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THE AUTOMATION OF AIR TRAFFIC:

LEGISLATIVE EVOLUTION AND ECONOMIC DEVELOPMENT

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INTRODUCTION

Remotely Piloted Aircraft Systems (RPAS)[1] are now widely considered to be the way of flying of the future, however, in order to fully exploit their potential, many different aspects are still to be studied, many concerns tackled, and many problems solved.

A large scale RPAS introduction in the civil airspace is the first important step of the growing Internet of Things, which will dramatically change our way of living, providing the human kind with an unprecedented access to power, as internet provided us with an incredible access to knowledge.

To approach this multifaceted domain, it is essential to start from the comprehension of the cyber dimension. The cyber dimension, created by mankind, is a real dimension, whose exploitation, if correctly conducted, will provide us with incredible capacities. To move inside this dimension, it is necessitous to understand it correctly, and to do so it is important to briefly run through the path of human development.

The network architecture, on which cyber is based, is the model on which our brain is based, and the human brain is the tool that allowed human beings to accelerate their progress in front of the rest of the animals. Our brain is the best example of the optimal use of "big data". A lot of information is stored in our neurons, and thanks to our synapsis, when we think about something, we connect all the different bits pertaining to the subject and we come out with a definite thought, that is more than the simple sum of the parts, and that allows us to take a decision or to do something in the most, hopefully, economic and efficient way. Our brain, however, has a limited quantity of memory space available, and moreover, especially in the past, connecting the different parts of knowledge was a time and distance consuming effort (which is the reason why progress was not as fast as today), and in the beginning only oral passage of information was the available tool for human beings to cross feed their thoughts, increasing the capacity to think forward.

Many different tools (tape recorder, radio, television, etc.) were recently created, but internet, with the cloud, was the first one that replicated completely the brain structure, a network of neurons and synapsis where the information could reside and could be

[1] RPAS (Remotely Piloted Aircraft System). The RPAS definition given by ICAO in the Circular 328-AN/190 is: "A set of configurable elements consisting of a remotely-piloted aircraft, its associated remote pilot station(s), the required command and control links and any other system elements as may be required, at any point during flight operation." The Remotely Piloted Aircraft is "an aircraft where the flying pilot is not on board the aircraft."

distributed to everybody looking for them. Obviously, the ability to reach all the pertaining information, selecting among an often overwhelming quantity of data, to put somebody in the condition of taking the best decision within the time available, will be a never ending technological improvement, and innovative research engines will provide big advantages to their users.

At this point, everything is ready for us to jump into the full automation of processes, moving the human being from “in the loop” to “on the loop”. As a matter of fact, more and more processes can be performed in a computer based process, with us acting only as controllers of the process. This is what the Internet of Things is aiming at. As the internet research engines are taking care of more and more complex researches on the web, in order to provide us with the most comprehensive and synthetic answers to our questions, or “queries”, in the world of real objects automation will completely take care of activities of things, where one of the results will be optimization of the travelling of people and goods from one place to another, in the most economic, efficient, safe, and fast way. Complete automation of movements will interest every object and will start in the air, with RPAS technology being the ground breakers of this revolution.

RPAS will create huge changes in the flight, insurance, privacy, safety and security regulations and in the technological, industrial, commercial and economic fields.

Amazingly, despite all these important aspects are closely interrelated, and the huge amount of work and the dimension of the initiatives, involving regulators, research centres, and industries that are aimed at inserting the RPAS into the commercial airspace, if somebody tries to get a comprehensive look at this new capacity it is not possible to find a document approaching this new sector with a holistic view. The feeling one gets is to be in front of a Rubik’s cube, in which all the colours and squares (the different types of know-how) are present, and to solve it we need to give them an ordered and commonly accepted shape.

The aim of this thesis is to try to provide a comprehensive vision of the possibilities the RPAS technology will offer us, its economic effects, and the different terrains that have to be covered to allow RPAS to be completely integrated and accepted in our future, considering that without a multidimensional and multifaceted approach this revolution will be hampered.

The thesis begins by viewing the major applications and potential users of RPAS in the first chapter. RPAS were initially created for military purposes during Second World War, and projected for dull, dirty, and dangerous missions. In time, with the evolution of technology, their capacities and possible uses have increased, and they are now able to complete many different and complicated tasks. Indeed, they may be employed in numerous fields, such as for military operations, communications and broadcast services, media and entertainment, digital mapping, pipelines inspection, crops surveillance, monitoring geophysical processes associated with natural hazards like earthquakes and volcanoes, tropospheric pollution and air quality, vegetation structure, glacier and ice sheet thickness and surface deformation, radiation levels, meteorology, and atmospheric chemistry. These vehicles are not only characterized by their flexibility of utilization, but also by various competitive advantages when compared with current technologies. In fact, drones will one day operate completely automated, and their use will reduce operation costs, be ecological, and prevent pilots' deaths from crashes since they are remotely piloted.

In the second chapter we take a look at the RPAS market, still primarily driven by military demand, that is growing at a fast pace, with forecasts of a spending that will triple over the next ten years reaching a total of $93 billion[2]. In the RPAS market the civil sector is rapidly expanding, and more specifically many start-ups are entering the market, with an overall investment of $450 million in 2015, which represents an increase of 300% if compared to 2014[3]. With the growth of the RPAS market many jobs will be created, and only in Europe it is estimated there will be 150,000 new jobs created by the RPAS industry by 2050[4]. Italy has an important role in this market, being the third greatest European exporter in the RPAS industry, right behind France and Austria, and seventh on a global scale, after Israel, USA, Canada, and Russia[5].

The third, fourth, and fifth chapter deal with the legal issues related to this new technology, analysing the steps that have been taken, and trying to identify the best ways to proceed in the development of a future globally harmonized regulation permitting integration of RPAS into the civil airspace.

The third chapter explores the airworthiness and certification requisites RPAS will need to

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[2] Teal Group, "PRESS RELEASE: UAV Production Will Total $93 Billion", 19 August 2015, http://www.tealgroup.com/index.php/teal-group-news-media/item/press-release-uav-production-will-total-93-billion.

[3] Balvé M., "The drones report: market forecast for commercial applications, regulatory process, and leading process", Business insider intelligence, 2014.

[4] House of Lords, "EU SUB COMMITTEE B ON CIVIL USE OF REMOTELY PILOTED AIRCRAFT SYSTEMS (RPAS)", 19 September 2014, http://www.parliament.uk/documents/lords-committees/eu-sub-com-b/CiviluseofRPAS/EU-Sub-Committee-B-Civil-use-of-Remotely-Piloted-Aircraft-Systems.pdf.

[5] Stockholm International Peace Research Institue (SIPRI), "% of total UAVs (1985 – 2014) supplied by exporting country", 2015.

possess for a safe and secure integration in the civil airspace. Currently, in Europe, each state has its own separate regulation for RPAS under 150 kg of take-off mass, although this, both for the weight limits and the variety of regulation among states, does not really give much freedom for RPAS operations and market increase. Legislators must assure the safety, the airworthiness, and the security of these new vehicles before they will fly above us. In order to reach a worldwide acceptance of RPAS they have to be certified as safe as manned aircraft, or even safer, so to overcome the fears related to the absence of an on-board pilot. Detect and avoid, interoperability, automatic landing procedures in case of loss of command and control, and cyber security are different certifications that not only need a legislation but also a mature technological development. For these requisites, technological progresses must be able to tackle the legislators' requests.

In respect of the speed at which governments are trying to produce the regulations for this new field experts say it is nearly a race. This is because many nations are fully aware of the economic advantages of being the first to create a complete regulation. In particular, the first countries creating regulations will set standards, which, if tested with positive results, may be followed by other countries, producing common RPAS rules across the world. Hence, this will create a difference between industries of "first move" countries, and industries of "second move" countries, with the first having advantages on the licensing of new technologies, and the latter ending up paying for the slowness of their own governments.

The fourth chapter examines the insurance and liability issues of the RPAS sector. Indeed, we must be aware that as soon as regulations will open the non-segregated civil airspace to RPAS, hundreds of thousands, and soon millions of drones will be flying above us, and no matter how elevate airworthiness requirements are, some accidents will happen. Current minimum insurance aircraft regimes, regulated under the European Regulation n. 785/2004, are based on maximum take-off mass bands (MTOM), originally thought for manned aircraft. It is true that RPAS are not left without minimum insurance requirements, because these regulations apply to both manned and unmanned aircraft, but the average missions that will be conducted using RPAS, and their location, could be different and often more dangerous than normal aircraft operations. The most important factor will be the location, since RPAS, if used in densely populated areas, risk to cause serious damage. This issue needs to be correlated with the fact that drones, not needing a cabin and the instruments for an on-board pilot, are usually lighter than manned aircraft and only have to respect the minimum insurance requirements set for the lowest MTOM band. At this point, although experts are still divided on the matter in absence of statistical data, we must understand if these minimum insurance requirements are enough to adequately compensate the victims of RPAS accidents, or if other requirements should be devised for the RPAS industry.

Last, the fifth chapter overlooks privacy issues related to the expanding RPAS market. This is probably the most problematic issue at stake, because if today we perceive the presence of airplanes and helicopters, tomorrow the existence of small, fast, and hardly perceivable drones, able to gather a lot of information, will risk transforming the world into a “Big Brother”. These vehicles are becoming increasingly sophisticated with the continuous development of new payloads and applications, and this is why an overarching framework would result inadequate and shortly obsolete. Thus, the best way to protect the citizens’ right to privacy would be not only to concentrate on the integration of the actual legislation, but also focusing on soft law measures and action items.

RPAS could be built with privacy by design features, able to prevent illegal use of drones so to achieve privacy and data protection. Operators should then be obliged to fly according to the data minimization principle, and informing the public of their operations through transparency protocols. It is only through the use of different instruments in parallel that the Privacy and Data Protection principles will be respected.

CHAPTER I

HOW RPAS ARE GOING TO CHANGE OUR LIVES: A REVIEW OF RPAS APPLICATIONS AND POTENTIAL USERS

Remotely piloted aircraft systems, as we know them today, were initially created for military purposes several decades ago. The first experiments started during Second World War, but it was only after the war ended that the first mass-productions began. Originally, they were only a training support for other aviation activities, such as Air Defence radio targets, and were considered stupid machines, which is the reason why they were given the name drones[6]. Drones were used for very specific missions, which normally lasted a limited amount of time, and their reputation followed them until modern days where, although with always less conviction, these systems are considered “expendable”.

In the last years, there has been a wider use of RPAS in many sectors, both military and civilian, thanks to the indisputable capacities this technology has demonstrated on the field. Created for repetitive, dangerous or extremely prolonged operations, and for this reason formerly identified with the acronym 3D (Dull, Dirty and Dangerous), during the years they were discovered to be suitable to a much broader range of missions. Comparing RPAS to humanely piloted aircraft, the first can apply to a vaster amount of assignments, also having a major flexibility due to the absence of human crew. The technological developments achieved in the RPAS sector gives these systems some substantial advantages, permitting them to go beyond the limits imposed by humanely piloted aircraft. On the human side, we must take into consideration the lives saved from eventual accidents, these being both of the pilots and of the passengers or people on the ground. It is not a secret that most of the air crashes are due to human error, meaning that if it were cancelled, and substituted with the possibility of technological break-down, statistics show us there would be less accidents. We must also notice the economic advantages coming with RPAS. Airplanes would be cheaper since there wouldn’t be the need for an expensive

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[6] Definition of drone taken from The Free Dictionary by Farlex: “A male bee, especially a honeybee, that is characteristically stingless, performs no work, and produces no honey. Its only function is to mate with the queen bee”; http://www.thefreedictionary.com/drone.

crew cabin, but even air crashes would cause fewer economic damages to the companies because there would be no human pilots on-board. In addition, operating costs would be reduced, not only for the absence of human pilots on-board, but also for the fuel savings and the possibility of more planes flying closer in the skies, only obtainable with a computer conducted navigation.

RPAS will change the idea of air navigation, passing from the present concept of “man in the loop”, where the on-board human pilot is necessary, to a close future “man on the loop”, where planes are going to be remotely piloted from the ground. After this, the next step will be the future “man out of the loop”, where computers will pilot the airplanes and pilots are only going to act as supervisors.

The fields that are going to benefit from the use of RPAS are so many that result hardly listable, and if even the task was adequately fulfilled, during the time between the completion of my work and your reading of it, some other utility will be invented, given the accelerated innovation pace which characterizes the sector. After this short warning, I nevertheless assure you I will try to do my best in giving a good idea of the big picture.

1. Defence sector

The tasks of information gathering, surveillance and target recognition (in brief ISR – Intelligence, Surveillance and Reconnaissance) have gone through a slow but constant transition towards the RPAS, performing several activities for the armed forces, as demonstrated during the conflicts in Iraq and Afghanistan.

RPAS provide way better and safer performances than manned aircraft in the fields of Change Detection[7], Automatic Target Detection and Recognition[8], Electronic Warfare[9], Communications Relay[10] and support to ground forces, in particular to Special Forces[11].

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7 “In the context of remote sensing, change detection refers to the process of identifying differences in the state of land features”, human infrastructures, deployment of military forces, etc. “by observing them at different times. This process can be accomplished either manually (i.e., by hand) or with the aid of remote sensing software.” Definition taken from: Karl J., Axel A., “Change Detection”, The Landscape Toolbox, http://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:change_detection.

8 “Automatic target recognition (ATR), is the ability for an algorithm or device to recognize targets or objects based on data obtained from sensors.” Definition taken from: “Automatic target recognition”, Wikipedia, https://en.wikipedia.org/wiki/Automatic_target_recognition.

9 “Electronic warfare (EW) is any action involving the use of the electromagnetic spectrum or directed energy to control the spectrum, attack an enemy, or impede enemy assaults via the spectrum. The purpose of electronic warfare is to deny the opponent the advantage of, and ensure friendly unimpeded access to, the EM spectrum. EW can be applied from air, sea, land, and space by manned and unmanned systems, and can target humans, communications, radar, or other assets”. Definition taken from: “Electronic warfare”, Wikipedia, https://en.wikipedia.org/wiki/Electronic_warfare#cite_note-JP3-13.1-1.

10 “Airborne communications relay is a technique employing aircraft fitted with radio relay stations for the purpose of increasing the range, flexibility, or physical security of communications systems”. Definition taken from: “Airborne radio relay”, Wikipedia, https://en.wikipedia.org/wiki/Airborne_radio_relay.

Today, RPAS can perform the entire cycle of military attack missions called F2T2EA (Find, Fix, Track, Target, Engage and Assess).

Other relevant capabilities relate to detection of dangerous substances in case of CBRN events[12] without exposing any human being at risk.

At sea, it is of utmost importance the capability to maintain a continuous and direct control of the sea surface at a much lower cost in terms of money and crews involved. The RPAS can perform extremely long-range missions, and crews can be easily exchanged, removing the limit of time created by the presence of human beings on-board.

The RPAS development in the field of military air transport will be greatly accelerated as soon as the civil transport authorities will define a commonly accepted standard to allow RPAS flight into non-segregated air space.

Cost reduction is an appealing feature for RPAS growth, particularly regarding the costs of personnel. Not only in terms of initial education and training, but due to the fact that in peacetime the continuous practice required by the crews can be maintained through simulated training, without performing expensive real flights. Not to forget that with the technological improvement, one person will be capable to conduct more than one aircraft at the same time[13].

If a RPAS was lost in enemy territory, there is no need to send highly risky search and rescue missions to recover the crews or the qualified personnel. Without the fear of somebody still on-board, the aircraft can be remotely destroyed using a satellite input, saving the military from the risk of its technology or classified data falling in the enemy’s hands.

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11 Special forces “are military units trained to perform unconventional missions”. Depending on the country, “special forces may perform some of the following functions: airborne operations, counter-insurgency, "counter-terrorism", covert ops, direct action, hostage rescue, high-value targets/man hunting, intelligence operations, mobility operations, and unconventional warfare”. Definition taken from: Yahya M, “Pakistan Army SSG Stands Among Top 10 Special Forces Of The World”, Pak Sar Zameen, 10 August 2014, http://sarzameenpak.blogspot.it/2014/08/pakistan-army-ssg-stands-among-top-10.html.

12 A CBRN “(chemical, biological, radiological and nuclear)” event is an event “in which chemical, biological, radiological or nuclear warfare (including terrorism) hazards may be present”. “A CBRN incident differs from a hazardous material incident in scope (i.e., CBRN can be a mass casualty situation) and intent. CBRN incidents are responded to under the assumption that they are intentional and malicious”. Definition taken from: “CBRN defense”, Wikipedia, https://en.wikipedia.org/wiki/CBRN_defense.

13 “The MQ-1 Predator, known as the Multi-Aircraft Control, or MAC system, entered operational testing with the first two-ship and four-ship Predator sorties being flown over a four-day period. During these sorties, members from the 53rd Test and Evaluation Group, Detachment 4, tested the MAC ground control station on its ability to enable a single pilot to simultaneously control four Predator aircraft over the skies of southern Nevada.” U.S. Air Force News, 26 September 2005.

2. Commercial operators

Commercial operators are strongly pushing for the use of RPAS in civil applications because of the expected benefits in terms of jobs and economic growth, which will be generated by the expanding RPAS market. Just as internet or the GPS system, that have changed the way we live today, RPAS are believed to be another evolution of our life styles, and its possible applications are rapidly increasing.

2.1.Infrastructure inspection

Infrastructure inspection is today one of the major utilizations of RPAS from commercial operators. The purpose of these missions is the observation of objects and buildings, particularly mobile phone towers, oil and gas pipelines, wind turbines, bridges, industrial locations and nuclear installations. Today, the monitoring of these infrastructural sites is quite expensive, and in the future drones may be the best operational mean to carry out safety and security checks[14]. Many of these buildings are troublesome to reach or located in rural areas, often requiring the support of RPAS in order to conduct the inspection efficiently, and without safety risks for human operators. The inspection of these structures is mainly visual, meaning the high-resolution videos taken with mounted cameras are the best way to carry them out, since the high definition videos can be viewed again, the videos may be stopped, and images may be zoomed or compared with previous inspections[15]. Such observations may also be executed using thermal imaging systems, permitting the operators to see what would not be possible with a normal visual inspection[16].

2.2.Earth mapping

Just as Google is using cars and satellites for geo-spatial mapping, RPAS could be capable to overlook and gain information from wide areas. Making a comparison, we can immediately see the limits posed by the systems we use today. Cars certainly can't fly, and can only take images of the world from a ground perspective, with the additional limit they can only be driven on roads, often finding huge difficulties on off road. Satellites are in orbit at kilometers of distance from the ground, being only able to take pictures from above, and without much detail because of the altitude. Instead RPAS can fly, and at different elevations, moving easily across the earth to film and record all the necessary

[14] Snider A., "Drones fly into nascent civilian market ripe with energy, environmental applications", E&E publishing, 25 January 2012, http://www.eenews.net/stories/1059958938.
[15] Haala N., "Photogrammetry & RPAS", Remotely piloted aircraft systems: Civil operations, Bruxelles, 9-11 December 2013.
[16] Barnard Microsystems, "Thermal Imaging Applications", http://www.barnardmicrosystems.com/UAV/features/thermal_imaging.html.

information, performing the job more efficiently and effectively than cars and satellites. According to necessities, drones can be fitted with all kinds of technologies. High altitude RPAS, next to high definition cameras, can mount thermal imaging devices or synthetic aperture radar[17], providing excellent images even in bad weather conditions during both daytime and nighttime. Drones may also use photogrammetric systems to obtain three dimensional elevation models and surface maps from the image data[18]. These equipped drones may also be used in geographical surveying, construction planning, oil, gas and mineral exploration. In case of natural disasters such as flooding, tornados, earthquakes and landslides drones may undertake identification of affected areas and landscape modifications. For man-made environmental disasters such as oil spills, ocean garbage patches or chemical plant explosions RPAS can be employed to map the contaminations or the areas covered by the hazardous waste.

2.3.Earth observation

At present day, earth observation and remote sensing are acquired using imagery collected from satellites and conventional aircraft. Tomorrow most of the data used to monitor atmospheric pollution, climate changes or environmental impact assessments may be gathered more efficiently utilizing RPAS. Governments and environmental organizations could employ drones to control volcanoes, forests, protect green space, monitor wildlife, or look over erosion[19]. RPAS are the perfect system to examine large areas of land, especially when human operations result too difficult or risky. Sectors like geology, seismology, oceanography, archaeology and meteorology would surely benefit from the use of drones.

RPAS may even be equipped with sampling and detection devices, collecting samples safely and cost-effectively. For reconnaissance functions, next to visual cameras, drones may have thermal-imaging sensors, electromagnetic spectrum sensors, biological sensors, and chemical sensors. Biological sensors can detect the airborne presence of various microorganisms, and chemical sensors analyse the concentration of each element in the

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[17] Sandia National Laboratories, "What is Synthetic Aperture Radar (SAR)?", http://www.sandia.gov/radar/what_is_sar/index.html.

[18] Claussen J., "MAVinci's next generation aerial image UAS: From flight planning to professional orthofoto and DEM", DIY Drones, 18 April 2011, http://diydrones.com/profiles/blog/show?id=705844%3ABlogPost%3A339917&commentId=705844%3AComment%3A1571849&xg_source=activity.

[19] AUVSI, "The Benefits of Unmanned Aircraft Systems: Saving Time, Saving Money, Saving Lives", https://epic.org/events/UAS-Uses-Saving-Time-Saving-Money-Saving-Lives.pdf.

air[20]. In Japan RPAS were used to monitor the area close to the Fukushima Daiichi nuclear plant after it was damaged by the 9.0 magnitude earthquake and tsunami in March 2011, avoiding human exposure to harmful radiations. Aviation Industry Corporation of China is testing another drone utility. In fact, the Chinese company intends to use drones to monitor and clear the skies from air pollution, releasing smog-cleaning chemicals in the air[21].

2.4.Other visual services

RPAS mounted with high resolution cameras may be used for different purposes, even beyond inspection and earth mapping. The examples are unlimited, going from capturing footage for publicity intents to private use for ludic activities.

Filmmakers are already using them, capturing amazing shots, while journalists can't wait to enter the era of "drone journalism"[22]. High-resolution videos and images will be immortalized as never before, bringing the film industry to new levels.

2.5.Increasing efficiency in agriculture

RPAS may aid farmers in managing fields by automating work, monitoring crops, and cutting costs. Close-up surveillance of farms permits the automatic identification of invasive species, diseases, or stress in crops[23]. Then, after spotting the problem, drones could spray fertilizers or pesticides, only acting in specific portions of the field instead of the entire crop, thereby limiting costs and waste[24]. For sites with a difficult terrain to cover by land vehicles, the new means would achieve an easier and effective control over crops and farm animals. RPAS will minimize human input necessities, making work easier and cost-effective.

2.6.Telecommunication providers

Another potential use of RPAS is to provide communication networks. Until now, broadband communication services, in areas without cable installations, could only be

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[20] Omara D., "Deploying Ruggedized Systems in Unmanned Military Vehicles for Advanced Air-Sea-Land Applications", Kontron, http://www.kontron.com/resources/collateral/white_papers/whitepaper-aplabs-part1_en.pdf.

[21] Badkar M., "China May Use Drones To Kill The Smog Problem", Business Insider, 5 March 2014, http://www.businessinsider.com/china-is-testing-smog-clearing-drones-2014-3?IR=T.

[22] Goldberg D., Corcoran M., Picard R., "Remotely Piloted Aircraft Systems and Journalism: Opportunities and Challenges of Drones in News Gathering", Reuter Institute for the Study of Journalism, University of Oxford, 2013.

[23] Increasing Human Potential, "Increasing Efficiency in Agriculture", http://increasinghumanpotential.org/benefits-of-technology/increasing-efficiency-in-agriculture/.

[24] Ehmke T., "Unmanned Aerial Systems for Field Scouting and Spraying", American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 3 December 2013, https://dl.sciencesocieties.org/publications/csa/articles/58/12/4.

supplied through satellites. Satellites work very well in providing communication services, unless in presence of bad weather conditions, but are quite expensive. Adding to the high costs of satellites there is even a major cost in the technologies used to obtain communication services from satellites, since the phone or antenna must be able to send and receive communications from a very long distance above the ground.

At the present moment only one person every three has internet access, and companies such as Facebook and Google are working so that everybody will one day have access to the knowledge and chances offered by internet, dreaming of connecting us all. Facebook is partnering with other six telecommunications companies trying to render internet access available to everybody with the project "internet.org"[25]. Google recently bought Titan Aerospace, a company that produces solar powered RPAS. These drones may be launched into the skies, and remain there autonomously for five years. If equipped with telecommunications technology they could connect the world cost-effectively[26].

2.7. Personal Transport

RPAS will be used for personal transport. Today we have cars, boats, planes and helicopters, which are all piloted by men. Tomorrow we will be able to fly wherever we want using a drone. It is going to be faster, efficient and completely automatic, where all we have to do is tell the computer where we want to go. The Chinese company Ehang created the Ehang 184, which can reach 100 km/h, transport up to 100 kg, and fly at up to 3500 meters of height. This RPAS is completely automatic, and only needs you to type in the destination using a computer, a tablet or a smartphone[27]. The initial intention is to use them for hospitals, hotels, and as taxis, but maybe one day we will all have one.

2.8. Innovative services

One of RPAS's greatest strengths is adaptability. There are many kinds of RPAS, of different sizes, costs, and capacities, which can be equipped with all types of technologies. This leaves their possible employment open to our imagination, creating new and novel services.

Thinking about transport of products Amazon is investing in drones, implementing the

[25] Internet.org, "informazioni", https://www.internet.org/about.

[26] Dotta G., "Google soffia a Facebook la Titan Aerospace", 15 April 2014, http://www.webnews.it/2014/04/15/google-titan-aerospace/.

[27] La Repubblica, "In viaggio senza pilota: arriva il primo drone che trasporta passeggeri", 7 January 2016, http://www.repubblica.it/tecnologia/2016/01/07/foto/drone_passeggeri_taxi-130772609/1/#1.

service “Amazon Prime Air” amongst its delivery offers[28]. Amazon Prime Air is a future delivery system that will enable customers to order anything from the internet and receive it delivered by RPAS in less than half an hour of time[29]. In a similar way, United Arab Emirates are planning to use drones for deliveries of documents and packaging[30]. Another new service could be using RPAS, mounted with thermal imaging payloads, to verify energy efficiency levels in buildings. Even real estate agents would benefit from the use of drones, maybe using them to create internet walk-throughs of the houses for their clients, being able to sell them more quickly. In the security services sector, implementing RPAS would grant a more efficient and cost-effective market offer, permitting security guards to monitor the client’s homes, intervening only when necessary. Security drones are becoming a reality, like the quadrotor created by Secom for private security issues[31]. Today, private property surveillance means fix cameras or security agents, the first remaining in the installed position, the latter being expensive. Tomorrow, companies like Secom are going to sell us drones that will fly around our property controlling everything from above.

For RPAS future employments it’s really one of those cases in which we can say that the limit’s the sky, which is true for both licit and illicit applications of the technology. This is the reason why an adequate regulation will be necessary.

3. Government operators

Governments and public authorities are potential users of RPAS. All around the world governments are testing RPAS in police, transportation and emergency departments for the most various operations. The advantage comes not only from efficiency, but also from cost effectiveness, meaning, that with the same amount of money, authorities obtain a greater result. American Police departments with aviation units spend an average of $300 million each year for aircraft purchases, fuel and maintenance. The costs deriving from buying and maintaining these units are huge, and to these costs, we must add the expenses of pilot training and fuel. The operational cost per hour of a manned helicopter is between $200 and $400 per hour, while for an RPAS we are talking about an average of $25 to $75 per

[28] Service-drone Germany, “Logistics + Transport”, http://www.service-drone.com/en/production/logistics-and-transport.
[29] Amazon, “Amazon Prime Air”, http://www.amazon.com/b?node=8037720011.
[30] Al Jazeera, “UAE to use drones for citizen services”, 12 February 2014, http://www.aljazeera.com/news/middleeast/2014/02/uae-use-drones-government-services-20142121717319272.html.
[31] Fingas J., “Secom offers a private security drone, serves as our eyes when we're away”, Engadget, 27 December 2012, http://www.engadget.com/2012/12/27/secom-offers-a-private-security-drone/.

hour[32]. We can clearly see how, with the same operational funds of one manned helicopter reconnaissance, a police department could cover five or more equally effective monitorings conducted with RPAS. However, savings would not only be made from operational costs, but also because the purchase price of an RPAS is much lower than the cost of a manned aircraft. Another difference with manned vehicles is the possibility of having small drones, which could be employed in scenarios such as police operations inside a building, or finding buried people after an earthquake, where larger vehicles would result useless.

3.1.National security and law enforcement

The idea of using RPAS for public order purposes is often criticized and results very controversial. If, on one side, we could make the world a safer place, on the other side we would have to accept being surveilled by drones, and the main question needing an answer here is if it would make the world a better place.

