giuffrè, 2010). See esp. pp. 569 ff. See also Marco Bona, *Art. 2054, Commentario del Codice civile* (Turin: UTET, 2011). See esp. pp. 326 ff. See also Antonello Negro, "Art. 2054," in *Artt. 2054-2059 - Fatti Illeciti - Vol.II: Circolazione Di Veicoli, Responsabilità Solidale, Valutazione, Danni Non Patrimoniali*, ed. Paolo Cendon (Milan: Giuffrè, 2009).

²⁴ Commission Staff Working Document. Evaluation of Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, Brussels, 7.5.2018, SWD(2018) 157 final, see

<https://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKewih9PmxmlbeAhUICsAKHRxQA1sQFjAAegQICBAB&url=https%3A%2F%2Feur-lex.europa.eu%2Flegal-content%2FEN%2FTXT%2F%3Furi%3D%3A2018%3A157%3AFIN&usq=AOvVaw0lq8XRuUau7t4Hw3aYyXCm> (last access 2.11.2018).

²⁵ Ernst&Young, Technopolis, and VVA, *Evaluation of Council Directive 85/374/Eec on the Approximation of Laws, Regulations and Administrative Provisions of the Member States Concerning Liability for Defective Products* (Brussels: European Commission, 2018). https://publications.europa.eu/en/publication-detail/-/publication/d4e3e1f5-526c-11e8-be1d-0aa75ed7_1a1/ lang_ua ge-en (last access 2.11.2018).

²⁶ Council Directive 85/374/EEC of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, in OJ L 210, of 7.8.1985.

²⁷ For a detailed analysis of this aspect with respect to driverless vehicles, please allow reference to Andrea Bertolini and Massimo Riccaboni, *The Regulation of Connected and Automated Driving. A Law and Economics Analysis of Liability Rules* (2018).

technological fragmentation, which could impair the creation of a common market for such devices, their free circulation, competition and ultimately the proliferation of a European industry, an intervention could be justified²⁸.

Otherwise, general civil responsibility is typically regulated at MSs' level, and despite theoretical efforts having been made to identify common denominators²⁹, no real attempt to provide a uniform set of rules was until today undergone. A detailed discussion of this matter falls beyond the purposes of the study and, more generally, of the debate about the need for the adoption of an alternative approach for drones. Reference will be made when essential.

²⁸ Bertolini and Palmerini.

²⁹ Within the European Group on Tort Law (EGTL), the Principles of European Tort Law (PETL) have been elaborated, in order «to address the fundamental questions underlying every tort law system» and with the aim of «identifying these principles, thus searching for a common law of Europe, without the necessity yet to lay these principles down in formal legal texts, such as a European civil code». PETL are thought, moreover, with a twofold aim, since «the finding of these principles will already have an important academic as well as practical value in itself since it will teach the academic and practitioner the fundamental questions underlying the law of tort in a particular country as well». For further information, see <http://www.egtl.org/> (last access 2.11.2018).

2 DEFINITIONS AND CRITERIA FOR CLASSIFICATION

KEY FINDINGS

- The RCA addresses issues of registration, certification and the general rules of conduct for operators, and does not address civil liability directly.
- It defines «unmanned aircraft» (UA) as any aircraft «operating or designed to operate autonomously or to be piloted remotely without a pilot on board of drones», thus including model aircraft. It identifies the overall degree of danger as the preminent criterion of classification.
- Implementing and delegated acts will regulate UA's certification and registration requirements, to ensure «safety, privacy, protection of personal data, security», by setting technical requirements for marketing and to allow the identification of both UA and their operators.
- MSs provide a different range of definition for UA, sometimes including and other times excluding autonomously operated aircraft; the majority of MSs classify drones according to their weight.
- Under a RMA, criteria that increase the overall potential risk of the single application, and diversify its importance, nature and size, may justify the imposition of specific requirements with respect to certification and insurance.
- Greater risks do not justify the need for a different liability scheme, identifying another subject as the ideal responsible party, whereas it might be sensible to differentiate liability depending on the use (commercial or recreational).
- The US regulates drones primarily at federal level since the sovereignty over the airspace belongs to the US Government.
- Drones are defined as aircraft «operated without the possibility of direct human intervention from within or on the aircraft» and are distinguished from model aircraft, kites, unmanned free balloons, moored balloons and amateur rockets.
- The Federal Aviation Authority (FAA) provides detailed registration requirements for all drones above 0.55 lbs. Registration requirements differ according to the use (professional or not), and yet apply to both.
- In the US drones are classified according to weight and purpose.

Drones are regulated both at MSs' and EU level. Despite the latter currently not addressing civil liability directly, it provides a broader framework with definitions, classification criteria, and certification requirements that need to be considered, according to the methodological considerations made above (see Section 1.1.1 above)

Therefore, the study will provide a brief account of current EU (see Section 2.1 below) and MSs' (see Section 2.2 below) legislation, as well as a brief introduction to US regulation at federal level (see Section 2.3 below), focusing on the different definitions of drones they provide, as well as identifying the relevant classification criteria employed. A table (see Table 1 – Definitions and classification criteria

by country below) will then briefly summarize the information provided, so as to ease the final discussion (see Section 2.2 below) on what criteria ought to be considered for the purposes of the identification of the optimal liability rule.

2.1 The European legal framework

Since 11 September 2018, the main EU body of law concerning drones is Regulation (EU) 2018/1139³⁰ (RCA), which does not directly address neither liability nor insurance, but only the related issues of registration, certification and the general rules of conduct operators must abide by.

Until 2018, regulation for drones depended upon their operating mass³¹. EU law concerned only UAVs which featured an operating mass exceeding 150 kg, while MSs were in charge for lighter devices.

Lately, the European legislator acknowledged that technological advancement, and the wide range of applications unmanned aircraft are used for, causes the mass-based criterion to become insufficient in defining the device's features, and subsequently the risks it entails³². Thence, the RCA includes all unmanned aircraft in its scope, whether exceeding 150 kg or not, in order to better pursue safety and compliance with rights guaranteed by EU law³³, while providing different regimes, concerning operating rules, according to other factors, such as, for instance, the risks involved, and the energy transferred (see *infra*). Indeed, the aforementioned risk-based and class-based approach, suggested by the European Parliament in SURPAS, is at the foundation of RCA itself.

Regardless of any other consideration, however, state-operated devices are exempted from compliance with RCA³⁴, revealing what might appear as an inconsistency with the aforementioned framework, chiefly focused on the specific risk a single device – due to its intrinsic characteristics and to the use it is put at³⁵ – gives rise to, which is largely independent from the public or private nature of the party operating it.

As per definition, the RCA resorts to the notion of «unmanned aircraft» (UA) as any aircraft:

«operating or designed to operate autonomously or to be piloted remotely without a pilot on board»³⁶.

Such a notion includes «model aircraft», only mentioned among the recitals as an unmanned aircraft «primarily used for leisure activities»³⁷, pursuant to a choice which is consistent with the most recent literature, that noted how establishing unnecessary distinctions «detrimentally affects the

³⁰ 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, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91, in OJ L 212/1 of 22.8.2018.

³¹ Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC, in OJ L 79, 19.3.2008.

³² Recital 26, RCA

³³ Recital 28, RCA.

³⁴ Art. 2(3)(a), RCA.

³⁵ Indeed, the European Parliament, in paragraph 30, CLRR, identifies search and rescue (S&R), typically performed by public authorities, as one of the fields where drone contribution is more advanced and effective.

³⁶ Art. 3(30), RCA.

³⁷ Recital 34, RCA.

development as well as implementation of regulatory solutions»³⁸. Indeed, it was discussed whether model aircraft should be kept separate, in as much as they do not always pose relevant threats, being typically operated in safe environments – ad-hoc facilities or open fields – and not in densely populated areas, by well trained and safety-aware users. Indeed

«the way the clubs for model aircraft are organised, their experience, their safety culture, etc. provide an equivalent level of safety to the one [desired]»³⁹.

For such a reason it could be disputed whether including them under UA for the purpose of regulating certification and registration requirements as well as liability is a sensible choice. However, the RCA is largely prospective (see also Section 3.1 below) since it calls on the Commission to adopt more detailed legislation, also with respect to certification requirements. Thence, if under those and other aspects (including liability) a distinction will be made, separating model airplanes, it is today hard to anticipate, given the general nature of existent norms.

As per the choice of the term «unmanned aircraft», it shall be noted that the most recent literature rather resorts to «RPAS», to clearly display that the drone is part of a system, and functions in combination with other devices and implements (see *supra*).

The RCA mentions both fully autonomous operation and remote piloting⁴⁰. However, while multiple reference is made to the latter⁴¹ – as well as to «equipment to control unmanned airplane remotely»⁴² –, autonomous or automatic operation is not further mentioned, beyond the very definition of UA.

UA's certification and registration requirements – to be defined through implementing and delegated acts as recalled by Articles 57 and 58 respectively –, consistently with a risk-centred perspective⁴³ – which takes into account «the operation or type of operations»⁴⁴ the device is to perform – are intended to ensure «safety, privacy, protection of personal data, security», as well as environmental protection⁴⁵. We shall thence expect that forthcoming legislation will take the peculiar characteristics of each application into account, in light of the material risks they might give rise to.

³⁸ Mikko Huttunen, "Unmanned, Remotely Piloted, or Something Else? Analysing the Terminological Dogfight," *Air & Space Law* 42, no. 3 (2017). See esp. p. 366.

³⁹ European Aviation Safety Agency (EASA, 2016), Prototype Commission Regulation on Unmanned Aircraft Operations, <https://www.easa.europa.eu/system/files/dfu/UAS%20Prototype%20Regulation%20final.pdf> (last access 2.11.2018). See also Filippo Tomasello and Marco Ducci, *Research for Tran Committee: Safe Integration of Drones into Airspace* (Brussels: European Parliament, 2016). See esp. p. 27.

⁴⁰ Different levels of automation exist, as it is today for the Society of Automotive Engineers (SAE) levels of automation in connected and automated driving solutions. See for instance Felipe Jiménez et al., "Communications and Driver Monitoring Aids for Fostering Sae Level-4 Road Vehicles Automation," *Electronics* 7, no. 10 (2018).

⁴¹ Pursuant to Art. 3(31), RCA, «a natural person responsible for safely conducting the flight of an unmanned aircraft by operating its flight controls, either manually or, when the unmanned aircraft flies automatically, by monitoring its course and remaining able to intervene and change the course at any time».

⁴² Pursuant to Art. 3(32), RCA, «any instrument, equipment, mechanism, apparatus, appurtenance, software or accessory that is necessary for the safe operation of an unmanned aircraft, which is not a part, and which is not carried on board of that unmanned aircraft».

⁴³ Recital 27, RCA, see also 1.2, Annex IX, RCA, where it is stated that «An unmanned aircraft must be designed and constructed so that it is fit for its intended function, and can be operated, adjusted and maintained without putting persons at risk».

⁴⁴ Recital 26, RCA.

⁴⁵ Recital 31, RCA.

At the moment of writing, only partial drafts are available, non-adopted and non-endorsed by the European Commission⁴⁶. No specific reference to insurance is made, nor to a liability framework. Nonetheless, the Draft Commission Implementing Regulation (DCIR) provides, in its Annex, detailed regulations for both the operator and the remote pilot – both before and during the flight –, for both open and specific operations, as well as for holders of a Light UAS Operator Certificate (LUC)⁴⁷.

For the purpose of this analysis, it is sufficient to mention that operators are burdened, among other tasks, of developing operational procedures, designating remote pilots, properly instructing them and providing them with all relevant pieces of information. On their side, remote pilots are required to obtain all relevant pieces of information, abstain from psychoactive substances, perform checks, assess the device's conditions, abide by the users' manual and be ready to interrupt the operation, should it become dangerous.

Consistently with a risk-based approach, conduct rules for operators and pilots cover more aspects and are more restrictive for specific operations, compared to open operations. Moreover, the framework related to operations involving a LUC are modelled after specific operations, plus additional requirements.

The extensive and narrow-tailored rules provided by DCIR, therefore, provide an accurate – though still tentative – assessment of the standards of conduct that may be expected from both drone operators and pilots.

More broadly, while certification serves the purpose of ensuring compliance with the RCA and subsequent delegated and implementing acts⁴⁸, registration is primarily intended to allow the identification of both UA and of operators, through «digital, harmonised, interoperable national registration systems» that all other MSs should be able to access, to exchange information⁴⁹.

Operators are required to register when «they operate any of the following: (a) unmanned aircraft which, in the case of impact, can transfer, to a human, kinetic energy above 80 Joules; (b) unmanned aircraft the operation of which presents risks to privacy, protection of personal data, security or the environment; (c) unmanned aircraft the design of which is subject to certification pursuant to Article 56(1)»⁵⁰. The concrete risks the single device poses, in light of its size, power and speed, as well as for the sensor or recording equipment it is provided with, justify such a selection that could however lead to a wide application of such duty, in particular considered how most drones meet the criterion *sub* (b) above.

⁴⁶ For further information, see https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2018-1460265_en (last access 2.11.2018).

⁴⁷ Pursuant to Art. 3, DCIR, «(a) UAS operations in the open category shall not be subject to any prior authorisation, nor to an operational declaration by the UAS operator before the operation takes place; (b) UAS operations in the specific category shall require an operational authorisation issued by the competent authority, or a declaration issued by a UAS operator; (c) UAS operations in the certified category shall require the certification of the UAS and of the operator, and the licensing of the remote pilot where applicable».

⁴⁸ Art. 3(9), RCA.

⁴⁹ Art. 56(7), RCA.

⁵⁰ Art. 4.2, Annex IX, RCA.

2.2 Member States' legal framework

Providing a detailed account of all MSs' legislation falls beyond the purposes of the current study.

Instead, it will provide a broad picture, primarily focusing on the definition of drones adopted, and on the classifying criteria chosen, as well as on duties to register.

2.2.1 Spain

Spain has regulated unmanned aircraft since 2002. The regulation was considerably revised in 2017 and it is provided by the Royal Decree 1036/2017, regulating the civil use of Unmanned Aircraft Systems (UAS)⁵¹.

Rules apply specifically to remotely-piloted aircraft systems RPAS (Article 5): autonomous UAS are not addressed in the Decree. In addition, concerning domestic classification system, the obligation of registration varies according to the drone's weight: registration is mandatory only for RPAS that weigh more than 25 kg (Article 9).

2.2.2 France

In France the use of civilian drones is regulated by the recent Decree of 17 December 2015, although rules of liability are mainly contained in the Transport Code⁵².

Drones are divided into three categories on the basis of their performance: leisure and competition drones, flying for experimental uses, and «particular activities», which essentially means commercial use of drones or everything else. Moreover, according to the Decree, geographical restrictions apply to drones of all categories, in order to ensure the safety of people, property and other aircraft. Governmental approval is required to fly over public areas of urban zones and the law specifies also maximum altitudes for drones' flight.

Registration is mandatory according to Article L6111-1 Transport Code, with the exception of unmanned aircraft that weigh less than 25 kg.

2.2.3 Belgium

The Belgian Transport Public Service recently published the Royal Decree of 10 April 2016⁵³, concerning the use of drones in Belgium. New law deals with remotely – piloted aircraft systems (RPAS), defined as an aircraft that weighs less than 150 kg and controlled by the pilot from a distance pilot station, and it leaves unregulated autonomous UAV (fourth paragraph of Article 1).

⁵¹ Real Decreto 1036/2017, de 15 de diciembre, por el que se regula la utilización civil de las aeronaves pilotadas por control remoto, y se modifican el Real Decreto 552/2014, de 27 de junio, por el que se desarrolla el Reglamento del aire y disposiciones operativas comunes para los servicios y procedimientos de navegación aérea y el Real Decreto 57/2002, de 18 de enero, por el que se aprueba el Reglamento de Circulación Aérea.

⁵² Arrêté du 17 décembre 2015 relatif à l'utilisation de l'espace aérien par les aéronefs qui circulent sans personne à bord (NOR: DEVA1528469A) Version consolidée au 12 juin 2018; JORF n°0298 du 24 décembre 2015 page 23897, Texte n° 22 Arrêté du 17 décembre 2015 relatif à la conception des aéronefs civils qui circulent sans personne à bord, aux conditions de leur emploi et aux capacités requises des personnes qui les utilisent (NOR: DEVA1528542A). See also the Ordonnance no. 2010-1307 du 28 octobre 2010 (basis of Transport Code).

⁵³ Arrêté royal 10 avril 2016 relatif à l'utilisation des aéronefs télé pilotés dans l'espace aérien belge, Moniteur Belge C – 2016/14116, page 25944.

The rules distinguish drones into three classes – drones for leisure, class 2 and class 1 (further divided between class 1b and class 1a) – on grounds of weight and operations. In detail, class 2 includes drones that weigh less than 5 kg, used for non-dangerous activities; class 1b RPAS are heavier and used for moderate risk operations and class 1a RPAS for dangerous activities.

Drones of all categories must be registered (Article 53), except for leisure drones.