Governments have used and are using RPAS for different operations, testing them for future widespread use. The police used drones for numerous purposes such as:

- Identifying marijuana cultivations[33]
- Surveillance of crowds at sports events[34], protests[35], festivals[36]
- Street patrolling and enforcement of anti-social behavior orders[37]
- To support police operations such as squat evictions[38]
- Monitoring undocumented workers, and undocumented immigrants
- Detecting waste collections and unlawful use of land[39]
- Seeking for run away or hidden thieves[40]
- To acquire crime scene images and data

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[32] Increasing Human Potential, "Enhancing Public Safety", http://increasinghumanpotential.org/benefits-of-technology/enhancing-public-safety/.
[33] 20 minuten, "Polizei-Drohne spürt Kiffer auf", 30 April 2009, http://www.20min.ch/digital/hardware/story/20551098.
[34] Volker E., "The Droning of the Drones: The increasingly advanced technology of surveillance and control", 2009, http://www.statewatch.org/analyses/no-106-the-droning-of-drones.pdf.
[35] Whitehead John W., "Drones Over America: Tyranny at Home", The Rutherford Institute, 28 June 2010.
[36] Randerson J., "Eye in the sky: police use drone to spy on V festival", The Guardian, 21 August 2007, http://www.theguardian.com/uk/2007/aug/21/ukcrime.musicnews.
[37] Smith Emma, "Nicked by the mini robot spy in the sky", The Sunday Times, 16 September 2007, http://www.thesundaytimes.co.uk/sto/ingear/tech_and_net/article71453.ece.
[38] Raven K., "Drohnen für den Kampf um Häuser und Städte", Kraven blog, 24 February 2008, http://blog.kairaven.de/archives/1510-Drohnen-fuer-den-Kampf-um-Haeuserund-Staedte.html.
[39] Eick V., "Umstrittenes Terrain. Fliegende Kameras als Ausdruck neuer Trends von Überwachung", 10 July 2008, pg. 47-54.
[40] Hull L., "Drone makes first UK 'arrest' as police catch car thief hiding under bushes", Daily Mail, 12 February 2010, http://www.dailymail.co.uk/news/article-1250177/Police-make-arrest-using-unmanned-drone.html.

- Search and rescue
- Imagery during fire suppression operations and for successive arson investigations[41]

All of these operations were covered at only a fraction of the cost of helicopter missions, and, although a much broader range of employments could be possible, there are still many regulatory and privacy issues which need to be solved before profiting from the full potential of RPAS.

Beyond internal law enforcement, drones would be an incredible technology to deploy for maritime security policies or border control, finally permitting nations to achieve a real control of boundaries, and to assure safety over the seas. RPAS will be able to monitor wide areas, informing authorities about anything that may request intervention, leaving many units free from patrolling mansions, and able to take action where necessary.

RPAS can be fitted with all kinds of payloads, in order to assist during different law enforcement operations. For the surveillance of people and vehicles, they can be equipped with high definition cameras, as well as GPS technology. To uncover hidden marijuana cultivations the same thermal cameras mounted on helicopters would be used, with the added advantage of remaining undetected. In addition, RPAS could service police where audio sensing and recording capacities are requested. RPAS can be equipped with devices ranging from simple microphones to "passive broad banded acoustic radar systems"[42]for accurately detecting acoustic events. While normal microphones are limited by the distance of the sound, and highly disturbed by other surrounding noises, such as the sound of the drones' engines, Microflown technologies' sensors have an amazing three-dimensional situational awareness. The new system, which can be fitted on the smallest RPAS, would be perfect for intelligence, surveillance and reconnaissance missions, being capable of identifying small guns at up to 2 kilometers, and rockets, artillery, and mortars at up to 10 kilometers, detecting not only the precise position, but also where the gunshots are aimed. This technology, first created for military purposes, if mounted on RPAS flown at an undetectable height from the ground, will easily permit, together with high quality video cameras, an accurate video and audio recording of any event happening below the drones. Polices of all the world would gain new strength with this double-sided powerful technology. If, on one side, fighting criminality would become much easier, since they could easily surveille criminal organizations without the nearby presence of police officers,

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[41] Villasenor J., "Observations from above: Unmanned Aircraft Systems and Privacy", Harvard Journal of Law & Public Policy, Vol. 36, No. 2, 2013, pg. 467.

[42] Microflown Avisa, "Microflown technologies", November 2010, http://microflown-avisa.com/wp-ontent/uploads/2014/02/Defence-Global-November-2010.pdf.

on the other side, we could not escape the chance of being under control in any moment.

Along with new hardware, innovative software is being created to support police. To prevent any illicit behaviour, drones mounted with visual or thermal imaging cameras can be fitted with "smart surveillance" software. This will enable automatic recognition of criminal conducts, informing authorities for any needed intervention[43]. In addition, a very controversial software allowing face recognition already exists, and is ready for implementation[44].

After all the technological capacities listed above, we can easily understand we have reached a technological turning point in surveillance and law enforcement. Putting together all the payloads, we could have a RPAS able to fly in the sky, at such a distance to result invisible to the naked eye, clearly seeing and hearing everything that is happening beneath it. If this doesn't seem enough, the software installed on the drone could check and record any dubious illicit action committed below it, immediately identifying who committed the crime thanks to facial recognition. Reading this can seem a bit scary, but it might be the beginning of a forthcoming world where, after recording your illegal activities for the trial, the drone itself will arrest you.

3.2.Regulatory enforcement

Authorities will certainly employ RPAS to enforce sector-specific regulations. Governments and environmental organizations can use them to protect green spaces, monitoring for illegal logging, controlling erosion, and observing wildlife[45]. Drones could also analyse the quality of air, land and water, ensuring we live in a healthy environment. If pollution were to be detected the drone could investigate the source, informing the authorities. Another use may be to control the territory for the building of unauthorized constructions, so to abolish them at the very beginning.

3.3. Civil Protection

Civil protection carries out activities of emergency planning, assessment, prevention, mitigation, response, emergency evacuation and recovery, in emergencies such as floods, earthquakes, invasion or civil disorder. RPAS would result really useful after all kinds of

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[43] Wright D., Friedewald M., Gutwirth S., Langheinrich M., Mordini E., Bellanova R., De Hert P., Whadwa K., Bigo D., "Sorting out smart surveillance", Computer Law & Security Review", Vol. 26, 2010, pg. 343-354.

[44] Conte A., "Drones With Facial Recognition Technology Will End Anonymity, Everywhere", Business Insider, 27 May 2013, http://www.businessinsider.com/facial-recognition-technology-and-drones-2013-5?IR=T.

[45] AUVSI, "The Benefits of Unmanned Aircraft Systems: Saving Time, Saving Money, Saving Lives", https://epic.org/events/UAS-Uses-Saving-Time-Saving-Money-Saving-Lives.pdf.

disasters since they could be used to monitor and determine the damage, to detect any chemical, biological or nuclear hazards, search for buried victims, or deliver supplies. Firefighters are already using drones to aid them during the operations, achieving a better view of the fire extension and gravity. In addition, during search and rescue operations, RPAS can search areas that are too remote or dangerous for operations with conventional equipment. This sector is expected to see a widespread use of RPAS to save people's lives.

4. Private use of RPAS

RPAS, as we have seen already, have a wide range of capacities, and can adapt to multiple uses. During Christmas 2015, many of us noticed that in electronics stores, such as Unieuro or Media World, a stand with different kinds of drones was positioned at the entrance. These drones usually mount visual cameras, and can often be controlled with the smartphones, making them perfect for ludic use. Thanks to smartphones and computers, users can also program RPAS for different needs, and then share their programs for public use making them downloadable by other users. These "private use" research and developments are accelerating the already rapid pace of innovation, and sometimes permit to transform a passion into a job. Communities, such as DIY Drones, already have more than 75 000 members, commenting, sharing ideas, and cooperating for RPAS development[46].

Private use of RPAS however, doesn't only consist in ludic activity, or creating and modifying software, but sometimes individuals add new physical payloads to the drones. Creating a personal RPAS is now possible for an expert citizen, since the most complicated part is the vehicle transporting all the payloads in the air. The only problem remains the control of personal RPAS, because they aren't subject to the stricter rules imposed to commercial vehicles above 150 kg of weight, and even if found during illicit use, such as spying the beautiful neighbour through the fifth floor bathroom window, the owner could be hard to identify.

[46] DIY Drones The Leading Community for Personal UAV's, http://diydrones.com/profiles/members/.

CHAPTER II

THE NEW EMERGING RPAS MARKET

Remotely Piloted Aircraft Systems belong to a rapidly growing sector in the world of aerospace industry, being an innovative opportunity for the technology intensive division of the manufacturing sector, despite the fact that until now they have been primarily driven by the military demand[47]. RPAS technical capacities have developed in time, from simulator-tested drones up to on the field battle-tested systems, in a continuous advancement for military operations.

In parallel, as previous military developed technologies such as ARPANET or the GPS, these technological advancements are creating new civil markets. Emerging markets are numerous, comprising agriculture, pipelines inspection, police, sea control, border security, natural disasters, global environmental monitoring, coverage of large public events, and many other possible applications. However, while the military drone market has been steadily growing during the last years, the civil drone market has developed quite slowly in relation to its potential mainly due to the lack of a regulatory framework.[48]

This increasing diversification of markets and utilizations of the product produces favorable circumstances for RPAS vendors, ranging from the big defense contractors to small companies and even start-ups, creating challenges for existing companies and opportunities for newcomers. Civilians often prefer to acquire data and information services rather than buying the physical equipment, and this will be a major business model change for capital equipment companies used to servicing military markets with contracts for large and expensive equipment. On the other side, companies offering data and information services, that will want to extend their product offerings, are going to face the incorporation of new and expensive RPAS technologies into their business models.[49]

The RPAS market is rising into a very competitive environment. Drones are born as an

[47]Harrison, G., "Unmanned Aircraft Systems (UAS): Manufacturing Trends", Congressional Research Service, 30 January 2013. https://www.fas.org/sgp/crs/natsec/R42938.pdf.

[48] Masutti A., "DRONES FOR CIVIL USE: EUROPEAN PERSPECTIVE ON THIRD PARTY LIABILITY AND INSURANCE", 2016.

[49] Vinters T. "Unmanned Aerial Vehicles: Growing Markets in a Changing World", Qi3 Insight, February 2014.

airborne platform, and will face competition from other air, space, maritime and terrestrial platforms. Nevertheless, analyzing the different market demands, we can understand how the strengths and weaknesses of RPAS, satellites, and maritime and terrestrial platforms are complementary, creating new opportunities for operations and products which will utilize them jointly.

Describing the RPAS market does not result easy at all, and this can be understood by the relevant differences which can be found in the currently existing reports and analysis, which significantly vary not only between research analysts, but also between reports of the same research analysts made in different years. These reports not only show the difficulty which even the best companies of market analysis encounter in analyzing this market, but also display the evidence of a market that has been heavily underrated in the past. The French Parliamentary Defense Committee in a 2009 report noted that "the market for drones is not like any other market".[50]

1. RPAS Global Market

The Remotely Piloted Aircraft Systems market was initially conceived to help national governments in buying more affordable and efficient aircraft for the defence sector. After many years of growth and development driven by the military segment, the market is now seeing a great increase in the commercial and civil sectors[51].

Today, the RPAS industry is a dynamic sector which will see a fast market expansion, in both the near and long term future. According to Markets and Markets, in 2015, the RPAS market is estimated to be worth $10.1 billion, and is expected to reach $14.9 billion by 2020, at a compounded average growth rate of 8.12% from 2015 to 2020[52]. In particular, the market is mainly expanding due to the request for non-defense applications, and for RPAS that are able to perform complex civilian tasks such as environmental monitoring or life-saving operations.

Teal Group predicts that spending on RPAS will triple over the next ten years with a total of $93 billion, from the actual $4 billion in 2015 to $14 billion by 2024. Military research investments will likely add some more $30 billion of spending during the next decade. Also RPAS payloads spending forecasts are very positive, as they are expected to double

[50] Assemblee Nationale, "Report No. 2127", 1 December 2009.
[51] Soshkin M., "Unmanned Aerial Vehicle (RPA) Manufacturing in the US", IBIS World, April 2015, pg. 19.
[52] MarketsandMarkets, "Unmanned Aerial Vehicles (UAV) market research report", October 2015, http://www.marketsandmarkets.com/Market-Reports/unmanned-aerial-vehicles-uav-market-662.html.

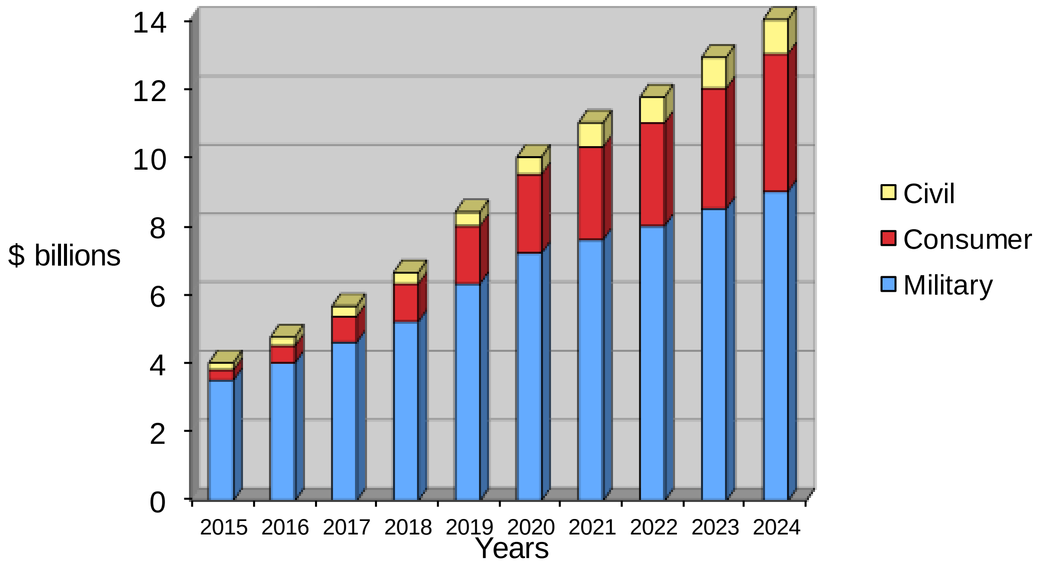
by 2024, passing from the actual $3.1 billion to $6.4 billion in 2024[53].

During the next decade, the RPAS market is forecast to be split in 72% military, 23% consumer, and 5% civil[54]. The military segment of the market will still be the prevailing one during the next ten years, although the civil sector will experience a huge expansion as soon as the civilian airspace is opened.

The graphic below shows us the 2015-2024 RPAS global market forecast, with data taken from a Teal Group report for the years 2015-2024.

Graph 1. RPAS global market forecast for the years 2015-2024

Source: Teal Group[55]



[53] Teal Group, "PRESS RELEASE: UAV Production Will Total $93 Billion", 19 August 2015, http://www.tealgroup.com/index.php/teal-group-news-media/item/press-release-uav-production-will-total-93-billion.

[54] Teal Group, "PRESS RELEASE: UAV Production Will Total $93 Billion", 19 August 2015, http://www.tealgroup.com/index.php/teal-group-news-media/item/press-release-uav-production-will-total-93-billion.

[55] Teal Group, "World Unmanned Aerial Vehicle Systems – 2015", 2015.

2. RPAS market by region

The United States remain the world's RPAS market leader with 20% of global recorded projects, and 42 design centres. The dimension of the US RPAS industry is impressive. The United States produce and deploy numerous tactical platforms, such as the Predator, the Global Hawk, and the Reaper, up to hand launched platoon-level drones. The actual US RPAS fleet consists of 6 000 RPAS, spacing from micro tactical RPAS to several hundred Reapers and Predators. RPAS market forecasts during the next decade for the US alone are put at more than $18 billion, with about half of the sum on ground stations and payloads. Thus, it is not surprising that American firms are worth 66% of the RPAS global market[56].

Israel, which currently detains about 2% of the world market share, is growing fast by selling its platforms to other nations for RPAS developments. Sales usually also include operational training and turnkey solutions. Israel is aiming to protect its personnel from operational danger, and also for this reason is strongly committing to the development of an extensive and technologically advanced RPAS capability. Placing its attention mainly on smaller platforms, Israel has now been producing surveillance and armed RPAS for many years. Israel has been a pioneer for many of the past and current RPAS developments, continuing to be a major player in RPAS sales across the world[57].

Europe is currently the second largest RPAS market, and during the last few years it has significantly emerged in comparison to Israel and the United States. In 2016 it represents about 15% of the global market[58], with European firms which are eager to obtain a larger share of the market despite Europe is currently buying many American and Israeli platforms. Viewing the many programmed European RPAS initiatives, and the quick development of key technologies, the European market forecast is positive although it is still a weak market player in relation to its possibilities.

The United States, Europe, and Israel are currently the three RPAS market leaders, but other states are entering the market and quickly developing RPAS capacities. Russia for example has activated various projects, though only few of them have flown until now. Even other countries, such as China, Pakistan, and Turkey, which are not highly aerospace developed, are entering the RPAS market. Analysts predict that in the future Asia will

[56] AUVSI, Association for unmanned vehicle system International, "The Economic Impact of Unmanned aircraft systems integration in the United States 2013", pg. 2 e ss.
[57] Israel Aerospace Industries, "Unmanned Air Systems", http://www.iai.co.il/2013/18892-en/BusinessAreas_UnmannedAirSystems.aspx.
[58] Eurosmart, "Unmanned Aerial Vehicle Market by Region", 2012.

become the second RPAS market only behind the United States, with China and Japan that will probably become primary industrial leaders[59].

Poland is a typical new entrant state with the 2014 production of the E-310, which is a low-to-medium altitude, short-range drone, produced by Eurotech in collaboration with Pit-Radwar, which is owned by Polish Armaments Group[60]. Other new entrants are seeking collaborative partners to access basic technologies, such as Pakistan that in 2009 signed an agreement with the Italian company Selex Galileo to co-produce the Falco RPAS[61].

In a similar way, Turkey desires acquiring RPAS technology, but is blocked by technology transfer controls in buying USA technologies. It has $4 billion market requests for drones over the next decade, and has begun autonomously developing RPAS capabilities to satisfy the demand[62].

Various Asian countries have also begun developing RPAS. For instance, South Korea has recently inked a $335,5 million deal with the Korean military procurement agency to mass-produce the KUS-FT[63]. Amongst the new entrants, China is perhaps the most dynamic. It has a strong commitment for military aerospace modernization, and perfectly understands RPAS are the future. For these reasons it has begun several projects, some of which include armed variants. However, not only the military vehicles are important, and it is why it is also strongly concentrating on civil RPAS[64].

India too is keen on developing RPAS capabilities. It is estimated to have a $2 billion market over the next decade, with the demand for a wide range of drones. The domestic industry is searching for international partners to acquire the basic technologies needed for a faster development of drones, while the government is worried for the possibility that other nearby nations, such as Pakistan, may soon acquire military drones from China[65].

A summary of the actual global RPAS regional market landscape is shown in the chart

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59 Hayward K., "Unmanned Aerial Vehicles: A New Industrial System?", Royal Aeronautical Society, November 2013.

60 Air-Force Technology.com, "E-310 Short-Range Unmanned Air System (UAS), Poland", http://www.airforce-technology.com/projects/e-310-short-range-unmanned-air-system-uas/.

61 Air-Force Technology.com, "Falco Tactical Unmanned Aerial Vehicle (UAV), Pakistan", http://www.airforce-technology.com/projects/falco-uav/.

62 Turkish Aerospace Industries, "UAV Systems", https://www.tai.com.tr/en/department/uav-systems.

63 Gady F. S., "South Korea's Military To Receive New Reconnaissance Drone", The Diplomat, 13 January 2016, http://thediplomat.com/2016/01/south-koreas-military-to-receive-new-reconnaissance-drone/.

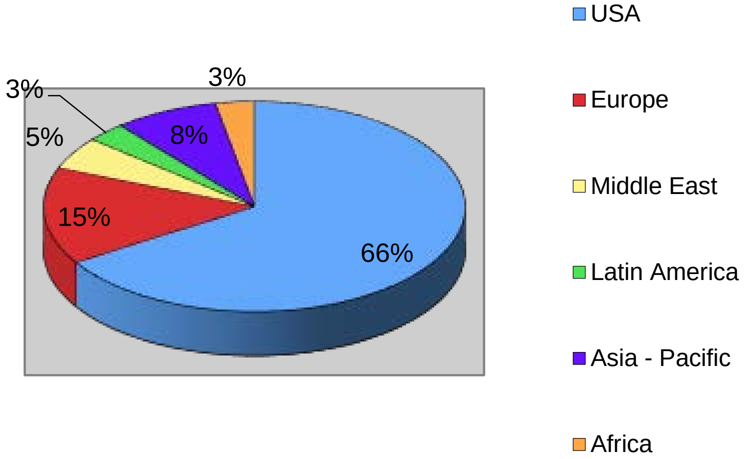
64 Mizokami K., "For the First Time, Chinese UAVs Are Flying and Fighting in the Middle East", Popular Mechanics, 22 December 2015, http://www.popularmechanics.com/military/weapons/news/a18677/chinese-drones-are-flying-and-fighting-in-the-middle-east/.

65 Chakravorty P. K., "Unmanned Aerial Vehicles (UAVs) Indian Perspective", India Strategic, February 2012, http://www.indiastrategic.in/topstories1369_Unmanned_Aerial_Vehicle.htm.

below, where the leadership of Europe and the United States can be clearly seen.

Graph 2. RPAS market by region

Source: Eurosmart[66]



3. The Italian RPAS market

Italy is the third greatest European exporter in the RPAS industry, right behind France and Austria, and seventh on a global scale, after Israel, USA, Canada, and Russia[67]. However, Italy is also the third biggest drone importing country with a 9.8% of the total number of drones produced worldwide, following India with its 13.2%, and the United Kingdom with its 33.9%[68].

In total, for the year 2015, the Italian RPAS industry is worth €350 million with about 500 industries involved, resulting in an average turnover of €700 000 and about seven employees per company, with most of the companies beyond €500 000 concentrated in the central part of Italy.

Amongst all companies involved in the sector, 53% are engaged in the production and assembly, while the remaining 47% are active in production and distribution of

[66] Eurosmart, "Unmanned Aerial Vehicle Market by Region", 2012.

[67] Stockholm International Peace Research Institue (SIPRI), "% of total UAVs (1985 – 2014) supplied by exporting country", 2015.

[68] Stockholm International Peace Research Institue (SIPRI), "% of total UAVs (2010 – 2014) received by country", 2015.

components[69].

In Italy, the RPAS industry is growing rapidly with many projects currently active, and that are going to be promoted in the near future, also through strategic partnerships. An example of this is the recent agreement signed by Italy, France and Germany on 18 May 2015 for the development of a European medium altitude, long-endurance (MALE) drone for military and civilian purposes by 2025[70]. The Italian RPAS industry currently has just less than 5 000 employees, but the actual increase of RPAS usage by consumer industries will soon create many new jobs for engineers, professionals, and technicians with capacities in this sector[71].

4. RPAS industrial landscape

Big aerospace companies are currently the RPAS market leaders, totalling most of the market value, although thousands of new entrants are staking their market claim partly due to the primitive nature of RPAS platforms, which do not often result to be more than a high tech model aeroplane[72].

Start-ups and small companies typically enter the market with projects that unite sensor makers with a small RPAS platform. For instance, the TOWHAWK, a micro tactical RPAS built by Irvine Sensors Corporation together with Applied Research Associates, embodies this approach. Their drone employs two cameras, mounted on a 26-inch electric wingspan platform, which is initially launched by a TOW missile tube. However, given the major importance of payloads and the easiness of producing or acquiring basic platforms, high technology based companies are also entering the RPAS market at an increasing rate, with specialised RPAS applications that need to be light, small, and technologically advanced[73].

The main industries that are developing and producing RPAS can be found in the United States, Europe, and Israel. Amongst these, some of the most important are: Elbit Systems, Israel Aerospace Industries, Finmeccanica, Piaggio, Lockheed Martin, Northrop Grumman,

[69] Doxa Marketing Advice, Mirumir, “Survey on the Italian Drone Industry: Profile of sector companies”, Dronitaly, 25-26 September 2015.
[70] Russon M., “France, Italy and Germany to develop European surveillance drone by 2025”, International Business Times, 18 May 2015, http://www.ibtimes.co.uk/france-italy-germany-develop-european-surveillance-drone-by-2025-1501880.
[71] Canadian Trade Commissioner Service, “Unmanned Aircraft Systems (UAS) Market Sector Profile – Rome, Italy”, September 2015, pg. 2.
[72] European Commission, “Towards a European strategy for the development of civil applications of Remotely Piloted Aircraft Systems (RPAS)”, Commission Staff Working Document, 6 September 2012.
[73] Defense-aerospace.com, “Irvine Sensors' Led TOWHAWK Program Participates in Successful Live Fire Exercise (LFX) Demonstrations”, 4 December 2008, http://www.defense-aerospace.com/articles-view/release/3/100350/new-aerial-sensor-for-combat-vehicle-crews.html.

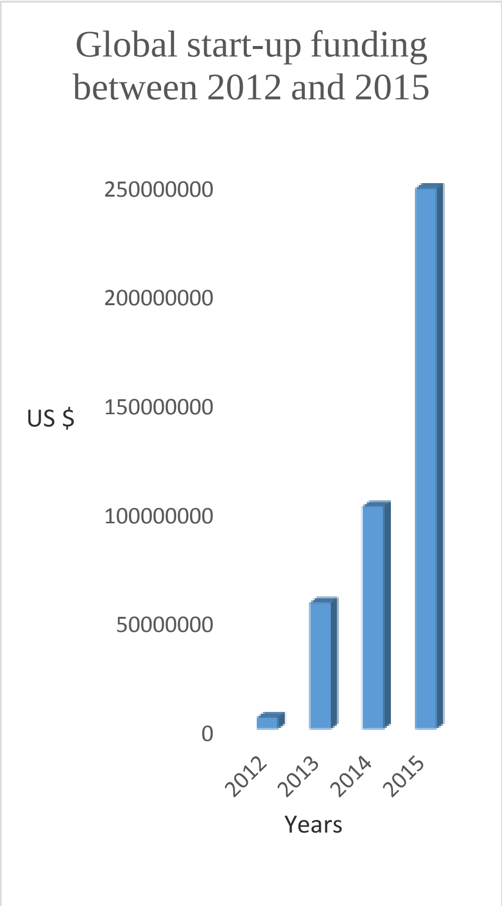
and Boeing.

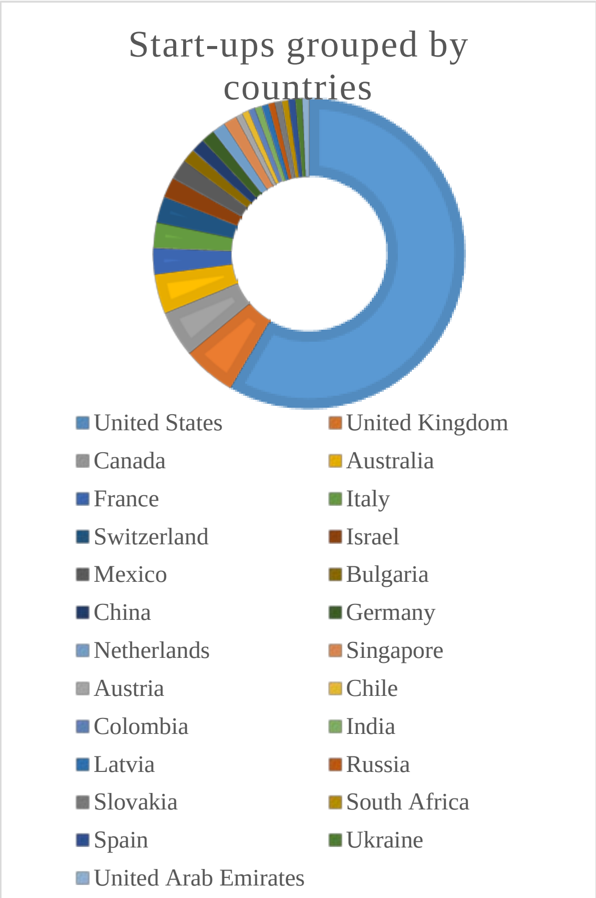
4.1 RPAS start-ups

Today drones are gaining attention from many young entrepreneurs, as the market is seeing numerous start-ups interested in this potentially multi-billion-dollar market. Reliable market estimates of the start-up market share in relation to the major industries are not available, although some market analysts are trying to give a view of this important and rapidly growing piece of the RPAS market.
To try and give an idea of the current global picture I put the data in two graphs, showing the funding in US$ globally received by start-ups in the last four years, and the countries where start-ups are being created around the world.

Graphs 3 and 4: RPAS start-up funding and percentage of start-ups by country

Source: Drones Startups[74]





[74] Drones Startups, “A snapshot of today's startup environment exploring commercial drones”, February 2016, http://drones-startups.silk.co/.

As the data shows us, the United States and Europe are the RPAS market leaders also in the part of the RPAS market created by start-ups, although what must be pointed out is the incredible growth of the market, which has more than doubled every year from 2012, that is here seen through the funding received by these sectors' start-ups. This growth is due to the relative easiness of entering the market, with the creation of low cost drones that have new capacities. It is now a market where the ideas count more than the finances, permitting the rise of many new businesses.

The main fields that start-ups are exploring include: aerial data (33%), drone hardware (24%), drone infrastructure (13%), drone software (11%), logistics/transport (11%), and drone retail (3%)[75].

4.2 U.S. major market players

United State industries currently dominate the RPAS market, with manufacturers having the largest share of the global RPAS market including General Atomics (20,4%), Northrop Grumman (18,9%), Boeing (1,5%), and AAI Corporation (1,2%)[76].

4.2.1 General Atomics Aeronautical Systems

General Atomics Aeronautical Systems is one of the most successful aerospace industries, producing RPAS including the Predator, and the Gray Eagle. It also manufactures technologically advanced Ground Control Stations, and provides pilot training and support services for RPAS operations. Its Mission System business unit designs and produces different payloads and sophisticated sensors, such as the Claw sensor, energy lasers, meta-material antennas, and high energy lasers for military and commercial applications worldwide. The company produces most of the vehicles' parts from composite materials, thus keeping them extremely light and resistant, also permitting the company to adapt to changes in customer requirements with a 60-day cycle up to integration. With the watchwords of simplicity, innovation, and risk-taking, it searches for high margins through technological complexity. As a result, General Atomics Aeronautical Systems is the world leader RPAS manufacturer[77].

[75] Drones Startups, "A snapshot of today's startup environment exploring commercial drones", February 2016, http://drones-startups.silk.co/.
[76] Glennon J. H., "Unmanned Aircraft Systems (UAS): Manufacturing trends", Congressional Research Service, 30 January 2013.
[77] General Atomics Aeronautical, "About GA-ASI", http://www.ga-asi.com/about-ga-asi

4.2.2 Northrop Grumman

Predictions on the future of the RPAS market brought also other aerospace companies to take an interest, with the view of excellent opportunities. Northrop Grumman produces the Global Hawk, which is one of the greatest and most technologically advanced RPAS we have today. Nonetheless, although it was an established aerospace company, it needed RPAS capabilities to enter the market, and the company acquired them by buying specialist companies such as Ryan Aeronautics, and more recently, Swift Engineering[78].

4.2.3 Boeing

Boeing is the world's largest aerospace company, although it is still not yet heavily involved in the RPAS market if we relate this to its small market share. Its market strategy has been similar to the Northrop Grumman one, as it acquired its long-term RPAS partner Insitu Group, which is now Boeing's RPAS unit. Boeing intends to acquire new RPAS specialized companies, reaching $1 billion in RPAS sales over the next five years[79].

4.2.4 Lockheed Martin

Lockheed Martin, funded in 1995, is another successful American aerospace company which is now seriously investing in unmanned vehicles. Its products range from the K-MAX to the High Altitude Airship, creating a broad range of RPAS delivering intelligence, communications and cargo delivery capabilities for military customers. The company is mainly producing drones for military and surveillance operations, although it is now seeing the potential of the civil market, and is developing many civil customer drones[80].

4.2.5 Aurora Flight Sciences

Aurora Flight Sciences is a company specifically dedicated to the development and creation of RPAS. It was initially created from the MIT's Aeronautics and Astronautics Institute, and for this reason its research center is still located there, while its production center is in Virginia. The companies' approach to the RPAS market is to work mainly on

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78 Northrop Grumman website, http://www.northropgrumman.com/AboutUs/Pages/default.aspx
79 Hayward K., "Unmanned Aerial Vehicles: a new industrial system?", Royal Aeronautical Society, November 2013, pg. 8.
80 Lockheed Martin, "Unfolding Eight Unmanned Aircraft that Can Improve Our World", 2015, http://www.lockheedmartin.com/us/news/features/2015/unfolding-eight-unmanned-aircraft-that-can-improve-our-world.html.

the research together with the MIT, and combine the results with practical engineering[81]. The company currently works on research programs with the NASA, and produces RPAS components for Northrop Grumman and the Unites States Air Force[82].

4.2.6 AeroVironment

AeroVironment is another example of a company whose prevailing purpose is research. Its focus is mainly on energy systems, electric vehicle systems, and RPAS. The company actually holds a $4.7 million, five-year contract with the United States Air Force for the production of advanced propulsion technologies to use on RPAS, together with other contracts for the development of solar power systems to mount on wings. The company is also specializing itself in the production of Nano-RPAS, with the development of “bird”, and even “insect” size drones for the United States Air Force[83].

4.3 European RPAS manufacturers

Europe is the second largest RPAS market, and most of the major European aerospace companies, conscious about the future market opportunities, are seriously investing in the development and production of RPAS. Even if European RPAS production is confined to small numbers, compared to the American production, forecasts predict Europe will gain a bigger share of the RPAS market during the next decade, with a fast growth of the European industries[84]. Below is a fast view of the major European market players, without the Italian companies that you will find in the next paragraph.

4.3.1 Airbus Defence and Space

The Airbus Group produces RPAS mainly for the defense sector, with its division Airbus Defence and Space. Its production is numerous, and includes important drones such as the Harfang MALE UAS, the Eurohawk HALE UAS, the Barracuda multi-sensor system, and the Zephyr[85]. It is also working in an important project for the study of a European developed unmanned aerial system, together with Dassault Aviation and Finmeccanica,

[81] Hayward K., “Unmanned Aerial Vehicles: a new industrial system?”, Royal Aeronautical Society, November 2013, pg. 7.
[82] Aurora Flight Sciences, http://www.aurora.aero/.
[83] AeroVironment, https://www.avinc.com/.
[84] MarketsandMarkets, “Unmanned Aerial Vehicles (UAV) market research report”, October 2015, http://www.marketsandmarkets.com/Market-Reports/unmanned-aerial-vehicles-uav-market-662.html.
[85] Airbus Defence & Space, “Unmanned Aircraft Systems”, http://militaryaircraft-airbusds.com/Aircraft/UAV.aspx.

after the agreement of France, Germany and Italy[86].

4.3.2 BAE

BAE Systems is a British multinational defense, security and aerospace company. It is ranked between the world's largest defense contractors, and is developing its own RPAS capabilities through some company and government/industry technological demonstrators. To quickly acquire RPAS technological capacities it also bought the US-based Advanced Ceramic Research, which was a specialized RPAS manufacturer. Amongst its offer we find the drones Taranis and Demon[87]. Currently the company has various RPAS programs, including the Mantis advanced concept demonstrator program, brought on together with partners such as Rolls-Royce, Selex, GE Aviation, QinetiQ, and Meggitt[88].

4.3.3 Dassault Aviation

Dassault Aviation is an important French Aerospace company. It has various projects intended to develop and produce drones, but the most important one is the nEUROn. The Dassault nEUROn is an experimental drone that is being developed with the international cooperation of Saab, the Hellenic Aerospace Industry, Airbus, Alenia, and RUAG, led by the Dassault company. The intention is to create a stealthy, autonomous drone, able to operate in medium to high threat combat zones. Its first flight was in 2012 but the vehicle is still being tested for operational use.

4.3.4 SAAB

The Swedish SAAB is one of the few companies in the world that are able to develop, integrate, and maintain complete aircraft systems. Its Airborne Solutions offer includes manned aircraft projected mainly for surveillance duties, and a range of unmanned vehicles in different versions of the drone Skeldar. The Skeldar is a medium-range RPAS, which is able to autonomously fly for hours providing real-time information to a ground station. It is

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[86] Airbus Defence & Space Press Release, "European MALE drone development: Airbus, Finmeccanica and Dassault Aviation welcome the signature of the trinational Declaration of Intent by Germany, Italy and France", 18 May 2015, https://airbusdefenceandspace.com/newsroom/news-and-features/european-male-drone-development-airbus-finmeccanica-and-dassault-aviation-welcome-the-signature-of-the-trinational-declaration-of-intent-by-germany-italy-and-france/.
[87] BAE Systems, "Products & Services", http://www.baesystems.com/en/what-we-do/products-and-services?siteAjax=Global&facetsFoldStatus=business_title%3Aclosed&searchSort=sort-default&searchQuery=*&facet_capability_title=Autonomous+Systems.
[88] Hayward K., "Unmanned Aerial Vehicles: A New Industrial System?", Royal Aeronautical Society, November 2013, pg. 8.

a very advanced drone since its high-level commands permit the drone to be used even through simple "Point and Fly" commands[89].

4.3.5 Safran

Safran is a French multinational aerospace, defense, and security company, formed by the merger between SNECMA and SAGEM in 2005. Safran has been producing tactical drones in France for over 15 years, and now its drones perform a number of different missions ranging from surveillance to gunship guidance. The Patroller, its most advanced drone, is a multi-sensor tactical drone that can be easily deployed in foreign theaters of operations, offering a 24-hour endurance[90].

4.3.6 Thales Group

Thales group is a French multinational company manufacturing electrical systems and providing services for the aerospace, defense, transportation, and security markets. Thales produces numerous RPAS spacing from mini RPAS to the longer range MALE and HALE systems. The company also produces various payload technologies and subsystems such as: optronic, radar, ESM, jamming, communications, navigation, and Automatic Take Off and Landing Systems. In addition to this, Thales is also the prime contractor for the UK's Watchkeeper €1 billion RPAS program signed in August 2005[91].

4.4 The Italian RPAS industry

Italy is the third greatest European exporter for the RPAS market. Its production is significant, and this technological production change could be a real chance for aerospace national industries. Italian aerospace industries are currently losing market share if related to the other world's leading aerospace industries, and this market change, if correctly tackled, will be the opportunity to obtain an important part of the future aerospace market. In giving a view at the main Italian industries we must keep this situation in mind as we look at the commitment of Italian companies in the innovative drone market[92].

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[89] SAAB, "AIRBORNE SOLUTIONS", http://saab.com/air/airborne-solutions/.
[90] Sarfan, "Drones", http://www.safran-group.com/defense/drones.
[91] Thales Group, "Unmanned Aerial Vehicles systems", https://www.thalesgroup.com/en/worldwide/defence/unmanned-aerial-vehicles-systems.
[92] Taranto Grottaglie Airport, Conference "Infrastruttura dedicata ad attività industriali orientata a sperimentazione e test di nuove soluzioni aerospaziali", 14 April 2014.

4.4.1 Finmeccanica Group

Finmeccanica is amongst the few European industrial realities developing and producing RPAS that has created every component necessary to the employment of its drones, from the platform with the sensors up to the control stations. From the 1st of January 2016 the Finmeccanica Companies Selex and Alenia Aermacchi, world leaders in RPAS production, have become divisions of the Finmeccanica Group bringing with them many capabilities.

The Group now produces several RPAS, such as the SKY-Y and the Falco, and has an important role in the nEUROn project. Its offer spaces from micro-RPAS to medium altitude endurance RPAS, all fully equipped with highly technological sensors to permit situational awareness[93].

The Falco, previously produced by Selex, and originally developed by Galileo Avionica, is the spearhead of the Italian RPAS industry. This drone is a semiautonomous plane with unique characteristics, that has been exported to different countries, including USA, Pakistan, and Saudi Arabia. The drone has a flight autonomy of 12 hours, with a range of 250 km, and its sensors allow vision through vegetation, making it perfect for discovering any hidden militia in war zones.

The SKY-Y is a MALE category drone, and amongst the few RPAS having received the permit to fly by ENAC. Furthermore, the SKY-Y has been the first RPAS able to operate through an electro optical sensor to transmit the data to the ground using a satellite system, and so being able to perform in all weather conditions thanks to the new Autonomous takeoff and landing technology.

It is not a case if Finmeccanica is developing satellite services that will one day be used as control stations for the drones. In fact, the future of air navigation control is not in ground stations but in satellites, since only through the use of satellites and autonomous takeoff and landing technology we will be able control aerial traffic in all weather conditions without losing communication.

Finmeccanica is also very interested in the civilian market for drones, developing capabilities for agriculture, disaster prevention, meteorology, environmental protection, surveillance, and mapping. All of this will contribute towards enhancing Italy's capacities and offer in this market[94].

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93 Finmeccanica, "Prodotti e Servizi", http://www.finmeccanica.com/product-services.

94 Canadian Trade Commissioner Sevice, "Unmanned Aircraft Systems (UAS) Market Sector Profile – Rome, Italy", September 2015.

4.4.2 Piaggio Aerospace

Piaggio is one of the world's first airplane producers, and amongst the few industrial realities active in both aircraft and aero-engine manufacturing. Its most important project, first presented at the Dubai Airshow in November 2014, is the Hammerhead. This drone is amongst the best existing remotely piloted MALE aircraft, with the capacity of reaching 13,700 meters of altitude, its 16 hours of flight endurance, and Automatic Take Off and Landing technology. The Hammerhead uses satellites to permit control from ground control stations at all times in all places[95].

4.4.3 Avio Aero

Avio, is a GE business which designs and manufactures components for civil and military aviation, today also working in the RPAS sector[96]. The company, in partnership with Finmeccanica, is developing an engine for the Piaggio's new Hammerhead. The investments for the production of the new engine consists of $500 million, and will be coming by the Mubdala Development Company which owns Piaggio[97].

4.5 The RPAS industry in the rest of the world

Beyond the USA and Europe, there are many other countries with a significant role in the RPAS market. First of all, the Israeli RPAS industry, with its innovative companies, is extensively selling its products around the world, also providing licenses for RPAS developments. Israel Aerospace Industries, Elbit Systems, and Bluebird are developing new systems, but world competition is getting harder. In the future these companies may lack the mass to compete with the other major industries, although joining forces between different Israeli industries, as is happening in Italy, may not be easy[98].

China and Japan are quickly gaining shares of the RPAS market, and its industries are becoming numerous while acquiring capabilities in the field.

China, that in 2010 had only 100 RPAS producers, currently has more than 230 RPAS developers and manufacturers, two thirds of which are private, and the rest are government

[95] Piaggio Aerospace, "Defense & Security", http://www.piaggioaerospace.it/en/defense-security.
[96] Avio Aero, "Who we are", https://www.avioaero.com/Who/Avio-Aero.
[97] Canadian Trade Commissioner Sevice, "Unmanned Aircraft Systems (UAS) Market Sector Profile – Rome, Italy", September 2015.
[98] Hayward K., "Unmanned Aerial Vehicles: A New Industrial System?", Royal Aeronautical Society, November 2013, pg. 8.

owned enterprises. However, the weakness of Chinese drones remains their quality[99].

Japanese industries are quickly growing, and trying to organize themselves in order to implement safety guidelines for manufacturing of drones. Main industries in the RPAS sector are industrial realities such as Kawasaki, Mitsubishi, Sky Remote, Hirobo, and Hitachi. Today they are all part of the Japan UAV Association to make sure Japan is in step with global movements[100].

5. Evidence of best practice

The implementation of best practices in the operation of automated aircraft is imperative in order to ensure the safety of the airways and on the ground, as well as the accomplishment of operational objectives with minimal hindrances. The RPAS market faces the challenge to ensure that both commercial and civil operators comply with safety standards. Evidence of best practice in the operation of automated aircraft will produce outcomes of collision avoidance, safe take offs and landings, accurate activity and maintenance logs, and full compliance with the RPAS regulations.

The beginning of the journey to RPAS best practices occurs in the stage of flight planning and extends to considerations of legal compliance, equipment safety, and the competency of operators. Regulations must be established to provide universal guidelines for environmental sustainability and safety. The automated vehicles must be registered with the proper permits for operation, including liability insurance, and should be equipped with safety equipment with the capacity to ground in the event of malfunction.

The proficiencies for RPAS operations are similar to those requested for pilots of traditional aircraft, and are required for the execution of professional standards in the operation of automated aircraft[101].

Relevant organizations should look into the risks associated with air safety, which stem from both the technology used to construct and control RPAS, as well as the unsafe or non-certified use of RPAS. What must be examined is the sophisticated nature of RPAS use regulation, which is a result of the fast technological development, the large range in capability and size of RPAS, and the wide spectrum of RPAS operators, going from people who use RPAS as a hobby, to commercial operators who operate at a large scale.

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[99] Haokui W. "The Experts: low altitude UAV aerial reconnaissance", Ifeng News, 6 September 2010, http://news.ifeng.com/mil/2/detail_2010_09/06/2441670_2.shtml.

[100] Japan UAV Association, "The Japan UAV Association", http://www.juav.org/menu01/introduction_juav.html.

[101] IPTS. "IFALPA Pilot Training Standards: Guides for Best Practice", International Federation for Air Line Pilot's Association, September 2012.

RPAS technology is emerging, and has not yet cemented the reliability that accompanies experienced and mature technologies. In particular, two aspects of RPAS technology provide adequate grounds for safety concerns. The first is the durability and quality of the materials used to construct drones, and the other is the technology that controls their behavior. With respect to quality of materials, stakeholders have noted that despite commercial aircraft being built to meet high requirement and safety standards that offer relative certainty regarding their functionality, the same cannot always be said about material quality[102].

Another difficulty coming from RPAS proliferation arises from the fact that they are often carelessly built, especially when homemade, and do not necessarily meet the required standards. This early stage is in fact still devoid of an international standard. Therefore, their abilities to maintain heading and altitude, coupled with their ability to withstand equipment failure, have not been determined. Several machines fail because the standards used in making components in even the best of brands is that of a hobbyist in a number of cases. Even RPAS that have been constructed to reflect military standards, evidently much higher than those for recreational and civil RPAS, may call for improvements before integration into the civil airspace[103].

Uttermost good faith and confidence in the construction quality of an RPAS is crucial when such a vehicle shares the same airspace with other drones and manned aircraft. A vast number of technologies should work hand in hand to ensure that RPAS can operate without posing a risk to nearby aircraft. In spite of the significant progress transpired in recent years, more work needs to be done in order to achieve an adequately safe operating environment[104].

6. Sector SWOT analysis

The RPAS sector is, in some features, similar to the aircraft market, although it does result to be an upgraded and future version of it, as it is able to go beyond many of its limits. Operations conducted using drones consent a major cost effectiveness of operations, given the major flexibility deriving from these adaptable platforms.

RPAS are also employed without pilots on board, thus both aircraft costs and weight are

[102]Kerasidou X., Buscher M., Liegl M.. " Don’t Drone? Negotiating Ethics of RPAS in Emergency Response", Proceedings of the ISCRAM 2015 Conference – Kristiansand, 24-27 May 2015.

[103]Kanellos L.. "Safety, Privacy and Net Neutrality Aspects of Civilian Drones." Net Neutrality Compendium, Springer International Publishing, 2015, pg. 271-279.

[104]Cremin P., Goodwill R., Simmons A., "EU SUB COMMITTEE B ON CIVIL USE OF REMOTELY PILOTED AIRCRAFT SYSTEMS (RPAS) Oral and written evidence", 19 September 2014.

reduced. The absence of onboard pilots means avoiding human deaths resulting from crashes, which is not only positive on the human side, but also for the companies' profits because it prevents eventual compensation costs for families, and additional training costs for new pilots.

In addition to this, the fact that RPAS can be computer piloted will soon be a necessity. Projections say that by 2035 many airports will be operating at their maximum capacity[105], thus needing the introduction of computer piloted planes able to fly closer to each other without accidents. Hence, RPAS are not only going to be necessary, but they are also going to reduce flight times and fuel consumption thanks to perfect trajectories that would eliminate the need for the current air pathways.

The lightness of drones, compared to manned aircraft, determines a significant reduction of pollutant emissions because less energy is needed to fly the plane, and with it comes lower fuel consumption. The minor amount of energy requested to keep the drones flying is also an opportunity for RPAS companies, as it permits the development of flight endurance with solar power. This will not only mean the production of environmentally friendly vehicles, but also the possibility of keeping these vehicles flying with no cost at all for years[106].

The RPAS market is a technological innovation driven market, with its sales coming from all the new possibilities offered by high tech payloads mounted on often small platforms. New opportunities drive the sales of the product together with these being heterogeneous. Indeed, drones are, and will always more be, high tech and cost effective machines consenting their utilizers many until now only imaginable uses.

This is a new sector, thus giving the opportunity to many of its players of entering as newly created companies. However, the real market expansion is still held back by a lack of global aviation regulations and standards. These standards and regulations will not only face the slowness of their creation, but also the high improbability of their global harmonization.

Another weakness of this sector is the high cost in R&D of specialized technologies. The problem is actually minor for customer drones, as they don't often mount more than a GPS and a high resolution camera, although there is a technological race between major companies in relation to military drones, and specialized civil drones, such as those

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[105] LUISS Business School, Studio Pierallini, "Terza Law Conference sull'aviazione", LUISS University, 16 June 2016.

[106] INEA Consulting, "Global Commercial and Civil UAV Market Guide 2014-2015", 14 October 2014.

employed for agriculture purposes[107].

Table 1. SWOT analysis of the RPAS sector

Strengths	**Weaknesses**
-Technological innovation driven market -Reduction of pollutant emissions -Cost effective operations -Access to unreachable areas	-Deficieny of global aviation regulations -Lack of unified international standards -High cost in R&D of specialized technologies
Opportunities	**Threats**
-New emerging market -Creation of new RPAS based services -Extensive possibilities of use -Flight endurance with solar power	-Slow creation and harmonization of global RPAS regulations -Possible higher failure rate of new and untested technology -Public opinion

SWOT

RPAS really offer a new world of opportunities for mankind, and, as computers before them, they give the opportunity of developing a new company from an idea. This is why many start-ups are entering the market, and why many new RPAS based services are being created. Drones offer extensive possibilities of use, and in a near future we will be seeing them for all kinds of operations.

Nonetheless, companies in the RPAS market will face two major threats. The first is a possible higher failure rate of new and untested technology given the initial stage of the market. The second is the public opinion. In a world of movies with robots conquering the world, and the privacy and employment problems which might arise in parallel with the market, an important objective is to make drones enter in people's lives so to be accepted[108].

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[107] Tikanmäki I., Tuohimaa T., Rajamäki J., "How and why Unmanned Aircraft Vehicles can improve Real-time awareness?", International Journal of Circuits, Systems and Signal Processing, 19 April 2011.
[108] Tuohimaa T., "Studies of Unmanned Aircraft Systems from the Perspective of Operational Use", Laurea University of Applied Sciences, Leppävaara, 2014.

7. Technology developments

Military and civil RPAS, regardless of the type, are employed for one or more of the following duties:

- Transport sensors (such as high resolution cameras, radar, infrared, microphones or biochemical sensors)
- Transport communication relays
- Transport cargo (such as bombs or ammunition for military RPAS, or maybe insecticides for civil RPAS)

Today, most drones are used to capture videos and images, thus requiring a limited range of technical capacities to carry out the required tasks. However, RPAS are used for a wide variety of purposes, and to be able to analyze the technological trends and development of new capabilities, through which the market is destined to grow, we can categorize the development of technologies into five sub-systems[109].

7.1 Platforms

RPAS are available in wide sizes, variations, and configurations. They can either be of fixed wings, such as traditional airplanes, or rotary systems, such as helicopters, having the capability of taking off and landing horizontally and/or vertically, weighing as little as grams up to tones. These vehicles are utilized for many applications, and this resulted in the development of numerous types of RPAS. These groups can be categorized into three groups.

Long Range RPAS are mostly used in the military field and amongst these the most famous types are the HALE (High Altitude Long Endurance), the MALE (Mid Altitude Long Endurance), and the VTOL (Vertical Take Off and Landings).

Mid-Range RPAS are mainly used in the military and the commercial sector, as they result too expensive for the private customer. The most famous types are the TUAV (Tactical Unmanned Aerial Vehicle), and the VTOL.

Short Range RPAS are used both in the military and the commercial sector, although they are mainly bought by private customers using them for video shootings. These include small RPAS, nano RPAS, micro RPAS, and VTOL. As you can notice the VTOL is the only type which is used for all categories, with its particularity of requiring only a small

[109] Vinters T. "Unmanned Aerial Vehicles: Growing Markets in a Changing World", Qi3 Insight, February 2014.

take-off and landing space.

RPAS platforms are being developed for a safer and widespread future use. To reach this objective RPAS industries understand there are certain capacities that are essential to develop. Indeed, drones will need to be able to communicate with each other for an inter-vehicular collaboration, be fit with sense and avoid capabilities, and be autonomous at least for emergency landing situations[110].

7.2 Payloads

The majority of payloads mounted on RPAS are sensors. Of course, military drones may also deploy weapons, and civil vehicles may carry for example pesticides, although the main use of RPAS is currently to gather information that can be remotely sensed.

To gather information, the RPAS market is able to use many of the sensors that have already been developed for use on manned aircraft, satellites, and radiosonde balloons. RPAS remote sensing functions comprise electromagnetic spectrum sensors, chemical sensors, biological sensors, and gamma ray sensors. Instead, RPAS electromagnetic sensors normally include visual spectrum[111], infrared[112], or near-infrared cameras, radar systems[113], LIDAR (Light Detection and Ranging)[114], acoustic[115], microwave sensors, ultraviolet spectrum sensors, and magnetometers. Many of these sensors already exist, but after the possibility of deploying them with RPAS their utility is growing, and for this reason investments on their development are increasing[116].

7.3 Energy and Propulsion

Currently, RPAS flight autonomy is still very limited, and this is especially true for small

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[110] Nagpal K., "UNMANNED AERIAL VEHICLES (UAV) MARKET", Defence Production & Acquisition Biz News, April 2015, http://www.defproac.com/?p=2041.

[111] Doyle A.. "AUVSI: Goodrich Demonstrates Miniature SWIR Camera". Flight Daily News, August 2009. http://www.flightglobal.com/news/articles/auvsi-goodrich-demonstrates-miniature-swir-camera-330785/.

[112] Kaur K.. "SPI Introduces FAA-Compliant Lightweight Thermal PTZ Solution for UAVs." Azo Robotics, June 2012. http://www.azorobotics.com/News.aspx?newsID=2909.

[113] Hoyle C.. "DSEi: Falco UAV Makes First Flight with PicoSAR Radar". Flight International, September 2009. http://www.flightglobal.com/news/articles/dsei-falco-uav-makes-first-flight-with-picosar-radar-331961/.

[114] Lucieer A., Christopher Watson and Darren Turner. "Development of a UAV-LiDAR System with Application to Forest Inventory Luke Wallace" . School of Geography and Environmental Studies, University of Tasmania, May 2012. http://www.mdpi.com/2072-4292/4/6/1519.

[115] Eshel T.. "New Gunshot Detection Capability Expands the Role of Mini-UAVs in Force Protection". Defense Update, October 2011. http://defense-update.com/20111031_new-gunshot-detection-capability-expands-the-role-of-mini-uavs-in-force-protection.html.

[116] Department of Transportation, Us. Air Force, "Unmanned Aircraft System (UAS) Service Demand 2015 – 2035: Literature Review & Projections of Future Usage", September 2013.

drones that are suffering from the early stage of battery technology. For this category of drones, the trend is definitely aimed at making lighter and more powerful batteries, consenting them to complete longer operations.[117]

However, for the bigger RPAS, there has been a concurrent increase in the demand for smaller, more efficient, and long-lasting power sources able to give energy and propulsion to the aircraft. Some companies, with projects such as the aforementioned Zephyr, are also trying to create systems able to provide a flight autonomy of years, and the final aim is obviously that of an unlimited autonomy.

Today, industries are using and developing a wide range of propulsion and power systems including: conventional fuel engine[118], disc based internal combustion[119], rotary engine[120], turbine alternator, distributed propulsion, solar turbine[121], electric[122], solar electric[123], hybrid[124], CNT fuel cell[125], hydrogen fuel cell[126], steam[127], HydroICE[128], magnetic resonance[129], laser[130], propane fuel cells[131], nuclear[132], hydrogen storage[133], and magneto

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[117] Hazel B., Aoude G., "In Commercial Drones, The Race Is On", Oliver Wyman, 2015, http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2015/apr/Commercial_Drones.pdf.

[118] PR Web, "Hirth Motors Launches new UAV Engine Family at AUVSI". August 2012, http://www.prweb.com/releases/2012/8/prweb9761774.htm.

[119]Coppinger R.. "US Military Funds Pistonless Disk Engine". Flight International, June 2008. http://www.flightglobal.com/news/articles/us-military-funds-pistonless-disk-engine-224851/.

[120] NWUAV Propulsion Systems, "Rotron RT300 and RT600 EFI/HFE Rotary UAV Engines", http://www.nwuav.com/uav-products/uav-rotary-engines.html.

[121]Mortimer G.. "AirScape UAV Solar Turbine to Deliver 30 to 90 Days of Flying Time!", SUAS News, November 2012, http://www.suasnews.com/2012/11/19684/airscape-uav-solar-turbine-to-deliver-30-to-90-days-of-flying-time/.

[122]Warwick G., "Electric Aircraft Promises Infinite-Range Flight", Aviation Week: Ares Defense Technology Blog, July 2012, http://www.aviationweek.com/Blogs.aspx?plckController=Blog&plckScript=blogScript&plckElementId=blogDest&plckBlogPage=BlogViewPost&plckPostId=Blog%3a27ec4a53-dcc8-42d0-bd3a-01329aef79a7Post%3a440cb322-d3e3-4c53-bfe0-a70a078e96a5.

[123] Silent Falcon UAS Technologies. "SILENT FALCON", http://www.silentfalconuas.com/silent-falcon.

[124]Egozi A., "Aeronautics' Aerosky 2 to Test Hybrid Engine on 2 June", Flight International, April 2008, http://www.flightglobal.com/news/articles/aeronautics-aerosky-2-to-test-hybrid-engine-on-2-june-222999/.

[125]Coppinger R., "Carbon Nanotube Catalyst to Improve Fuel Cell Endurance", Flight International, February 2009, http://www.flightglobal.com/news/articles/carbon-nanotube-catalyst-to-improve-fuel-cell-endurance-322628/.

[126] Demerjian D., "Boeing Has Seen the Future, And It Includes Hydrogen", Wired, December 2008, http://www.wired.com/autopia/2008/12/boeing-has-seen/.

[127] Brown D., "Making Steam Without Boiling Water, Thanks to Nanoparticles", Washington Post, November 2012, http://articles.washingtonpost.com/2012-11-19/national/35505658_1_steam-nanoparticles-water.

[128] Coxworth B., "HydroICE Project Developing a Solar-Powered Combustion Engine", Gizmag, November 2012, http://www.gizmag.com/hydroice-solar-powered-engine/25139/.

[129] Aron J., "UAVs Fly Wireless Power to Remote Locations", New Scientist, June 2012, http://www.newscientist.com/blogs/onepercent/2012/06/uavs-take-power-to-remote-loca.html.