2.2.4 The United Kingdom

The UK acts that cover the regulation of drones are the Civil Aviation Act 1982⁵⁴, the Air Navigation Order 2016⁵⁵ and the recent Air Navigation (Amendment) Order 2018⁵⁶. The definition of drone is contained in the Guidance by Civil Aviation Authority on UAS operation in UK airspace⁵⁷:

«An aircraft which is intended to operate with no human pilot on board, as part of an Unmanned Aircraft System. Moreover, an UA: is capable of sustained flight by aerodynamic means is remotely piloted and/or capable of degrees of automated or autonomous operation; is reusable; and is not classified as a guided weapon or similar one-shot device designed for the delivery of munitions».

Hence, the UK regulation involves not only RPAS, but also autonomous UAS.

Classification of UAS is based on simple discriminants or types (e.g. balloon, fixed or rotary wing) and mass: SUA (less than 20 kg) and Light UAS (from 20 kg to less than 150 kg). In addition, Article 94 of the Air Navigation Act 2016 establishes restrictions on the areas where drones can operate. An aircraft must not fly in or over the UK unless it is registered with the Civil Aviation Authority.

2.2.5 Italy

In Italy, drones are mainly regulated by the Ente Nazionale dell'Aviazione Civile (ENAC) Regulation (modified on 21 May 2018)⁵⁸ and by the Navigation Act⁵⁹ (Royal Decree 327/1942).

The ENAC Regulation distinguishes between RPAS and autonomous UAS: RPAS are defined as remotely – piloted aircraft systems without people on board, whereas an autonomous system is described as a RPAS in which the pilot cannot intervene in real time to control the aircraft.

The operation of a UAS that weighs more than 25 kg requires a registration (Article 14). No particular procedure is required for small drones.

⁵⁴ Of 27.5.1982.

⁵⁵ 2016 No. 765, of 13.7.2016.

⁵⁶ 2018 No. 623, of 23.5.2018.

⁵⁷ Unmanned Aircraft System Operations in UK Airspace – Guidance. Sixth edition, 31.3.2015.

⁵⁸ Regolamento ENAC – Mezzi aerei a pilotaggio remoto, Edizione 2 del 16 luglio 2015, modified by the Emendamento 4 del 21 maggio 2018.

⁵⁹ Regio Decreto 30 marzo 1942, n. 327.

2.2.6 Denmark

The Danish Air Aviation Act⁶⁰ defines a drone as an unmanned aircraft and it contains detailed rules concerning different flight areas and conditions to fly over them (in particular outside or over inhabited areas).

Thus, the categorization does not concern weight or size of drones, but the area in which they fly. In particular, the most important difference is related to the age of the remote pilot: it is possible to fly over inhabited areas only if the professional remote pilot has attained the age of 18 (paragraph 126 e. Chapter 9). It is a condition for all categories of operation that the drone owner is registered with the Danish Transport, Construction and Building Authority.

2.2.7 Sweden

The use of drones in Swedish airspace is regulated by the Swedish Transport Agency's regulations on unmanned aircraft systems of 4 October 2009⁶¹. Section 2 of Chapter 1 of this regulation describes an UAS as a system which consists of an unmanned aircraft and other components which are required to be able to control the aircraft at a distance, by one or more persons. Thus, it seems not to concern RPAS.

Swedish system provides several categories of drones based on weight and areas where they are allowed to fly: category 1a, for drones with maximum take-off weight of less than or equal to 1.5 kg, which are flown only within the visual line of sight of the pilot; category 1b, for drones with maximum take-off weight of more than 1.5 kg but less than or equal to 7 kg, which are flown only within the visual line of sight of the pilot; category 2, for drones with maximum take-off weight of more than 7 kg which are flown only within the visual line of sight of the pilot and category 3, for drones which are allowed to be controlled beyond the visual line of sight of the pilot (Section 1 of Chapter 2). The operator doesn't have any obligations of registration, but UAS of all categories must be marked with the operator's name and telephone number and with the approval number from Swedish Transport Agency (Section 13 of Chapter 2).

2.2.8 Czech Republic

The use of civilian drones in the Czech Republic is governed by Czech Republic Aviation Law 49/1997⁶². Attachment X of this law concerns unmanned aircraft systems: Article 1 defines autonomous aircraft as unmanned aircraft that does not allow pilot intervention in the management of the flight and unmanned aircraft (UA) as aircraft which is intended to be operated with no pilot on-board.

The law requires different limitations and flight conditions according to the drone's weight and functions: it distinguishes into drones that weigh less than 0.91 kg, between 0.91 kg and 7 kg, between 7 kg and 20 kg, more than 20 kg; according to weight, drones can be used for recreational activities or for commercial and experimental purposes. Obligations of registration vary according to this categorization: in fact, registration is required only for commercial and experimental uses.

⁶⁰ Consolidated Act no. 1036 of 28 August 2013 with the amendments following paragraph 6 of Act no. 736 of 25 June 2014, paragraph 9 of Act no. 742 of 1 June 2015, Act no. 1896 of 29 December 2015, paragraph 39 of Act no. 426 of 18 May 2016 and Act no. 602 of 4 June 2016.

⁶¹ (UAS) TSFS 2009:88 AVIATION Series GEN.

⁶² Act 49/1997 Coll. on civil aviation and amending Act 455/1991 Coll. on trade licensing (Trade Licensing Act) as amended by later regulations (further referred to as Civil Aviation Act).

2.2.9 Poland

Aviation Act and implementing regulations issued by the Minister of Transport, Construction and Maritime Economy (Regulation of 26 March 2013; Regulation of 3 June 2013; Regulation of 26 April 2013) regulate the operations of unmanned aircraft systems in Poland⁶³.

No definition of UA is provided by Polish law, but only one of «flying model», that is «unmanned aerial vehicles of mass of not more than 150 kg, used only in operations within range visual visibility of VLOS for recreational or sports purposes».

Polish acts (paragraph 2 of Regulation of 7 August 2013) distinguish between commercial and non-commercial use of drones: a certificate is mandatory only for operators of commercial UAS. Registration is required for UAS exceeding 25 kg.

2.2.10 The Netherlands

The use of civilian drones in the Netherlands is governed by the recent Regulation of remotely – piloted aircraft systems of 6 October 2017⁶⁴.

Rules apply specifically to remotely – piloted aircraft systems (RPAS), defined by Article 1 of the Regulation: it clarifies that a RPAS is not a model aircraft. Flying with completely autonomous unmanned aircraft remains prohibited.

Operating RPAS that weigh more than 4 kg involves many standard restrictions on flight areas and it requires specific authorisations (Article 14, Article 15, Article 16). For example, the maximum altitude attainable is 120 m, visual line of sight cannot be interrupted, drone cannot fly more than 500 m far from the observer or pilot and closer than 50 m to infrastructures or people.

If the drone weighs less than 4 kg, special rules apply: the pilot cannot stay further than 100 m from the drone, while it must fly at an altitude lower than 40 m, in areas where manned aircraft can fly at low altitude, or 50 m, in all other areas.

2.2.11 Austria

Austrian law regulates drones in the Austrian Aviation Act⁶⁵. For the purpose of this study – thus, excluding drones used for national security service and military purposes – unmanned aerial vehicles are subject to four-partite definition, based on their technical specifications, and the purpose of their use.

The first category comprises «flight models», unmanned devices [...] that can be used independently in flight within the visual line of sight of the pilot, within a radius of no more than 500 m and, ii) only

⁶³ Ustawa z dnia 3 lipca 2002 r. Prawo lotnicze, Dziennik Ustaw Rzeczypospolitej Polskiej, Aug. 16, 2002, No. 130/2002, 1112; Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki Morskiej z dnia 26 marca 2013 r. w sprawie wyłączenia zastosowania niektórych przepisów ustawy – Prawo lotnicze do niektórych rodzajów statków powietrznych oraz określenia warunków i wymagań dotyczących używania tych statków, Dziennik Ustaw, 2013, 440; Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki Morskiej z dnia 3 czerwca 2013 r. w sprawie świadectw kwalifikacji, Dziennik Ustaw, 2013, 664; Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki Morskiej z dnia 26 kwietnia 2013 r. w sprawie przepisów technicznych i eksploatacyjnych dotyczących statków powietrznych kategorii specjalnej, nieobjętych nadzorem Europejskiej Agencji Bezpieczeństwa Lotniczego, Dziennik Ustaw, 2013, 524.

⁶⁴ Regeling op afstand bestuurde luchtvaartuigen Geldend van 01-07-2016 t/m 06-10-2017.

⁶⁵ Bundesgesetz vom 2. Dezember 1957 über die Luftfahrt (Luftfahrtgesetz – LFG), BGBl. Nr. 253/1957 (NR: GP VIII RV 307 AB 318 S. 40. BR: S. 128.

free of charge and non-commercially in the leisure area and exclusively for the purpose of the flight itself».

The second category – commonly referred to as «toy drones» – comprises unmanned devices with maximum motion energy below or equal to 79 joules, which can be flown independently, and are operated no higher than 30 m above ground.

The third category – «Class 1 Unmanned aerial vehicles» – are only allowed to be operated in the direct (without technical aid) unobstructed line of sight between the pilot and the aircraft, with a maximum flight altitude of 150 m above ground level, and can also be flown for commercial purposes or purposes other than the flight itself. An approval from the Austro Control is needed.

The fourth type – «Class 2 Unmanned aerial vehicles» – comprises unmanned vehicles that are capable of autonomous flight and can be operated beyond the visual line of sight. They will be certified and operated like manned civil aircraft, and pilot licenses are necessary for the operation. They can currently only be operated as experimental aircraft.

2.2.12 Germany

In Germany, the regulation of unmanned aircraft is contained in two main acts: the Air Traffic Act and the Air Traffic Regulation⁶⁶. The former defines an unmanned aerial systems (UAS) as an «unmanned aerial vehicles (UAV), including their control stations, which are not used for hobby or recreational purposes» (paragraph 1). Thus, the categorization depends on the use of UAV: drones used for leisure are not included in the category of UAS, but they are classified as model aircraft.

Different authorisations from the aviation authority are required for UAS weighing more than 5 kg: a general authorisation for drones that weigh 5 kg (valid for two years) and a specific authorisation case by case for UAS that weigh between 5 and 25 kg (valid for the time specified in the authorization). Using UAS that exceed 25 kg or outside the visual line of sight of the operator is generally prohibited.

2.2.13 Ireland

In Ireland, an unmanned aircraft is defined by the Irish Aviation Authority Small Unmanned Aircraft (drones) and Rockets Order 2015⁶⁷ as an aircraft including a drone without a human pilot on board (Article 2). The Irish system does not provide a complex categorization of drones: according to Article 6 of the Order, all drones that weigh over 1 kg must be registered.

2.3 The United States legal framework

In the United States drones are regulated primarily at federal level, and the Federal Aviation Administration (FAA) is the authority in charge. The main bodies of law relevant to UA are Part 107 of the Federal Aviation Regulations (FAR)⁶⁸, and Section 331 and ff. of the FAA Modernization and Reform

⁶⁶ Luftverkehrsgesetz in der Fassung der Bekanntmachung vom 10. Mai 2007 (BGBl. I S. 698), das zuletzt durch Artikel 2 Absatz 11 des Gesetzes vom 20. Juli 2017 (BGBl. I S. 2808; 2018 I 472) geändert worden ist (LuftVG), Neugefasst durch Bek. v. 10.5.2007 I 698, zuletzt geändert durch Art. 2 Abs. 11 G v. 20.7.2017 I 2808; Luftverkehrs-Ordnung vom 29. Oktober 2015 (BGBl. I S. 1894), die zuletzt durch Artikel 2 der Verordnung vom 11. Juni 2017 (BGBl. I S. 1617) geändert worden ist, Geändert durch Art. 3 G v. 28.6.2016 I 1548, Änderung durch Art. 2 V v. 30.3.2017 I 683 (Nr. 17) Änderung durch Art. 2 V v. 11.6.2017 I 1617 (Nr. 37) mWv 1.7.2017 noch nicht berücksichtigt Ersetzt V 96-1-2 v. 10.8.1963 I 652 (LuftVO).

⁶⁷ Irish Aviation Authority Small Unmanned Aircraft (drones) and Rockets Order, S.I. No. 563 of 2015, of 21.12.2015.

⁶⁸ In itself Title 14 of Code of Federal Regulations (CFR) on 21 June 2016, which came into effect on 29 August 2016.

Act (FMRA)⁶⁹. Indeed, Section 49 U.S. Code, paragraph 40103 on the sovereignty and use of airspace, establishes that

«The United States Government has exclusive sovereignty of airspace of the United States».

Since the FAA is competent to adopt regulations on air traffic and aircraft, state laws are limited in this field. State and local regulations might introduce restrictions with respect to flight areas where drones can be operated, and yet such restrictions require a previous consultation with FAA⁷⁰ to be enacted. Other aspects, such as – possible limitations to – police power in the use of UAS are also dealt with at State level⁷¹, as well as issues of liability that depend upon the application of general principles of tort law as well as of product liability (see Section 3.3 below).

All other aspects, ranging from the definition of drones, to registration requirements, classification, and flight authorization are instead dealt with at federal level as indicated.

In particular Part 107.3 of the FAR defines unmanned aircraft as

«an aircraft operated without the possibility of direct human intervention from within or on the aircraft», and

a small unmanned aircraft as

«an unmanned aircraft weighing less than 55 pounds [...]» (25 kilograms).

Such definitions are broad and general – for they only exclude the presence of a human pilot on or in the aircraft – allowing for further adaptation to future technological advancements.

Both UA and SUA are clearly differentiated from model aircraft, moored balloons, kites, amateur rockets, and unmanned free balloons, who are instead regulated by Part. 101, FAR that establishes a simplified regime based on a

«community-based set of safety guidelines and within the programming of a nationwide community-based organization».

Drones are primarily classified according to two criteria: weight and purpose. With respect to the former three categories are identified, namely: UA weighing less than 0.55 lbs, UA comprised between 0.55 and 55 lbs, and UA exceeding 55 lbs.

With respect to the latter, public, civil, commercial and recreational use are distinguished.

Classification according to weight, among others, matters for the purpose of registration requirements. All drones weighing more than 0.55 lbs are to be registered. Those that exceed 55 lbs must undergo a more articulated registration procedure, that unlike that for smaller devices, cannot be completed electronically⁷².

⁶⁹ No. 112-95 of 14.2.2012. This body of law concerns mostly the authorization framework, which falls outside the issues discussed in this analysis.

⁷⁰ State and Local Regulation of Unmanned Aircraft Systems (UAS), Fact Sheet, Federal Aviation Administration, Office of the Chief Counsel, December 17, 2015.

⁷¹ For instance, in Virginia: House Bill n. 2125, January 14, 2015, *A bill to amend the Code of Virginia by adding in Chapter 5 of Title 19.2 a section numbered 5 19.2-60.1, relating to use of unmanned aircraft systems; search warrant required*; in New Jersey: Assembly Bill n. 1039, October 27, 2014, that requires police to obtain a warrant before using surveillance drones, except in emergency situations; in California: Assembly Bill n. 856, October 6, 2015, CHAPTER 521, *An act to amend Section 1708.8 of the Civil Code, relating to privacy*. In a number of States, such as New York and Pennsylvania, there are currently no state bodies of law about drones.