[130] Boyle A., "Laser Beam Keeps Robo-plane Buzzing for Two Days Straight", MSNBC Cosmic Log, July 2012, http://cosmiclog.nbcnews.com/_news/2012/07/12/12690006-laser-beam-keeps-robo-plane-buzzing-for-two-days-straight?lite.

hydrodynamics[134]. All of these systems, for RPAS use, must be built taking into consideration the parameters of size, weight, efficiency, autonomy and speed.

7.4 Command, Control, and Communication Systems

When we view RPAS Command, Control, and Communication (C3) links there are a series of concerns which need to be taken into consideration. Unfortunately, there is not only the risk of losing communication, and with it the control of the drone, but since these vehicles are remotely controlled there is the possibility of hostile interference into communications to steal the control of the aircraft[135]. This is why governments are seriously investing to avoid this from happening, and cybernetic projects are being brought on.

Nonetheless, these systems require elevate levels of autonomy, even when correctly controlled by operators. Consequentially, there are various categories of technologies that result essential to the future development of RPAS, and that are placed in first place for RPAS R&D. These include: sensor fusion, path planning, communication, trajectory generation, trajectory regulation, task allocation, operational safety, and cooperative tactics[136].

7.5 Data fusion and information processing

At present, information systems are growing in complexity, with bigger volumes of data, and processes. All components of a system, and even different systems, are becoming interdependent in what will be a market for "Big Data". Requests and investments on development for storage space, user interfaces, and high processing powers are rapidly increasing.

Information technology is following the trends of computing power, memory expansion, miniaturization, and advanced algorithms for data processing and management.

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[131] Ultra Electronics AMI, "Ultra Electronics, AMI Delivers 45 Fuel Cells for Use in Military UAS", July 2012, http://www.ultra-ami.com/2012/07/ultra-electronics-ami-delivers-45-fuel-cells-for-use-in-military-uas/.

[132] Sweetman B., "Benefits of Nuclear UAVs", Defense Technology International, May 2012, http://www.aviationweek.com/awmobile/Article.aspx?id=/article-xml/DT_05_01_2012_p14-450521.xml&p=1.

[133] Carey B., "L2 Aerospace, Cella Energy Pursue Hydrogen Storage for UAVs.", AINonline, July 2012, http://www.ainonline.com/aviation-news/2012-07-09/l2-aerospace-cella-energy-pursue-hydrogen-storage-uavs.

[134] Mullins J., "Invention: Plasma-powered Flying Saucer", New Scientist, May 2008, http://www.newscientist.com/article/dn13840-invention-plasmapowered-flying-saucer.html.

[135] Office of Defense Acquisition, Technology, and Logistics, "Unmanned Systems Roadmap: 2007-2032", Washington D.C., December 2007, Pg. 129.

[136] EUROCONTROL, "RPAS: The big picture", http://www.eurocontrol.int/articles/rpas-big-picture.

Investments on these technologies made in the commercial market, for computers and smartphones, will mean lower costs for RPAS since they will be already available and easily adaptable[137]. The fast increase in computing power, together with the decrease in relative cost we are experiencing today, shows us hardware for information processing on RPAS will not be a problem[138].

8. Personnel

The majority of the RPAS industry personnel currently consists of military, engineers, and IT specialists. However, the scope of the RPAS job market has far exceeded military applications and is now offering new positions in the agriculture, telecommunications, oil, gas, first response, and delivery services industries. Education and training opportunities are also growing to accommodate the projected future growth of the industry. Approximately 50 colleges across the globe have added curriculums such as a B.S. Degree in RPAS operations that provide virtual classrooms for autonomous operations[139]. When talking about RPAS, the high standards and high technological demands require highly skilled personnel. First of all, pilots, or ground operators, are needed to remotely control drones from the ground stations. This duty is a unique and challenging one because they have to control something they are not physically flying inside, requiring them to be individuals of high caliber intelligence.

Other personnel include system specialists, which are in charge of the operation of the whole system, its maintenance and troubleshooting. They design and oversee the operation of methods of receiving, processing, and sending data. A simulator coordinator is required in the control cockpit as well. The duty of a simulator coordinator is to design and model the simulation of the autonomous systems, and to track the travel path of these drones.

Finally, also simple maintenance personnel must be specialized because RPAS maintenance is very technical and requires all systems, and not only the aircraft, to be functioning correctly. Thus, the attention must also be given to ground control stations, communication links, on-board payloads, launch and recovery equipment, and integration

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[137] Department of Transportation, Us. Air Force, “Unmanned Aircraft System (UAS) Service Demand 2015 – 2035: Literature Review & Projections of Future Usage”, September 2013, pg.60.
[138] INTEL, “50 Years of Moore's Law”, http://www.intel.com/content/www/us/en/silicon-innovations/moores-law-technology.html.
[139]Wynbrandt, J., “Growing Job Demand in Unmanned Aerial Systems”, Flying, 2015, http://www.flyingmag.com/careers/growing-job-demand-unmanned-aerial-systems.

of instruments[140].

9. Employment impacts

With the growth of the RPAS market many new jobs will be created, and although today most of the new jobs are offered by manufacturers, soon also many maintenance and operational places will be requested[141]. Employment impacts, I believe, are as important, if not more, as economic impacts, although, strangely enough, today there are only two RPAS market studies forecasting employment impacts for this industry. A 2013 AUVSI report[142] gives a precise estimate of the employment impacts in the United States, saying that "by 2025, total job creation is estimated at 103,776". The other study comes from the AeroSpace and Defence Industries Association of Europe, and has calculated that, by 2050, 150,000 new jobs will be created in Europe.[143]

Considering these numbers, we can imagine the creation of hundreds of thousands of specialized new jobs in the RPAS industry, although we must also look at the negative side of this job creation, that will be technological unemployment. A 2015 report of the world economic forum says that more than 5 million jobs will be lost during the "fourth industrial revolution",[144] but it is not clear how many of these jobs regard RPAS.

When we produce a drone to survey and fertilize the crops, jobs will be created in the manufacturing industry, and there will even be an operator needed to control the drone during missions, but the drone will replace workers in the fields, and they will lose their jobs. The same will happen for taxi drivers, mail carriers, truckers, security guards, aircraft pilots, and all those jobs that can be substituted by automation. The future can be seen in the past by looking at the industrial revolution. During this period, many people lost their jobs due to technological changes. With the introduction of labor saving machines, and more efficient processes, products became cheaper and more available, but at the expense of many workers' jobs.

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[140] Hobbs A., Herwitz S. R., "Human Factors in the Maintenance of Unmanned Aircraft", San Jose State University Foundation, NASA Ames Research Center, NASA Research Park, 2006.

[141] Nath T., "How Drones Are Changing The Business World", Investopedia, 1 June 2015, http://www.investopedia.com/articles/investing/010615/how-drones-are-changing-business-world.asp.

[142] AUVSI, Association for unmanned vehicle system International, "The Economic Impact of Unmanned aircraft systems integration in the United States 2013", 2013, pg. 2.

[143] House of Lords, "EU SUB COMMITTEE B ON CIVIL USE OF REMOTELY PILOTED AIRCRAFT SYSTEMS (RPAS)", 19 September 2014, http://www.parliament.uk/documents/lords-committees/eu-sub-com-b/CiviluseofRPAS/EU-Sub-Committee-B-Civil-use-of-Remotely-Piloted-Aircraft-Systems.pdf.

[144] World Economic Forum, "Future of Jobs", 2015, http://reports.weforum.org/future-of-jobs-2016/.

Currently the dates of important industrial revolutions are three: in 1784 the steam engine was created, symbolizing the first industrial revolution; in 1870 we started using petroleum and the first mass productions began; and finally in 1970 we entered the computer era with the third industrial revolution. These are important dates to remember, because they mark different dates in history when machines have replaced humans. The date of the fourth industrial revolution still has to be established, although historians are not sure if we are already living it or not, and only in the future we will be able to decide which service, product, or new job was the founding act of the new era.

The only certainty is that the fourth industrial revolution is set to change forever the society and the world economy, with innovations that will have both positive and negative impacts on the lives of the world's citizens.

The risk is that the industrial revolution will overwhelm the world's economy, and especially the job economy, with the tasks of millions of people that can be performed by machines rather than by human beings, with the advantage of higher productivity and lower costs. According to the report of the World Economic Forum, "Future Jobs", by 2020 the world will lose 7.1 million jobs, that will be partially counterbalanced by the creation of 2.1 million highly qualified jobs. The balance is still very heavy because, if provisions are right, we are going to see about 5 million jobs disappear during the next four years, due to new technologies that can do (better and at lower cost) some tasks performed until now by human beings. The main characters of the fourth industrial revolution will be RPAS, robotics, nanotechnology, 3D printing and biotechnology.

John Maynard Keynes, in 1936, with great foresight, called this situation "technological unemployment" defining it as "unemployment due to the discovery of means of economizing the use of labor outrunning the pace at which we can find new uses for labor"[145]. We have to admit Keynes was probably not wrong with his prophecy. The issue is that advances in technology will reduce the opportunities for unskilled workers. The third industrial revolution, the internet revolution, has already created a substantial difference between workers that are "born digital", and able to use new technologies in the workplace, and the older generation of workers still bound to pen and paper. The fact is that the job economy is still undergoing the effects of the third industrial revolution and we are already going beyond, with drones that will be able to fly us around, deliver mail, grow crops, and map geographical areas, robotics that can perform office work, nanotechnology

[145] John Maynard Keynes, "Keynes's General Theory of Employment, Interest, and Money", 1936.

and 3D printing that can take the place of traditional productions.

There is a serious risk of leaving millions of people behind, overcome by automation of technology. In addition, the 2 million new jobs will be concentrated in areas such as computer science, mathematics, architecture and engineering. It is clear that in this perspective the answers that governments will give to society and the job economy are decisive.

10. Value Chain

Until now, the RPAS market has been predominantly military, with a customer base that knew exactly the possible applications of the technology, and that was able to utilize it and maintain it with little help from external industries. With such a market, industries were basing their considerations on a very simple and traditional military value chain, with limited value in the downstream RPAS sector since these operations were usually autonomously conducted by military employees.

In civil markets however, the RPAS sector value chain is far more complex, with a downstream sector becoming an opportunity for a plurality of enterprises. Indeed, civil users require various enabling technologies, of which the RPAS platform is only one. The others include payloads, operational control, and data acquisition and processing. This determines a wider value chain for the civil market[146].

For civil users the fundamental element is the data acquisition and processing, as it is what provides the knowledge on which to base decisions. Nonetheless, to first acquire the data, there is the need of appropriate remote sensing instruments mounted onto the platform. As a result, if companies are evaluating where to place themselves in this industry, they must consider that the most profitable segments of the value chain will be at the beginning (with the production of the payloads), and at the end (data acquisition and interpretation) of the value chain. This leaves the RPAS platform builders in a difficult position if they are interested in achieving a valuable share of the value chain, and this must be considered in any business model[147].

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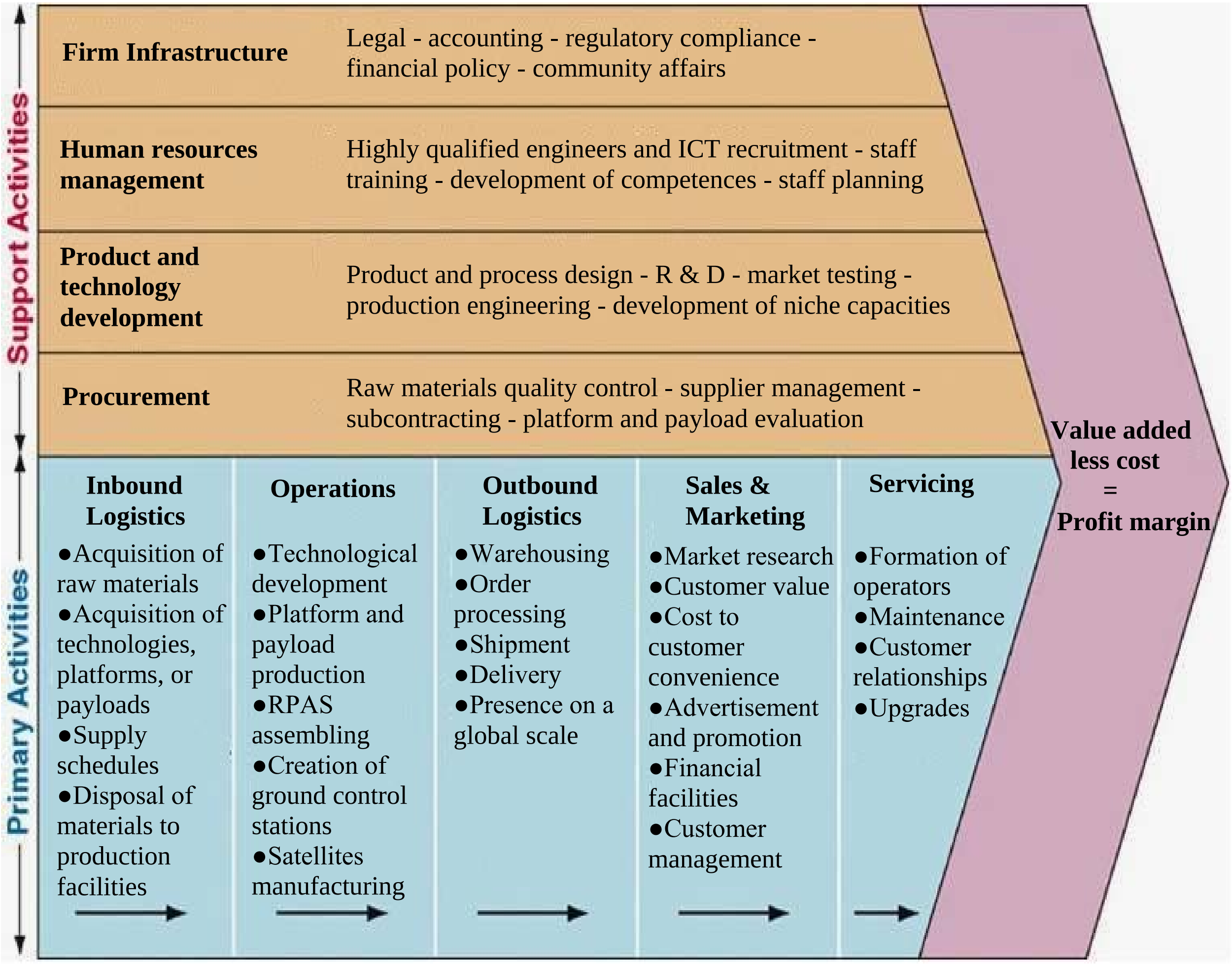
[146] Strat Aero Plc, “INVESTOR PRESENTATION”, October 2015.
[147] Lake M., Shammai S., “The UAV Market – a new perspective”, http://www.growthconsulting.frost.com/web/images.nsf/0/6BE253A7665980FB80256EE5004EBAFD/$File/FarnboroughForum.pdf.

Table 2. Value Chain for the Upstream RPAS civil market sector

Source: Qi3 Ltd[148]



To adequately explore the RPAS civil sector value chain, I decided to separately show the upstream and downstream activities of this market. Certainly, an enterprise comprising both would be fully integrated, although this situation is very rare to find. Commencing from the upstream activities, we find the industries producing platforms, technologies, payloads, control stations, and satellites. These industries will begin by acquiring raw materials to produce the platforms and payloads, or may even acquire platforms and payloads from other industries to only proceed in their assembly. Technological development is of major importance for upstream activities, which must offer superior operational capacities to hinder concurrent enterprises. Without completely expanding towards downstream activities, these companies could also offer the formation of RPAS operators able to exhaustively exploit the drones' offerings.

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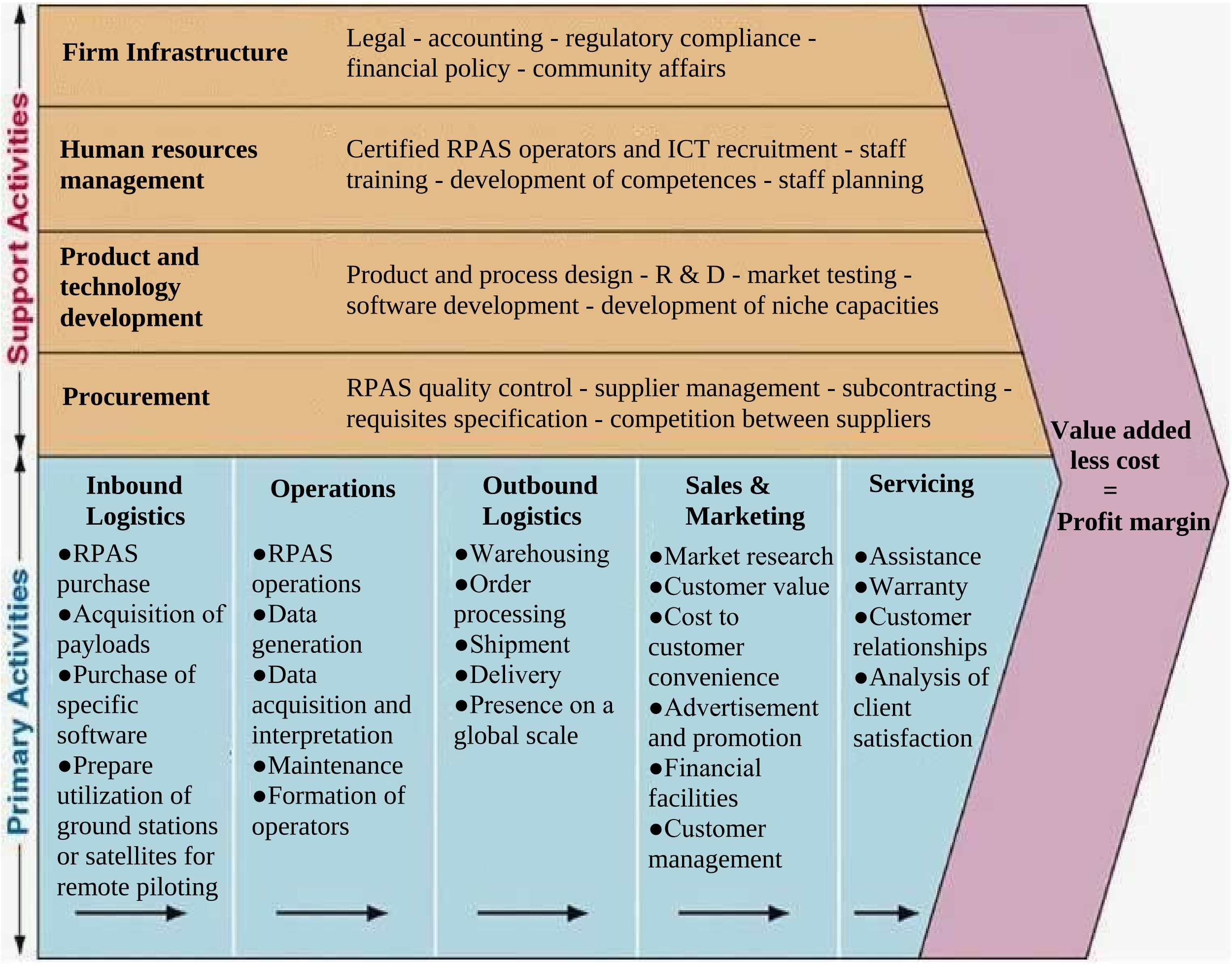
148 Vinters T. "Unmanned Aerial Vehicles: Growing Markets in a Changing World", Qi3 Insight, February 2014.

Table 3. Value Chain for the Downstream RPAS civil market sector

Source: Qi3 Ltd[149]



Downstream activities don't focus on RPAS production, but prefer to offer the final service requested by the customer. This is because civil customers are often not interested in buying RPAS to conduct operations (apart from the case of ludic activities), but rather prefer a specific finished product or result. Thus, these companies will buy the RPAS, hire certified RPAS operators, or train RPAS operators, and then offer on the market services that are more effective and efficient than other means, when conducted with RPAS. Downstream activities may be started with very small amounts of money, since anybody could train to become a RPAS operator, and buy a drone. A few examples of this could be companies offering aerial mapping, pipeline inspection, or wedding filmmaking.

Creating business models that will successfully exploit the RPAS value chain will be challenging, and, although it would be impossible to propose a generic solution to this task,

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149 Vinters T. "Unmanned Aerial Vehicles: Growing Markets in a Changing World", Qi3 Insight, February 2014.

I will present a couple of possible approaches.

A first way could be to focus on the RPAS strengths, such as efficiency, operational flexibility, low costs, and deployability, in combination with the markets and applications where these capacities will provide some major competitive advantage. This is the strategy which has already brought to success many niche technology companies.

However, the multitude of market opportunities being created by this market will create great challenges to RPAS industries. Civilian customers will increasingly prefer acquiring data and processed information services rather than buying the RPAS and performing the operations themselves. This is a fact to be considered when deciding where to place the company inside the market.

Another, and maybe more ambitious approach, would be to combine the major strengths of this market by investing in R&D for sophisticated enabling technologies and sensors, and conjunctly providing requested services, so to satisfy directly customers' needs becoming an Applications Service Provider. This strategy will lead to very large and profitable corporations such as Schlumberger[150] and Halliburton[151]. These corporations certainly have several strategic advantages, bringing in-house services and technologies, and controlling large parts of the value chain so to maximize profits. Such a solution also creates high barriers for other entrants because these major companies will be able to control access to the customer.

The RPAS market is rapidly growing, and emerging markets deriving from this emerging sector will create many opportunities. The companies' success will be determined by their approach to the value chain, and according to the business model they will prefer as by platform manufacturing, technical innovation, market understanding, and operational excellence[152].

11. Lines of business development and future investments

Lines of business development can be defined through the use of business models, so to make targeted and possibly fruitful investments. In 2005, MIT researchers conducted a

[150] Schlumberger, "About us", http://www.slb.com/about/who.aspx.
[151] Halliburton, "Halliburton Home Page", http://www.halliburton.com/en-US/default.page.
[152] Vinters T. "Unmanned Aerial Vehicles: Growing Markets in a Changing World", Qi3 Insight, February 2014.

study on the 1,000 most successful American firms[153]. Their research brought to the creation of the MIT BMAs (Business Model Archetypes), that allowed to categorize the various businesses, allowing them to be compared. What really interests us about this study, in relation to the RPAS industry, is that the researchers found out that companies selling the use of assets produced more profit than those selling the physical assets. In other words, this confirms the customers' trend towards a will for the product without the desire of acquiring the physical assets necessary to its generation.

Especially in the RPAS market, where most businesses are new entries receiving financing to start up, these business models must analyze customer needs, costs, revenue, and value proposition for the product or service that will be sold. Currently, although most businesses in this sector are start-ups, the greatest market shares are still held by major aerospace companies predominantly producing military drones. However, the rapid growth of the military applications will also benefit civil applications thanks to the technology transfer.

Possible applications and lines of business development for the RPAS market are countless, including infrastructure inspection, earth mapping, earth observation, agriculture, telecommunication providers, transport, security, civil protection, and ludic uses[154].

According to a Business Insider Intelligence 2014 report[155], in 2016 worldwide investments in the sector will reach $ 2.3 billion, with some big expenses regarding the development of advanced payloads. However, looking at the future of a sector born for use in military operations or para-military, unmanned aircraft will find more and more space in the daily use by 2020, with a civil market that will progressively outdo the military market. Furthermore, producers who have gathered great fortunes and expertise in the field of war, could not be able to exploit this advantage in the civil sector, due to the changing market conditions and growth rates, so far regulated by very restrictive laws.

In 2015, $450 million was invested in startups with an idea for a new application in the drone market. The overall budget reflects an increase of 300% compared to 2014. In this scenario, a key role is played by the licenses the FAA granted to traders in the US, and it is also through these exemptions that sector trends in the RPAS industry can be analyzed.

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[153] Weill P., Malone T. W., D'Urso V. T., Herman G., Woerner S., "Do Some Business Models Perform Better than Others? A Study of the 1000 Largest US Firms", Sloan School of Management Massachusetts Institute of Technology, 2005.

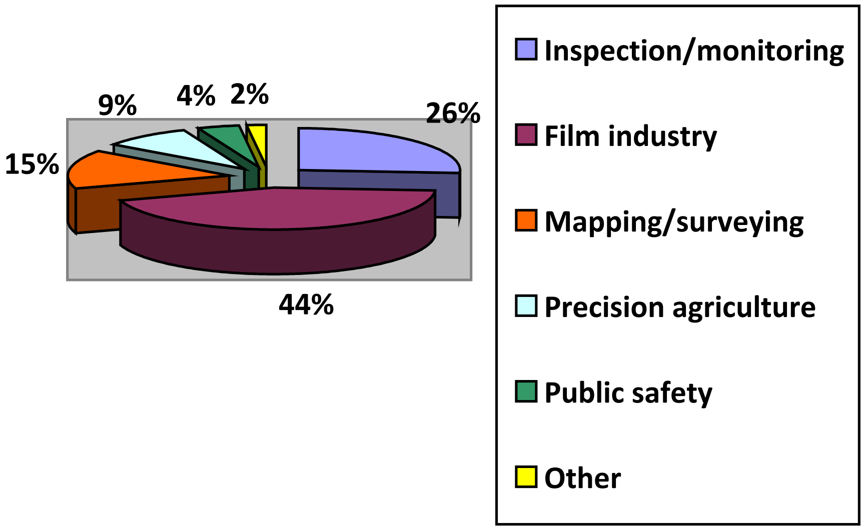
[154] Department of Transportation, Us. Air Force, "Unmanned Aircraft System (UAS) Service Demand 2015 – 2035: Literature Review & Projections of Future Usage", September 2013.

[155] Balvé M., "The drones report: market forecast for commercial applications, regulatory process, and leading process", Business insider intelligence, 2014.

Nonetheless, despite the continuous increase of investments in the field of drones, the entire industry is at an early stage with 67% of all investments being made in the initial phase of development[156].

Graph 5. FAA drone exemptions by use-case as of July 2015

Source: CBInsights[157]



Graph 5 shows us the main investment areas for the drone industry, on the base of FAA requested exemptions. On the total of these requests, 53% were from startups. These are obviously not a particular sector, but it shows us the innovative nature of the civil drone industry, characterized by a large number of small companies that were born directly with the creation of this new sector.

RPAS have a great potential that may be used in all sectors that can benefit on their ability to provide visions from new perspectives, to detect phenomena that would not be visible from the ground, and to substitute human operators during the inspection of hazardous or contaminated environments. The civil sector with major investments is currently the agricultural sector[158], where companies active in the RPAS industry are conducting numerous research activities, working in symbiosis with agronomists and colleges, to

[156] Balvé M., "The drones report: market forecast for commercial applications, regulatory process, and leading process", Business insider intelligence, 2014.
[157] "The future of frontier tech: Analyzing trends in drones, space, and AR/VR technology", CBInsights, 28 August 2015.
[158] AUVSI, Association for unmanned vehicle system International, "The Economic Impact of Unmanned aircraft systems integration in the United States 2013", 2013.

refine data capture techniques and data analysis with the aim of providing farmers with increasingly effective results.[159] The images that can be easily collected using drones are excellent to understand general field health and issues. The use of drones for surveillance of farm crops can increase crop yields, and at the same time minimize the cost of traveling on very large areas. Inspections conducted from above, through drone operations, will in fact eliminate the necessity of direct human control on the field, giving a clear picture of the situation. This means that if today farmers apply fertilizer and pesticides in a uniform way, tomorrow they are going to apply them according to the real necessities of the crop in different parts of the field.

Investments on the RPAS sector today are investments on ideas that will offer many new services, with entrepreneurs believing that drones coupled with smart sensors can be developed to be an effective tool for the future[160]. The success of the idea will depend on the placement of the company in the value chain, the correct evaluation of customers' needs, and the use of synergies with other companies. Until today, the aircraft industry was accessible to few large companies with huge capitals, but with RPAS the aircraft industry is changing, and the power is moving in the hands of investors with an idea.

12. Barriers to success

While RPAS offer a unique range of features, there are multiple issues that must be overcome before a real integration of these vehicles in civil airspace, and our everyday lives.

First of all, there is a lack of consensus on definitions, classifications, and operational concepts. This can be easily viewed by the fact that RPAS are named in many different ways, such as UAV, UAS, or SAPR. This may create some misunderstandings during operations because not everyone recognizes all the different terms for the same system[161].

Another problem is the absence of some complete and harmonized global certification standards and regulations addressing RPAS operations, and their operators. This is the major obstacle withholding an explosion of the market, and the reason why we are not

[159] SALT&LEMON, "I droni per l'agricoltura", Geomedia, 2015.

[160] Verbeke J., Hulens D., Ramon H., Goedemé T., De Schutter J., "The Design and Construction of a High Endurance Hexacopter suited for Narrow Corridors", ICUAS'14-The 2014 International Conference on Unmanned Aircraft Systems, Orlando, Florida, USA, 27-30 May 2014.

[161] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", 10 March 2011.

seeing many drones in the civil skies, since they simply aren't allowed[162].

A relevant issue is also the need for an effective and affordable collision avoidance system, not only working with similar systems, but also able to detect non-transponder equipped aircraft. Without this technology RPAS integration into civil airspace would create many damages to other aircraft.

Always looking at the security aspect, there are little or none adequate business cases for RPAS operations on which to create statistics. This doesn't consent a proper evaluation of the risks inherent to drones, therefore holding back the RPAS insurance market, leading to high costs for RPAS insurance, and in some nations even the absence of insurance offers on the market[163].