⁷² Registration is to be carried out online. For further information, see <https://www.faa.gov> (last access 22.11.2018)

Table 1 – Definitions and classification criteria by country

Member State	Legal Act	Definition	Categorization according to weight	Categorization according to flight range	Categorization according to purpose
Spain	Real Decreto 1036/2017 (Art. 5, Art. 9)	Aircraft that the pilot controls from a distant pilot station	> 25 kg		
France	Arrêté du 17 décembre 2015 (Art. 3) + code des transports (Art. L6111-1)	Aircraft without persons on board	> 25 kg		Leisure and competition drones; drones for experimental uses; drones for particular activities (commercial use)
Belgium	Arrêté royal 10 avril 2016 (fourth paragraph of Art. 1; seventeenth paragraph of Art. 1)	Aircraft that weighs less than 150 kg and controlled by the pilot from a distance pilot station	> 5 kg		class 2: non-dangerous activities; class 1b: for moderate risk operations; class 1a: for dangerous activities
UK	Guidance by Civil Aviation Authority (Section 2 Chapter 1)	An aircraft which is intended to operate with no human pilot on board (remotely piloted and/or capable of degrees of automation)	SUA 0-20 kg; Light UAS 20-150 kg; UAS > 150 kg		

Italy	Regolamento ENAC (art 5; art. 6)	RPAS: remotely piloted aircraft systems without people on board; UAS: a RPAS in which the pilot cannot intervene in real time to control the aircraft	> 25 kg		
Denmark	Air Navigation Act (Chapter 9 paragraph 126 b, d, e)	A drone shall mean an unmanned aircraft		In built-up areas; outside built-up areas	
Sweden	Swedish Transport Agency's regulations on unmanned aircraft systems (UAS) (Chapter 1 and 2)	A system which consists of an unmanned aircraft and other components which are required to be able to control the aircraft at a distance	Category 1A: < 1.5 kg (< 150 J); Category 1B: 1.5 – 7 kg (< 1000 J); Category 2: > 7 kg	Categories 1A, 1B, 2: within the visual line of sight of the pilot; Category 3: beyond the visual line of sight of the pilot	

Czech Republic	Czech Republic Aviation Law 49/1997, Attachment X (Art. 1; Art. 6)	Autonomous aircraft: An unmanned aircraft that does not allow pilot intervention in the management of the flight; Unmanned aircraft (UA): An aircraft which is intended to be operated with no pilot on-board	< 0.91 kg; 0.91 – 7 kg; 7 – 20 kg; > 20 kg		
Poland	Aviation Act + implementing regulations: Regulation of 26 March 2013; Regulation of 3 June 2013; Regulation of 26 April 2013, Regulation of 7 August 2013 (paragraph 2)		> 25 kg. Special provisions for drones under 5 kg and, moreover, under 0,6 kg		Commercial operations; recreational and sports operations
The Netherlands	Regeling op afstand bestuurd vliegtuig in Geldend van 01-07-2016 (Art. 1)	Remotely-piloted aircraft, unmanned; it is not a model aircraft. Completely automated drones are not allowed	> 4 kg (Special rules for a mass over 4 kg but not over 25 kg)		Commercial operations (UA weighing more than 25 kg are considered commercially exploited); recreational operations (model aircraft)

Austria	Paragraphs 24c-f of the Austrian Aviation Act		Model airplane < 5 kg; Toy drones 5 - 25 kg within the visual line of sight of the pilot; Class 1 UA: 25 - 150 kg, within the visual line of sight of the pilot; Class 2 UA: 25 – 150 kg, beyond the visual line of sight of the pilot	Model airplane: Within a radius of 500 m Toy drones: max 30 m from the ground Class 1 UAV max 150 m from the ground	Model airplane: only recreational use; Class 1 UA: commercial operations
Germany	Air Traffic Act (LuftVG) (paragraph 1)	Drones as unmanned aerial vehicles (UAV), including their control stations, which are not used for hobby or recreational purposes	< 5 kg (maximum weight of model aircraft); 5 – 25 kg (maximum weight of UAS)		Commercial use (UAS); recreational use (model aircraft)
Ireland	Irish Aviation Authority Small Unmanned Aircraft (drones) and Rockets Order 2015 (art. 2)	An aircraft, including a drone, without a human pilot on board	> 1 kg		

	Legal Act	Definition	Categorization according to weight	Categorization according to flight range	Categorization according to purpose
United States	FAA Regulation, Part. 107.3 (Title 14 of Code of Federal Regulations) for Small Unmanned Aircraft Systems. Section 333, FMRA, for non-small ones	An aircraft that is operated without the possibility of direct human intervention from within or on the aircraft	< (0.55 lbs (< 250 g): unregistered SUAS < 55 lbs: SUAS < 55lbs: UAS	Operations only below 400 ft (120 m)	Business operation and Recreational operation

2.4 Discussion and conclusions

The definition of drones. The definition of drones adopted at EU and MSs' level show some degree of variation. The EU notion – such as the Swedish – is quite broad and encompasses both remotely piloted aircraft and autonomously operated ones. Some MSs, such as the Netherlands, instead, prohibit the latter category radically. Others, allow both while keeping them separate, such as Czech Republic.

The definition adopted at federal level in the US is broad, since it includes both autonomous and remotely operated devices, similarly to the RCA.

However, the EU definition resorts to more detailed technical requirements by recalling two alternative flying techniques – namely, autonomous operation and remote piloting – that are instead absent in the one provided by the FAR, resorting only on the absence of a human pilot on-board.

Classification of drones. Variation is observed also with respect to classification requirements. While the RCA overcomes the primacy of weight as the preeminent criterion, to adopt a risk-centred perspective, most MSs still widely resort to it. Indeed, weight, as well as maximum flight altitude, and the energy it develops, determine the overall degree of danger the single application might give rise to.

Other elements as well however, could generate non-physical risks, such as the possibility to acquire images and sound – as identified by the RCA, see Recital 31 and Annex IX, 1.3 and 4.2(b) –, representing a potential breach to by-standers' privacy.

In the US federal regulation instead, classification based on weight and purpose influences registration requirements – as well as other aspects such as authorization for flight operations that fall beyond the purposes of the current study and are thence not here addressed – that are nonetheless extremely broad. Indeed, all drones exceeding 0.55 lbs must undergo registration. Said criteria, however, do not affect liability or insurance requirements for they are largely absent in federal regulation (see Section 3.3 below).

Impact of risk-related criteria on certification and insurance requirements. Such criteria, increasing the overall potential risk of the single application, might justify the imposition of specific requirements with respect to certification but also insurance. Indeed, certification serves the purpose of inducing high level of safety investments *ex ante* to limit potential risks, whereas insurance – as further described below (see Section 3.1.2) – aims at providing compensation to the victim once the risk materializes. Thence, being both bodies of rules risk-dependent, they might take the nature, importance, and size of risks each devices brings about into account, differentiating corresponding requirements. In such a perspective, it is sensible, for instance to distinguish a model aircraft from a drone, excluding the duty to insure for the former – as put forth by Austrian law, whose compulsory third-party insurance shall not apply to «toy drones», unmanned devices with maximum motion energy below or equal to 79 joules (see Section 3.2) – and imposing it to the latter.

Impact of risk-related criteria on liability. However, liability rules might instead abide the same principles. The circumstance that one specific drone poses greater risks *per se* does not justify the need for a different legal scheme, identifying another subject as the ideal responsible party, not even in a RMA (see Section 3.4 below).

Impact of use-related criteria on liability. Instead, a distinction based on the purpose for which the drone is used might be of relevance in that respect. Indeed, it might be sensible to differentiate the position of a professional operator from that of the occasional user that employs the device for recreational uses (see 3.4 below).

The RCA and its subsequent implementation and delegated acts will replace conflicting MSs' legislation, however, considering the largely prospective nature of the applicable norms – as above briefly discussed (see Section 2.1) – any more detailed consideration could only be partial.

3 LIABILITY, INSURANCE AND RISK-MANAGEMENT

KEY FINDINGS

- Under the RCA, the operator shall be held responsible for failing to ensure the safety of drones' operation, according to criteria to be further specified by the Commission.
- Drones also fall within the scope of the PLD. The PLD semi-strict liability for defective products regime is problematic, due to the difficult ascertainment and apportionment of liability in case of advanced technologies, to its uncertain scope of application, and to the availability of the development risk defence.
- The IR obliges operators to purchase compulsory insurance, according to a mass-based classification where light devices employed for leisure or non-commercial purposes are exempted, and thus subject to non-uniform MSs laws. Such approach is unsatisfactory, as other risk-factors need to be taken into account.
- MSs' legislation is articulated and results from the extension of civil aviation rules. Most countries adopt at least one strict liability rule, burdening primarily the operator; in others, the owner, and in one the pilot. Few countries resort to standards of care, the majority adopts stricter rules, coupled with liability caps.
- Most MSs establish a duty to acquire third-party liability insurance, at times differentiating between commercial and non-commercial use.
- In the US liability for accidents involving SUA rests with the pilot, through a fault-based liability rule. No specific provision addresses drones weighing above 55 lbs.
- In the US, no compulsory insurance requirement is provided, but it is deemed «prudent» of a remote pilot to evaluate the adequacy of his coverage before operating the drone.
- Victims of accidents caused by drones, as of now, don't easily obtain compensation in Europe, due to lack of insurance and identification, or insolvency. Compensation funds could solve the problem.
- A RMA suggests that liability should not be attributed on the basis of considerations of fault, rather on the party that is best positioned to minimize risks and acquire insurance, thus decoupling *ex ante* deterrence – to be achieved via safety regulation – and *ex post* compensation.
- In a RMA perspective, the operator is best positioned to manage risks and thus shall be held strictly and objectively responsible, as to limit litigation costs, provide clear criteria for the ascertainment of liability, ease access to justice. Given the small awaited economic consequences, liability caps would not be appropriate.
- Both the RCA and the majority of MSs are adequate in a RM perspective, where they burden the party who may best identify and manage risks efficiently. However, overlap with the PLD and other liability regimes may compromise compensation.
- The adoption of uniform rules on the matter of civil liability and insurance requirements for drones at EU level, as initiated through the RCA, is the best option for regulating civil liability for civil use of drones.

When discussing civil liability for accidents involving the use of drones, three are the parties that theoretically might be held liable, namely the user (pilot), the owner (often the operator), and the manufacturer.

Indeed, the first is the party who materially pilots the device, and whose conduct can be influenced through liability rules in order to – theoretically⁷³ – induce the optimal – *rectius* desired – level of care in the completion of the activity. Because the pilot is the one who controls the device, he can determine how it is manoeuvred, and all risks associated to the deployment of the drone may – more or less – directly be traced back to his conduct. In such a perspective, a rule holding the user liable primarily pursues a function of deterrence, ideally preventing accident from occurring, by inducing a sufficient level of care on the side of the human user. Indeed, rules holding the user liable would most commonly be fault-based⁷⁴, thence the deviation from a desired standard of conduct ought to be demonstrated in order to determine his liability and thence a duty to compensate damages. Absent specific rules, the liability of the user or of the pilot might also be established on the grounds of general principles of liability for fault, enacted in most MSs' legal systems⁷⁵.

The owner, instead, might be a different subject than the user, in particular when drones are employed for commercial purposes. Holding the owner liable abides a similar rationale to that underlying rules on the circulation of road vehicles, namely ensuring the victim obtains compensation⁷⁶. Typically, in

⁷³ Empirically it is often observed that fault-based rules still do fail to induce the optimal level of effort on the side of the agent.

⁷⁴ A strict standard of liability does not induce additional deterrence over and beyond a standard of reasonable care. In fact, by definition a standard of care identifies the level of effort in avoiding the accident that can be demanded of a user in the given circumstances and only the failure to match that effort justifies holding the user liable. An objective standard of liability holds the party liable, irrespective of other considerations such as those just mentioned. This certainly aids the victim in obtaining compensation – easing the burden of proof the latter needs to satisfy in order to establish the liability of the defendant – but cannot *ex ante* induce the party to behave with a higher level of care than that which would be considered reasonable under a fault-based rule, for a discussion see Richard Posner, *Economic Analysis of Law*, Seventh ed. (Wolters Kluwer, 2007). See esp. p. 182.

⁷⁵ To provide some examples of liability for tort systems, Art. 2043 of the Italian Civil Code states that «Any fact, by negligence or scienter, which causes wrongful harm to others, obliges the person who has committed the fact to compensate the damage», while, according to Art. 1240 of the French Civil Code, «every fact of the man who causes damage to another, obliges him by whose fault it happened to compensate», and paragraph 823 of the German Civil Code (BGB) states that «anyone who intentionally or negligently violates the life, body, health, freedom, property or other right of another person is obliged to compensate the other for the resulting damage». Therefore, the French system does not explicitly require wrongfulness, while the Italian code clarifies that only wrongful damages give rise to compensation, and the German law provides a relatively detailed list of hypotheses. On this point, the PETL, at Art. 2:101, state that «damage requires material or immaterial harm to a legally protected interest» and Art. 2:102, «(1) The scope of protection of an interest depends on its nature; the higher its value, the precision of its definition and its obviousness, the more extensive is its protection. (2) Life, bodily or mental integrity, human dignity and liberty enjoy the most extensive protection. (3) Extensive protection is granted to property rights, including those in intangible property. (4) Protection of pure economic interests or contractual relationships may be more limited in scope. In such cases, due regard must be had especially to the proximity between the actor and the endangered person, or to the fact that the actor is aware of the fact that he will cause damage even though his interests are necessarily valued lower than those of the victim. [...]». See Helmut Koziol, "Protected Interests," in *Principles of European Tort Law. Text and Commentary*, ed. European Group on Tort Law (Wien: Springer, 2005).

⁷⁶ When the owner is not materially operating the drone he has no control over the way it is maneuvered, thence should an accident occur it might only be deemed the indirect consequence of his decision to let the given pilot operate the device. One could talk in this respect of a *culpa in eligendo* or *in vigilando*, yet both theories merely attempt to justify through the fictional creation of a desirable standard of care in selecting the pilot and overseeing his conduct – Olivier Moréteau, "Liability for Others," in *Principles of European Tort Law. Text and Commentary*, ed. European Group on Tort Law (Wien: Springer, 2005). – the imposition of an objective – or semi-objective – standard of liability.

fact, the owner would be held jointly and severally liable with the user, thence doubling the subject who might be called upon to compensate the damage suffered. This very aspect – identifying a second party who could be forced to repay damages – ensures the victim might aggress a broader set of assets – those that belong to the one and to the other – radically reducing the risk of insolvency of the pilot. Indeed, the pilot might not possess sufficient economic resources⁷⁷ to repay the entire damage he caused, and, in case of a commercial use, might not have a direct control over the functioning and maintenance of the application – carried out by the owner –.

Moreover, it might not always be easy to identify who materially was piloting a single drone, while the ascertainment of the owner is simply achieved by imposing the registration of the device the moment it is purchased. For the same reasons, the owner might also be best positioned to acquire insurance. Such rules are typically objective, in as much as they do not require the claimant to demonstrate a specific fault or deviation from a desirable conduct. The deterrence such kinds of rules might exert is therefore limited. In the case of drones, the owner will often correspond to the operator, defined by Article 3.13, RCA, as «any legal or natural person operating or proposing to operate one or more aircraft», and upon which detailed requirements are set by Article 2.2, Annex IX, RCA, regarding its «means» (let. a), «management system» (let. b), as well as its internal «arrangements» aimed at ensuring continuing compliance with applicable regulation (let. d).

Finally, since drones are products for the purposes of the PLD, the manufacturer is liable for all damages that derive from a defect of the device. This is a (semi-) strict standard of liability, and represents the primary body of EU law that directly influences the apportionment of liability among the different players involved, absent any specific discipline on such matter in the RCA. The fundamental rationale underpinning said body of rules is twofold: (i) ensure high levels of consumer protection by inducing adequate safety investments on the side of manufacturers⁷⁸, (ii) ease victims' compensation through a rule of liability without fault⁷⁹.

Whether those objectives are materially attained by the directive and its national implementations is currently being debated, and the Commission has recently released studies that attempt to evaluate the performance of the directive over the past decades, since its enactment. The major concerns will be discussed below (see Section 3.1.1 below), even if it is not possible, given the nature of the current study, to dive into the details of an empirical law and economic analysis of this body of rules.

Attention will be devoted to the problem of whether the claimant is truly well positioned to demonstrate the existence of a defect and if economic incentives suffice to justify legal action against the manufacturer in case of damages.

One of the major issues posed by the application of existent laws to new technologies pertains to the overlapping of different sets of rules originally conceived to address clearly distinct cases. Indeed, while the liability of the user and that of the owner might either coexist – in case the owner is held jointly and severally liable with the user – and in most cases the reason for the accident will be traced back to the

⁷⁷ A similar rationale is the one that induced the Italian legislator in 1942 to establish the joint and several liability of the owner of the vehicle, next to the driver under Art. 2054 of the Italian Civil Code. See Palmerini and Bertolini, in *Digital Revolution: Challenges for Contract Law in Practice*. See esp. p. 257.

⁷⁸ Recital 6, PLD: «To protect the physical well-being and property of the consumer, the defectiveness of the product should be determined by reference not to its fitness for use but to the lack of the safety which the public at large is entitled to expect; whereas the safety is assessed by excluding any misuse of the product not reasonable under the circumstances»,

⁷⁹ Recital 2, PLD: «Whereas liability without fault on the part of the producer is the sole means of adequately solving the problem, peculiar to our age of increasing technicality, of a fair apportionment of the risks inherent in modern technological production».

one who materially operated the device, the application of the PLD might further complicate the picture. Establishing if an accident was due to the malfunctioning of the device – eventually a design defect – or the reckless behaviour of the user might not be obvious, and could instead require articulated – thence economically burdensome – factual ascertainment, in particular when increasing levels of automation are considered.

Liability rules then directly influence the functioning of insurance requirements. In order to determine who needs to acquire insurance and to cover which risks it is necessary to establish with a high level of certainty who bears what risk, and how the latter qualifies. This entails having the issue of liability apportionment sufficiently clarified, as well as a correct understanding of the kind of accidents that may be caused, their frequency, and the – economic – consequences they might cause. In such a perspective it shall be noted that even if a rule clearly burdened one party among those mentioned, the coexistence of another sets of rules – such as the PLD – might still lead to a certain degree of uncertainty with respect to the distribution of liability. The mere provision of a duty to insure is therefore *per se* insufficient.

The study will therefore provide a brief overview of the EU (see Section 3.1 below) and MSs' legal framework (see Section 3.2 below) before undergoing an overall discussion (see Section 3.4 below) of the current articulated legislative picture applicable to drones.

3.1 The European legal framework

As above mentioned (see Section 2.1 above) the RCA does not directly address issues of liability and insurance. The regulation, however, is largely prospective, in as much as it calls upon the Commission – among other – to:

«[...] adopt implementing acts laying down detailed provisions concerning: [...] (a) the specific rules and procedures for the operation of unmanned aircraft as well as for the personnel, including remote pilots, and organisations involved in those operations; [...] (c) the privileges and responsibilities of the holders of certificates and of natural and legal persons making declarations»⁸⁰,

and delegates the Commission – among other – to:

«lay [...] down detailed rules with regard to: (a) the specific conditions for the design, production and maintenance of unmanned aircraft [...] as well as for the personnel, including remote pilots, and organizations involved in those activities, necessary to ensure compliance with the essential requirements referred to in Article 55^[81] (d) the privileges and responsibilities of the holders of certificates and of natural and legal persons making declarations»⁸².

Such aspects would clearly influence liability rules, both with respect to the identification of required features the design of the UA ought to display – possibly specifying some aspects of relevance for the PLD (see Section 3.1.1 below) – and with respect to the responsibilities of holders of relevant certificates

⁸⁰ Art. 57, RCA.

⁸¹ Art. 55, RCA, refers to «Essential requirements for unmanned aircraft», and is there recalled in order to mention the possibility of determining some requirements with respect to features and functionalities that ought to be designed into the drone.

⁸² Art. 58, RCA.

that could be both manufacturers – or parties involved in the design and maintenance of UA – as well as operators, and remote pilots⁸³.

Indeed, Annex IX already lays out some duties on the manufacturer, who is required on the one hand to ensure privacy and data protection regulation are respected by design and by default⁸⁴, see Article 25, and Recital 78, General Data Protection Regulation (GDPR), and, on the other hand, together with the supplier, that users are comprehensively informed on safe drone operation⁸⁵.

UA are required not to put people or property at danger⁸⁶, and that entails that a drone should be controllable and manoeuvrable «under any foreseeable operating conditions, throughout, and sufficiently beyond the operation for which the aircraft was designed»⁸⁷. Such criteria closely recall those defining the notion of consumer expectations, referred to in the PLD⁸⁸ (see Section 3.1.1 below).

Extensive requirements, moreover, are clarified with regard to organisations⁸⁹ and subjects involved in unmanned aircraft operations⁹⁰.

The RCA establishes the liability of the operator «for the operation»⁹¹, whose safety he is required to ensure at all times, by abiding «the laws, regulations and procedures, pertinent to the performance of their duties, prescribed for the area, airspace, aerodromes or sites planned to be used [...]»⁹². This encompasses ensuring «the safety of third parties on the ground and of other airspace users and minimiz[ing] the risks resulting from adverse external and internal conditions, including environmental conditions, through maintaining appropriate separation distance during all phases of the flight»⁹³. Detailed dispositions are then dedicated to electromagnetic compatibility and radio spectrum⁹⁴.

Such rules, to be refined by a subsequent intervention of the Commission, clearly will contribute to shaping the overall framework, possibly impacting the analysis here conducted profoundly. All considerations will thence be necessarily based on the current picture, despite partial. It may certainly

⁸³ Art. 56, RCA.

⁸⁴ Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation) (Text with EEA relevance), in OJ L 119, 4.5.2016, (GDPR). See Paul Lambert, *Understanding the New European Data Protection Rules* (CRC Press, 2017). See esp. 329-336 and 337-340. Daniel Rucker and Tobias Kugler, *New European General Data Protection Regulation* (Wien: Beck, Hart, Nomos, 2018). See also Art. 1.3, Annex IX, RCA.

⁸⁵ Art. 1.4, Annex IX, RCA, states: «The organisation responsible for the production or for the marketing of the unmanned aircraft must provide information to the operator of an unmanned aircraft and, where relevant, to the maintenance organisation on the kind of operations for which the unmanned aircraft is designed together with the limitations and information necessary for its safe operation, including operational and environmental performance, airworthiness limitations and emergency procedures. This information shall be given in a clear, consistent and unambiguous manner. The operational capabilities of unmanned aircraft that can be used in operations that do not require a certificate or declaration must allow the possibility to introduce limitations which meet airspace rules applicable to such operations».

⁸⁶ Art. 2.1.1, Annex IX, RCA.

⁸⁷ Art. 2.1.4, Annex IX, RCA, see also 2.1.3 and 2.1.5 with respect to safety requirements that take into account failure of one or more systems.

⁸⁸ Art. 6, PLD.

⁸⁹ Art. 2.2, Annex IX, RCA.

⁹⁰ Art. 2.3, Annex IX, RCA.

⁹¹ Art. 2.4.1, Annex IX, RCA.

⁹² Art. 2.4.2, Annex IX, RCA.

⁹³ Art. 2.4.3, Annex IX, RCA.

⁹⁴ Artt. 2.5 and ff., Annex IX, RCA.

be observed that liability rules so conceived tend to extend the liability of the operator substantially, in a way that clearly abides the compensatory rationale briefly described above (see Section 1.1.2).

Since drones are products for the purposes of Article 2, PLD, the European regime concerning the liability for defective products needs to be examined (see Section 3.1.1 below).

Finally, a general framework on insurance is provided by Regulation 785/2004⁹⁵ (IR) that, however, does not specifically mention «drones», «RPASs», «UAVs» or the like, being applicable to air carriers and aircraft operators at large. Indeed, RCA does not even mention IR, so coordination between these two Regulations is not provided by the EU legislator. Given that at least some UA are to be deemed as «aircraft», reference will be made to this body of rules concerning aircraft insurance.

The applicable bodies of law will be, therefore, analysed, assessing whether they are consistent with the elements and features that are introduced by advanced unmanned aircraft, and suggesting regulatory proposals that would help in combining innovation and consumer protection.

3.1.1 Liability for defective products

The PLD establishes that the «[...] producer shall be liable for damage caused by a defect in his product»⁹⁶, and that the claimant seeking compensation «[...] shall be required to prove the damage, the defect and the causal relationship between defect and damage»⁹⁷, thence not fault or negligence on the side of the defendant.

Despite sometimes defined as a hypothesis of strict-liability, the PLD actually sets a system of semi-strict-liability, given the specific defenses put forth by Article 7, PLD, in particular the development risk defence (let. e), pursuant to which the producer might escape liability if he demonstrates «that the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered»⁹⁸.

Moreover, a product is defective when it «does not offer the safety that a person is entitled to expect, considering all circumstances»⁹⁹ such as the presentation of the product, its reasonably expected use and the time in which it was put into circulation.

A product might be deemed defective in three different sets of occasions: a single specimen might deviate from the intended design and thus from the other specimens of the mass-production, thus constituting a «manufacturing defect»; warnings about the potential dangers arising from the use of the device might not be adequately communicated or signaled, thus determining an «information

⁹⁵ Regulation (EC) No 785/2004 of the European Parliament and of the Council of 21 April 2004 on insurance requirements for air carriers and aircraft operators, in OJ L 138, 30.4.2004.

⁹⁶ Art. 1, PLD.

⁹⁷ Art. 4, PLD.

⁹⁸ Some of the MSs have enacted the defence – such as Germany and Italy, see Ulrich Magnus, "Product Liability in Germany," in *European Product Liability. An Analysis of the State of the Art in the Era of New Technologies*, ed. Piotr Machnikowski (Cambridge: Intersentia, 2016). See esp. p. 263. Moreover see Franzoni, in *Trattato Della Responsabilità Civile*. See in particular pp. 611 ff. – others instead have limited its scope – such as France, see Jean-Sébastien Borghetti, "Product Liability in France," in *European Product Liability. An Analysis of the State of the Art in the Era of New Technologies*, ed. Piotr Machnikowski (Cambridge: Intersentia, 2016). See esp. p. 226 –.

⁹⁹ Art 6, PLD.

defect»; lastly, the very design of the product might be deemed defective, for it does not provide necessary safety or is unreasonably dangerous, thus representing a «design defect».

Despite the claimant not being required to identify the specific cause of the defect, showing that the product is indeed defective might still prove cumbersome, as it requires technical skills and access to data which will most likely be lacked by the victim. Such burden would be particularly difficult in the case of design, as it will entail acquiring the expert opinion of a technician whom, once he has accessed data regarding the functioning of the device¹⁰⁰, is capable of analyzing it and demonstrating the existence of a defect in the way the product was conceived. The more technologically complex the product, the harder satisfying such a requirement is going to be.

However, the liability of the producer can also be reduced if he proves the contributory negligence of the victim.

Since the PLD rests on a regime of maximum harmonization for claims based on product liability, art 13 PLD allows MSs to create or keep different liability rules, which the victim of an accident caused by a defective product may rely on, to the extent that such rules belong to a different system of contractual or non-contractual liability, such as fault or warranty in respect of latent defects¹⁰¹.

The PLD has recently been subject to assessment by the European Commission through reports¹⁰² the results of which are also summarized in the Staff Working document¹⁰³ and are subject to further discussion by an Expert Group appointed on 8 June 2018 that works in two formations, one dealing with the directive itself, the other with new technologies. Purpose of the expert groups is to produce a report that addresses the applicability of the PLD to traditional products and new technologies, and the development of «guiding principles for possible adaptations of applicable laws related to new technologies».

The reports as well as the Staff Working document highlight some issues that emerge both theoretically and empirically from the application of the PLD observed in the period between 2000 and 2016 across all MSs. Some of these aspects are of relevance for all applications of the directive, irrespective of the field of application – technologically advanced products or more traditional ones – others are of particular importance when robotics, IoT and AI are taken into account.

The overall conclusion reached is that the PLD is adequate also to face the challenges posed by existing products¹⁰⁴. However, some aspects might deserve further clarification.

¹⁰⁰ This in particular might be problematic, for the data generated by the sensors and eventually recorded by an Event Data Recorder (EDR) could be claimed as proprietor information by the manufacturer, who opposes its disclosure for the purpose of protecting its industrial secrets.

¹⁰¹ See Court of Justice of the European Union (CJEU). 25.4.2002, *María Victoria González Sánchez v. Medicina Asturiana SA*, C-183/00. ECLI:EU:C:2002:225, para. 23-34.

¹⁰² Ernst&Young, Technopolis, and VVA.

¹⁰³ SWDE, see *supra*.

¹⁰⁴ It shall be noted that the study only identified one single case where a claim was brought regarding a technologically advanced product, namely a computer storage unit, which caused a loss of information. The case, however, does not appear significant for the analysis here conducted and any consideration with respect to the adequacy of the PLD to address technologically advanced products. Not only does it lack statistical value, but also appears not to be representative of the same category of products as those here addressed, UA and advanced robotics, whose technical complexity largely exceeds that of a computer and of its operating software. No relevant conclusions about the adequacy of the PLD when applied to

For instance, the limited number of cases collected, decided across the MSs over the period observed, was primarily explained as a consequence of a prevailing number of out-of-court settlements. However, no specific data are provided on such a point – such as official numbers or reports – and merely relies on interviews, where the primary respondents were business users themselves. The reliability of the conclusions that are drawn is thence much more limited. Moreover, it shall be noted that competing bodies of law – above all consumer sales regulation¹⁰⁵ – are often applied towards a similar end – in such cases avoiding litigation – in order to achieve a partially different result – the replacement of a defective good purchased – and might easily be confused by non-experts.

As per the notion of product, it is as of today disputable whether software could be included¹⁰⁶. This could *per se* represent a major issue when UA as other technologically advanced products are considered, where the software and hardware element are tightly connected in their functioning, and most likely the former represents the novel aspect of the application, differentiating it from the technology it intends to replace – traditional aircraft, in the current hypothesis –.

The ascertainment of the causal nexus between the defect and the damage appears then to be another aspect that burdens the claimant, preventing litigation or its success¹⁰⁷. Determining that harm is the consequence of a defect in the functioning of the device requires an in-depth analysis of the product, of its functioning – eventually of its design – that presupposes relevant technical expertise, acquiring which might represent a non-viable cost for the user.

Finally, defences, such as the development risk defence (Article 7, let. E, PLD) might allow manufacturers to escape liability, leaving the burden of the economic consequences of the accident on the victim, and ultimately modifying the strict standard of liability theoretically put forth by Article 2, PLD. The rationale underpinning such a defence is typical of a rule of negligence. Indeed, the manufacturer who met the state of the art of scientific development and technological advancement may not be blamed when, nonetheless, a harmful event resulted from the use of his product. Theoretically, no additional safety investment could be demanded of him¹⁰⁸, thence no further deterrence could be provided by an objective standard of liability holding him liable even in such cases where he could not be blamed. However, as indicated by Recitals 1 and 2, PLD respectively, said rules are intended to ensure

«a differing degree of protection of the consumer against damage caused by a defective product to his health or property»

and

emerging technologies can therefore be drawn from that example. For further information, see Ernst&Young, Technopolis, and VVA. See especially pp. 24-25.

¹⁰⁵ Directive 2011/83/EU of the European Parliament and of the Council of 25 October 2011 on consumer rights, amending Council Directive 93/13/EEC and Directive 1999/44/EC of the European Parliament and of the Council and repealing Council Directive 85/577/EEC and Directive 97/7/EC of the European Parliament and of the Council, in OJ L 304, 22.11.2011, Council Directive 93/13/EEC of 5 April 1993 on unfair terms in consumer contracts, in OJ L 95, 21.4.1993, and Directive 1999/44/EC of the European Parliament and of the Council of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees, in OJ L 171, 7.7.1999.

¹⁰⁶ Bernhard A. Koch, "Product Liability in Austria," in *Product Liability. An Analysis of the State of the Art in the Era of New Technologies*, ed. Piotr Machnikowski (Cambridge: Intersentia, 2016). See also Ulrich Foerste and Friedrich Graf von Westphalen, *Produkthaftungshandbuch* (Munich: Beck). See in particular paragraph 47.

¹⁰⁷ Ernst&Young, Technopolis, and VVA. See especially p. 28.

¹⁰⁸ See also Posner. See, moreover, Carlo Castronovo, *La Nuova Responsabilità Civile* (Milano: Giuffrè, 2006).

and

«liability without fault on the part of the producer is the sole means of adequately solving the problem».

Therefore, in the perspective of ensuring the victim's compensation, the circumstance that the agent may not be reprehended for the standard of behaviour he conformed to appears secondary. The risk of unexpected and unforeseeable outcomes – or unknown unknowns – is better borne by the party who derives economic benefits from the activity overall, rather than the occasional harmed party. The former might insure against such events – assessing the statistical possibility of their occurrence – and on the one hand could provide needed compensation, and on the other hand manage such costs by spreading them onto all users of the same product. Such an approach is part of an alternative methodology – not entirely foreign to the PLD and current legislation – that might be called a RMA (see Section 3.4.5 below).

Some of those criticalities are most certainly exacerbated by products such as drones. On the one hand technological complexity causes the material ascertainment of the defect to become ever more complex, as well as the exact establishment of a causal nexus, and, on the other hand, human-machine cooperation causes different bodies of rules to overlap. When a high automation degree is to be used by a human being who retains some control, at least under certain conditions, any accident might require the application of both the PLD and national regulation, primarily tort law rules, as described above.

3.1.2 Insurance regime for air carriers and aircraft operators

As mentioned before, a basic framework on insurance requirements for aircraft operators and air carriers is provided by IR.

IR is aimed at fostering consumer protection, and it states¹⁰⁹ that

«It is important to ensure a proper minimum level of insurance to cover liability of air carriers in respect of passengers, baggage, cargo and third parties».

This is further clarified, by stating that¹¹⁰

«The objective of this Regulation is to establish minimum insurance requirements for air carriers and aircraft operators in respect of passengers, baggage, cargo and third parties».

Indeed, the distinction between international and national aviation is getting weaker¹¹¹ and, if insurance were compulsory but minimum coverage were not provided, general trust on airlines and air transport could be endangered.

It is still worth noting that insurance is only unilaterally compulsory, that is, pursuant to IR, operators need to have their devices insured, but insurance companies are not required to insure every potential operator. In such a perspective, the regulatory framework differs from the one related to compulsory motor insurance, which features a bilateral obligation both to be insured and to insure.

¹⁰⁹ Recital 1, IR.

¹¹⁰ Art. 1, IR.

¹¹¹ Recital 2, IR.

The unilateral obligation above described could endanger a safe and secure deployment of UA, because – absent consistent and plentiful data on UA operations – insurance companies have no incentive to offer products in the UA-related branch. Therefore, operators may find it hard to obtain insurance, and maybe eventually choose not to pursue coverage at all.

IR is applicable to generally all air carriers¹¹² and aircraft operators¹¹³ flying, even partially, over the territory of a Member State; nonetheless, exemption is provided for some categories of devices that often include unmanned aircraft, such as all model aircraft¹¹⁴ with a maximum take-off mass (MTOM) of less than 20 kg¹¹⁵, and aircraft with a MTOM inferior to 500 kg¹¹⁶, provided that they are not used for commercial purposes or are used for local flight instruction that does not require border crossing¹¹⁷.

The aforementioned exemption would create a regulatory gap for unmanned aircraft, leading to the application of non-uniform MSs solutions for a relevant number of light devices employed for leisure or at least non-commercial purposes.

Moreover, given the fact that a European Regulation ranks above national law, all aircraft under 20 kg would not need to be insured, which seems to worsen the position of people who might be damaged by such devices.

When assessing the unmanned aircraft framework, IR is mostly relevant when concerning damages to goods and to third parties, while liability for damages to passengers and their baggage is less important, since remotely piloted devices designed to carry people still lack industrial development.

On the one hand, when liability for damages to third parties is considered, the European legislator established different minimum insurance requirements according to MTOM, and devices belonging to the lightest class, that is below 500 kg, need to be insured for a minimum of 750.000 Special drawing rights (SDR). Data for assessing whether this amount is consistent with the damages that a device weighing up to half a tonne can cause still lack¹¹⁸.