Further on, RPAS operations are missing an available protected frequency spectrum, and most of conducted operations are illegal because there are no security controls on RPAS utilization. The easiness of illegal operations, given the defiance of controls, determines serious security, privacy, and insurance issues. These operations are the greatest problem in relation to public apprehension, and the possibility of rejection of RPAS employment. The public needs to be assured on the safety, and the limited risks for their privacy, deriving from the presence of flying RPAS. If this objective won't be reached, the market could find itself in front of a high and unpassable wall.

Finally, the major aerospace industries are entering the RPAS market, while recognizing this to be the future, although most of their revenues are still coming from manned aircraft. These industries might lose large amounts of market share with this modification of the aerospace sector, thus slowing down the change as much as possible[164].

13. Final considerations

The RPAS market is the future of the aircraft market, where the creation of new wealth happens through innovation. Schumpeter was right in seeing how between allocative aim, and the objective of change, the world has chosen the second[165]. However, this innovation choice is living in a high tech world, where the power of creation and success is passing

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162 European RPAS Steering Group, "Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System", Final report from the European RPAS Steering Group, June 2013.

163 Sanger L., "Mandatory Aviation Insurance: A Domestic and International Perspective", Slack & Davis L.L.P., https://www.slackdavis.com/wp-content/uploads/2009/05/mandatory_aviation_insurance08.pdf.

164 DeGarmo M. T., "Issues Concerning Integration of Unmanned Aerial Vehicles in Civil Airspace", MITRE Corporation, November 2004.

165 Schumpeter Joseph A., "The Theory of Economic Development. An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle", Harvard Economic Studies, January 1934.

from the hands of industries, and people with big financial availabilities, to minds with an idea. This phenomenon is positive in a world where globalization was gradually bringing the world towards an industrial reality dominated by a few large industries that would have wiped out all the others[166].

The RPAS sector is living the entrance of a multitude of start-ups, and businesses created from low financial availabilities, and a hopefully successful idea. All of these companies are born for the development, manufacturing, and distribution of a product based on the concept that resources are scarce, and must be placed in a rational way[167]. An allocation based on efficiency and effectiveness outdoes the other enterprises, which perish in front of companies with a stronger product[168].

RPAS, under the aspects of possible utilization and economic power are amazing, and will be amongst the most important technologies of the ongoing fourth industrial revolution. Their strengths are many, and in such a variety of sectors, that they will substitute human operators in many low specialization jobs. This substitution will happen faster than most of us imagine, since the cost of inertia[169], outlined by Leibenstein, is too low in relation to the gains for the industries adopting RPAS. In many sectors, such as agriculture, pipeline inspection, or transports, the use of new technologies will reduce the need for human operators, increasing production quality and speed, lowering costs and risks, and eliminating concurrent enterprises not embracing the change[170].

Such a production increase, as indicated to us by Adam Smith, will have the effect of an “invisible hand” lowering the costs of many products[171], although the reduction of costs won’t necessarily generate wealth, since they are accompanied by the loss of many low specialization jobs.

During the ongoing fourth industrial revolution there will be the loss of about 5 million jobs[172], leaving lots of people behind. What governments need to take into consideration when deciding future policies is that the failure of the consumer is as serious, if not more, as that of the entrepreneur. Major focus should be put on the issue of the income

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166 Personal notes taken during lessons of “Economia dell’Impresa”, Professor Cesare Pozzi.
167 Simon Herbert A., “Causalità, razionalità, organizzazione”, Il Mulino, 1985.
168 Alchian Armen A., “Uncertainty, Evolution and Economic Theory”, Journal of Political Economy, January 1950, pg. 211-221.
169 Leibenstein Harvey, “Allocative Efficiency vs. ‘X Efficiency’”, The American Economic Review, Volume 56, Issue 3, June 1966.
170 Alchian Armen A., “Uncertainty, Evolution and Economic Theory”, Journal of Political Economy, January 1950, pg. 211-221.
171 Smith Adam, “La ricchezza delle nazioni”, Grandi Tascabili Economici Newton, Roma, 1975.
172 World Economic Forum, “Future of Jobs”, 2015, http://reports.weforum.org/future-of-jobs-2016/.

distribution, because otherwise we will reach the situation of a consumer bankruptcy, with consumers that will no longer be able to buy[173]. This situation will initially widen disparities between the rich and the poor, until leading to a catastrophic result of whole system failure, where companies will not be able to sell products and services to failed consumers.

Another fact that governments must take into account is the setting of standards and the creation of patents. RPAS, as manned aircraft, will have to respect a list of safety and security requirements. These requirements will partially follow actual aircraft safety standards, but will also be created by the nations making the "first move". A serious risk for industries of "second move" countries is that these standards have already been set in other countries, and the foreign industries are creating and patenting new technologies while they are still unsure of what regulations will be. If then "second move" countries decide to follow the standards already set up by "first move" countries, which have been tested, and might be followed according to harmonization principles, industries of "second move" countries will suffer terrible disadvantage. This way, "second move" country industries will have to pay for registered patents of technologies they have unjustly been limited from developing first[174].

The Italian industry and government organizations have very well understood the need of being a "first move" country[175], thus speeding up the creation of regulations and standards at a both national and European level. The risks of not taking this chance, and being left behind, are great for a nation like Italy which is trying to get out from a situation of low economic growth and precarization of the whole economy. In Italy the production trends are following this direction, with the evidence of a country that certainly continues to export in always more specialized market segments, now mainly concentrated in engineering, but without seeming to dispose of an industrial system able to tow the development of the country beyond a modest survival[176].

Italy could regain a leading position in the global economy by promptly entering emerging high tech markets, of which the RPAS sector, and the future satellite control systems are an important part. Nonetheless, timing is important to be the first in the creation of standards

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[173] Mancuso E., "Politica Keynesiana: Il rilancio dell'economia tra libertà e benessere", Armando Editore, 2003.
[174] Benedetto Marasà, Vice Direttore Generale ENAC, Personal Interview on RPAS, 16 December 2015.
[175] Palmiotti D., "L'aeroporto di Grottaglie si rafforza come base per testare i droni", Il Sole 24 ORE, 5 March 2016.
[176] Pozzi Cesare, Bianchi Patrizio, "Le politiche industriali alla prova del futuro: analisi per una strategia nazionale", Il Mulino, 2010, pg. 40.

and patents, and this is why the Italian industry will only rise again with the collaboration of the legislative system and government institutions.

CHAPTER III

AIRWORTHINESS AND CERTIFICATION OF TECHNOLOGIES AND CAPACITIES

RPAS have been employed for many years, both in military and civilian sectors, although only recently the debate regarding their commercial applications and their integration with civil aviation got under way. The discussion also regards safety issues such as legislation, certification, and training, together with privacy, liability, and insurance matters.

In fact, there are no specific supranational (international or European Union) laws or regulations governing this matter. At international/universal level, the International Civil Aviation Organization (ICAO) is working on updating the Technical Annexes to the Convention on International Civil Aviation of 1944, to provide the Contracting States with general guidelines.

At international/regional level, the European Union has taken initial steps as the lack of a defined EU regulatory framework confines the possibility to operate RPAS in non-segregated environments. This may jeopardize the development of the RPAS market and therefore requires careful consideration.

The emergence of this new market needs to be further assessed, and appropriate actions must be taken on the European level to help development and provide the necessary framework within a reasonable time, confirming federation of efforts and rapid benefits for this sector. The task is to permit the progressive integration of RPAS into civil aviation from 2016 onwards, as required by the European Commission.

In summary, RPAS offer new services and applications, going beyond traditional aviation, which involves new opportunities, but even new challenges, requirements and threats, and this is the criteria to be considered in drafting, adopting, and implementing a regulation on the matter. In particular, the adoption of a new regulatory framework involves the assessment of several matters and aspects, such as the issue of insurance and liability, the respect of citizens' fundamental rights, the right to privacy and the protection of personal data, airworthiness and the inclusion into a well-established certification system, current and future security challenges, and defense matters (as cyber security strategies and counterterrorism perspectives).

1. The Involvement of ICAO in Providing an International Regulatory Framework on RPAS

The Convention on International Civil Aviation, signed at Chicago on 7 December 1944 and amended by the ICAO Assembly, provides for minimum standards to ensure the safety of civil aviation and environmental protection relating thereto,[177] including a specific provision regarding RPAS in its Article 8.[178]

The Chicago Convention replaced the Paris Convention of 13 October 1919 which, in turn, contained a similar provision. In fact, Article 15 of the Protocol of 15 June 1929, amending the Paris Convention, refers to pilotless aircraft, providing that "[n]o aircraft of a contracting State capable of being flown without a pilot shall, except by special authorization, fly without a pilot over the territory of another contracting State". Article 8 of the Chicago Convention replaced this provision stating that, with regard to pilotless aircraft, "[n]o aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft."

Recently, ICAO has started its contribution to the expected regulations for integrating RPAS. The involvement of the Organization in the determination of such regulation began on 12 April 2005, during the first meeting of its 169th Session. Here the Air Navigation Commission requested the Secretary General to consult selected States and international organizations with respect to several matters of the sector, such as: (i) actual and expected international civil RPAS activities in civil airspace; (ii) procedures to avoid that RPAS used as State aircraft cause danger to civil aircraft; and (iii) procedures eventually adopted for the issuance of special operating authorizations for international civil RPAS operations.

According to this mandate, the first ICAO meeting on RPAS was held in Montreal on the 23rd and 24th of May 2006. Its objective was to define the potential role of the Organization in RPAS regulatory development work.

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[177] Abeyratne R., "Convention on International Civil Aviation. A Commentary", Springer, Canada, 2014.

[178] Mendes de Leon P., Scott B. I., "An Analysis of Unmanned Aircraft Systems Under Air Law", in Završnik A. (Eds.), "Drones and Unmanned Aerial Systems. Legal and Social Implications for Security and Surveillance", Springer, 2016, pg. 187.

During the second informal ICAO meeting, which took place in Palm Coast, Florida, on January 2007, it was agreed that ICAO had to coordinate the development of a guidance document that would lead the proceeding regarding the adoption of a regulation. Even though it was not a binding text, the document, having to the more hortatory or promotional language, could function as the basis for the different States and organizations in the following stages directed at the development of the regulation. This was a good prospect to ensure harmonization and uniformity at an early stage.

On 7 April 2007, ICAO Air Navigation Commission established the Unmanned Aircraft Systems Study Group (UASSG). UASSG was created to serve as the focus and coordinator of all ICAO RPAS related work, with the task of ensuring the interoperability and harmonization between the different parties and contributions, assuring high level direction and supervision to States and organizations for RPAS approvals and operations. Its task is to concentrate on RPAS employed for international operations, in order to find a consensus and create the foundation for common recognition of approvals.

In 2011, the ICAO UASSG adopted Circular 328 on UAS (unmanned aircraft systems) and proposed amendments to Annexes 2, 7 and 13[179] of the Chicago Convention regarding the use of RPAS in international civil aviation. Later in 2015, a new RPAS handbook was disclosed, covering subjects such as the conditions for airworthiness certificates, RPAS operational approval, operator certification and new conditions for airworthiness, maintenance and operation.[180]

Specifically, ICAO Circular 328 was published on 10 March 2011 and is the culmination of three years of intense work by UASSG. The Study Group did not use the term RPAS, but agreed the term "unmanned aircraft" which would be meant as an umbrella concept for any aircraft intended to be operated without a pilot on board.[181]

The need to harmonize the matter, and to determine the discipline applicable to these new instruments, is reflected in the part of the Circular where it is provided that there are a number of articles of the Chicago Convention that are applicable to UAS. These include: Article 3 bis (State sovereignty); Article 8 (Pilotless aircraft); Article 12 (Rules of the Air); Article 15 (Airport and similar charges); Article 29 (Documents carried in aircraft); Article 31 (Certificates of airworthiness); Article 32 (Licenses of personnel); and Article 33

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[179] Annex 2 contains "Rules of the Air", Annex 7 deals with "Aircraft Nationality and Registration Marks", Annex 13 contains provisions regarding "Aircraft Accident and Incident Investigation".

[180] ICAO, Doc 10019, "Manual on Remotely Piloted Aircraft Systems (RPAS)", 2015, http://www.wyvernltd.com/wp-content/uploads/2015/05/ICAO-10019-RPAS.pdf.

[181] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", 10 March 2011.

(Recognition of certificates and licenses).

Some additional observations regarding selected of the abovementioned articles are required.

In the Circular, in relation to the specific applicability of Article 3 bis to RPAS,[182] it was specified that "[c]ontracting States are entitled, in certain circumstances, to require civil aircraft flying above their territory to land at designated aerodromes, per Article 3 bis b) and c). Therefore, the pilot of the RPAS will have to be able to comply with instructions provided by the State, including through electronic or visual means, and have the ability to divert to the specified airport at the State's request. The requirement to respond to instructions based on such visual means may place significant requirements on certification of RPAS detection systems for international flight operations."

As it has been highlighted above, Article 8[183] specifics the conditions for operating an aircraft without a pilot over the territory of a contracting State. To appreciate the consequences and effects of this norm and its inclusion, from the Paris Convention of 1919 (Article 15) into the Chicago Convention of 1944, the intent of the drafters have to be considered. "Remote-control and uncontrolled aircraft were in existence at the time, operated by both civil and military entities. "[A]ircraft flown without a pilot" therefore refers to the situation where there is no pilot on board the aircraft. Consequently, any RPAS is a "pilotless" aircraft, consistent with the intent of the drafters of Article 8."[184]

Other two provisions to be conjunctly considered are Article 31 and 33.

Article 31 deals with certificates of airworthiness and makes such kinds of certificates compulsory for every aircraft engaged in international navigation. These certificates must be issued or rendered valid by the State in which the aircraft is registered. "In the interest of safety, an aircraft must be designed, constructed and operated in compliance with the appropriate airworthiness requirements of the State of Registry of the aircraft. Consequently, the aircraft is issued with a Certificate of Airworthiness declaring that the

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[182] Article 3 bis b) provides that "[t]he contracting States recognize that every State, in the exercise of its sovereignty, is entitled to require the landing at some designated airport of a civil aircraft flying above its territory without authority…. it may also give such aircraft any other instructions to put an end to such violations. c) Every civil aircraft shall comply with an order given in conformity with paragraph b) of this Article […]".

[183] Article 8 states that "[n]o aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft."

[184] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", cit., para. 4.3.

aircraft is fit to fly."[185]

According to the Circular, Article 31 applies equally to manned and unmanned aircraft engaged in international navigation. All aircraft, whether manned or unmanned, have many characteristics in common. Consequently, most RPAS assessments will likely be based on the regulations already provided for manned aviation. However, even though the majority of the existing manned aircraft are applicable to RPAS as well, for others a new or interpretative solution may be required. In other words, airworthiness is based on well-established airworthiness design standards. Nevertheless, existing performance standards provided for manned aviation may not apply or adequately address RPAS configurations. In fact, there is a number of areas that are unique to RPAS, and therefore are not addressed in current ICAO instruments, and are more critical because of the potential degree of their impact. "Review of these areas will likely result in changes to technology growth, international infrastructures, regulations and standards, and operational procedures."[186]

Until the differences will be regulated, standards and recommended practices (SARPs) for Certificates of Airworthiness are adopted in Annex 8, addressing the airworthiness of aircraft (which is illustrated later in this paragraph), although an inadequacy will occur in how States adopt such certificates.

Article 33 provides the basis for mutual recognition of certificates and licenses, so even for the certificate of airworthiness.[187] The theme of certification regards the inclusion of RPAS into a well-established certification system, and compliance with some requirements in a manner similar to that of manned aircraft. The Circular departs from the consciousness that RPAS operate with supporting system elements (remote pilot station, C2 data links, etc.), and this brings new complexities to the subject of certification because each of these system elements will be changeable. This means it is likely that a single RPAS will not always be operated from the same remote pilot station using the same C2 (command and control) data link.[188]

It is even likely that components will be located in different States. "The long-haul flight operating from one region of the world to another will face increasing C2 and

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[185] Annex 8 to the Convention on International Civil Aviation, Chicago, 7 December 1944.

[186] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", cit., para. 6.10.

[187] Article 33 states that "[r]ecognition of certificates and licenses Certificates of airworthiness and certificates of competency and licenses issued or rendered valid by the contracting State in which the aircraft is registered, shall be recognized as valid by the other contracting States, provided that the requirements under which such certificates or licences were issued or rendered valid are equal to or above the minimum standards which may be established from time to time pursuant to this Convention."

[188] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", cit., pg. 25.

communications performance issues as the aircraft travels further from its remote pilot station. While the performance (e.g. data link transaction time, availability) may not be detrimental in the oceanic and remote en-route environments, it will be different in the congestion of the continental and aerodrome environments. To address these issues, it may be necessary to handover piloting control from the “home” remote pilot station to one in the destination locale. Legal issues related to certification, licensing and the recognition of documents in this new scenario would have to be addressed.”[189]

In addition, complex legal issues and agreements between States would have to be dealt prior to another additional scenario becoming feasible. It relates to the fact that the remote pilot station could be operated as a commercial enterprise by a “remote pilot station operator”. In order to operate and maintain the remote pilot station, this operator is expected to be issued the approval from the State Civil Aviation Authority. In this context, specific aircraft types which can be operated from the remote pilot station are the factors to be taken into account. It should be observed that the State of the remote pilot station operator, and that of the operator of RPAS, might be different and not correspond.

From an operational point of view, two possibilities to facilitate a flexible operational system configuration are envisaged in the Circular. The first option described is that the certification of the RPAS is documented with the Type Certificate issued to the RPAS. Drones and the remote pilot station associated with the aircraft are considered as two separate entities. The configuration of the RPAS as a whole would be included in the Type Certificate of the RPAS, under the responsibility of one unique Type Certificate holder. The remote pilot station associated is verisimilarly to be considered in a manner comparable to engines and propellers because it could have a Type Certificate issued by the remote pilot station State of Design.[190]

The second option predicts new certificates comparable to the existing Type Certificate and Certificate of Airworthiness for the remote pilot station(s). This solution departs from

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[189] ICAO Circular 328-AN/190, “Unmanned Aircraft Systems (UAS)”, cit., pg. 25.

[190] In the Circular, it is also reasoned that “[t]he configuration of RPA and remote pilot station(s) would be certified in conjunction with the RPA by the State of Design of the aircraft and documented in the Type Certificate data sheet. The remote pilot station then is “part” of the RPAS. This would give the RPA State of Design responsibility for the overall system design. The RPA State of Design would also have responsibility for providing any mandatory continuing airworthiness information. The State of Registry would have responsibility for determining continuing airworthiness of the RPAS in relation to the appropriate airworthiness requirements. More than one remote pilot station could be associated with the RPA as long as the configuration is described in the Type Certificate. A Certificate of Airworthiness would be issued for the RPA, and it would remain the responsibility of the operator to control the configuration of the RPAS (RPA, remote pilot station and data links).” ICAO Circular 328-AN/190, “Unmanned Aircraft Systems (UAS)”, cit., pg. 25-26.

the traditional method, as the design configuration of the RPAS would be considered separately for the RPAS and the remote pilot station.[191]

As we already know, the aircraft must have a Certificate of Airworthiness. "In the first option the remote pilot station associated with the aircraft will be linked to the RPA Certificate of Airworthiness, either through the Certificate of Airworthiness directly or through configuration control mechanisms per flight (e.g. RPA logbook). In this option, only the RPA will be registered. In the second option, the remote pilot station will have a separate certificate, similar to the RPA Certificate of Airworthiness, and there must be an operator-controlled system document with which the RPAS (i.e. RPA and remote pilot station) configuration is controlled. In this option, requirements for registration of the RPAS elements will have to be explored."[192]

These Certificates of Airworthiness, whether issued according to the first or the second option, as stated in Article 33, must be based in compliance with at least the minimum international (airworthiness) standards established by Annex 8. In case of non-compliance with international established airworthiness requirements, the Certificate of Airworthiness has to be appropriately marked on those areas of failure.

The abovementioned Annex contains broad standards which provide, as stated above, for application by the national airworthiness authorities, "the minimum basis for the recognition by States of Certificates of Airworthiness for the purpose of flight of aircraft of other States into and over their territories, thereby achieving, among other things, protection of other aircraft, third parties and property."[193]

According to Annex 8 there are a number of requirements: (i) the issuance of a Type Certificate, by the State of Design, to provide evidence of an approved design; (ii) the production of the aircraft in a controlled manner that ensures conformity to its approved type design; (iii) the issuance of a Certificate of Airworthiness on satisfactory evidence; (iv) aircraft compliance with the design aspects of the appropriate airworthiness requirements; and (v) the cooperation of the State of Design, State of Registry and the type certificate holder to guarantee the continuing airworthiness of aircraft.

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[191] "This means that the airworthiness of the RPA and the comparable certification for the remote pilot station would be dealt with individually. An RPAS designer would have responsibility for verifying the RPA, and remote pilot station(s) could be configured into an "airworthy" system. It is not clear yet what the exact RPAS design process approval (similar to what is currently called Type Certificate) and RPAS production process approval (currently called Certificate of Airworthiness) would be, but they would require a fundamental change to the approach to certification". ICAO Circular 328-AN/190, *Unmanned Aircraft Systems (UAS)*, cit., pg. 26.

[192] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", cit., pg. 26.

[193] Annex 8 to the Convention on International Civil Aviation, Chicago, 7 December 1944.

Annex 8 indicates the different design aspects for manned airplanes and helicopters, engines and propellers such as (without intending to be exhaustive): a) unsafe features or characteristics; b) flight characteristics; c) structural strength and other characteristics; d) design and construction; e) power plant and installation; f) rotor and power transmission (for helicopters); g) instruments; h) systems and equipment; i) operating limitations and information; j) systems software; k) crashworthiness and cabin safety; l) operating environment and Human Factors.

Annex 8 deals even with the issue of terrorist attacks which are not inappropriately considered in the Circular. In the Annex it is provided that "following the recent events of highjacking and terrorist acts on board aircraft, special security features have been included in aircraft design to improve the protection of the aircraft. These include special features in aircraft systems, identification of a least-risk bomb location, and strengthening of the cockpit door, ceilings and floors of the cabin crew compartment." This has to be updated and adapted to RPAS.

The same Circular finds that performance standards currently in use for manned aviation may not apply or satisfactorily regulate RPAS operations. Accordingly, several issues have been identified and need to be addressed, such as that regarding that SARPS are confined to aircraft over 750 kg, projected for the carriage by air of passengers, cargo or mail; SARPS for remote pilot stations; and provisions for C2 data links.[194]

In addition, the Circular is aware of the unsuitableness of current categorization of manned aircraft certification standards to new RPAS technology. This involves that a number of areas have to be addressed, including new types of airframes and power plants; methods of construction that are non-traditional; and technologies and systems for detect and avoid, operational communications, C2 data links (comprising infrastructure, protected spectrum and security) etc.[195]

In summary, Circular 328 is the first of a series of texts that are to be produced for ICAO by the UASSG. The next stage was to take the document and build on it to produce a manual for use by States as a guide in producing, in turn, their own guidance material and/or regulations.

According to this, in 2015, a RPAS handbook has been published.[196] The text assists States, industry, service providers and other stakeholders as it deals with issues and matters

[194] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", cit., pg. 28.
[195] ICAO Circular 328-AN/190, "Unmanned Aircraft Systems (UAS)", cit., pg. 28.
[196] ICAO, Doc 10019, "Manual on Remotely Piloted Aircraft Systems (RPAS)", cit.

regarding the regulatory framework. It analyzes how the existing provisions regarding manned aviation apply to unmanned aircraft, and provides some guidance on how to deal and find a solution to the gaps. The material will be revised and expanded as the actual regulatory framework develops and is adopted.

On 6 May 2014, a larger board, the Remotely Piloted Aircraft Systems Panel, established by ICAO Air Navigation Commission, consisting of twenty-one States and nine international organizations, replaced the UASSG. It coordinates all the activities carried out by ICAO in its commitment regarding RPAS in order to favor harmonization, even coordinating with other ICAO expert groups. In addition, the Panel: supports and gives guidance in the regulatory process according to its RPAS regulatory concept; proposes amendments and coordinate the development of RPAS; evaluates the effects of suggested regulations on existing manned aviation; and coordinates, "as needed, to support development of a common position on bandwidth and frequency spectrum requirements for command and control of RPAS for the International Telecommunications Union (ITU) World Radio Conference (WRC) negotiations."[197]

According to this, the Panel aspires to develop standards and recommended practices for unmanned aircraft to be delivered to ICAO Council in 2018, regarding airworthiness, operations (including RPAS operator certification) and licensing of remote pilots. SARPs will be the basis in the drafting and adoption of ICAO's 191 Member States national regulations. Since even the mandate to adopt RPAS standards involves great commitment, due to the complexity and innovative character of the matter, we can imagine that, in turn, the adoption of the complete regulatory framework for RPAS will be a lengthy process, lasting many years.

2. The European Policy on RPAS. An Overview

A high and uniform degree of protection in civil aviation should be ensured to European citizens with the adoption of the necessary instruments, containing safety rules and measures capable of guarantying that products, people and organizations in the Union comply with such rules. This system would help achieving the free movement of goods, people and organizations in the internal market.

In this context, since RPAS are aircraft, they have to comply with the abovementioned aviation safety rules. However, their expansion is inhibited and limited by the lack of a proper and specific regulatory framework in the majority of Member States, other than by

[197] ICAO, Doc 10019, "Manual on Remotely Piloted Aircraft Systems (RPAS)", cit., Chapter I, pg. 4.

the constraint that individual authorizations have to be issued from each Member State, as provided by ICAO regulations, where manufacturers would like to sell or where providers would like to operate. In this context, some Member States have started adopting national rules regarding a certification process,[198] but in the absence of European standards, to be developed by the European Aviation Safety Agency (EASA), it is very difficult that a RPAS european market will develop, hindering significantly the emergence of this sector. Domestic authorizations do not profit from a system of mutual recognition and do not give authorization for European wide activities, either to produce or to operate RPAS. In fact, regulations on certification would not only establish the rules to manufacture the aircraft, but also, even more importantly, gradually authorize operations, so that industry could gain valuable practical expertise and progressively develop. The creation of such rules to allow civil RPAS operations must be combined with the necessity to protect safety, security, and privacy, which are a precondition for public acceptance of drones.

In addition, the need regarding the development of a legislative framework, especially defined at European level, to be later adopted domestically by Member States, has its roots in the vital protection of human rights, and the adoption of required safeguards regarding national and interantional public order and secutity. In fact, the development of civil RPAS applications requires ensuring that none of them could represent a threat to citizens' privacy or physical integrity. The industrial sector is not investing on RPAS craving for legal certainty, and the actual lack of a regulation framework discourages, as this situation leads to insecurity and inconsistency.[199] Moreover, the market of drone applications can better emerge with the adoption of a regulation that can assure the safety and the operation of the civil aviation system in case of RPAS flying in non-segregated environments. To this end, the European Union, together with the contribution of other authorities, at European and national levels, has to adopt an enabling regulatory structure.

Accordingly, the European Union is involving other partners in the adoption of a legislative framework such as: EASA, the national Civil Aviation Authorities, the European Organisation for Civil Aviation Equipment EUROCAE, Eurocontrol, the Joint

[198] These States include: Austria, Belgium, Czech Republic, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, United Kingdom.

[199] See, the Commission Staff Working Document. SWD (2012) 259, "Towards a European strategy for the development of civil applications of Remotely Piloted Aircraft Systems (RPAS)", 4 September 2012.

Authorities for Rulemaking on Unmanned Systems JARUS[200], the SESAR Joint Undertaking (SJU), the European Defence Agency, the European Space Agency, the RPAS manufacturing industry and operators.[201]

In this context, the European Aviation Safety Agency was established by Directive 216/2008 to properly assist the Union in the realization of the abovementioned "mandate", with expertise in all aspects of civil aviation safety and environmental protection. It should assist the Commission in the preparation of the necessary legislation, and support the Member States and industry in its implementation. EASA should issue certificates, deliver guidance material and adopt technical findings.[202]

In addition, the Agency should issue its recommendations, which will be used by the Commission in the proposal for the revision of the basic European safety regulation.

The European RPAS Roadmap outlines a plan that provides for the adoption and subsequent insertion of civil RPAS into common airspace, and therefore common regulation, in a 15-year timeframe.[203] This strategy is articulated in three pillars, such as "(1) research and development; (2) safety regulations, technical standardization, and additional measures such as privacy and data protection; and (3) insurance and liability. The proposals relating to the introduction of common airspace with civil RPAS are aimed at 2016 and the years thereafter."[204]

According to the said roadmap, a number of steps have already been taken. In fact, the European Council has adopted its statements on the matter during the 2013 Summit and issued a specific Communication later in 2014. In addition, the European aviation community endorsed the Riga Declaration in 2015, and the Article 29 Data Protection Working Party (WP29) delivered numerous opinions on Privacy and Data Protection related to RPAS.

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[200] JARUS is an international body, consisting of experts from the National Aviation Authorities and regional aviation safety organizations. Austria, Australia, Belgium, Brazil, Denmark, Canada, CH, Czech Republic, Spain, Finland, France, Greece, Israel, Italy, Malta, Netherlands, Norway, Russian Federation, South Africa, United Kingdom, USA are members, together with Eurocontrol and EASA.

[201] EU Doc. COM/2014/0207 final, "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", 8 April 2014.

[202] EU Doc., "Regulation (EC) No 216/2008 of the European Parliament and of the Council 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", 20 February 2008.

[203] Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System; Final report European RPAS Steering Group — June 2013.

[204] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the 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", 15 October 2014, para. 4.5.