Besides, some authors argue that a classification which considers only MTOM, regardless of other factors such as the performed operation or the pilot's experience, does not prove satisfactory¹¹⁹.

Indeed, the potential amount of damages – and, in relation to that, the minimum coverage and the insurance premium, as well, are likely to be higher if the area over which the UA is flying is more dangerous, the pilot less experienced, even if the employed device features a smaller MTOM.

On the other hand, while regulating liability for damages to goods, IR imposes a minimum insurance cover of 17 SDR for each transported kilogram, which is an extremely small amount, as well.

¹¹² Pursuant to Art. 3(a), IR, this means «an air transport undertaking with a valid operating licence».

¹¹³ Pursuant to Art. 3(c), IR, this means «the person of entity, not being an air carrier, who has continual effective disposal of the use or operation of the aircraft».

¹¹⁴ No specific definition is provided of «model aircraft» by IR.

¹¹⁵ Art. 2.2(b), IR.

¹¹⁶ «In so far as the insurance obligations under this Regulation relating to the risks of war and terrorism are concerned». Art. 2.2(g), IR.

¹¹⁷ Art. 2.2(g), IR.

¹¹⁸ Steer, Davies, and Gleave, *Study on the Third-Party Liability and Insurance Requirements of Remotely Piloted Aircraft Systems* (European Commission, 2014). See esp. paragraphs 5.29 and 6.1.

¹¹⁹ Cecilia Severoni, "La Disciplina Normativa Attuale Degli Aeromobili a Pilotaggio Remoto," *Diritto dei trasporti*, no. 1 (2016). See esp. p. 85.

Globally, coordination between IR and RCA should be sought, while the current exemptions, as well as low and inconsistent insurance minimums, could hinder the aim itself of compulsory insurance.

3.2 Member States' legal framework

In the subsequent Section, the study will provide a brief account of specific MSs legislation, in particular focusing on (i) which subjects are being held liable, (ii) on what grounds – strict or fault-based liability – (iii) existing insurance requirements. Table 2 – Civil liability rules by country summarizes relevant information, to ease subsequent discussion (see Section 3.4).

3.2.1 Spain

The Royal Decree 1036/2017¹²⁰ contains many technical provisions, but it leaves some issues, such as privacy, cybersecurity and civil liability, unregulated. A critical analysis of the provisions related to the producer and the operator can help to reconstruct the civil liability rules. The former is responsible for the aircraft produced and he has some obligations of maintenance (Article 15), the latter is responsible under Article 26, concerning insurance. This provision requires insurance to cover damages to third parties on the surface (Article 26) and it includes a reference to the Navigation Act 48/1960¹²¹. Articles 119 and 120 of this Act introduce a system of strict liability for operators, so they are liable regardless of whether or not they are at fault, but this rigid rule is balanced by the provision of limitations of the right of compensation. Nonetheless, this condition does not apply in the case of gross negligence or intentional misconduct.

3.2.2 France

The Decree of 17 December 2015 does not address liability issues: however, Article L6131-1 of Transport Code¹²² identifies the operator as the subject liable for damages to persons and property on the surface: in agreement with the following Article L6131-2, it introduces a system of strict liability. In fact, operator is liable for damages to persons and property on surface, without being allowed to prove that he is not at fault or that the injured person is at fault. To ensure the right of compensation to the injured person, Article L6131-4 states that the owner is responsible with the operator for damages to third parties.

3.2.3 Belgium

The two main actors burdened to ensure the safety of the operations are the operator and the pilot (from his distant pilot station). According to the Royal Decree of 10 April 2016¹²³, the operator has many responsibilities (Article 80): he must control that the operations comply with the requirements of his handbook and he is required to ensure that the RPAS is covered by insurance. Further, operators must evaluate the risks for the safety of persons and property on the surface, each time before the flight. Also the pilot has many obligations (Article 82, Article 83), in order to guarantee the safety during the period

¹²⁰ Real Decreto 1036/2017, de 15 de diciembre, por el que se regula la utilización civil de las aeronaves pilotadas por control remoto, y se modifican el Real Decreto 552/2014, de 27 de junio, por el que se desarrolla el Reglamento del aire y disposiciones operativas comunes para los servicios y procedimientos de navegación aérea y el Real Decreto 57/2002, de 18 de enero, por el que se aprueba el Reglamento de Circulación Aérea.

¹²¹ Ley 48/1960, de 21 de julio, sobre Navegación Aérea. Texto consolidado, última modificación: 17 de octubre de 2014.

¹²² See also ordonnance no. 2010-1307 du 28 octobre 2010 (basis of Transport Code)

¹²³ Arrêté royal 10 avril 2016 relatif à l'utilisation des aéronefs télé pilotés dans l'espace aérien belge, Moniteur Belge C – 2016/14116, page 25944.

of the flight: for instance, he must check weather conditions before the flight. Overall, the Decree does not address specifically liability issues, but the operator should be considered liable for damages on the surface. Drones of all categories must be insured (Article 97), except for those used for leisure activities.

3.2.4 The United Kingdom

Liability for damages caused by a small drone follows the same rules of the system established for other aircraft. The general rule is contained in the Article 241 of the Air Navigation Order 2016¹²⁴ and it introduces a fault-based liability: it states that

«A person must not recklessly or negligently cause or permit an aircraft to endanger any person or property».

More specifically in the particular case of small UAS, according to article 94 of the Order, the person in charge of a small unmanned aircraft

«may only fly the aircraft if reasonably satisfied that the flight can safely be made and the person in charge must maintain direct, unaided visual contact with the aircraft sufficient to monitor its flight path in relation to other aircraft, persons, vehicles, vessels and structures for the purpose of avoiding collisions».

Civil Aviation (Insurance) Regulations 2005¹²⁵ contain rules concerning insurance requirement: they state that aircraft operators must hold «adequate insurance to meet their liabilities in the event of an accident», including third party accident insurance.

3.2.5 Italy

The rules for damages to third parties on the surface are provided by the Italian Navigation Act. Article 965¹²⁶ addresses the rules of operator liability of an aircraft (a drone is considered as an aircraft by Article 743) through a reference to international rules, and therefore the Rome Convention of 1952¹²⁷. This Convention introduces the concept of strict liability: a person who suffers damage on surface has the right to compensation. To be entitled to compensation it is sufficient to prove that the damage was caused by an aircraft during a flight: if the damage is not a direct consequence of the incident, the injured person does not have the right to compensation. The balance between strict liability and operators' interests is in limitations of compensation according to Article 971.

It is forbidden to fly if the UAS is not covered by insurance (Article 32 ENAC Regulation).

¹²⁴ 2016 No. 765, of 13.7.2016.

¹²⁵ SI 2005/1089, of 2.4.2005.

¹²⁶ Codice della navigazione, approvato con R.D. 30 marzo 1942, n. 327, aggiornato al Decreto legge 16 ottobre 2017, n. 148, «Disposizioni urgenti in materia finanziaria e per esigenze indifferibili», convertito con modificazioni dalla L. 4 dicembre 2017, n. 172).

¹²⁷ Convention on damage caused by foreign aircraft to third parties on the surface, signed at Rome, on 7.10.1952.

3.2.6 Denmark

Paragraph 127 of Danish Air Aviation Act¹²⁸ addresses the issue of liability with the introduction of a strict liability rule. In case of personal injury or damage to property outside the aircraft, the owner is liable to compensate for the damage, except when

«the injured himself has caused the damage intentionally or by gross negligence».

Contrary to other countries, in which the operator is required to pay damages, in Denmark the obligation burdens the owner: even if a user causes the damages, the owner is liable.

The owner must also purchase insurance to cover claims for compensation arising against him or the user for personal injury or damages to property outside the aircraft (paragraph 130).

3.2.7 Sweden

The Swedish Transport Agency's regulations on unmanned aircraft systems of 4 October 2009 does not address liability issues. The rules of liability for damages caused in the course of aviation on persons or property on the surface are found in Chapter 9 of Swedish Aviation Act¹²⁹, which contains a reference to the Swedish Act on Liability for Injury as a Result of Aviation¹³⁰. This Act introduces a strict liability system (Article 1), but the amount of compensation varies according to the nature of the error or negligence of liable person or if the injured person is at fault. The owner (Article 1) and the possessor (Article 4) are required to pay damages.

Insurance is mandatory for all categories of UAS (Section 12 Chapter 2 of Swedish Transport Agency's regulations on unmanned aircraft systems) in accordance with Regulation (EC) 785/2004 of the European Parliament and of the Council of 21 April 2004 (IR).

3.2.8 Czech Republic

Article 3.1.1 of Chapter 3 of Czech Republic Aviation Law¹³¹ addresses liability issues and it provides a system of fault based liability: hence, the person that remotely pilots the UA is liable only if the aircraft is operated in a negligent or reckless manner so as to endanger life or property of others. Moreover, according to Article 3.1.9

«a remotely piloted aircraft shall be operated in such a manner as to minimize hazards to persons, property or other aircraft and in accordance with the conditions».

Purchasing insurance is mandatory only for certain categories of drones: drones that weigh more than 20 kg and drones used for non-commercial purposes, also if they weigh less than 20 kg.

¹²⁸ Consolidated Act no. 1036 of 28 August 2013 with the amendments following paragraph 6 of Act no. 736 of 25 June 2014, paragraph 9 of Act no. 742 of 1 June 2015, Act no. 1896 of 29 December 2015, paragraph 39 of Act no. 426 of 18 May 2016 and Act no. 602 of 4 June 2016.

¹²⁹ Luftfartslag (2010:500).

¹³⁰ 1922:382.

¹³¹ Act 49/1997 Coll. on civil aviation and amending Act 455/1991 Coll. on trade licensing (Trade Licensing Act) as amended by later regulations (further referred to as Civil Aviation Act).

3.2.9 Poland

Rules of civil liability are contained in Annex 6 and 6a of regulation 26 March 2013¹³²: the liable party is the operator, who has many safety obligations. More specifically, he is required to check the technical conditions of the drone before flight and to use control devices in accordance with the recommendations and restrictions set by the producer. During the flight, operator must give priority to manned aircraft and avoid actions or omissions that could obstruct air traffic (Chapter 3 of Annex 6).

Annex 6 introduces a system of strict liability: the operator is required to pay compensation for damages to third parties regardless of whether or not he is at fault.

Insurance is mandatory for drones used for commercial purposes and for drones of all categories weighing more than 5 kg, according to Annex 7. The minimum amount covered by insurance is 3000 special drawing rights for drones weighing between 5 and 20 kg.

3.2.10 The Netherlands

The aforementioned body of law, *Regeling Modelvliegtuigen* (HDJZ/LUV/2005-2297), states that insurance against civil liability, related to death or injury of third parties or other damage affecting third parties, is compulsory when the drone weighs less than 4 kg¹³³.

When the UA is commercially operated – that is, within a lucrative organisation – third party liability insurance is required, with a minimum coverage of 1 million Euros.

3.2.11 Austria

Under the Austrian Aviation Act¹³⁴, civil liability and third party liability insurance for damage caused by aircraft or self-propelled aircraft are regulated according to paragraphs 146 ff. of the Act.

Pursuant to paragraph 148, if a person is killed or suffers a physical injury, or a physical object is damaged by an accident occurred during the operation of an aircraft or an aviation vehicle that can be used independently, the owner of said aircraft or aviation vehicle shall be liable for the compensating the damage. According to paragraph 149, if at the time of the accident the aircraft or the aviation vehicle which can be used independently in flight is used without the will of the holder, the user shall be liable instead. However, the holder remains liable for the compensation of the damage if such use has been made possible because of his fault or that of the person using the device on his command.

Pursuant to paragraph 151, the liability of the owner for any damage caused by a device weighing less than 20 kg, the owner shall be liable for any accident up to an amount of 500 000 SDR. In case of the aircraft or self-propelled aircraft, liability has a series of caps, depending on the maximum take-off mass (MTOM). For MTOM of less than 500 kg, a maximum of 750,000 SDRs shall be compensated.

Pursuant to paragraphs 164 and 165, the owner of an aircraft or an aeronautical vehicle which can be used independently in flight shall, at least beyond the amounts provided for in paragraph 151, take out

¹³² Rozporządzenie Ministra Transportu, Budownictwa i Gospodarki Morskiej z dnia 26 marca 2013 r. w sprawie wyłączenia zastosowania niektórych przepisów ustawy – Prawo lotnicze do niektórych rodzajów statków powietrznych oraz określenia warunków i wymagań dotyczących używania tych statków, *Dziennik Ustaw*, 2013, 440.

¹³³ *Wet luchtvaart Geldend van 28-07-2018 t/m heden*. More broadly, see *Regeling op afstand bestuurde luchtvaartuigen Geldend van 01-07-2016 t/m 06-10-2017*.

¹³⁴ *Bundesgesetz vom 2. Dezember 1957 über die Luftfahrt (Luftfahrtgesetz – LFG)*, BGBl. Nr. 253/1957 (NR: GP VIII RV 307 AB 318 S. 40. BR: S. 128).

third-party liability insurance to cover damage claims by persons or items not carried in the aircraft or self-propelled aircraft, and that the injured party can assert his claim for damages under the insurance contract in question against the insurer as well. If the insured risk is borne by several insurers, they will all be held jointly liable.

3.2.12 Germany

Liability for damages caused by unmanned aircraft is regulated according to paragraphs 33 ff. LuftVG¹³⁵. Pursuant to such rules, if, during the operation of an aircraft, an accident results in the death of someone, injury to his body or health, or damage to a property, the owner of the aircraft is obliged to compensate for the damage, unless the aircraft has been used without the knowledge and will of the owner, being the user liable instead (unless the use has been possible due to the owner's own fault, if he gave the aircraft to the user or if he is the employer of the latter). Liability of the user according to general statutory liability remains unaffected. General contributory negligence rules apply. Compensation covers both loss of property, pecuniary damages, physical injury and death, loss of income, pain and suffering, but liability is limited to specific amount depending on the weight of the aircraft, and special caps to the compensation provided to the victim in case of death and personal injury. However, the letter of federal law remains unaffected, according to which the user is liable to a greater extent for damage arising from the operation. Compulsory third party insurance is required.

3.2.13 Ireland

Article 7 of Irish Aviation Authority Small Unmanned Aircraft (drones) and Rockets Order 2015¹³⁶ contains the rules of civil liability for damages to third parties on the surface. The liable party, as in the UK, is the person who is in charge of the operation of a small unmanned aircraft: he is required to pay compensation only when damages to the life and property of others on surface are caused by a negligent or reckless behaviour in flight operations.

Unlike other countries, in Ireland purchasing insurance is not mandatory, but recommended by the Irish Aviation Authority.

3.3 The United States federal regulation

As anticipated above, federal legislation only addresses liability with respect to SUA, but no specific provision addresses larger devices (weighing more than 55 lbs)¹³⁷. In such cases general tort law provisions apply, defined at State level, through Common law and regulation when applicable.

Pursuant to paragraph 107.19, FAR the remote pilot in command of the SUA is

«directly responsible for and is the final authority as to the operation of the small unmanned aircraft system».

¹³⁵ Luftverkehrsgesetz in der Fassung der Bekanntmachung vom 10. Mai 2007 (BGBl. I S. 698), das zuletzt durch Artikel 2 Absatz 11 des Gesetzes vom 20. Juli 2017 (BGBl. I S. 2808; 2018 I 472) geändert worden ist (LuftVG).

¹³⁶ Irish Aviation Authority Small Unmanned Aircraft (drones) and Rockets Order, S.I. No. 563 of 2015, of 21.12.2015.

¹³⁷ Vivek Sehrawat, "Liability Issue of Domestic Drones," *Santa Clara High Technology Law Journal* 35 (2018).

Thence, no other subjects – such as the commercial operator, owner or manufacturer (see Section 3 above and 3.4.3 below) – are expressly identified as possibly liable through an ad-hoc provision¹³⁸.

Indeed, Part. 107.23, FAA Regulations¹³⁹, dealing with «hazardous operations» establishes a fault-based liability rule, holding the pilot responsible, by stating that:

«No person may: (a) Operate a small unmanned aircraft system in a careless or reckless manner so as to endanger the life, or property of another; (b) allow an object to be dropped from a small unmanned aircraft in a manner that creates an undue hazard to persons or property».

Reference to «recklessness» and «carelessness» clearly recalls the notion of a tort of negligence, thence a typical fault-based rule, present in all legal systems. However, recent literature questions its true nature, and adequacy¹⁴⁰ (see Section 3.4.3 below).

No specific provision instead addresses drones of larger size, giving rise to similar concerns and triggering identical criticism as those referred to above, both with respect to the adequacy of such a choice in providing sufficient protection and certainty to potential victims.

The Small UAS Rule does not include a liability insurance requirement, but the Department of Transportation explained that

«prudent remote pilots should evaluate their existing insurance policies to determine whether they have appropriate coverage for these operations»¹⁴¹.

Drones could also fall under the notion of products, relevant for the application of product liability rules, both as emerging from ad-hoc enacted State provisions and from case law.

A depiction of the articulated picture of that body of law falls beyond the purpose of the current study¹⁴² but law and economics literature has often pointed to the inadequacy of such principles as currently applied by courts in ensuring adequate incentives to ex ante safe design¹⁴³.

The PLD, however, was largely inspired by the US approach to product liability, with respect to which, it shall suffice to refer to the Restatement 3rd of Torts Product Liability, Paragraph 1,

«One engaged in the business of selling or otherwise distributing products who sells or distributes a defective product is subject to liability for harm to persons or property caused by the defect»

¹³⁸ Criticism in this respect was advanced by Sarah Jane Fox, "The Rise of the Drones: Framework and Governance - Why Risk It?," *Journal of Air Law and Commerce* 82 (2017).

¹³⁹ In itself Title 14 of Code of Federal Regulations (CFR) on 21 June 2016, which came into effect on 29 August 2016.

¹⁴⁰ Kristopher Kent Harris, "Drones: Proposed Standards of Liability," *Santa Clara High Technology Law Journal* 35 (2018).

¹⁴¹ Federal Register, 81, 124, of 28.6.2016.

¹⁴² David G. Owen, *Products Liability Law*, second ed. (St. Paul (MN): Thompson West, 2008).

¹⁴³ See Mitchell A Polinsky and Steven Shavell, *Handbook of Law and Economics*, vol. I (North-Holland, 2007). See also Mitchell A Polinsky and Steven Shavell, "The Uneasy Case for Product Liability," *Harvard Law Review* 123 (2009-2010). A recent study on Civil Aviation Aircraft, and the exemption introduced by the General Aviation Revitalization Act, Senate Bill: S. 1458 (103rd), 1994, (GARA), demonstrates the impact of moral hazard on flight operation. Possibly some conclusions could also apply to drones.

Table 2 – Civil liability rules by country

Member State	Legal Act	Liable Party	Nature of Liability	Limitations & Exemptions	Duty to Insure
Spain	Real Decreto 1036/2017 (Art. 15, Art. 16) + Ley Navegación Aerea (Art. 119, Art. 120)	Operator	Strict	Limitation to compensation: 220 000 special drawing rights except in case of gross negligence or intentional misconduct	Yes
France	Arrêté du 17 décembre 2015 + Code des transports (Art. L6131.1)	Operator/owner (in case of leasing)	Strict	Unlimited	Yes
Belgium	Arrêté royal 10 avril 2016 (Art. 80, Art. 81)	Operator/pilot	Strict		Yes. Exception: non-commercial use
UK	Civil Aviation Act 1982, Air Navigation Order 2016 (Art. 94; art. 241), Air Navigation (Amendment) Order 2018	Person in charge	Fault-based	Unlimited	Yes

Italy	Regolamento ENAC + Codice della Navigazione (r.d. 327/1942, Artt. 965, 971) + Rome Convention (Art. 1)	Operator/user	Strict	Limitations to compensation: minimum insurance coverage in accordance with European legislation, except if the operator is negligent	Yes
Denmark	Air Navigation Act (Chapter 9, paragraph 126; Chapter 10, paragraph 127)	Owner/user	Strict	Unlimited	Yes
Sweden	Swedish Aviation Act 2010:500 (Chapter 9) + Swedish Act on Liability for Injury as a Result of Aviation 1922:382 (art. 1).	Owner/possessor	Strict	Unlimited	Yes
Czech Republic	Czech Aviation Law 49/1997 (Art. 3.1.1, Art. 3.1.9 of Chapter 3)	Operator	Fault-based		Mandatory for drones > 20 kg; drones used for non-commercial purposes, even if < 20 kg
Poland	Regulation of 26 March 2013 (Annexes 6 and 7)	Operator	Strict		Mandatory for drones used for commercial purposes; for drones > 5 kg even if used for leisure activities

The Netherlands	Regeling op afstand bestuurd vliegtuigen Geldend van 01-07-2016 t/m 06-10-2017 + Wet luchtvaart Geldend van 28-07-2018 t/m heden	Owner	Strict		If < 4 kg, insurance against civil liability for damages to third parties. If commercial, as for < 4kg, but with € 1 million coverage
Austria	Paragraphs 146 ff of the Austrian Aviation Act	Owner, unless he proves that drone was being employed against his will	Strict	Liability cap according to MTOM	Yes (exception: toy drones)
Germany	German Aviation Regulation (LuftVG, Article 33)	Owner, unless he proves that drone was being employed against his will	Strict	Liability cap according to MTOM	Yes
Ireland	Irish Aviation Authority Small Unmanned Aircraft (drones) and Rockets Order 2015 (art. 7)	Person in charge	Fault-based	Unlimited	No, recommended

	Legal Act	Liable Party	Nature of Liability	Limitations & Exemptions	Duty to Insure
United States	FAA Regulation, Part. 107.19 ff. (Title 14 of Code of Federal Regulations) for Small Unmanned Aircraft Systems.	Remote pilot in command	Fault-based	Unlimited	No, recommended

3.4 Discussion and conclusions

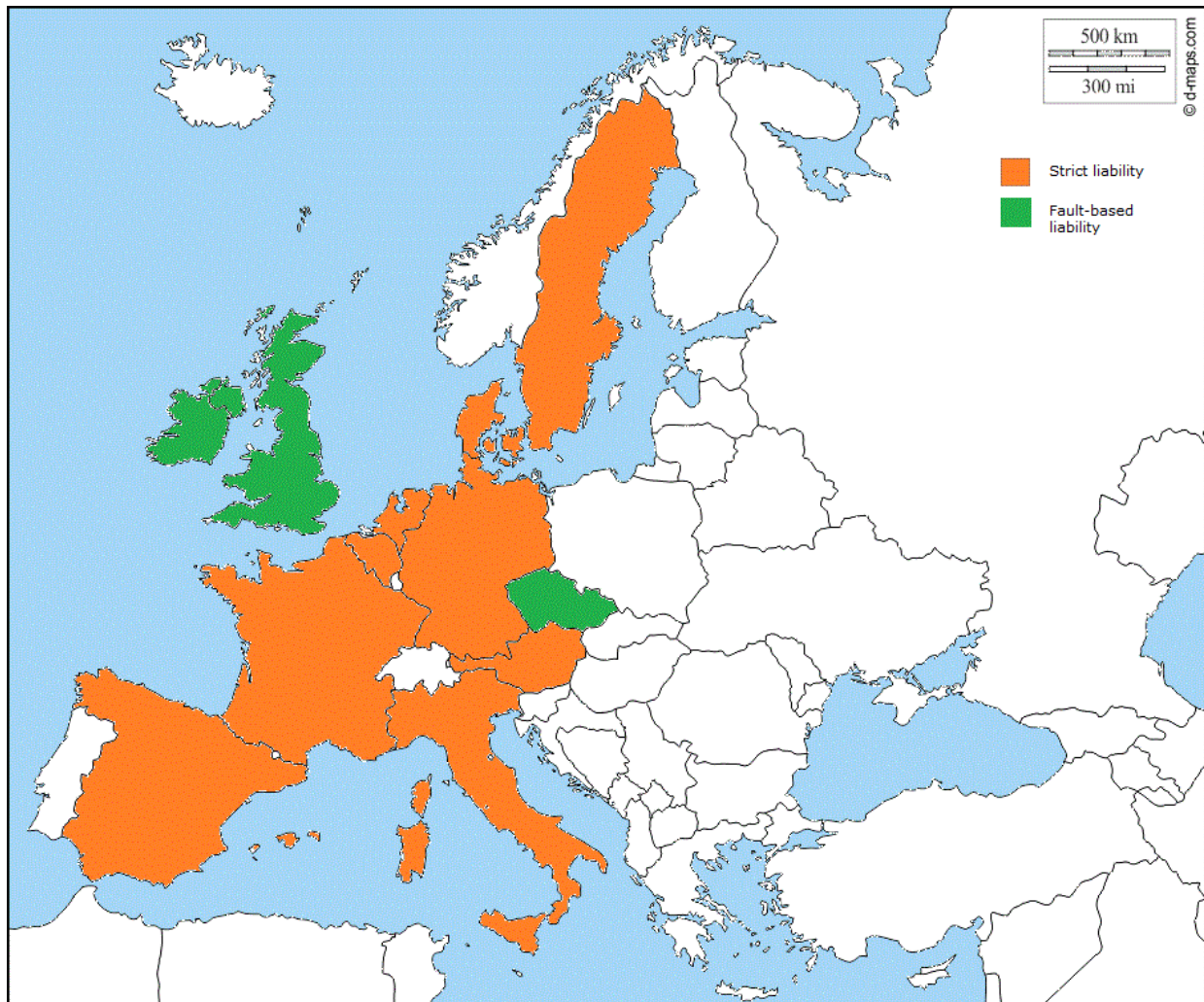
In the subsequent section we will provide an overview and discussion of all the liability-related issues, starting with the current European and MSs' framework

3.4.1 The EU and MSs' legal framework: an assessment

The European legal framework on liability, as is, does not clearly define the position of the operator and of the pilot in details. As described above, future interventions of the Commission – pursuant to the relevant integration and delegated powers the RCA attributes to it – will profoundly shape such aspects, thence considerations on this matter might only be partial.

Operator's liability. It is clear however, that the operator could be held responsible on a broad number of cases, for failing to ensure the safety of drones' operation, according to criteria that still need to be further specified. Operator's liability would primarily abide a compensatory rationale, for the control the party could exert on the way the drone is maneuvered and used is only very indirect. However, the operator, in particular when a legal person, would represent the party providing a service through the use of UA and thence be sufficiently well positioned to identify risks, and manage them efficiently.

The European legal framework on insurance is only partially applicable to drones, for many would be exempted, primarily based on the fact the fall under those categories of devices that are excluded from the application due to their mass. However, mass based classification has been ascertained as insufficient in the classification of UA by the RCA, reasonably stressing the importance of other risk-related factors. Thence some greater coordination between these two bodies of law could be beneficially pursued, eventually also leading to a greater degree of uniformity of solutions applicable across MSs.



Map 1 – Map of civil liability rules by country (fault-based or strict)

The MSs’ legal framework on liability. The picture that emerges from the brief overview of MSs’ legislation on drones is particularly articulated. As depicted in the graphical representation, most countries adopt at least one strict liability rule, burdening primarily the operator¹⁴⁴, typically in charge of ensuring the safety of the entire activity – on the ground and in the air – and, in other cases, the owner¹⁴⁵, and in one case the pilot¹⁴⁶. At times, the owner and operator are held jointly and severally liable¹⁴⁷.

¹⁴⁴ Such as Spain, France (which burdens the owner too, see also fn. 147) Belgium (which burdens the pilot as well, see also fn. 146), Italy (which holds the user liable, too) and Poland. Some more countries burden primarily the operator, too, but according to a fault-based approach, see fn. 149.

¹⁴⁵ Such as Denmark, Sweden, the Netherlands, Austria and Germany, though in the two latter countries the owner is entitled to prove that the drone was being used against his will in order to be exempt from the duty to compensate for damages.

¹⁴⁶ A notable example is Belgium (see fn. 144). Italy (see fn.144) and Denmark (see fn.145) make reference to the «user» instead of the «pilot», but the two notions oftentimes overlap, especially if the device is remotely piloted and not totally automated, which is the case for the absolute majority of UA as of now.

¹⁴⁷ For instance, in France (in case of leasing, see also fn. 144), in Austria, and in Germany.

Often such rules were not conceived for drones specifically, rather are the result of the direct or indirect extension of those applicable to civil aviation¹⁴⁸. Most likely, despite the obvious differences between the two kind of air vehicles, the rationale of primarily ensuring victims' compensation might justify the plain extension and application of identical rules to drones, in particular when used for commercial purposes. Indeed, the operator could be the party best positioned to manage all risks associated with the use of the device, also in a RMA perspective (see Section 3.4.5 below for a more detailed discussion).

Just a few countries instead resort to standards of care, thence applying traditional fault-based liability¹⁴⁹, favouring the agent over the potential victim.

A strict liability rule, instead, certainly favours the claimant, by easing the burden of proof he needs to meet. Often such rules are coupled with liability caps¹⁵⁰, limiting the overall exposure of the responsible party to a maximum fix amount, the rationale being that of striking a fair balance and reducing the overall economic risk associated with undergoing a certain – otherwise typically dangerous – activity, deemed socially desirable¹⁵¹. This is normally the case with civil aviation. If the damages an operator could be bound to face in case of an accident involving a civil aviation plane transporting a number of passengers and their property weren't limited, they would constitute an excessive burden. Realistically, the cost of air travel would become alternatively so high as to be accessible only by a limited share of the overall population, or simply so economically inefficient that no enterprise would survive. In a policy perspective, allowing liability caps serves a number of purposes, on the one hand ensuring the victim obtains at least a partial recovery of her loss, and on the other hand favouring an optimal level of activity in a specifically desirable field.

However, in the case of drones there seems to be no real need to limit *ex ante* the potential liability of the party, be it the owner, operator or pilot. Indeed, the nature of the activity, the absence of a relevant number of human passengers, the still more limited size of the device itself, substantially reduces the awaited economic consequences that might occur in case of an accident. Even in the worst case scenario, a drone of relevant size crashing on a crowd might only injure a limited number of bystanders. The tragic risk could in most cases be compared to that borne by a driver rather than that undertaken by an air carrier transporting dozens of passengers. For those reasons, a liability cap would prove less of an obvious solution so long as drones are concerned, also when used for commercial purposes.

The MSs' legal framework on insurance requirements. If an UA satisfies the weight and employ requirements provided by IR, the latter itself makes insurance coverage compulsory. Most MSs, moreover, establish a duty to acquire third-party liability insurance for devices that are not

¹⁴⁸ This is, for instance, the Italian case. In this system, a relevant amount of regulation on UA comes from bodies of law that substantially predate the diffusion of drones.

¹⁴⁹ Namely the United Kingdom, Ireland and Czech Republic. In none of these countries the owner is liable, while liability falls upon the person in charge in the former two hypotheses, and on the operator in the latter. Indeed, the wordings «operator» and «person in charge» largely overlap.

¹⁵⁰ In Austria and in Germany, liability caps depend on the drone's MTOM, while the Italian legislator chose to adopt the minimum insurance coverage mentioned in the European legislation, with the notable exception of negligence on the part of the operator. In the latter hypothesis, liability is unlimited. A similar pattern is established in the Spanish system, where a cap of 220 000 SDR is set and liability is unlimited only in case of gross negligence or intentional misconduct.

¹⁵¹ Polinsky and Shavell, *Handbook of Law and Economics*. See esp. p. 355.

encompassed by IR, too¹⁵², at times differentiating among MTOM classes and between commercial and non-commercial users¹⁵³.

Generally speaking, the higher the drone's MTOM, and the more professional (thence, the less recreational) its employment, the tighter the duty to take insurance.

Therefore, when a national legal framework does not make insurance compulsory for all classes of UA, the majority of exemptions from the duty to insure are chiefly provided for devices that are both lighter than a fix mass and employed for non-commercial and non-professional purposes.

3.4.2 The US legal framework: comparative considerations

The US legal framework on liability is not specifically defined for drones exceeding 55 lbs. When an accident occurs involving such devices, general tort law principles and case law applies, varying depending on the State, for tort law is generally a matter of common law and State regulation. Most commonly a fault of negligence will sanction the conduct of the pilot. Absence of specific provisions does not allow to define the liability of the operator or owner in greater detail, and case law is only partial and fragmented.

As far as SUA are concerned, instead, the responsibility of the remote pilot is established through a fault-based rule, in light of the consideration that he is the one in control of the operation of the device.

Both options, however, encounter the criticism discussed below (see Section 3.4.3 below), and often recalled in the US literature on the matter (see Section 3.3 above).

The US legal framework on insurance. No ad-hoc insurance requirements are provided for by existent regulation, not even with respect to SUA. Theoretically, the victim could then find the responsible party to be insolvent, and thence incapable of providing adequate compensation of all damage caused, in particular when the drone is operated for non-commercial purposes. This appears as a suboptimal choice in a RM perspective (see Sections 3.4.4 and 3.4.5 below).

3.4.3 The optimal choice of liability rules

Objective vs. fault-based liability rules. When comparing strict and fault-based rules, the former appear to be preferable, for they limit litigation costs, easing access to justice by a wider share of potential victims, providing very clear criteria for the ascertainment of liability.

At the same time, among the different parties identified by MSs legislation as objectively responsible, the operator is possibly a more efficient choice for the reasons already referred to above (see Chapter 3 above) in particular when the drone is used for commercial purposes.

¹⁵² Among the examined countries, Spain, France, the United Kingdom, Italy, Denmark, Sweden, and Germany introduced a general obligation to insure, while most other ones require insurance in the majority of hypotheses (see fn. 153). Therefore, 12 countries out of the 13 examined require – despite to a different extent – insurance for the UA that fall out of the scope of IR.

¹⁵³ Drones for non-commercial use are allowed to be operated without insurance in Belgium, and the same exemption is provided in Austria for toy drones. Other countries regulate according to both weight and purpose: in the Czech Republic insurance is compulsory for all drones, apart from the ones that are both a) lighter than 20 kg, and b) commercially employed. In Poland, all drones weighing more than 5 kg must be insured, as well as lighter ones, if commercially employed. In the Netherlands, a minimum coverage of € 1 million is required for all drones employed commercially.