3. The European Council Summit of 19 December 2013 on Common Security and Defence Policy

The European Council Summit, which took place on 19-20 December 2013, for heads of State or Government, tasked to deliberate European Defense Industry issues, called for action to enable the progressive integration of RPAS into civil airspace from 2016 onwards. In that context, the European Council found that "[a]n effective Common Security and Defence Policy helps to enhance the security of European citizens and contributes to peace and stability in our neighbourhood and in the broader world."

According to the Conclusions of the Summit, RPAS were included in the challenges falling within the European Common Security and Defence Policy (CSDP).[205]

In addition, the European Council welcomed "the development of Remotely Piloted Aircraft Systems (RPAS) in the 2020-2025 timeframe: preparations for a programme of a next-generation European Medium Altitude Long Endurance RPAS; the establishment of an RPAS user community among the participating Member States owning and operating these RPAS; close synergies with the European Commission on regulation (for an initial RPAS integration into the European Aviation System by 2016); and appropriate funding from 2014 for R&D activities".[206]

4. The European Commission Communication on a Sustainable Use of RPAS

On 8 April 2014, the European Commission responded to two appeals: the call of the European manufacturing and service industry to eliminate barriers that jeopardize the introduction of RPAS in the European single market, and the call of the European Council Summit.

The organ issued a Communication to the Parliament and the Council, under the title *A new era for aviation. Opening the aviation market to the civil use of remotely piloted aircraft systems in a safe and sustainable manner*.[207] This text set out the Commissions' guidelines on how RPAS operations should be faced within the framework of European policy. Legislative action had to aim at two objectives such as the progressive development of the commercial drones market and, at the same time, safeguarding the public interest.

In particular, the Commission recognized the relevance of the insertion of RPAS into the European market, which represented a step towards the aviation market of the future. This

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205 EU Doc. EUCO 217/13, "European Council 19/20 December 2013 Conclusions", 20 December 2013.
206 EU Doc. EUCO 217/13, "European Council 19/20 December 2013 Conclusions", cit., para. 11.
207 EU Doc. COM/2014/0207 final, "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", cit.

will produce effects on the European industry, as the direction for future regulatory developments play an important role in investment planning.

In the document, with regard to the need of developing a regulatory framework, aimed at assuring safe operations into non-segregated airspace, the Commission stated that this would have "the regulatory preconditions to integrate RPAS into the European airspace from 2016 onwards, covering the necessary basic regulatory issues to ensure a coherent and effective policy, including on the appropriate scope of EASA competence. Any possible legislative action will be preceded by an impact assessment."[208]

In the Commissions' position, it was also set out that a number of technologies that are necessary to the safe integration of RPAS into the European market were not yet available and, therefore, had to be developed. To this end, it was suggested to direct R&D investments towards these new technologies. This referred "mainly to command and control, detect and avoid technologies, protection from various forms of attack, transparent and harmonized emergency procedures, decision-making capacities so as to ensure predictable flight patterns, and human factors."[209]

Of course, it was also important to guarantee three other aspects: namely the security of data transmitted to and from RPAS; the protection of fundamental human rights such as the right to privacy against any RPAS operations; and the inclusion of insurance and compensation arrangements in case of accidents.

On 15 May 2014, the European Commission decided to consult the European Economic and Social Committee. The latter adopted its opinion on 1 October 2014.[210]

In the document, it was highlighted the importance of having to determine the timeframe regarding the integration of RPAS into existing forms of aviation at European level and in the ICAO, given the growing interest in drones whose take-off weight does not exceed 150 kg. In this context, the adoption of measures and solutions by means of an harmonized regulation were found to have a decisive part in the acceptance of RPAS within the

[208] EU Doc. COM/2014/0207 final, "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", cit., pg. 6.

[209] EU Doc. COM/2014/0207 final, "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", cit., para. 3.5.

[210] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the 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", cit.

European Union.[211]

The Committee's opinion does not seem to give a valuable contribution to the issue, limiting its content, for instance, to the illustration of the Commissions' Communication, or stressing that RPAS have to be given the resources, visibility and regulatory stability to face the challenges and to make use of the development opportunities in this sector.

"In order to make use of the opportunities provided by the single market, regulators must address the challenge of implementing a clear yet flexible legal framework that clears the way for investment in new RPAS technology and applications such as 3D printers and the industrial internet."[212]

The most interesting part of the opinion regards the issue of liability and insurance. In relation to this, the Committee found that a fundamental prerequisite for flying of RPAS is setting a new legislation that makes third-party liability insurance mandatory for operators and users of RPAS. The Committee highlighted how this kind of insurance must be created following the regulations provided for manned aircraft.[213] In addition, to attain ideal operating conditions, it was necessary that the competent European Union entities, regulatory authorities, and professional organizations for civilian RPAS or similar organizations established a regulatory framework dedicated to the training of RPAS pilots and operators, and for licensing.[214]

Furthermore, another aspect that must be necessarily taken into account regards the liability of RPAS operators, which has in turn to consider the particularity of these operations that involve a high level of automation. Currently, insurance requirements for air carriers and aircraft operators are set out in Regulation (EC) No 785/ 2004, but this does not contain any reference to the specific liability and insurance aspects of RPAS.[215]

The Committee supported the Commission's intention to take initiatives in the area of air traffic control, on the awareness that the operation in the airspace of both manned and unmanned aircraft, for civil or military purposes, and the establishment of related safety

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[211] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the 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", cit., paras. 2.4 and 2.5.

[212] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council", cit., para. 5.1.3.

[213] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council", cit., para. 5.2.1.

[214] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council", cit., para. 5.2.2.

[215] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council", cit., para. 5.2.3.

standards, would have conducted to a substantial workload for such services. Thus, this gives the opportunity to create a form of cooperation and synergy between civil and military activities, aiming at testing commercial applications and innovations. It is also most unquestionably advisable to focus on regulatory priorities and to the relationship between European and international law.[216]

5. The Conference on Remotely Piloted Aircraft Systems, Riga, 6 March 2015

The European Commission strategy to support the progressive development of the RPAS market in Europe has been endorsed by the aviation community in the Riga Declaration, during the Conference on remotely piloted aircraft systems.

Specifically, the European aviation community gathered in Riga, in March 2015, to exchange a view on how to take advantage from the new opportunities emerging on the RPAS market in the European context, with special regard to the creation of job positions, and new scenarios of development for the manufacturing industry and drone users.

The Latvian Presidency of the Council of the European Union, European Commission representatives, Directors General of Civil Aviation of the EU Member States, data protection authorities and leaders of manufacturing industry and service providers recognized the significance of taking joint European action, taking into account the orientations given in the Communication of the European Commission.

Commissioner Bulc's speech at the RPAS Conference in Riga highlighted that "[d]rones must fly safely in all circumstances and must not harm people in the air or on the ground. Europe should develop safety rules focused on addressing the risk associated with operating a drone. Those rules must be proportionate to that risk. And they should be international, as much as possible. This basic regulatory framework should be put in place without delay, as from this year, in order to help the private sector to take well-informed investment decisions."[217]

The Conference established the following basic principles to guide the regulatory framework in Europe:

- RPAS have to be considered as new types of aircraft. Their regulation has to be established bearing in mind the risk of each operation.
- There is the need to develop European rules for the safe provision of drone services.

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[216] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council", cit., para. 5.4.1.

[217] Bulc V., "The Future of Flying. Conference on remotely piloted aircraft systems, Riga, 6 March 2015". Speech - 6 March 2015, http://ec.europa.eu/commission/2014-2019/bulc/announcements/future-flying-conference-remotely-piloted-aircraft-systems-riga-6-march-2015_en.

- The full integration of drones in the European airspace requires the development of technologies and standards.
- Public acceptance is essential to the development of drone services.
- Personal liability of the operator of the drone.

According to the first principle, it is important that the adoption of any regulation is informed to safety criteria. In the Declaration, it is stated that "[t]he provision of drone services must not be less safe than is accepted from civil aviation in general. The incremental integration of drones in the aviation system must not reduce the level of safety presently achieved in civil aviation. Although no-one is on board the drone, people in other aircraft or on the ground could get hurt in case of an accident or an unscheduled landing."

The second principle, regarding a timely intervention, is developed on two levels, namely the indication of the "organs" involved in the process of adopting the said regulation, the need to activate, and the method to be used. With regard to the first aspect, the aviation community considered that safety rules, including on remote pilot and operator qualifications, should be developed at the European level by the European Aviation Safety Agency, building on the experience developed at domestic level within European Union Member States, also based on the established cooperation with ICAO. In relation to the second aspect, it was stressed the urgency of providing a basic set of rules. In this context, the European Aviation Safety Agency should have started consultations with stakeholders by the middle of 2015 with a view to providing a proposal on a regulatory framework regarding the operations of RPAS and the risks associated to it. By the end of 2015, the Agency had to use the results of the consultation to propose a position on these matters. On the recommendations provided by the Agency, the European Commission had to present a proposal for the revision of the basic European Safety Regulation. Such proposal should provide for the progressive risk-based regulation of drones.

The crucial importance of developing and validating key missing technologies and the ensuing required standards is outlined in the abovementioned point three, where it is stressed the need for suitable investment in technologies that are a requisite to integrate drones into the aviation system.

The principle of public acceptance as a key to the growth of drone services refers, in the Riga Declaration, to the respect of citizens' fundamental rights, such as the right to privacy and the protection of personal data, which must be guaranteed. "Rules need to clarify what is acceptable and what is not, and they require to be properly enforced." Public acceptance of RPAS also involves issues regarding security risks. Therefore, it is essential that drones must be designed in order to eliminate such risks, employing devices such as cyber-defense or geofencing.[218] Nevertheless, a proper design or the adoption of operational restrictions cannot entirely impede the harmful use of drones and, in this context, it is important to involve the national police and justice systems, which by mandate have to address those risks.

This involves the legal liability of RPAS users. In the Declaration, the statements adopted are addressed to national authorities that should domestically implement any law in order to enforce responsibility. This assumes for RPAS to have an identifiable owner or operator. "The regulator should seek the least bureaucratic way to achieve this." Reference is made, being an example, to the fact that "the mandating of electronic identity chips on drones – "IDrones" – as is today envisaged in some states, could be formalized through a safety rule, which would contribute to the effective implementation of privacy and security requirements."[219]

Member States should establish and define the regulations regarding insurance and third-party liability, and monitor the functioning of the instruments devised to restore victims. In addition, they should establish financial support systems under law (compensation funds as those employed in the motor insurance sector) to provide compensation to victims that have been injured by RPAS operations.

6. Criteria to be Followed in the Definition of an European Standard and Challenges to be Confronted

The absence of harmonized regulations in the European Union, and of validated technologies, is the foremost impediment to open the RPAS market. The task is to work on a combination of new and existing regulatory actions at the European level, dealing with all relevant issues, including the insertion of safety (comprising airworthiness), security, and privacy and data protection requirements within existing EU rules in these areas. These challenges must be undertaken, and the suitable instruments therefore adopted as a pre-requisite in order for RPAS to be operated on any safe scale in civilian surroundings. Each of these challenges, even if briefly dealt with, has to be taken into account separately.

The European Aviation Safety Agency is the most appropriate authority to develop a

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[218] Geofencing is used to create a virtual perimeter around a geographic area, so that if the vehicle leaves the designated area an alarm is triggered, or some other event happens. For RPAS it is a valid technology, because if the drone goes beyond its virtual boundaries authorities will be informed, or maybe an installed software could pass the control of the drone directly to the authorities' control station.

[219] Riga Declaration on Remotely Piloted Aircraft (drones). Framing the Future of Aviation, Riga, 6 March 2015, para. 5.

common European regulation, resorting to its established consultation process. Such rules must be compatible with ICAO standards. In this context, EASA will cooperate with JARUS, which has created a forum where Member States and international organisations can create a consensus on the rules to be adopted. EASA will also cooperate with EUROCAE, the European Organisation for Civil Aviation Equipment which develops standards.

Safety is one of the principal objectives of the European Union aviation policy, and a criteria to be followed in the definition and adoption of an appropriate regulatory framework. In this context, regulations regarding airworthiness are one of the aspects of safety regulations in the aviation industry, and therefore, provisions to reduce risks are envisaged.

Furthermore, I must again bring the attention to the fact, often pointed out by the industry stakeholders, that the expansion of the European RPAS market is hindered by the corresponding regulatory system consisting of fragmented rules for ad hoc operational authorizations which, of course, in turn constitutes an administrative block. Besides, authorizations issued at national level by the competent authorities do not benefit from mutual recognition and, as a consequence, such authorizations do not permit to produce or to operate RPAS within Europe. On the contrary, in this context, an European system of mutual recognition for certificates or licences should be established for RPAS manufacturers, operators, and other organisations.

Another requisite to be considered in drafting common rules regards the issue of security as RPAS are not immune to potential unlawful actions. As recognized by the European Commission, "[p]otentially, RPAS could be used as weapons, the navigation or communication system signals of other RPAS could be jammed or ground control stations hijacked."[220]

In general, the protection from cyber-attacks of the command and control links of RPAS put a particular challenge. In fact, with this respect, it has been found that "[u]sing the systems in combat situations — or even in certain non-military situations, such as agricultural pest control — will require that security standards be adapted, notably when commanding and controlling the payload. Operating aerial vehicles beyond the line-of-sight (BLOS) — which will become standard for long-endurance RPAS — will also place burdens on data transmission (capacity, global availability and reliability), which depend

[220] EU Doc. COM(2014) 207 final, "Opinion of the European Economic and Social Committee on the communication from the Commission to the European Parliament and the Council", cit., para. 3.3.

on satellites and other modes of transmission."[221]

At the Wales Summit in September 2014, NATO acknowledged that cyber-attacks "can threaten national and Euro-Atlantic prosperity, security, and stability", "will continue to become more common, sophisticated, and potentially damaging", and that "the impact of cyber-attacks could be as harmful to modern societies as a conventional attack".[222]

There are several motivations to conduct cyber-attacks, such as to steal money, to run industrial intelligence, or to use the information collected for political and military objective. A contemporary study defines cybercrime as "a growth industry, where returns are great, and the risks are low".[223]

Amongst the different kinds of cyber-attacks, those targeting critical infrastructure, such as energy, communications, logistics, financial institutions and governance, are appraised to be the most destructive and detrimental. Attacking these infrastructures might also only be the initial phase of a broader plan which, after having neutralized infrastructure and created disorder, involves attack to the country.

There are different cyber-attackers, such as individual hackers or even organized crime groups and States. The latter can also operate by mean of individuals and groups so that they can perform on their behalf and remain disguised.

Other than difficulties regarding the drafting of a suitable regulation, this matter involves practical issues as well to avoid unlawful interference, so that manufacturers and operators can take the appropriate security mitigating measures. In fact, it has to be taken into account that the management of 4D trajectories in the future air traffic management system, and the remote control, and the major amount of aircraft, necessarily imply the communication and sharing of information in real time by different aviation operators in order to optimize the performance of the system. Accordingly "[a]ddressing security vulnerabilities in information and communication are therefore essential elements of the ATM Master Plan, of which RPAS will become an integral part. The identified security requirements will then need to be translated into legal obligations for all relevant players, such as the air navigation service provider, RPAS operator or telecom service provider,

[221] Karock U., "Drones: Engaging in debate and accountability", Directorate-General for External Policies, http://www.europarl.europa.eu/meetdocs/2014_2019/documents/sede/dv/sede210915policyinsightdrones_/sede210915policyinsightdrones_en.pdf, pg. 3.

[222] NATO, 'Wales Summit Declaration', Press Release, 5 September 2014.

[223] Intel Security, "Net Losses - Estimation the Global Cost of Cybercrime, Economic Impact of Cybercrime II", Santa Clara, California, June 2014, pg. 2.

under the oversight of the competent authorities."[224]

The responsibility to protect from cyber-attacks lies with the States themselves. Cyber capabilities and protection differ amongst European Union Member States. The United Kingdom, Germany, and France, that are the most powerful and largest countries, and Netherlands, as a medium-sized country, invest more than other nations in cyber capabilities. This has to be appreciated since investments in cybersecurity are not straightforward and well-conceived, due to the immaterial and abstract nature of such investments.

"Updated intelligence legislation that enables early warning and also cross-border acquisition of information is essential. The authorities should know what to do when a cyber-attack occurs, just as they know what to do when a country is attacked via land, sea or sky."[225]

Some European Union countries have adopted a protective legislation, despite not all Member States have national cybersecurity strategies. Nevertheless, this is not entirely archetypal because, for instance, in Sweden, even though there is no cybersecurity strategy, the kind of cyber control adopted is evaluated as efficacious and this is managed by the Försvarets radioanstalt (National Defense Radio Establishment) which operates under the control of the Ministry of Defense, following Internet activity and gathering intelligence for the Swedish government.[226]

Other than security issues, the opening of the aviation market to RPAS would need an evaluation of the measures that are necessary to ensure the respect for fundamental rights, and the data protection and privacy requirements. As it has been said, this includes the respect for the right to private and family life, and the protection of personal data. The acknowledged risks come from the operation of civil RPAS applications because the collection of personal data raises privacy, ethical or data protection issues, especially with regard to the area of surveillance, monitoring, mapping or video recording.

Any processing of personal data must be based on a legitimate ground. Consequently, RPAS operators would need to comply with the applicable data protection provisions, remarkably those domestically adopted by Member States pursuant to the Data Protection

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[224] EU Doc. COM/2014/0207 final, "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", cit., pg. 7.

[225] Hopia H., "Dawn of the Drones. Europe's Security Response to the Cyber Age", Wilfried Martens Centre for European Studies, 2015, pg. 38.

[226] Hopia H., "Dawn of the Drones. Europe's Security Response to the Cyber Age", cit., pg. 38.

Directive 95/46/EC[227] and the Framework Decision 2008/977[228]. In this context, it is of relevant importance to assess how to make RPAS applications compliant with data protection rules. The same legislation and political control may diminish the risk of abusing the information gathered. For instance, to reach the scope, guidelines and regulations regarding the use by law enforcement authorities of the information gathered by RPAS need to be clearly defined. It would also be advisable "to consult experts and relevant stakeholders; to address the measures in their field of competence, possibly including awareness raising actions, to protect fundamental rights, and to promote measures under national competence".[229]

Last but not least challenge that must be taken into account when defining European standards and regulations on RPAS, is that regarding liability and insurance aspects, even with the highest safety standards, accidents may occur, and in these cases, victims must be restored for any injury or damage.

In brief, it is of paramount importance to ensure that new technologies and RPAS services can develop in full respect of the required high levels of safety, security, and privacy protection.

7. The Italian Regulation on RPAS

Since ICAO standards require that States authorize RPASs in order for them to be able to fly (as it has been seen in Article 31 of the Convention on International Civil Aviation)[230], certification is a necessary preliminary level that should be taken into account in order to allow the European aviation industry to be competitive at universal level. Italy has been one of the first countries which has adopted a regulation on RPAS, including commercial use thereof.

Specifically, the use of RPAS is set in Article 743 of the Italian Navigation Code, as amended by the Legislative Decree no. 96 dated as of 9 May 2005. In particular, Article 743 states that "[a]ircraft shall mean any machine designed for the transportation by air of persons or property. Remotely piloted aerial vehicles are also considered aircraft, as

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[227] EU Doc. 95/46/EC, "Directive on the protection of individuals with regard to the processing of personal data and on the free movement of such data", 23 November 1995.

[228] EU Doc. 2008/977/JHA, "Council Framework Decision on the protection of personal data processed in the framework of police and judicial cooperation in criminal matters", 27 November 2008.

[229] This is one of the Action undertaken by the European Commission, as stated in the "Communication from the Commission to the European Parliament and the Council", Action 4.

[230] Article 31 of Certificates of the Convention on International Civil Aviation, regarding airworthiness, states that "[e]very aircraft engaged in international navigation shall be provided with a certificate of airworthiness issued or rendered valid by the State in which it is registered."

defined by special laws, ENAC regulations and, for the military, by decrees of the Ministry of Defense. The distinctions of the aircraft, according to their technical specifications and use shall be established by ENAC with its regulations and, in any case, by special legislation in this field".

ENAC, the Italian Civil Aviation Authority, has published the said Regulation providing the general conditions that apply to unmanned aircraft systems, falling under its jurisdiction, that are operated for commercial purposes in Italy. Specifically, the second edition of the Regulation, adopted on 16 July 2015, regulates the private use of remotely piloted aerial vehicles (RPAS), and was amended on 21 December 2015.

The Regulation is the first step adopted in this matter and is aimed at ensuring, at least in our country, legal certainty in an emerging area. The act is informed to important principles and criteria, such as safety, the obligation to restore any caused damage, and privacy protection.

RPAS falling under the jurisdiction of ENAC in the Italian system are the so-called "*Sistemi di Aeromobili a Pilotaggio Remoto*", namely unmanned aircraft systems having two distinctive elements, that is to say: (i) a take-off weight lower than 150kg; and (ii) they are flown by a remotely based pilot. The text specifically provides that "[p]ursuant to the Regulation of the European Parliament and of the Council (EC) No 216/2008, RPAS of maximum take-off mass not exceeding 150 kg and those designed or modified for research, experimental or scientific purposes are under ENAC responsibility."[231] It is important to note the reference made to European Union legislation, to understand the relevance of the rules established at regional level.

The use of the RPAS requires ad hoc authorizations that must be issued by ENAC. For the purposes of the authorization procedure, two categories of RPAS are distinguished, namely that of "light drones" (with a takeoff weight lower than 25kg) to which a first and more flexible set of rules is applicable, and "heavy drones" (with a takeoff weight higher than 25 kg) where stricter rules are applicable.

It follows that the Regulation provides for two different levels of authorizations, which vary according to the weight of the RPAS, and to its actual use.

Under certain conditions, the operation of RPAS with a takeoff weight lower than 25kg, in case of non-critical specialized operations (for instance those which do not involve over flights congested areas or restricted areas), is based on a simple self-certification

[231] ENAC, second edition of the Regulation "Mezzi Aerei a Pilotaggio Remoto", Article 2, para. 2.

(containing the statements which declare that the system complies with the Regulation), submitted to ENAC along with a supporting documentation. After having verified that the information contained in the filed documents satisfies the requirements prescribed by the regulation, ENAC may deliver the said authorization.[232]

Besides, specified operations of light RPAS characterized by a high level of risk, namely in case of critical specialized operations, other than any operation of heavy RPAS, entail a formal certification delivered by ENAC, resulting from a technical review of the drone. With regard to this procedure, some clarifications are required. First, critical flying operation indicates those operations which are carried out in "congested areas", i.e. those "residential, industrial, commercial, sporting areas or settlements and, in general, areas where gatherings, even temporary, of people are possible".[233] In such cases, the authorization procedure includes the carrying out of investigations by ENAC, which has to ascertain the system's capability to safely carry out the activities concerned (Article 11). Secondly, in relation to systems with aircraft of maximum take-off mass more than or equal to 25 kg, both a certificate for the aircraft and an authorization for the air operator shall be required, regardless of whether the flying operations are critical. Furthermore, the Regulation provides for the registration of the RPAS in the Remote Piloted Aircraft Register to be assigned specific registration marks that must be affixed on the ground control station, together with an identification plate to be attached to the RPAS and to the ground station (Article 8).

Also, together with the possession of appropriate authorization issued by ENAC, "in case of specialised operations carried out for third parties, an agreement must be signed between the RPAS operator and the client, by which the parties define their respective responsibilities and agree on the suitability of RPAS for the planned operation and any relevant limitation" (Article 7). The relevance of this rule lies in the fact it obliges the operator and the client to define the terms of their agreement, clearly stating the activities they will respectively carry out and the purpose followed, in this way identifying appropriate individual responsibilities and objectives.

Furthermore, the Regulation requires a pilot license to fly RPAS, issued at the completion of a specific training course, officially recognized by ENAC. Only these pilots are allowed

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[232] Legance Avvocati Associati, "DRONES: A NEW REGULATION BY THE ITALIAN CIVIL AVIATION AUTHORITY", Newsletter, April 2014, http://www.legance.it/00651/DOCS/n-ENG_Apr_2014.pdf.

[233] ENAC, second edition of the Regulation "Mezzi Aerei a Pilotaggio Remoto", Article 5, Definition of Congested Areas.

to operate such aircraft. In addition, since the operation of an aircraft has to be in compliance with the flight rules, it is assumed that the pilot is aware of the Rules of the Air contained in an ENAC's Regulation (Regole dell'Aria, dated 23 April 2012) that, accordingly, provides the rules of conduct at airports and on board of the aircraft applicable to aircraft registered in Italy.

The Regulation also covers the issue of insurance and the obligation to cover any damage caused by the use of RPAS, provided that insurance is mandatory, regardless of the maximum take-off mass of the aircraft used. In this respect, Article 32 of the Regulation establishes that "SAPR cannot be operated without valid, adequate third party insurance, not less than the minimum insurance coverage of the table in Article 7 of Regulation (EC) no. 785/2004".

Finally, it is worth noting that the Regulation rules on data protection and privacy, refers to our Data Protection Code. Article 34 provides that "[w]here the operations carried out by a RPAS could lead to the treatment of personal data, this fact must be referred in the documentation submitted for the granting of the relevant authorization. 2. Personal data must be processed in respect of Decree 30 June 2003 No 196, as amended (data protection code), particularly with regard to the use of modalities that allow for a person to be identified only in case of necessity, pursuant to Art. 3 of the Code, as well as in accordance with the measures and precautions to safeguard people concerned as prescribed by the Authority in charge of the protection of personal data."

The Italian Data Protection Authority has not yet adopted any decision regarding the infringement of the Italian Data Protection Code. However, the fast-growing drone industry and the widespread use of RPAS is expected to raise and increase privacy concerns and, therefore, complaints to the competent Authority.

CHAPTER IV

INSURANCE AND LIABILITY ISSUES

A fundamental condition for the expansion of the civil RPAS market is that these air vehicles present the same safety requirements as manned aircraft. The statistics acquired until today are very limited, if compared with the information we have about manned airplanes, but show us that insofar these safety requisites are respected by RPAS.

However, accidents may occur, and victims must be adequately compensated for any damage caused by RPAS flights. This, not only means the need for an easy identification of the responsible towards the victims, but also that the liable party must be able to pay the indemnity. To achieve this result, we need a clear legislation assuring a fair liability regime, and a mandatory insurance, granting the same standards, if not higher, than we currently have regarding manned aircraft.

A compulsory insurance regime, although it will raise the costs, will not restrain the expansion and development of the RPAS market, instead being one of the bases for its final explosion. The exigency for an adequate third-party liability regime is present not only for the need of compensating victims, but also for earning people’s acceptance of RPAS. For this reason, without the regulations, the RPAS market is still at a halt, and won’t be able to grow in the civil market.

1. Liability

Liability is “the state of being legally responsible for something”.[234] A first distinction we must make in liability regimes is the difference between a strict liability regime and a fault-based liability regime. While, for the first, the party is liable with no need to prove its fault or negligence, in the latter regime the victim needs the proof of some kind of negligence, and the liable party may avoid paying compensation if it proves the event was not its fault. However, for both regimes, some countries have limited liability, signifying the attainable reparation is not unlimited, restricting the obtainable indemnity for the victims.

Currently, there is no common international liability regulation for the aviation industry. Although some international regulations exist, such as the Rome Convention, their

[234] Merriam Webster, “Simple Definition of liability”, http://www.merriam-webster.com/dictionary/liability.

international effects are limited since they are only ratified by few states. For this reason, national law primarily regulates aircraft liability. Not only in the world, but also in Europe, there is no uniformity in aviation liability regimes, which each state is free to decide autonomously.

1.1.European Liability regulations

Looking at European member states, we can see how most of them have strict liability regimes for ground damage, although some countries, like the Netherlands, have fault-based regimes. Another difference can be found in the legal basis for the liability regimes. In member states such as France, Czech Republic, or Romania, aviation liability is defined by the Civil Code, while in others, such as Germany, Denmark and the United Kingdom, we find the liability definition in an Aviation Act. In Italy, the liability basis for the aircraft industry is in the Italian Navigation Law, which in December 2013 was extended to RPAS. Additionally, there is no uniformity even in the liability limits. Countries such as Denmark, United Kingdom, France and Romania have unlimited liability regimes, while in Italy, and Germany liability is limited, except where the operator is found to be negligent.

Strict liability regimes are in some cases combined with fault-based regimes, depending on circumstances. In the United Kingdom for example, surface damages are subject to a strict liability rule, while to accidents occurred in the air applies a fault-based rule.

1.2. Strict liability regime versus Fault-based liability regime

Victims claiming compensation after an accident will find the process easier under a strict liability regime, rather than on a fault-based one. The main advantage of the strict liability rule over the fault-based one is that the claimants will only need to prove the damage, and there won't be the necessity of establishing the faults. Establishing the faults after aviation accidents is a complex, and lengthy operation, thus removing the need of establishing faults for the claimants will grant them a faster compensation.

In strict liability regimes, the law identifies the liable party, which is usually the operator, and victims will have the right to ask the liable party for compensation. However, this principle does not preclude the damaged parties from making claims against others, such as the producer, if the product was defective. The European Product Liability Directive EC No. 34/1999 establishes that manufacturers and importers of RPAS are liable without faults every time a defective product causes damage.

In fault-based regimes, responsibility must be verified before proceeding for any compensation. Since the ascertainment of responsibilities is a long and complicated

process, victims will probably have to wait a long time before attaining any compensation.
To conclude the analysis, a strict liability regime is preferable for the victims, which see their requests satisfied within a reasonable amount of time, instead of having to wait the responsibility assessment. However, this regime may result irrational for operators, which will have to pay for damage even when they are not at fault, obliging them to indemnify the victims in advance, and then hoping to get the money back from the responsible party.