The differentiation between professional and non-professional use: liability. In such a perspective, it might be possible to differentiate professional from non-professional use. In the former, other parties might be held liable, namely the pilot or owner, for there might not be a third and distinct party, who organizes the entire activity. Indeed, often times the operator will correspond to the owner, and in some cases to the pilot himself. The latter however could be a different party for the device might also be occasionally borrowed.

When the drone is used for recreational purposes or anyway for non-commercial ones, holding the owner liable might also prove as efficient as holding the operator in all other circumstances, for he is the party that could be more easily identified, in particular when the drone is subject to registration requirements, who could better ensure maintenance and control over the use of the device, and acquire insurance. Such a solution would abide a similar rationale as that put forth by many MSs in establishing the liability of the owner of a vehicle involved in an accident (see Chapter 3 above).

In any case, rules of joint and several liability could also be used to further ensure the victim's adequate protection, eventually holding both the pilot and owner responsible.

The differentiation between professional and non-professional use: insurance. The distinction between commercial and non-commercial use could thence be justified on the ground of the need to identify different parties to be held liable – the operator and the owner/pilot respectively –, however, in a pure risk-centred perspective – such as that underpinning the RCA – it should not directly influence the duty to acquire insurance coverage. Indeed, when the potential risks associated with the use of drones are considered, the mere fact that the device is used for purely recreational or personal purposes does not directly and obviously mitigate risks, often the contrary. Professional operation most commonly will ensure higher standards of compliance with all legislation. Risks are instead dependent upon the intrinsic characteristics of the device (see Section 2.2 above), such as size, speed, energy, the possibility to record images and sounds. The decision to impose a duty to insure should vary according to such elements, eventually being excluded for smaller devices that do not pose substantial risks due to their technical peculiarities, not on other considerations such as the nature of the activity.

The problem with the apportionment of liability among parties (in particular in light of manufacturers' liability). Strict liability rules allow for the clear identification of the party to be held responsible and ease the position of the claimant in recovering the damages suffered. However, the technical complexity of drones might lead to accidents that involve and depend upon the malfunctioning of the device, eventually traceable to the very design and manufacturing, or even due to lack of adequate information on the risks, characteristics and functioning of the device (see also Section 3.1 above)¹⁵⁴.

¹⁵⁴Said risks are even more specified by the RCA that what typically emerges for all other categories of products falling under the PLD. Such informational requirements are today not fully defined in as much as the intervention of the Commission with implementing and delegated acts is intended to shape them further. Indeed, as mentioned above, Art. 58, RCA, requires the Commission to establish «detailed rules with regard to: (a) the specific conditions for the design, production and maintenance of unmanned aircraft [...] as well as for the personnel, including remote pilots, and organizations involved in those activities, necessary to ensure compliance with the essential requirements referred to in Article 55[...] (d) the privileges and responsibilities of the holders of certificates and of natural and legal persons making declarations». Therefore, though not

Indeed, increasing automation causes a relevant number of functions to be directly managed by the device itself. Thence, should an accident occur it might be the consequence of a failure of the system rather than of human intervention. Non-fault based rules by definition do not attribute liability on the basis of failure to meet a desired standard of conduct of the party being held responsible. Thence, the objective liability of the operator or owner is unrelated to the material cause of the accident. This simplifies the position of the claimant who would not need to determine whether the cause of damage shall be traced back to a defect or to human intervention¹⁵⁵. However, when the defendant is called in to compensate damage, he might still possess an action in recourse against the manufacturer, should the product be defective.

In such a perspective, the criticism typically addressed to the PLD and above briefly described (see Section 3.1.1 above) could easily be here recalled. In particular, the burden of proof with respect to the identification of the defect and of the causal nexus could discourage the party who was bound to pay the first instance to sue the manufacturer, in particular should the damage be of a limited economic value. This could particularly affect the position of non-professional users.

3.4.4 Compulsory insurance schemes and compensation funds

Possible problems with insurance (and compulsory insurance schemes). The identification of duties to acquire insurance for third party liability is certainly beneficial to ensure victim's compensation. Such duties, as above mentioned, should not depend on the professional nature of the activity, rather on the intrinsic characteristics of the device that might give rise to relevant risks. Differentiation should not thus be use-based but only risk-based.

In such a perspective, a more relevant concern could be posed by the difficulty to clearly identify and quantify said risks due to the increase in the number of ways drones are used, the scenarios, the possible rights, beyond bodily integrity, that could be affected in case of accidents. Describing this complexity in details falls beyond the scope of this study, for it largely depends on empirical considerations and market analysis of available insurance products. Yet it should not be overlooked in a policy perspective.

Uncertainty with apportionment between manufacturers on the one side and other parties on the other side – as briefly described above – could also affect the possibility to clearly identify for what risks each party needs to insure. Most likely, given the complexity of suing in recourse the producer, the party identified as objectively liable would bear all those risks as well.

The need for a compensation fund. Both a 2014 study funded by the European Commission¹⁵⁶, and a 2016 study funded by the European Parliament¹⁵⁷ suggest that, since buying and operating drones can

addressing directly liability nor insurance, the framework provided by the RCA and the forthcoming delegated and implementing acts is bound to exert a relevant influence on it, at least through the setting of requirements, both for devices, for personnel involved and for operations.

¹⁵⁵ Nonetheless, in some legal systems, such as Denmark and Sweden, liability – otherwise strict – is excluded in case of relevant negligence or wilful misconduct on the side of the damaged person. See Sections 3.2.6 and 3.2.7, above.

¹⁵⁶ Steer, Davies, and Gleave. See esp. pp. 20 ff.

¹⁵⁷ Tomasello and Ducci. See esp. Section 4.9.3, p. 39.

be relatively easy and inexpensive, an ad-hoc compensation fund could be advisable in order to strengthen the possibility for victims to recover damages.

Indeed, victims of accidents caused by drones, as of now, don't easily obtain compensation, for instance, when the device is not insured, or not identified – because lost or wholly destroyed after the accident – or the insurance cannot provide coverage, which may happen if the operation at matter is not duly approved.

For similar issues, in the field of road transportation, EU Motor Directive (MOTD)¹⁵⁸ required MSs to establish compensation funds, in order to protect victims in some hypotheses, notably the ones of an uninsured vehicle or of an unidentifiable one.

In the motor insurance framework, those funds are paid by all insured motorists, through a small quota on their regular insurance premiums.

Nonetheless, the compensation fund for motor vehicles is feasible because of the large number of insured motorists, which makes it possible to raise substantial amounts of money without having a dissuasive effect from buying an insurance product for one's own vehicle.

Therefore, implementation in the UA market could be more difficult, chiefly because of the only partially accomplished diffusion of drones. Such difficulties, however, do not diminish the utility of similar solutions, even more if some drones are exempt from a duty to acquire independent insurance. Moreover, a similar fund could also be financed by imposing a tax on the sale price of the device, thence forcing the internalization of the associated costs by all final users.

Indeed, neither the RCA nor the IR have implemented this point so far.

3.4.5 A Risk-Management Approach

A Risk-Management Approach. A RMA is grounded on the idea that liability should not be attributed on the basis of considerations of fault – defined as the deviation from a desired conduct – typical of most tort law systems, rather on the party that is best positioned to (i) minimize risks and (ii) acquire insurance¹⁵⁹.

One fundamental consideration underpinning such alternative approach is that liability rules are not always efficient in ensuring adequate incentives towards a desirable *ex ante* conduct, be it a safety investment – such as in the case of producers' liability (as emerging from the PLD) – or a diligent conduct – such as the driver's or pilot's in the case of road circulation or drone operation respectively

¹⁵⁸ Directive 2009/103/EC of the European Parliament and of the Council of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability (Text with EEA relevance), in OJ L 263, 7.10.2009.

¹⁵⁹ Please allow reference to Bertolini, "Insurance and Risk Management for Robotic Devices: Identifying the Problems." The viability of such an approach was also considered in CLRR (paragraphs 53 and 55) that stated: «[the European Parliament] considers that the future legislative instrument should be based on an in-depth evaluation by the Commission determining whether the strict liability or the risk management approach should be applied [... Moreover, the European Parliament] notes that the risk management approach does not focus on the person who acted negligently as individually liable but on the person who is able, under certain circumstances, to minimise risks and deal with negative impacts».

–. That end is best attained through the adoption of detailed *ex ante* applicable regulation, such as safety regulation, abundant at EU level and susceptible of further perfecting.

A second fundamental consideration is that complex litigation discourages claims by victims, in particular when the economic interest at stake is limited, at once raising issues of access to justice, and allowing the externalization of costs upon the unjustly harmed party. Complexity in litigation is a consequence, among others, of two factors that are both present in robotics, artificial intelligence and emerging technologies more broadly, namely (i) technical complexity that also leads to informational asymmetry, and (ii) the overlapping of multiple rules, theoretically applicable to the same case, leading to the liability of different parties.

The issue *sub* (i) is material and might not be avoided, yet needs to be taken into account when conceiving adequate policy responses. In a system, such as that defined by the PLD, increasing technical complexity causes the demonstration of the existence of a defect to become ever more difficult. The party that possesses more information – the manufacturer – and typically larger economic resources is also best positioned by the current distribution of the burden of proof, for it is the claimant that needs to show the existence of a defect and of a causal nexus.

The issue *sub* (ii) is purely legal, and could be tackled by simplifying the overall framework by identifying one party – in a one-stop-shop perspective – that is clearly and unambiguously responsible towards the claimant under all circumstances. To that end opting for strict and even absolute liability rules appears an adequate solution. The concern is thence that of primarily ensuring the compensation of the victim, in a more efficient and less litigation-intensive fashion.

Moreover, according to a RMA the party to be held liable might be the one that is not responsible for the accident. Instead it should be the party that could better prevent it – minimizing the risk – and better manage it – once the risk materializes –, eventually by acquiring adequate insurance coverage. The party best positioned to ensure all software updates are correctly installed is most likely not the final user. Experience shows that individuals often delay the update of their systems – personal computers and hand-held devices –, and such distraction and reckless behaviour could most certainly be blamed. Yet, if the purpose were to ensure that safety-critical updates are installed onto all devices – eventually also drones – it might be sensible to burden another party – most likely the manufacturer – with that duty to update. The latter, in fact, could conceive the device in a fashion that when turned on, were the relevant software not installed, it would refuse to operate. Similarly, as already discussed above, when a single product might be used by multiple agents and the identification of the party materially operating it at the moment of the accident might be complex, holding the owner liable might ease the compensation of the victim.

Those rationales – as briefly demonstrated above – are not entirely foreign to current legal systems at EU and MSs' level. Yet they might often require to depart from a more common logic of personal reprimand that typically characterizes civil liability rules. Indeed, in the examples provided, the parties identified as ideal respondents – according to a RMA – may not be blamed for the accident, since they did not directly contribute to its occurrence.

As far as drones are concerned, the solutions that appear to be emerging at MSs' level, as well as EU level, largely resorting to the strict liability of the operator (see Section 3.4.1 above), might be deemed quite consistent with a RMA.

The clear identification of a single party to be held responsible towards the victim through a strict standard of liability, irrespective of the ascertainment of the material causes of the accident, clearly simplifies the position of the claimant, according to the criteria described above.

The problem with apportionment is however not completely overcome, in particular due to the theoretical possibility of applying the PLD, with all the constraints and inefficiencies that this might entail. In particular, it might be complex to determine whether a single accident is the consequence of the erroneous behaviour of the human user or of a failure of the system due to its defective nature. Technological complexity and informational asymmetry between the user/pilot/operator on one side, and the manufacturer on the other side, might prevent an effective internalization of risks by the latter.

Such effect above all hinders non-professional users, primarily those that would be called in to compensate damages directly, without being covered by insurance contracts, and who would not possess sufficient economic resources – and incentives – to meet the complex burden of proof that requires them to demonstrate the liability of the manufacturer pursuant to Article 1, PLD.

3.4.6 The role for Europe

The optimal level of legislative intervention. Liability rules play a relevant role in shaping the incentives to the different players involved in the research, production, and use of a given technology.

This entails also that during the research and production phase liability rules are going to be taken into account when deciding which technical solution to adopt among possible alternatives.

Indeed, the EU is aware of such a perspective in as much as it directly exploits regulation-by-design for instance to ensure privacy is respected in the very way the device functions¹⁶⁰. If a given application needs to be designed as to «meet the requirements of this Regulation and protect the rights of data subjects», among different solutions the one will be implemented that ensure compliance. Thus, a plain inference allows us to await that a similar effect, as the one played by data protection regulation, will also be exerted by liability rules. This goes beyond the effort of making products safe. Indeed, if the manufacturer expects to be held liable from the use of event data recorders and/or the implementation of automation of certain tasks and controls, it might opt for alternative solutions that minimize the risks of being called in to compensate damages in case of an accident. This effect isn't *per se* a problem, however acknowledging it forces us to consider the consequences of fragmentation at EU level under another perspective.

Indeed, legal fragmentation always represents a barrier to the entrance of a given market and thence prevents the creation of a level playing field, and the creation of a common market, but when technologically advanced products are considered, the aspect briefly described further exacerbates this effect.

Studies¹⁶¹ have already shown with respect to other technologies – such as Connected and Autonomous Driving solutions (CADs) – what the cost of the absence of EU intervention might be.

¹⁶⁰ The principle of privacy-by-design is put forth by the GDPR, Art. 25, and Recital 78.

¹⁶¹ Tatjana Evas, *A Common Eu Approach to Liability Rules and Insurance for Connected and Autonomous Vehicles* (Bruxelles: European Parliament, 2018). It is available at [www.europarl.europa.eu/RegData/etudes/STUD/2018/615635/EPRS_STU\(2018\)615635_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2018/615635/EPRS_STU(2018)615635_EN.pdf) (last access 2.11.2018).

However, the impact on the design of technology of increasingly more bodies of legislation should also induce policy makers to take into account this additional perspective. Indeed, a difference in legislation across MSs could lead to the proliferation of different kinds of devices, some of which are conceived to operate just in one legal system and not in another one. In some cases – such as CADs – where the same device could theoretically be used in different MSs – when it is driven across borders – the effect could be particularly severe. Yet, even with drones that are primarily intended to be operated in short-distance flights, this could represent a substantial limitation and hinder the proliferation of a EU market and industry in the field.

All such considerations, add on to those that *per se* suggest the need for a European intervention in the regulation of emerging technologies¹⁶². Thence, considering the recent enactment of the RCA and the awaited implementation and delegated acts could profoundly shape the aspect of liability as well, there are strong policy grounds to suggest the adoption of uniform rules on the matter of civil liability and insurance requirements for drones at EU level.

Approaches to regulation. When discussing technology regulation, the issue is often made whether it is more sensible to resort hard-law or soft-law, not to hinder innovation¹⁶³.

The Commission has appointed an expert group to discuss the adequacy of existent liability rules to regulate new technologies, and a second one to undergo an assessment of the PLD. Both are asked to assist the Commission «in developing principles that can serve as guidelines for possible adaptations of applicable laws at EU and national level relating to new technologies»¹⁶⁴, that could also be conceived as soft law, suggesting a possible interpretation of existent rules, so as to avoid undergoing a more comprehensive revision. There are grounds to challenge the efficacy of soft-law approaches to liability regulation in general, yet in the case at hand it appears superfluous.

Indeed, the recent adoption of the RCA and the awaited implementing and delegated acts, clearly demonstrate that an option in favour of hard law was already made by EU policy-makers with respect to drone regulation. The considerations here drawn instead show how it would be possible and also advisable to address civil liability too with an identical approach. That would not entail an undue interference with MSs' tort law systems.

¹⁶² Please allow reference to Bertolini and Palmerini.

¹⁶³ Leenes et al.

¹⁶⁴ For further information see

www.ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3592 (last access 2.11.2018).

4 CONCLUSIONS AND RECOMMENDATIONS

The following chapter presents the **conclusions** (see Section 4.1 below) that may be derived from the analysis conducted, and finally formulates a series of **policy recommendations** (see Section 4.2 below) on possible interventions EU institutions could consider, in order to address the issue of civil liability arising from accidents involving the use of drones.

4.1 Conclusions

The conclusions here drawn summarize the considerations formulated in the previous chapters, and touch upon all the issues addressed, namely (i) definitions and classification requirements, (ii) liability, insurance and risk management, and, finally, (iii) the role for Europe in the regulation of drones.

Indeed, in order to determine how civil liability should be regulated it is necessary to determine how drones are to be defined and classified (see Section 4.1.1 below), since the latter also determines the requirements each device is subject to in terms of – for the matters here considered – registration, and insurance.

Moreover, once alternative liability models are described and discussed, identifying the one that is preferable (see Section 4.1.2 below), there is a need to determine at what level – MSs or European – legislation ought to be adopted, and which approaches ought to be selected among possible alternatives – hard or soft-law – (see Section 4.1.3 below).

4.1.1 Definitions and classification requirements

Definitions are essential for the correct identification of the item being regulated. **The definition put forth by the RCA appears to be adequate.** Indeed, it encompasses a very broad set of applications, and yet it will be further specified through the classification that the Commission will provide with the implementation and delegated acts, to finely regulate products certification, safety requirements, and registration, as well as to address some aspects relevant for the application of liability rules. **More detailed considerations could only be based on the referred acts that were not, as of today, adopted.**

As put forth by the RCA, drones should be classified according to the risks they give rise to, rather than just weight. Risks to be taken into account are both material and immaterial. With respect to the former, the weight, speed, flight altitude, overall energy, ability to operate autonomously are certainly relevant and other criteria might be identified. Indeed, the larger and faster the drone, the more energy it generates, the more dangerous the impact could be. To this end, also the place where it might be used could be relevant. As per immaterial harm, other aspects, including the possibility to acquire images and sound should be considered, for they might lead to the violation of other relevant – at times fundamental – rights of third parties.