1.3.Identification of the liable party

To obtain compensation, even in the strict liability regime, we must first identify the liable party. Therefore, if the law obliges the operator to compensate the victim, a definition of the term is very important, especially for RPAS, because of the major complexity that characterizes the sector.
Where registration or license is needed for RPAS operations, determining the operator is very easy, since the person or entity on the permit will be indicated as the operator. The "operator" notion is usually well defined in the regulatory context, like in the EASA Basic Regulation No. 216/2008. The Rome Convention of 1952 defines the operator as "the person who was making use of the aircraft at the time the damage was caused, provided that if control of the navigation of the aircraft was retained by the person from whom the right to make use of the aircraft was derived, whether directly or indirectly, that person shall be considered the operator". Nevertheless, the term "operator", in some states, may be differently evaluated by the courts, according to whether there is a civil or common law system.
In addition to any regulatory problems in identifying the liable party, RPAS present another complication, as there is the possibility of accidents where the operator cannot easily be found. Let us imagine the case of an operator losing control over its drone, which flies away from its view, and crashes into a car. At this point, depending on the honesty of the operator, the owner of the car will discover who caused the damage, or will suffer the crash without any compensation. If RPAS will not have any physical information permitting the identification of the operator, or at least the owner, directly on the drone, many compensations will be avoided. If we think about it, it is the same reason why cars have registration plates. Member states like Czech Republic, France, Italy, Netherlands, and Sweden, have already made fitting a fire-proof ID plate on drones a compulsory requirement, and the following conduct should be followed by the other states, or made obligatory by the European Commission. I also believe that, although model aircrafts are used for a ludic scope, it would be a good idea to extend the provision to these planes as

well, maybe fixing a minimum weight for the application of the duty.

1.4.Harmonization of liability regimes

As we have seen until now, aviation liability regimes around the world are based on different principles, being the cause of legal complications for operators and insurers in the sector. RPAS liability regimes are similar to manned aviation regulations, because RPAS are considered aircraft, and national laws of many States do not make a distinction between aircraft with a pilot onboard and aircraft without. Confirmation of the need to not make this separation comes from the International Civil Aviation Organization, which in its Circular 328-AN/190 states: “whether the aircraft is manned or unmanned does not affect its status as an aircraft.”[235]

It is since the Warsaw conference in 1929 that attempts for a uniform aircraft liability regime are put in place, though with poor performance. On the 29th of May 1933 we had the Rome Convention for the unification of rules relating to damage caused by aircraft to third parties on the surface. This Convention never became effective, and was replaced on 7 October 1952 by a new Rome Convention on “Damage Caused by Foreign Aircraft to Third Parties on the Surface”. Then, attempting a modernization of the liability limits, the Convention was revised in 1978 by the Montreal Protocol.

Only forty-nine States have ratified the Rome Convention, and this shows us the absence of a worldwide, harmonized regime, when we think it is the most important international treaty on third-part liability. It is also relevant to notice the absence of some main aviation jurisdictions, such as Australia[236], Canada[237], China, Japan, USA, and of many European States, like Germany or Austria.[238]

For the future, the importance of the Rome Convention relies in the fact it might be a base

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[235] Circular 328 AN/190, International Civil Organization, https://www.trafikstyrelsen.dk/~/media/Dokumenter/05%20Luftfart/Forum/UAS%20-%20droner/ICAO%20Circular%20328%20Unmanned%20Aircraft%20Systems%20UAS.ashx.

[236] “Canada signed the Convention on 26 May 1954 and ratified it on 16 January 1956. On 29 June 1976, a notification of denunciation of the Convention by the Government of Canada was received by the International Civil Aviation Organization, which took effect on 29 December 1976.” Notes from the ICAO “CONVENTION ON DAMAGE CAUSED BY FOREIGN AIRCRAFT TO THIRD PARTIES ON THE SURFACE SIGNED AT ROME ON 7 OCTOBER 1952”.

[237] “Australia signed the Convention on 20 October 1953 and ratified it on 10 November 1958. On 8 May 2000, a notification of denunciation of the Convention by the Government of Australia was received by the International Civil Aviation Organization, which took effect on 8 November 2000.” Notes from the ICAO “CONVENTION ON DAMAGE CAUSED BY FOREIGN AIRCRAFT TO THIRD PARTIES ON THE SURFACE SIGNED AT ROME ON 7 OCTOBER 1952”.

[238] International Civil Aviation Organization, “CONVENTION ON DAMAGE CAUSED BY FOREIGN AIRCRAFT TO THIRD PARTIES ON THE SURFACE SIGNED AT ROME ON 7 OCTOBER 1952”, http://www.icao.int/secretariat/legal/List%20of%20Parties/Rome1952_EN.pdf.

for an, at the moment improbable, harmonization of third party liability regimes. While analyzing the key provisions of the Convention, we must keep in mind it only applies where an aircraft, registered in one of the contracting states, causes damage in another contracting state, thus excluding national operations.

Article 1 shows us the Convention is based on a strict liability regime, where it says: "Any person who suffers damage on the surface shall, upon proof only that the damage was caused by an aircraft in flight or by any person or thing falling therefrom, be entitled to compensation as provided by this Convention". This indicates us that any person on the ground, who suffers damage from an aircraft accident, only needs to prove the casual connection between the damage and the plane, without having to demonstrate any faults.

Article 2 of the Rome Convention, as we have seen above, defines "the term "operator"". The "operator" is the liable party, thus permitting the application of the strict liability regime.

Article 11 worries about the liability limits, imposing different limits "for damage giving a right to compensation", based on the mass of the aircraft. What concerns is the minimum weight compensation limit of "500 000 francs[239] for aircraft weighing 1000 kilogrammes or less". The limit, which until today was sufficient for manned aircraft, could be too low for RPAS, although only the future can really tell us. This consideration springs to mind if we look at the difference between these two kinds of aircrafts. Aircrafts weighing less than 1000 kg are usually operated away from densely populated areas, are not numerous, and have been given these benefits by balancing the possible damages with the raise of insurance costs for the users. RPAS instead, will often be used to fly over cities or events, drastically raising both damage probabilities, and amounts. Furthermore, most RPAS weigh less than 1000 kg, thus liability limits based on weight should be revisited for RPAS. However, Article 12 states: "If the person who suffers damage proves that it was caused by a deliberate act or omission of the operator, his servants or agents, done with intent to cause damage, the liability of the operator shall be unlimited". The Article justly removes the liability limits listed by Article 11 when the act or omission of the operator, is done intentionally.

Finally, after the September 11th attacks in 2001, ICAO revisited the Rome Convention producing two independent, new Conventions, namely the Unlawful Interference

[239] "The sums mentioned in francs in this Article refer to a currency unit consisting of 65 ½ milligrammes of gold of millesimal fineness 900.", Article 11 subparagraph 4, ICAO "CONVENTION ON DAMAGE CAUSED BY FOREIGN AIRCRAFT TO THIRD PARTIES ON THE SURFACE SIGNED AT ROME ON 7 OCTOBER 1952".

Convention, and the General Risks Convention. However, the Conventions never came into force due to a lack of international support.

With a clear view over the liability regimes for RPAS, we can say there is no common legislation, not even in the European Union, for third party liability. Of course, a harmonized legislation would have the advantage of legal certainty, encouraging foreign operations, reducing insurance costs, and giving major security to the victims. In spite of the certainty advantage deriving from harmonization, we still are without an internationally accepted regulation. The reasons for this situation can be found in the different national liability regimes, which, being based on diverse principles, make it difficult for the nations to find a commonly accepted regime.

Suggesting the need for a common third party liability regime in the present international situation where, after nearly a century of attempts in the manned aviation sector, we have no harmonized regime, would really mean believing in a miracle. Achieving the needed agreements between states for the RPAS sector, as has been for the manned aviation sector, is likely to be very hard. Hence, imagining a day in which the goal of the third party liability regime harmonization is going to be reached, it is mostly probable to obtain a common regime for both manned and unmanned aircraft, rather than only for RPAS.

2. Insurance Requirements

After the law has provided the victims with the adequate legal tools to determine the person or entity responsible for damage, the damaged party would remain scarcely protected if the liable party did not have the satisfactory financial strength to pay for compensation. This is why, without mandatory insurance requirements, a perfectly created third party liability regime could sometimes result useless. Imagining a future world, with millions of RPAS flying through the skies, it would be hard to accept that after an accident where we lose our home or a dear relative, and after establishing the responsible party, we were left with little or no compensation because of a lack in insurance requirements. The development of the RPAS industry could suffer the absence of adequate minimum insurance requirements, as the reduced costs for the industry, deriving from the cut on insurance policies, would be counterbalanced by a missed gain of the citizens’ trust, greatly slowing down the markets’ growth.

2.1. European Community Regulation 785/2004

EC Regulation 785/2004 establishes “minimum insurance requirements for air carriers and aircraft operators in respect of passengers, baggage, cargo and third parties"[240] in the European Union. Article 2 also says, "This Regulation shall apply to all air carriers and to all aircraft operators flying within, into, out of, or over the territory of a Member State to which the Treaty applies". This regulation, although it wasn't designed thinking about RPAS, applies to all aircraft, both manned and unmanned, since even here no distinction is made, and the ICAO recognition of RPAS as aircraft is followed.

None of the Member States has adopted their own aviation insurance requirements, but since 785/2004 is a Regulation, it applies directly to all the Member States without need of a transposition into national law. Therefore, EC regulation 785/2004 is the only reference point for RPAS insurance requirements throughout Europe. It might be strange to notice the contrast in the harmonization level of rules having the same scope. While there is no aviation third party liability common rule in Europe, after the responsibility is differently ascertained according to the country where the accident occurs, there is then an only regulation establishing minimum aviation insurance requirements for all Member States. The reason for this diversity could be, as indicated previously, a divergence in the national principles utilized for determining the liable party. Instead, a common regime for minimum insurance requirements has been obtained because of a minor distance between Member State positions.

Article 2 of the Regulation, after saying the regulation applies to all air carriers and all aircraft operators, tells us the "Regulation shall not apply to:" "State aircraft", "model aircraft with an MTOM[241] of less than 20 kg", "foot-launched flying machines (including powered paragliders and hang gliders)", "captive balloons", "kites", and "parachutes (including parascending parachutes)". These exemptions are important because a mandatory insurance requirement for every activity would mean a raise in costs for the citizens, and it is best to exclude it where unnecessary. Nonetheless, as we will see further on, for model aircraft with an MTOM of less than 20 kg the exclusion could be questionable in relation to RPAS.

Article 4 defines the "Principles of insurance", for "Air carriers and aircraft operators", which "shall be insured in accordance with this Regulation as regards their aviation-

[240] Article 1 subparagraph 1, 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.

[241] “"MTOM" means the Maximum Take Off Mass, which corresponds to a certified amount specific to all aircraft types, as stated in the certificate of airworthiness of the aircraft", Article 3 Definitions, 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.

specific liability in respect of passengers, baggage, cargo and third parties". The Regulation worries about a complete coverage for the damaged parties as it carries on saying "The insured risks shall include acts of war, terrorism, hijacking, acts of sabotage, unlawful seizure of aircraft and civil commotion." In addition, "aircraft operators shall ensure that insurance cover exists for each and every flight", regardless of how and by who the flight is operated. Article 4(3) also prevents any legal problem arising from the application of the Regulation by saying "this Regulation is without prejudice to the rules on liability as arising from: international Conventions to which the Member States and/or the Community are parties, Community law, and national law of the Member States." This means the Regulation is not changing liability rules arising from international conventions or national laws, so that if there were a third party liability contrast between these and the Regulation, the first would prevail.

2.1.1 Maximum take-off mass bands as a basis for minimum insurance requirements

Articles 6 and 7 define minimum insurance requirements in respect of liability for passengers, baggage, cargo and third parties.

Examining the regulation, looking at RPAS minimum insurance requirements, what really interests us is Article 7 which, "in respect of liability for third parties", sets different minimum insurance covers according to the aircraft maximum take-off mass. The insurance requirements range from a minimum of 0,75 million SDRs[242] for aircraft with an MTOM lower than 500 kg, to 700 million SDRs for aircraft with an MTOM of 500 000 kg or more. Regulation 785/2004 applies to RPAS, but most drones would fall under the lowest band, with very few RPAS having to respect the requirements fixed for the other bands. Specifically, the requirements of the two lowest bands are:

- MTOM below 500 kg: the minimum insurance requirement is of 0,75 million SDRs, equivalent to €957 070,00 in January 2016.
- MTOM between 500 and 1 000 kg: the minimum insurance requirement is of 1,5 million SDRs, equivalent to €1 914 140,00 in January 2016.

[242] ""SDR" means a Special Drawing Right as defined by the International Monetary Fund", Article 3 Definitions, 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. 1 SDR = 1.2760945 Euro at 22 January 2016.

The use of MTOM bands for the definition of minimum insurance requirements is surely a good base, though it could result inadequate because it does not take into consideration the nature of RPAS operations. The possible damages, originating from a crash, vary hugely according to the area the drone is overflying, its kinetic energy, building materials, operator training, the presence of a parachute or automatic landing procedures, and many other characteristics, which cannot only be estimated with mass bands. The concept to highlight here is the difference between a typical level of damage based on MTOM, and a typical level of damage based not only on MTOM, but also on some of the previously mentioned characteristics of the flight. Let's start the reasoning by accepting that, averagely, €957 070,00 are enough to repay damage caused by a RPAS accident with a drone weighing less than 500 kg. After this, let us imagine two completely different scenarios. First, we take into consideration a 500 kg RPAS flying over the countryside to map the area, and intuitively we can say the average level of damage caused by a crash will be low. Then, let us imagine a 100 kg RPAS flying over a densely populated area, taking photographs of the crowd at a concert. If the second RPAS, with a mass of only a fifth of the RPAS in the first operation, were to fall on the crowd, probably €957 070,00 would not be enough. Currently, the minimum insurance requirements are based on mass bands, but implementing some additional factors would make the regulation more effective.

As we have seen, the damage caused by RPAS accidents derives from a large number of factors and circumstances, which will differ every time. The issue here is that it is not possible to accurately list all these factors under the law, because we would create a regulation that would be too complex to both follow and enforce. The choice made by the European Union, until today, is a choice of simplicity, so to maintain an easily understandable regulation that will not create interpretation problems. This however, will inevitably create some situations where the insurance requirements will not be sufficient to cover the damage caused by RPAS. Nonetheless, low minimum insurance requirements do not prevent insurers from adequately assessing the risk, and proposing their clients higher liability covers.

On the other hand, after indicating a substantial difference in the operating profile of RPAS, compared to manned aviation, we must recognize there are no real differences between the factors causing the damage level of RPAS, and of aviation with onboard pilot. In fact, the damage caused by an accident will always depend on the area overflown, pilot training, kinetic energy, the presence of emergency landing procedures and other characteristics, which are similar for both sectors. The main concern related to RPAS, which could cause implementation of additional requirements, is the major amount of operations conducted over densely populated areas, although the same situation already happens today for manned aviation, where flights approaching city airports fly over the city before landing.

In order to evaluate if the minimum insurance requirements for third party liability based on the MTOM bands of Regulation 785/2004 are enough, we must commensurate them with the damage that may derive from an RPAS accident. Unfortunately, since we are only at the birth of the RPAS civil market, there is no data on which to base estimations, making it very difficult to develop reliable RPAS risk profiles.

2.2. International comparison on RPAS insurance requirements

The European Community, in relation to RPAS third party liability cover, has one of the most advanced laws we have up to date. Many nations are still regulating RPAS operations, and are far away from establishing minimum insurance requirements. To make a comparison with other nations, which already have advanced RPAS regulations, I will take into account Australia and the USA.

RPAS operations in Australia are regulated by part 101 of Civil Aviation Safety Regulations (CASR) 1998, which took effect in 2002. The Australian law prescribes all the rules for the use of unmanned aerial vehicles, even taking into consideration model aircraft. It sets high security standards, requiring pilots to have a Controllers Certificate, and precisely lists all the necessary certifications. However, these Regulations do not mention any insurance requirements for RPAS. The Australian Civil Aviation Safety Authority recommends operators to obtain third-party liability insurance, and most operators subscribe for insurance, although it is legal to fly without it. Additionally, for commercial operators, the request for insurance often comes from customers, which are unwilling to pay for operations without an appropriate insurance policy.

In the United States, the Federal Aviation Administration and the Department of Transportation develop regulations, policies, and procedures for aviation operations. Even here, RPAS regulations assuring safety through all the mandatory certifications have been created, and are constantly being updated for a market that is still growing. Nonetheless, until now there has been an almost complete silence by the FAA in regard of minimum insurance requirements. An important difference, which we must take into consideration, is that the USA never created a federal requirement for general aviation aircraft to have insurance, except in case of interstate operations. For this reason, RPAS regulations are following the current lack of insurance requirements related to manned aircraft, where federal insurance requirements do not exist, and some states create their own mandatory insurance regulations[243]. This failure could represent a serious obstacle for the RPAS market, which would lose the trust of the American citizens suffering losses without being able to recover from the parties causing the injury.

3. Uninsured RPAS operations

RPAS operations conducted in the European Union require authorization from the responsible authorities. During the authorization process authorities must verify that the operator has an adequate third-party liability insurance certificate. Although insurance cover is a necessary requisite for legally operating RPAS in the European Union, there is the risk of uninsured RPAS operations.

Uninsured RPAS employment may happen for many reasons:

- RPAS operations conducted without acquiring the necessary authorizations, or beyond the rules stated in the authorization;
- RPAS employment where authorizations have never even been requested by the operators or the owners;
- Operations with the necessary authorizations, and an adequate third-party insurance liability cover, but where RPAS are used outside the limits imposed by the insurers, making the insurance void;
- Operations with both insured or uninsured RPAS, where after the incident identification of the operator results impossible.

Hence, there will be cases where, because of uninsured RPAS operations, some victims will not be able to receive satisfactory compensation. Until today, due to the limited amount of drones flying in the skies, this is not a real issue, but it will become a big problem with the expansion of the market.

To solve this issue, we can take example from other sectors, such as the motor vehicle sector, where compensation funds ensure that victims of accidents from uninsured drivers are adequately compensated. To obtain the compensation funds, following the system that is already applied in other fields, a small percentage of the insurance fees could be endowed to the fund. This would protect the citizens from the risk of uninsured operations by at least granting them some reparation for the damage.

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[243] Sanger L., “Mandatory Aviation Insurance: A Domestic and International Perspective”, Slack & Davis L.L.P., https://www.slackdavis.com/wp-content/uploads/2009/05/mandatory_aviation_insurance08.pdf.

Establishing a compensation fund for the RPAS sector is an interesting idea, but the current stage of the RPAS industry poses an issue. A compensation fund needs to be affordable, efficient, transparent and minimal. Establishing a levy on RPAS insurance products, in a market with few operators, does not consent a distribution of the fund payments, becoming a burden for the RPAS industry. Not only could the fund become a burden, but always because of the limited amount of contributors to the fund it would exist without a solid financial support, and might fail its scope. For this reason, the European Commission will have to make an evaluation, trying to balance the necessity of protecting the victims with the chance of slowing down a sector that has a great potential.

4. Model Aircraft

RPAS, differently from manned aircraft, come in all weights and shapes, sometimes falling under the definition of model aircraft. Model aircraft incidents have never been an issue until now, since aviation enthusiasts usually fly them over fields, and far away from people that might be injured. The situation is about to change, because small RPAS will be numerous, and will probably be used even above densely populated areas.

ICAO Circular 328-AN/190 gives us the only current international definition of model aircraft, stating that "model aircraft, generally recognized as intended for recreational purposes only, fall outside the provisions of the Chicago Convention, being exclusively the subject of relevant national regulations".[244] Inside the European Union instead, the RPAS Roadmap 2013, which mainly represents the views of the RPAS industry, says that "model aircraft used in VLOS[245] exclusively for recreational purposes, and 'flying' toys, should not be considered RPAS".[246]

As we have seen before, Regulation 785/2004 does not apply to model aircraft with an MTOM mass under 20 kg. This is an issue, especially because there is no common definition of "model aircraft" in the European Union, and each Member State has to define autonomously what a "model aircraft" is. In Member States where the model aircraft definition does not result to be clear, the exemption could allow operators to conduct RPAS missions without the mandatory third-party liability insurance, thus causing the previously mentioned problems of uninsured operations.

Currently, many Member States do not have a definition of "model aircraft" in national law

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[244] ICAO Circular 328-AN/190 Chapter 2 paragraph 2.4.

[245] VLOS stands for visual line of sight, meaning the RPAS should always be visible to the eye of its operator.

[246] Roadmap for the integration of civil RPAS, Final Report, Annex 1, pg. 10, 2013.

or regulations, although this legal vacuum is being quickly filled by the states, and is comprehensible due to the initial stage of the RPAS industry. However, the significant variation in the definition of model aircraft poses the risk that the same operation, conducted by the same equipment, will be classified as model aircraft in some States and not in others.

An interesting comparison, between the different definitions of model aircraft within the various European Member States laws, has been made in the Steer Davies Gleave 2014 final report on third-party liability and insurance requirements of RPAS for the European Commission.[247] In particular, analyzing the laws, we can view how Member States define "model aircraft" based on different characteristics, which are:

- Only considering the weight of the aircraft (Denmark in relation to insurance, where there is no requirement for model aircraft under 7 kg);
- Only considering the purpose of the operation (United Kingdom, where RPAS used for sporting and recreational purposes are considered model aircraft);
- Considering both weight and purpose (France, Netherlands, Czech Republic, Romania);
- Considering purpose and design (Sweden, where RPAS used or designed for activities that are not recreational are not model aircraft);
- Considering kinetic energy, radius, and purpose (Austria, where model aircraft must be operated exclusively free of charge for non-commercial purposes in recreational activities or in the public interest, having a maximum kinetic energy of 79 joules, and operated within visual line of sight with a radius of no more than 500 m);
- Considering both purpose and pilot's line of sight (Italy, where model aircraft must be used exclusively for sport and recreation, not equipped with autonomous flying devices, and flying constantly under unaided visual line of sight).

With a particular attention on the Italian Regulation, the Italian Civil Aviation Authority (ENAC) on the 16th of July 2015 updated its Regulation for RPAS under 150 kg.[248] Following the previous regulation it makes a first distinction based on MTOM, differently ruling RPAS above and under 25 kg.[249] In addition to this, it makes another classification based on the criticality of drone operations. The Italian regulation in fact, recognizes the

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[247] Steer Davis Gleave, "Study on Third-Party Liability and Insurance Requirements of Remotely Piloted Aircraft Systems (RPAS)", Final Report, November 2014.

[248] Regulation "Mezzi Aerei a Pilotaggio Remoto", ENAC, 16 July 2015.

[249] Art. 6, Regulation "Mezzi Aerei a Pilotaggio Remoto", ENAC, 16 July 2015.

difference between operations conducted in visual line of sight, and operations that are beyond line of sight.

The rules for RPAS under 25 kg introduce new requirements from the 1st of July 2016. Specifically, all RPAS must display an electronic identifying device consenting real time transmission and recording of all the operative data. Furthermore, both the vehicle and its ground station must have license plates permitting an easy identification of the system and its operator. When employing RPAS for non-critical operations its operator must evaluate the planned activity, the systems' airworthiness, and the operational risks, subsequently submitting a declaration of compliance to ENAC.[250] Critical operations have a different procedure to follow, and the critical nature mainly depends on the location.[251] Flying over densely populated areas or between buildings, to make an example, is acknowledged to be critical. For critical operations, specific authorization is necessary, and is granted only after an evaluation of the type of operation, its location, the pilot's training, and the RPAS airworthiness.[252] Critical operations with RPAS below 25 kg above densely populated areas are allowed under certain conditions, which are mainly safety characteristics of the drone. However, flying over groups of people is always prohibited.

The Italian Regulation also worries about RPAS lighter than 2 kg.[253] According to Article 12 of the Regulation, RPAS with an MTOM under or equal to 2 kg will be considered non-critical in all types of operations, provided that the drones' design characteristics are of an inoffensive nature, as assessed by ENAC, or by another authorized entity.

The masses of RPAS and operations listed above are typical of model aircraft, however "model aircrafts" are regulated by Art. 35 of the Regulation. These are defined as a remotely piloted device, without people onboard, used exclusively for recreational and sport purposes, not equipped with autonomous flying devices, and flying constantly under unaided line of sight.[254] This category does not need any declarations or authorization for the operations, although it must respect the following technical requirements:

- MTOM under 25 kg
- Maximum wing surface of 500 dm^2
- Maximum wing loading of 250 g/dm^2

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[250] Art. 9, Regulation "Mezzi Aerei a Pilotaggio Remoto", ENAC, 16 July 2015.
[251] Fernandez I.O., "The New Italian Regulation on UAV: in force from September 2015", 10 September 2015, http://www.aviationspacejournal.com/2015/09/10/the-new-italian-regulation-on-uav-in-force-from-september-2015/.
[252] Art.10 and Art. 11, Regulation "Mezzi Aerei a Pilotaggio Remoto", ENAC, 16 July 2015.
[253] Art. 12, Regulation "Mezzi Aerei a Pilotaggio Remoto", ENAC, 16 July 2015.
[254] Art. 5, Regulation "Mezzi Aerei a Pilotaggio Remoto", ENAC, 16 July 2015.

- Maximum piston engine size of 250 cm^3; or maximum electric engine power of 15 kW; or maximum turbine engine thrust of 25 kg (250 N), or maximum turboprop engine power of 15 kW.

"Model aircraft" are also prohibited from flying over populated areas or near buildings and infrastructure, must fly within a maximum radius of 200 m, and within a maximum height of 70 m.

The Italian Regulation for RPAS under 150 kg is currently one of the best developed regulations amongst European Countries, but even admitting its adequacy it remains different from the others causing issues for cross-border flights, and raising insurance costs.

EASA, in July 2014, proposed a distinction between RPAS and model aircraft saying that "model aircraft are those exclusively used for recreational, sport or similar purposes (regardless of mass, authorized operations and on-board sensors); and RPAS are those used for 'professional' purposes (commercial, non-commercial, corporate, aerial work)."[255] This proposal is not important for the definition itself, which may be modified after a discussion between Member States, but represents a starting point for a common definition, and if accepted will help the European Union towards a common Regulation.

Across the ocean the FAA outlined the statutory parameters for model aircraft flying in the United States[256], in Section 336 of Public Law 112-95 (the FAA Modernization and Reform Act of 2012).[257] Section 336 defines "model aircraft" as "an unmanned aircraft that is: (1) capable of sustained flight in the atmosphere; (2) flown within visual line of sight of the person operating the aircraft; and (3) flown for hobby or recreational purposes."

In Section 336 we also find the conditions that must be respected by "model aircraft", that are:

" (1) the aircraft is flown strictly for hobby or recreational use;

(2) the aircraft is operated in accordance with a communitybased set of safety guidelines and within the programming of a nationwide community-based organization;

(3) the aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program

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255 EASA NPA 2014-09 Transposition of Amendment 43 to Annex 2 to the Chicago Convention on remotely piloted aircraft systems (RPAS) into common rules of the air, paragraph 2.4.5.4.1 Model aircraft, pg. 13, July 2014.

256 FAA, "Model Aircraft Operations", 4 March 2015, https://www.faa.gov/uas/model_aircraft/.

257 Section 336 of Public Law 112-95 (the FAA Modernization and Reform Act of 2012), 14 February 2012, https://www.faa.gov/uas/media/Sec_331_336_UAS.pdf.

administered by a community-based organization;

(4) the aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft; and

(5) when flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) with prior notice of the operation (model aircraft operators flying from a permanent location within 5 miles of an airport should establish a mutually-agreed upon operating procedure with the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport))."

We find many similarities with the Italian legislation, beginning from the definition of "model aircraft", finding even here indication of the use for recreational purposes, and the flight within visual line of sight. Also, the same limits are imposed for weight, since 55 pounds are approximately 25 kg[258].

These conditions are set to consent aviation enthusiasts to continue flying model aircraft without needing any authorization or insurance cover, which would otherwise greatly raise the costs for practicing their hobby. It is important to ascertain that these RPAS operations do not fall within the unknown or illegal market of operations, and that the limits imposed are sufficient for the citizens' protection.

5. RPAS insurance market and adequate information needs

Acquiring third-party liability insurance is mandatory before beginning RPAS operations, and for this reason the availability and the cost of insurance policies is of major importance for the sector. In the next decade there is going to be a big increase of demand for the RPAS insurance market, although currently the market offer is scarce. The issues withholding insurance market offer will only be solved by the introduction of RPAS regulations and by the flow of time.

One of the first problems for RPAS insurance companies are countries where RPAS regulations do not exist, such as Hungary. It is true that if national law prohibits RPAS operations there is no need for insurance, but this lack of regulation only widens another issue, which is the small size of the RPAS market.

Insurance companies work by spreading the risks within a sector, so that if they must pay compensation for a claim they will have the money because of the subscription of

[258] 55 pounds correspond to 24,9476 kg.

numerous policies. The RPAS market is currently quite small compared to the amounts insured, so that if an insurance company were to pay compensation for a severe RPAS accident, this might offset all the possible revenue from the sector. For this reason, insurers prefer to invest in other sectors, with higher volumes, that are more stable and secure, where they believe profits are going to be higher.

The small size of the market, together with its early stage, is also causing another great issue for insurers, which is the lack of adequate information. In fact, differently from the manned aircraft sector, there is very little information about the probability of incidents, and their potential damage, thus impeding insurers from calculating the risks. In particular, insurers need information on both operational data, and the number of incidents with the indication of the damage caused. Only processing this information, they will be able to calculate, for the different weights and classifications they will analyze them in, the effective probability of damage risk for drones.