Such classifications should be of relevance for the purposes of the correct identification of safety and certification requirements, that are *per se* tightly connected with the operation of liability

rules. As explained¹⁶⁵ such rules compete with liability rules in ensuring high levels of safety investment *ex ante*, and according to the discussion provided, pursuant to a RMA¹⁶⁶, they are even preferable a tool towards that end.

Such considerations could also affect the prevision of insurance requirements, but not lead to its exclusion (for a more detailed discussion see Section 4.1.2 below). Drones that pose more limited risks might be less burdened in that respect.

Identical considerations can be made for a **duty to register the drone, which should always be present** also to ease the identification of the owner and operator. Exemptions could only be granted for model aircraft, and toys. The solution adopted by the US federal legislation appears adequate and reasonable¹⁶⁷.

The commercial or non-commercial nature of the use might instead justify the adoption of partially different liability rules, in as much as it might lead to the identification of another ideal responsible party¹⁶⁸.

4.1.2 Liability, insurance & risk management

Strict liability rules, clearly identifying one liable party, are preferable to fault-based rules.

In such a perspective, despite some degree of variation observable across MSs, **the operator appears as the ideal respondent and ought to be held *prima facie* liable for all damages arising from the use of the drone, even those that are a consequence of the erroneous piloting, and or a malfunctioning that could be traced back to a defect.** As indicated also by the RCA¹⁶⁹, and in a risk-management perspective, he is best positioned to ensure the safety of drones' operation¹⁷⁰, and to acquire insurance.

The solution adopted in the US federal regulation seems instead less efficient due to the considerations drawn above¹⁷¹, much more so the absence of any rules as it is the case for larger aircraft¹⁷².

Rights to act in recourse against the pilot and manufacturer ought to be granted, yet the position of the claimant ought to be simplified, by identifying one clear respondent according to a one-stop-shop approach¹⁷³.

Alternatively, if more parties (owner and/or operator and/or user) **ought to be held liable, they should be jointly and severally liable**, for the same accidents in order to ease the position of the claimant in recovering the damages suffered, and reducing complex litigation to apportion liability among said parties¹⁷⁴.

¹⁶⁵ See Section 2.2.

¹⁶⁶ See Section 3.4.4 above.

¹⁶⁷ See Sections 2.3 and 2.2 above.

¹⁶⁸ See Section 4.1.2 below.

¹⁶⁹ Art. 2.4.1, Annex IX, RCA.

¹⁷⁰ See Section 3.4.5 above.

¹⁷¹ See Section 3.4.3 above.

¹⁷² See Section 3.3 above.

¹⁷³ See Section 3.4.3 above.

¹⁷⁴ See Section 3.4.3 above.

For drones used for recreational and non-commercial purposes, the owner might be the subject more easily identifiable, and upon which liability is better rested¹⁷⁵. Instead, in all other cases, the operator might be the party that more easily could intervene to both mitigate them and manage them once they materialize, providing compensation.

Overall, the efficiency of EU product liability regulation should be questioned, and some of the most relevant criticalities highlighted above addressed¹⁷⁶. However, as far as the regulation of civil liability for accidents deriving from the use of drones is concerned, **it shall suffice to identify the one party held liable as *prima facie* responsible for all damages deriving from a defect in the drone**. Indeed, increasing automation observed in drone design as much as in any other technologically advanced application, could pave the way to complex litigation where the claimant needs to ascertain and demonstrate whether the accident was due to human error or, instead, a defect in the device. The operator – or owner – instead, should not be able to escape liability towards the claimant on the grounds that the accident is to be traced back to a defect in the device. **Instead, he should be burdened to first compensate the damage suffered and eventually act in recourse against the manufacturer on those grounds, pursuant to the PLD**¹⁷⁷. In fact, he would be best positioned to insure against those risks, control the quality of the device he uses, and ensure adequate maintenance.

Insurance requirements should be provided – despite to a different degree – with respect to all classes of drones. Exceptions could be made for model aircraft, and particularly small drones to be used for purely recreational purposes¹⁷⁸.

The different nature of the use – commercial or not – the drone is to be put at should not determine the existence of a duty to insure. Indeed, what ought to matter is the mere existence of a risk, and that is inherent to the characteristics of the device¹⁷⁹ (see Section 2.2 above). A professional use might theoretically be safer, despite more frequent, thence justifying lesser concerns. **The duty to insure should only be determined by the risks inherent to the device in light of its characteristics and potential applications**¹⁸⁰.

A compensation fund should be established in order to provide compensation in all cases where an accident occurs and the device is not registered, insured, and the operator and/or owner and/or pilot are not identified. Said fund could also cover damages, according to identical criteria, in all cases that a device is involved for which a duty to insure is not provided¹⁸¹.

The fund could be financed through a tax or fee or contribution to be paid at the moment the drone is purchased or by the manufacturer directly¹⁸².

¹⁷⁵ See Section 3.4.3 above.

¹⁷⁶ See Section 3.1.1 above.

¹⁷⁷ See Section 3.4.3 above.

¹⁷⁸ See Section 3.4.4 above.

¹⁷⁹ See Section 2.2 above.

¹⁸⁰ See Section 3.4.4 above.

¹⁸¹ See Section 3.4.4 above.

¹⁸² See Section 3.4.3 above.

4.1.3 The role for Europe

Advanced robotics and AI are of strategic importance for the future of the European industry, and European institutions are well aware of the crucial role regulation plays in this respect in as much as, in its Communication of 25 April 2018, the Commission identifies the need to «Ensure an appropriate ethical and legal framework»¹⁸³ as one of the pillar strategies.

Indeed, «New technologies are based on values»¹⁸⁴, and thence the EU by ensuring a «sustainable approach [...] creates a competitive edge [...]»¹⁸⁵ by providing «an appropriate framework which promotes innovation and respects the Union's values and fundamental rights as well as ethical principles such as accountability and transparency»¹⁸⁶.

Among said issues, liability rules are of primary importance, in as much as they shape incentives for all players involved in the research, production, distribution and use of any device. Moreover, liability rules are already, at least in part – and primarily through the PLD –, established at EU level, in light of the very consideration of the need to provide a level playing field, as a prerequisite for the proliferation of EU industry. All such considerations, support the conclusion that EU intervention on such matters is always overall advisable and appropriate.

More specifically, however, the analysis conducted in the preceding chapters and sections allows some more precise recommendations to be formulated, that rest on the peculiarities of the advanced applications considered, namely drones, ultimately concurring with what has just been recalled at a more general policy level.

Liability rules and insurance requirements ought to be regulated at EU level in order to avoid excessive fragmentation¹⁸⁷. Indeed, liability rules determine how technology evolves, thence absence of uniformity across MSs in this respect might prove particularly detrimental for the creation of a common market, and the proliferation of a EU industry in the field. Different liability rules in different MSs could favour alternative technological solutions that would then cause one device – designed primarily to conform to the requirements put forth by one legal system – to be not immediately deployable in another MS, where other criteria apply.

Hard law is required to this end, and the implementation and delegated acts could represent a valuable opportunity for the Commission to intervene, considering how the possibility of shaping operators' liability is explicitly present. In this respect the IR ought to be revised and coordinated with the RCA and its, partially diverging, rationales¹⁸⁸.

4.2 Policy recommendations

The preceding analysis allows us to conclude with a series of policy recommendations touching upon all the different matters addressed in the current study, including (i) classification and (ii) registration requirements, (iii) liability, (iv) insurance, the possibility to resort to (v) a compensation fund, and (vi) the role for Europe, that may be summarized as follows:

¹⁸³ AICOM, 4.

¹⁸⁴ AICOM, 3.

¹⁸⁵ AICOM, 3.

¹⁸⁶ AICOM, 3.

¹⁸⁷ See Section 3.1 above.

¹⁸⁸ See Section 3.1 above.

-
- (i) Classification**
- The Risk-based classification the RCA puts forth is most appropriate also in a Risk-Management perspective, and should be used to determine certification and insurance requirements.
- (ii) Registration**
- All drones should be subject to registration requirements with the only exception of model aircraft and toy drones, similarly to what is provided by the US federal legislation.
- (iii) Liability**
- Liability rules should be strict, not fault-based, and burden one party specifically, pursuant to a one-stop-shop approach.
 - Said party should also be prima facie responsible for damages deriving from a defect in the device or human errors in the operation of the drone. In such cases the party should then be allowed to sue in recourse the manufacturer and the pilot respectively.
 - If more party were held liable they should be jointly and severally liable for the same damages.
 - The operator is the party best positioned to be held liable because he is best positioned to identify and manage the risks and acquire insurance.
 - In the case of non-commercial use of drones, the owner might be more easily identifiable and thence be held responsible as opposed to the operator or jointly and severally obliged with him.
- (iv) Insurance**
- All drones should be covered by third-party insurance for damages deriving from their operation. Exceptions could be provided for model aircraft and toy drones.
 - Insurance should only be made dependant on the different level of risks the single device poses in light of its intrinsic characteristics, not on the ground of the commercial or non-commercial nature of the use.
 - Coordination between the RCA and the IR in this respect is needed.
- (v) Compensation fund**
- A compensation fund should be established to cover damages in all cases where the drone is not insured, and the pilot and/or owner and/or operator cannot be identified.
 - Such compensation fund could be financed through taxation or fees to be paid when the product is sold or manufactured.
- (vi) The role for Europe**
- Liability should be regulated at EU level to avoid market fragmentation as well as diverging technical solutions, reflecting differences in liability regulation across MSs.

REFERENCES

- Bertolini, Andrea. "Robots as Products: The Case for a Realistic Analysis of Robotic Applications and Liability Rules." *Law Innovation and Technology* 5, no. 2 (2013): 214.
- Bertolini, Andrea. "Insurance and Risk Management for Robotic Devices: Identifying the Problems." *Global Jurist*, no. 2 (2016): 1-24.
- Bertolini, Andrea and Erica Palmerini. *Regulating Robotics: A Challenge for Europe*. Bruxelles, 2014.
- Bertolini, Andrea and Massimo Riccaboni. *The Regulation of Connected and Automated Driving. A Law and Economics Analysis of Liability Rules*. Edited by Working Paper, 2018.
- Bona, Marco. *Art. 2054*. Commentario del Codice civile. Edited by Enrico Gabrielli and Ugo Carnevali. Turin: UTET, 2011.
- Borghetti, Jean-Sébastien. "Product Liability in France." In *European Product Liability. An Analysis of the State of the Art in the Era of New Technologies*, edited by Piotr Machnikowski, 205-36. Cambridge: Intersentia, 2016.
- Castronovo, Carlo. *La Nuova Responsabilità Civile*. Milano: Giuffrè, 2006.
- Commission, European. *Follow up to the European Parliament Resolution of 16 February 2017 on Civil Law Rules on Robotics*. Bruxelles, 2017.
- Ernst&Young, Technopolis, and VVA. *Evaluation of Council Directive 85/374/Eec on the Approximation of Laws, Regulations and Administrative Provisions of the Member States Concerning Liability for Defective Products*. Brussels: European Commission, 2018.
- Evas, Tatjana. *A Common Eu Approach to Liability Rules and Insurance for Connected and Autonomous Vehicles*. Bruxelles: European Parliament, 2018.
- Foerste, Ulrich and Friedrich Graf von Westphalen. *Produkthaftungshandbuch*. Munich: Beck.
- Fox, Sarah Jane. "The Rise of the Drones: Framework and Governance - Why Risk It?" *Journal of Air Law and Commerce* 82 (2017): 683-715.
- Franzoni, Massimo. "L'illecito." In *Trattato Della Responsabilità Civile*, edited by Massimo Franzoni, vol I. Milano: Giuffrè, 2010.
- Granshaw, Stuart I. "Rpv, Uav, Uas, Rpas... Or Just Drone?" *The Photogrammetric Record* 162, no. 33 (2018): 160-70.
- Harris, Kristopher Kent. "Drones: Proposed Standards of Liability." *Santa Clara High Technology Law Journal* 35 (2018): 65-109.
- Hasan, Kazi Mahmud, S. H. Shah Newaz, and Md. Shamim Ahsan. "Design and Development of an Aircraft Type Portable Drone for Surveillance and Disaster Management." *International Journal of Intelligent Unmanned Systems* 6, no. 3 (2018): 147-59.
- Huttunen, Mikko. "Unmanned, Remotely Piloted, or Something Else? Analysing the Terminological Dogfight." *Air & Space Law* 42, no. 3 (2017): 349.

- Jiménez, Felipe, José Eugenio Naranjo, Sofía Sánchez, Francisco Serradilla, Elisa Pérez, María José Hernández, and Trinidad Ruiz. "Communications and Driver Monitoring Aids for Fostering Sae Level-4 Road Vehicles Automation." *Electronics* 7, no. 10 (2018): 228.
- Koch, Bernhard A. "Product Liability in Austria." In *Product Liability. An Analysis of the State of the Art in the Era of New Technologies*, edited by Piotr Machnikowski, 121. Cambridge: Intersentia, 2016.
- Kozioł, Helmut. "Protected Interests." In *Principles of European Tort Law. Text and Commentary*, edited by European Group on Tort Law, 29-34. Wien: Springer, 2005.
- Lambert, Paul. *Understanding the New European Data Protection Rules*. CRC Press, 2017.
- Leenes, Ronald, Erica Palmerini, Bert-Jaap Koops, Andrea Bertolini, Pericle Salvini, and Federica Lucivero. "Regulatory Challenges of Robotics: Some Guidelines for Addressing Legal and Ethical Issues." *Law Innovation and Technology* (2017): 1-44.
- Magnus, Ulrich. "Product Liability in Germany." In *European Product Liability. An Analysis of the State of the Art in the Era of New Technologies*, edited by Piotr Machnikowski, 237-74. Cambridge: Intersentia, 2016.
- Moréteau, Olivier. "Liability for Others." In *Principles of European Tort Law. Text and Commentary*, edited by European Group on Tort Law, 112-19. Wien: Springer, 2005.
- Negro, Antonello. "Art. 2054." In *Artt. 2054-2059 - Fatti Illeciti - Vol.II: Circolazione Di Veicoli, Responsabilità Solidale, Valutazione, Danni Non Patrimoniali.*, edited by Paolo Cendon. Milan: Giuffrè, 2009.
- Owen, David G. *Products Liability Law*. second ed. St. Paul (MN): Thompson West, 2008.
- Palmerini, Erica and Andrea Bertolini. "Liability and Risk Management in Robotics." In *Digital Revolution: Challenges for Contract Law in Practice*, edited by Reiner Schulze and Dirk Staudenmayer, 225-59. Baden-Baden: Nomos, 2016.
- Palmerini, Erica, Andrea Bertolini, Fiorella Battaglia, Bert-Jaap Koops, Antonio Carnevale, and Pericle Salvini. "Robolaw: Towards a European Framework for Robotics Regulation." *Robotics and Autonomous Systems* 86 (2016): 78-85.
- Polinsky, Mitchell A and Steven Shavell. *Handbook of Law and Economics*. Vol. I: North-Holland, 2007.
- Polinsky, Mitchell A and Steven Shavell. "The Uneasy Case for Product Liability." *Harvard Law Review* 123 (2009-2010): 1437.
- Posner, Richard. *Economic Analysis of Law*. Seventh ed.: Wolters Kluwer, 2007.
- Rucker, Daniel and Tobias Kugler. *New European General Data Protection Regulation*. Wien: Beck, Hart, Nomos, 2018.
- Sehrawat, Vivek. "Liability Issue of Domestic Drones." *Santa Clara High Technology Law Journal* 35 (2018): 110-34.
- Severoni, Cecilia. "La Disciplina Normativa Attuale Degli Aeromobili a Pilotaggio Remoto." *Diritto dei trasporti*, no. 1 (2016): 65.

Steer, Davies, and Gleave. *Study on the Third-Party Liability and Insurance Requirements of Remotely Piloted Aircraft Systems*. European Commission, 2014.

Taylor, A. H. *Radio Reminiscences: A Half Century*. Washington, D.C.: US Naval Research Laboratory, 1948.

Tomasello, Filippo and Marco Ducci. *Research for Tran Committee: Safe Integration of Drones into Airspace*. Brussels: European Parliament, 2016.

This study – commissioned by the European Parliament’s Policy Department for Citizens’ Rights and Constitutional Affairs at the request of the JURI Committee – analyses existing European and national legislation on the regulation of drones for civil use, discussing how they are defined and classified, whether certification and registration is required, how liability is apportioned between the subjects involved, and if compulsory insurance is provided for. Finally, on the basis of a risk-management approach, the study elaborates recommendations for future policy formulation.

DISCLAIMER

This document is addressed to the Members and staff of the European Parliament to assist them in their parliamentary work. The content of the document is the sole responsibility of its author(s) and should not be taken to represent an official position of the European Parliament.