Before moving on with other considerations, there is an important theme to point out. Currently, for RPAS under 150 kg of MTOM, each Member State has its own rules, which differ from State to State. Although these rules are publicly available, companies willing to invest in RPAS insurance first need to look at the different laws so to understand the requirements of each Member State. This job will be assigned to lawyers that, because of a continuous updating and modification, will constantly need to follow the insurance company bringing it up to date with the new regulations. All of this determines some high initial and ongoing costs for the company.

As a result, there is not much competition in the sector, with only a little number of insurers offering RPAS insurance policies. The insurance industry still sees this market as an immature class of business, although it expects it to be mature in a few years, after the market expansion, and the implementation of additional safety technologies.

Moving on with the analysis of the reasons why, differently from other insurance markets, such as the manned aviation or car insurance market, the RPAS insurance market suffers from an over-capacity of request, rather than an under-capacity, we will now look at the insufficiency of adequate information issue.

The insurance industry needs RPAS operational data to assess risk profiles, and without this information it can only take the information it already has in relation to manned aircraft, which results to be the most similar sector. The industry has more times emphasized this necessity, indicating the high risk of operating within a partially unknown field.

Within the RPAS market, we have a sort of separation between the known and the unknown market. The difference stands in the fact that not all RPAS are registered with the authorities, and some unregistered RPAS are flown without complying with national rules. Therefore, the operational data can only be gathered on the known market by the authorities of the Member States. After this there is another limitation, and it is that very few Member States, such as Italy, France, Sweden, Germany, and the Czech Republic, actually gather RPAS operational data, and the gathered data is not yet available for the insurance industry.

The unknown or illegal market instead, is only estimated in size by following the sales of RPAS, and of this market it is not possible to assess how many operations are conducted, and whether there is a prevailing of legal or illegal operations. The difficulty resides in the simple access to light or small RPAS by privates, which can easily buy them on the internet or at the mall. These RPAS may cause damage or injury to third-parties, and will probably be very hard to identify.

At this point, after looking at the picture of the situation, we can understand why there are not many insurers willing to invest in the RPAS market, since for them it represents a jump in the unknown. It is true that, although they do not have the same power of prohibiting certain types of operations as the regulators have, they can protect themselves by limiting the nature of the operations they are willing to insure, but many risks about uncertainty would remain. Investing in this market right now would mean taking a risk, which is something insurers like to invest in but not to take. For this reason, until there will not be an expansion of the RPAS market, and easy access to operational data and incident reporting, I believe competition in the RPAS insurance industry will be low, and costs for the operators will remain high.

CHAPTER V

PRIVACY ISSUES

The use of RPAS in civil air spaces entails many new possibilities, but along with these new capacities come privacy issues we didn't have to cope with in the past. If today we live in a world in which we easily perceive the presence of piloted helicopters and planes, tomorrow our world will have millions of RPAS flying through the air, which will be smaller, faster and harder to see, and will be able to gather a lot of information (visual photography, thermal imaging, biometric identification, GPS data etc.). This is why we need a robust privacy and data protection discipline, both to protect and convince the citizens about the use of RPAS. Not reaching the objective could mean a harsh world to live in, an unconvinced public, and a consequent hampering of this important technology. To solve this, we must examine the new privacy concerns coming along with the use of drones in civil airspace. Then we have to analyze if the current legislation is enough to guarantee us the same rights we have today, and if not, how can we achieve this.

1. Privacy concerns arising with the use of RPAS technology

RPAS are a new technology coming into our lives that will probably change the nature of surveillance. Looking at the future, we must ask ourselves a few questions: how are they going to impact on our everyday activities and are they going to limit our privacy? Is the world going to become like living in a "Big Brother"? How can we prevent all this, but still keep the benefits of this incredible technology?

1.1. The use of RPAS for surveillance activities

Drones were initially developed for military use, and today, as many technologies born for military use, they are being applied to civil purposes. The first civil uses of RPAS begun with governmental authorities, in order to help monitor protests, check the frontiers, or search for cultivations of marijuana. Today police drones are operating both in the U.S.A. and in Europe. The Dutch Parliament in April 2014 has even approved a legislation enabling Police to use drones for surveillance of the country and its citizens[259]. Therefore, drones are already aiding governments for surveillance purposes, but we must observe how companies, professionals, and citizens are beginning to use RPAS. In fact, companies may use them to monitor their competitors, a journalist to easily photograph or follow celebrities, and citizens for recreational purposes, or to secure their private property. The difference between traditional surveillance means, such as the aerial surveillance with big and noisy piloted helicopters, or fix CCTV[260] systems is that drones "offer new angles for visual surveillance"[261]. This because differently from fix CCTV they are able to follow individuals during their observation, which becomes nearly impossible with fixed security cameras, and diversely from piloted helicopters they can be smaller and silent, permitting them to observe anything without being noticed by the surveilled[262]. Another new characteristic is that today we cannot achieve continuous surveillance, while drones will soon be using solar panels to fly, being able to fly for long periods of time with little expense[263]. This easily shows us where the future of government and police controls is heading, a world with less privacy but more security, a world where obtaining information is going to be costless, where enforcing the law is going to be easier, and our privacy will only be protected by privacy data protection protocols[264]. As we can see, RPAS are going to change the way in which surveillance is conducted[265], reinforcing not only governmental control but also private surveillance. Private companies are showing to be very interested in drones, both for security reasons and to control employees[266], and companies like National Geographic and Google are already using them to achieve information. The conclusion to which the Electronic Privacy Information Centre has arrived sums it up:

"Drones present a unique threat to privacy. Drones are designed to undertake constant,

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[259] Gijzemijter M., "Dutch authorities now allowed to film citizens using drone", April 2014, http://www.zdnet.com/article/dutch-authorities-now-allowed-to-film-citizens-using-drones/
[260] Acronym meaning Closed Circuit Television.
[261] Wright D. "Drones: Regulatory challenges to an incipient industry", Computer & Law Security Review, Vol. 30, 2014, pg. 227.
[262] Ryan Calo M., "The Drone as Privacy Catalyst", Stanford Law Review, December 2011, http://www.stanfordlawreview.org/online/drone-privacy-catalyst.
[263] Prigg Mark, "The silent spy drone that could stay in the sky forever", The Daily Mail, 17 July 2012, http://www.dailymail.co.uk/sciencetech/article-2174976/The-silent-spy-drone-stay-sky-forever.html.
[264] Villasenor J., "Observations from above: Unmanned Aircraft Systems and Privacy", Harvard Journal of Law & Public Policy, Vol. 36, No. 2, 2013, pg. 458-517.
[265] Courtland E., "Drones in Canada- Will the proliferation of domestic drone use in Canada raise new concerns for privacy?", OPC research reports, March 2013.
[266] Schlag C., "The New Privacy Battle: How the expanding use of drones continues to erode our concept of privacy and privacy rights", Pittsburgh Journal of Technology Law and Policy", Vol. 13, No. 2, 2013, pg. 11.

persistent surveillance to a degree that former methods of video surveillance were unable to achieve"[267]

1.2 Privacy concerns linked to RPAS activities

Given the new possibilities that drones offer for surveillance and data achieving, we must now take into account the privacy concerns arising with the new technology. Before analysing them we must consider that surveillance might be conducted through both visual (cameras with visual, thermal or infrared imaging), and non-visual means (microphones, recognition systems, location systems). Privacy studies[268] show us that the following issues arise in relation to visual-surveillance: function creep, chilling effect, dehumanisation of the surveilled, transparency and visibility, accountability and voyeurism. Instead, related to additional non-visual surveillance we find: lack of respect for bodily integrity, tracking and loss of locational privacy, loss of privacy around association and group membership.

1.2.1 Function creep

Function creep occurs when drones are "purchased for specific, restricted operational uses, but come to be used for more common, controversial reasons"[269]. For example, let's imagine that RPAS are being used by the police to monitor a demonstration, and after the demonstration the videos are also viewed to fine people who have not paid for parking, or who have violated speed limits. We can imagine a similar scenario in the private sector, where drones are employed for road mapping, but later the gathered information is sold to other companies, which buy it for different purposes. Another example can be found in the United States, where drones were bought to secure the nations' borders and were later "fully engaged in the war on drugs"[270]. Function creep is double-sided because if on one side we can utilize the same drones for multiple activities, on the other side the concern is that of losing track of the use that is made of them.

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[267] Electronic Privacy Information Centre, "Domestic Unmanned Aerial Vehicles (UAVs) and Drones", https://epic.org/privacy/drones/.

[268] Finn Rachel L., "Privacy and data protection issues related to use of civil RPAS", The civil use of drones, a challenge to privacy?, 28 May 2014, http://ec.europa.eu/DocsRoom/documents/5576/attachments/1/translations/en/renditions/native.

[269] "Commission wants drones flying in European skies by 2016", Statewatch News Online, 14 September 2012, http://www.statewatch.org/news/2012/sep/eu-com-drones.htm.

[270] Barry T., "Homeland Security Drones Mission Creep from Border Security to National Security", Border Lines Blog, 20 March 2013, http://borderlinesblog.blogspot.it/2013/03/homeland-security-drones-mission-creep.html.

1.2.2 The chilling effect

The "chilling effect" refers to all those cases in which individuals are uncertain about whether they are being watched, and so "attempt to adjust their behaviour accordingly"[271]. Chilling "implies an undesirable slowing"[272], leading to "the inhibition or discouragement of the legitimate exercise of a constitutional right"[273]. This brings people to be afraid of using their civil rights and liberties, to use their freedom of association, their freedom of expression; they will certainly be discouraged from participating to public events or social movements. Imagine what it could be like to live a life where every single move you make outside of the walls of your house may be observed, and you are only sure it's possible, without ever knowing when and how.

Many studies, such as the one conducted by doctoral researcher in experimental psychology Sander van der Linden, show us that people act differently when they know that they are being observed[274]. Other studies conducted by scientists at Newcastle University demonstrated that only hanging up posters with the image of eyes watching us changes the way people behave[275]. As we can see, these studies demonstrate the Panopticon theory, developed by Jeremy Bentham for prisons, workhouses, mental asylums and schools. The theory explains that if you design these places in such a way that the guards or the supervisors could watch the prisoners, the workers, the patients or the students in any moment, without them knowing when they were being watched, the surveilled would act in a self-censored way[276].

The choice of deterring undesirable behaviour by leaving the surveilled in a situation of uncertainty has been largely criticised. In the future there will be many drones flying in the sky, and advanced software utilities may be installed to detect unlawful behaviour and alert the police. We could live in a world without robbery, less homicides, no dog poop in the park, clean streets etc. but is this really worth it? Roger Clarke argues that this way we would achieve "the chilling of lawful social, economic, cultural and political behaviours", and "the feeling that they know all about you anyway can lead the persons at risk to result

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[271] Gutwirth S., Leenes R., de Hert P., Poullet Y., "European Data Protection: Coming of Age", Finn Rachel L., Wright D., Friedewald M., chapter "Seven Types of Privacy", Springer, Dordrecht, 2013, pg. 16.
[272] Wikipedia, "Chilling effect", 28 February 2015, https://en.wikipedia.org/wiki/Chilling_effect.
[273] Your Dictionary, "chilling-effect", http://www.yourdictionary.com/chilling-effect#law.
[274] Van der Linden S. "How the Illusion of Being Observed Can Make You a Better Person", Scientific American, 3 May 2011, http://www.scientificamerican.com/article/how-the-illusion-of-being-observed-can-make-you-better-person/.
[275] In the study, people were much more careful about littering behaviour in a university cafeteria, only thanks to the posters of eyes being hang up.
[276] Warriar L., Roberts A., Lewis J., "An analysis of Jeremy Bentham and Michel Foucault and their present day relevance", December 2002, http://studymore.org.uk/ybenfou.htm.

in hyper-vigilance or even paranoia"[277].

Giving up on reducing unlawful behaviours to maintain privacy would be a failure, just as much as renouncing on privacy to achieve a safer world. I believe the solution lies in the middle, so to obtain a safer world without abandoning our privacy rights.

1.2.3 Dehumanisation of the surveilled

RPAS will change the nature of surveillance in many ways. Another difference will be that today's police have to monitor the city with fix cameras or personally; even journalists must go at the celebrities' parties and follow the VIP trying not to be seen[278]. In the future police and journalists might be able to do the same job by staying at their computer desk. The same applies for investigators, spies, and all those jobs in which being there personally will no more be necessary.

Pilots will be kilometres away from their mission, operating the vehicles in the same way as we play today with a computer game. This brings to a psychological detachment from the mission, weakening the pilots' understanding of reality, and loosening their constraints of conscience.

1.2.4 Transparency and visibility, accountability and voyeurism

RPAS will mostly fly undetected by the people on the ground, being able to take videos, capture sounds and intercept communications, and for this reason, they result to be the perfect instrument for covert surveillance. Policy makers are debating on how to impose a duty to inform the public of the RPAS activities, this way safeguarding transparency requirements and permitting citizens to know what is happening in the air above them. The fact that informing the public of the surveillance activities does not permit the drone pilots (let us imagine a private investigator) to act undetected, raises questions on the actual respect of the duty to inform the public, and obtain permissions by drone operators[279].

In addition to visibility, we have accountability issues. In any infringement of law, as much as the right to private life, citizens will ask damage refunding to the responsible for the

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[277] Clarke R., "The Regulation of Civilian Drones' Impacts on Behavioural privacy", Computer Law & Security Review, Vol. 30, No. 3, 2014, pg. 4.

[278] Ryan Calo M., chapter "Robots and Privacy", Patrick Lin,Keith Abney,George A. Bekey, "Robot Ethics: The Ethical and Social Implications of Robotics", MIT Press, 2012, pg. 187-202.

[279] Belgian Privacy Commission, "La Commission vie privée répond aux questions fréquemment posées concernant les drones", 22 April 2014, http://www.privacycommission.be/fr/news/la-commission-vie-priv%C3%A9e-r%C3%A9pond-aux-questions-fr%C3%A9quemment-pos%C3%A9es-concernant-les-drones.

infringement, which in many cases will have to be identified[280]. However, the identification of the person or legal entity responsible for the damage is probably not always going to be possible, given that surveillance with drones can be carried out by anyone who owns one with the adapt attachments, and controlling the lawfulness of RPAS activities is very complex for the authorities.

The accountability issue is worsened by the possibility of drones being hacked. For example, in April 2014, in Western Australia, a hacked drone that was filming a competition injured an athlete[281]. Without an accountability discipline fixing the problem, damage suffered by individuals from RPAS activities may often remain without compensation, leading to a widespread abuse of the instrument.

What's more is that RPAS may be used by private individuals without any license or authorisation, believably leading to "voyeurism, harassment, stalking and even acts of gratuitous violence"[282]. Crossing the border between lawful and unlawful use of drones will be very simple and with little risk for the private users.

Finally, journalists and paparazzi are going to enjoy a new way of working, with many advantages and less risks. The Reuters Institute of Journalism is studying the opportunity and challenges of RPAS, advocating for a regulatory framework in the journalistic sector. Even the Federal Aviation Administration is looking into unsuitable use of drones by journalists.

Although journalists may be regulated, the problem remains with paparazzi and the improper use of drones by citizens. Even with fines, paparazzi would probably continue taking shots of celebrities, at least until they will be able to earn more than the fines they are going to face.

1.2.5 Lack of respect for bodily integrity

RPAS could be equipped with technologies such as biometric sensors, able to recognize people from the face, fingerprint, DNA, or hand geometry, and software able to recognize the behaviour or attributes of single individuals. Authorities are concerned about future use

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[280] European RPAS Steering Group, "Roadmap for the integration of civil Remotely-Piloted Aircraft Systems into the European Aviation System", Annex 3 "A study on the societal impact of the integration of civil RPAS into the European Aviation System", June 2013, http://ec.europa.eu/enterprise/sectors/aerospace/files/rpas-roadmap-annex-3_en.pdf.

[281] Radulova L., "Woman athlete suffers head injuries after 'hackers took control of drone filming race and made it crash'", Mail Online, 8 April 2014, http://www.dailymail.co.uk/news/article-2599269/Australian-triathlete-injured-crashing-drone-pilot-loses-control.html.

[282] Clarke R., "The Regulation of Civilian Drones' Impacts on Behavioural privacy", Computer Law & Security Review, Vol. 30, No. 3, 2014, pg. 4.

of these technologies believing they will lead to an invasive control and surveillance of individuals.

Picturing a near future where "drones with facial recognition or soft biometric recognition will be able to recognize and track individuals based on attributes such as height, age, gender, and skin colour"[283] is quite scary for a lot of us. It would mean being always traceable, and easily under control.

Companies such as Facebook are already using biometric analysis[284], and this helps them to increase marketing actions, and reduce costs. We can easily imagine that in the future companies will desire mounting drones with these technologies, making them go around profiling customers, permitting them even more specific marketing actions.

1.2.6 Locational and associational privacy concerns

Equipped with Global Positioning System or Automatic Number Plate Recognition drones can infringe locational privacy. Locational privacy "encompasses the right of individuals to move in their "home" and other public or semi-public places without being identified, tracked or monitored"[285]. Tracking peoples' movements cannot only infringe locational privacy but many other rights, as it may reveal many sensitive personal data such as political, religious or sexual preferences.

Being able to follow peoples' movements, together with biometric recognition, can also interfere with associational privacy, permitting drone operators to identify group memberships. Identifying group memberships would certainly cause a huge "chilling effect", reducing the frequency of people associating with others.

2. Drones, Privacy and Data Protection Law

Currently, both in the United States and in Europe, there are no specific RPAS privacy or data protection laws. Both in Europe and in the United States policy-makers are trying to understand whether the existing technology neutral laws are enough to protect people's privacy, or if there is the need for specific regulatory frameworks. Given this, the applicability of the current regulatory framework for the RPAS has to be analysed, to

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[283] Thompson II, R. M. "Drones in Domestic Surveillance Operations: Fourth Amendment Implications and Legislative Responses", CRS Report for Congress, April 2013 pg. 4.

[284]Weissman Guthrie C., "Facebook is being sued for amassing the world's largest stash of facial-recognition data", Business Insider, 6 April 2015, http://uk.businessinsider.com/facebook-biometric-program-2015-4?r=US&IR=T.

[285] Gutwirth S., Leenes R., de Hert P., Poullet Y., "European Data Protection: Coming of Age", Finn Rachel L., Wright D., Friedewald M., chapter "Seven Types of Privacy", Springer, Dordrecht, 2013, pg. 16.

facilitate an understanding of the gaps where the integration of specific rules created for RPAS might be necessary.

2.1.Privacy Law in Europe

Under European Union law, Article 8 of the European Convention of Human Rights (ECHR), and Article 7 of the Charter of Fundamental Rights of the European Union (CFREU) protect the right to private life. These principles are also regulated by the jurisprudence of the European Court of Human Rights (ECtHR), and it's why, to fully understand them, we must also take some cases into consideration.

2.1.1. Article 8 of the European Convention of Human Rights

Article 8 of the ECHR reads as follows:

1. Everyone has the right to respect for his private and family life, his home and his correspondence.
2. There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic wellbeing of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others.[286]

As we can see the first paragraph of Article 8 grants us the right to respect for our private life, family life, home and correspondence. Nevertheless, the Strasbourg Court dealing with the interpretation of the four enunciated rights in Article 8 has recognized a broad definition for each of them. To make an example, the right to respect for a private home also includes a room in a guesthouse, a hotel room or a boat[287]. The Court did not stop here, and it held that Article 8 also includes the right to personal data protection. In the *Costello-Roberts v. the United Kingdom* case, it affirms, "that the notion of "private life" is a broad one, which […] is not susceptible to exhaustive definition"[288]. This means we cannot limit the protective scope of Article 8 to any specific area of life but it also extends

[286] Council of Europe, European Convention on Human Rights, Article 8, http://www.echr.coe.int/Documents/Convention_ENG.pdf.
[287] Docquir Benjamin, "Le droit de la vie privée: aperçu général et règles de proportionnalité", Docquir B., Puttemans A., "Actualités du droit de la vie privée", Bruylant, Bruxelles, 2008, pg. 6-10.
[288] European Court of Human Rights, *Costello-Roberts v. the United Kingdom*, application no. 13134/87, 25 March 1993, paragraph 36.

to “personal dignity and autonomy and the interaction a person has with others, both in private or in public”[289].

Nevertheless, the second paragraph of Article 8 introduces some limitations to the right to private life, which cannot be absolute, but must be balanced with other protected rights and liberties. In particular, any limitation must be “in accordance with the law”, necessary and proportionate, and in the interests of one of the indicated legitimate aims. This means that when the Court recognises an interference with the scope of Article 8(1), it then examines whether the infringement is justified or not, under the conditions of Article 8(2).

Trying to understand possible violations of RPAS to Article 8(1), we must separate visual surveillance activities from non-visual surveillance activities. For visual surveillance activities, we must again divide the private sphere from the public places, while for the non-visual surveillance activities we will look at interception of communications and location surveillance.

Any visual surveillance operations conducted with drones, to monitor somebody within its private sphere, will result unlawful according to Article 8(1). This because the private sphere covers the most intimate aspects of human beings. It may be separated from the public sphere by physical boundaries (home or personal relationships) and intimate fields of information (sensitive or personal)[290].

Instead, visual surveillance activities in public places is possible, but with some limitations. The Venice Commission defines a public area as a “place which can be in principle accessed by anyone freely, indiscriminately, at any time and under any circumstances”, where “one is conscious that one will be at least seen, even recognized, and that one’s behaviour may be scrutinized by anyone”[291].

Looking at case law in the *Herbecq v. Belgium* case the Commission decided that monitoring in public spaces, without recording the visual data does not interfere with the individual’s private life[292]. However, in the case *P.G. and J.H. v. United Kingdom*[293], the Court went further, making a distinction between “monitoring as such”, and “recording

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[289] Liberty, Protecting Civil Liberties Promoting Human Rights, “Article 8 Right to a private and family life”, https://www.liberty-human-rights.org.uk/human-rights/what-are-human-rights/human-rights-act/article-8-right-private-and-family-life.

[290] Nissenbaum H., “Toward an Approach to Privacy in Public: Challenges of Information Technology”, Ethics & Behaviour, Vol. 7, 1997, pg. 207.

[291] Venice Commission, “Opinion on Video Surveillance In Public Places by Public Authorities and the Protection of Human Rights”, Council of Europe, Strasburg, March 2007, pg. 3-5.

[292] Venice Commission, “Herbecq and the association “Ligue des droits de l’homme” v. Belgium”, application n. 32200/96 and 32201/96, Decision of 14 January 1998, pg. 92.

[293] European Court of Human Rights, *P.G. and J.H. v. United Kingdom*, application no. 44787/98, Judgment of 25 September 2001.

data in a systematic or permanent way", and in the *Perry v. United Kingdom*[294] *case* it affirms that although monitoring a public place doesn't violate Article 8(1) ECHR, recording the data in a systematic or permanent way may interfere with the right to a private life.

We can see from these cases that a use of RPAS in public places would not violate Article 8(1) ECHR as long as the information is not recorded[295]. However, if the monitoring were conducted through sophisticated means such as thermal imaging, night vision, or video analytics, it will likely interfere with the right to private life protected by Article 8(1).

Still, drones are also able to operate with non-visual surveillance technologies such as interception of communications, and location surveillance. Even here, the jurisprudence provides us with some guidelines to determine whether non-visual surveillance activities undertaken by drones are in contrast with Article 8(1) ECHR.

In *Klass v. Germany*[296], the Court considered that any legislation authorizing secret surveillance "amounted to an interference with the exercise of the right set forth in Article 8 para. 1". In addition to secret surveillance legislation, even some surveillance implementation methods may result in contrast with Article 8(1), such as installation of wiretapping or bugging instruments in somebody's home or workplace, interception of communications, and monitoring of paper messages[297]. If we apply this jurisprudence to surveillance operations undertaken by drones, we understand that utilising them to intercept communications will result in breach of Article 8(1).

However, drones may also be employed for location surveillance, with GPS or other sensors able to read GPS tags or signals. For these kind of surveillance activities the *Uzun v. Germany*[298] case is of major importance. The Court here, apart from saying that even GPS surveillance is in breach with Article 8(1), makes an important distinction between

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[294] European Court of Human Rights, *Perry v. United Kingdom*, application no. 63737/00, Judgement of 17 July 2002.

[295] Williams V., "Privacy Impact & the Social Aspects of Public Surveillance", Covert Policing Review, London, 2008.

[296] European Court of Human Rights, *Klass v. Germany,* application no. 5029/71, Judgement of 8 September 1978.

[297] For surveillance implementation methods in breach with Article 8 ECHR see cases: European Court of Human Rights, *Kopp v. Switzerland*, application no. 23224/94 Judgment of 25 March 1998; European Court of Human Rights, *Valenzuela Contreras v. Spain,* application no. 27671/95, Judgment of 30 July 1998*;* European Court of Human Rights, *Khan v. the United Kingdom,* application no. 35394/97, Judgment of 12 May 2000*;* European Court of Human Rights, *Armstrong v. the United Kingdom,* application no. 48521/99, Judgment of 16 July 2002; European Court of Human Rights, *Chalkley v. the United Kingdom,* application no. 63831/00, Judgment of 12 June 2003; European Court of Human Rights, *Hewitson v. the United Kingdom,* application no. 50015/99, Judgment of 27 August 2003.

[298] European Court of Human Rights, *Uzun v. Germany,* application no. 35623/05, Judgement of 2 September 2010.

"soft surveillance" (location surveillance), and "hard surveillance" (visual surveillance, interception of communications), establishing a graduation in the interference level of Article 8 (1) based on the type of surveillance technology used. It follows that RPAS surveillance operations conducted with the use of "soft surveillance" technologies will more easily be justified under Article 8(2), than if the drones were mounted with "hard surveillance" technologies like visual surveillance.

2.1.2. Article 7 of the Charter of Fundamental Rights of the European Union

Article 7 of the charter reads as follows:

Everyone has the right to respect for his or her private and family life, home and communications.[299]

Comparing Article 7 CFREU with Article 8 ECHR, we can see how it "contains rights corresponding to those guaranteed by Article 8 (1) ECHR[300]". The only difference is in the word "communications", where in Article 8 ECHR we read "correspondence". Therefore, to Article 7 CFREU we must give "the same meaning and the same scope as Article 8(1) of the ECHR, as interpreted by the case-law of the European Court of Human Rights", in the case *Varec SA v. Belgium*[301].

2.2.Data Protection Law in Europe

RPAS operators recording any "information related to an identified or identifiable natural person"[302] must also respect the European Data Protection Law. Here the European legislation makes a distinction between the different types of operators recording the data. For commercial operators and for public authorities (except law enforcement bodies) Data Protection Directive 95/46/EC applies.

Article 29 Working Party[303] tells us that visual surveillance data, as much as biometric

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[299] Official Journal of the European Communities, Charter Of Fundamental Rights Of The European Union, (2000/C 364/01), http://www.europarl.europa.eu/charter/pdf/text_en.pdf.

[300] Aidan O'Neill QC, "How the CJEU uses the Charter of Fundamental Rights", Eutopia Law, 3 April 2012, http://eutopialaw.com/2012/04/03/how-the-cjeu-uses-the-charter-of-fundamental-rights/.

[301] Case C-450/06, *Varec SA v. Belgium*, Judgement of the Court (Third Chamber), of 14 February 2008

[302] Article 29 Data Protection Working Party, Opinion 4/2007.

[303] "The Article 29 Working Party is an independent European working party that deals with issues relating to the protection of privacy and personal data", from Commission for the protection of privacy, http://www.privacycommission.be/en/art-29-wp.

data, location data, and traffic data all fall under the Data Protection Directive[304]. Another important point is what it means to “identify someone indirectly”. Here Art. 29 WP explains to us how nowadays it is very easy to gather information about people, and once we have enough data, and maybe even with the help of an analytical system, we can identify the person to which the recorded data is referred. In the future, it will be even easier to identify someone as technologies develop, and so the concept of personal data must be expanded to the point in which, even with the latest technology, you are not able to identify the natural person from the data recorded. Let’s imagine a photograph taken by an RPAS from the sky, in which you only see the top of a person’s head. Looking at the image, we could say it is not personal data since the person is not recognizable. Let’s now imagine that we know when the image was taken, and from the image we can recognise the location (maybe somebody’s garden). In this case, the image becomes personal data, as we will probably be able to identify the person in the captured image, and this is the reason why personal data is also context-dependant.

The difference between Data Protection Law and Privacy Law applied to RPAS, is that the first will only protect us when the RPAS has collected personal data, while Privacy Law preserves us from being observed in a systematic way or with the use of sophisticated technologies, regardless of the collected data. Furthermore, the Data Protection Directive does not prohibit the processing of personal data (as Privacy Law which directly protects us from being recorded), but it sets out all the requirements for the legal processing of personal data.

RPAS operators who will collect personal data must respect a series of rights and duties. To begin with, in appliance with the transparency principle, they must inform the data protection authority and members of the public, that they will use RPAS in activities that may collect personal data, also indicating who the collector is and which are the purposes of the data processing. Then, according to Article 6 of the Data Protection Directive 95/46/EC personal data must be:

(a) processed fairly and lawfully;

(b) collected for specified, explicit and legitimate purposes and not further processed in a way incompatible with those purposes.

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[304] Article 29 Data Protection Working Party, Opinion 3/2012, Opinion 4/2014.

(c) adequate, relevant and not excessive in relation to the purposes for which they are collected and/or further processed;

(d) accurate and, where necessary, kept up to date;

(e) kept in a form which permits identification of data subjects for no longer than is necessary for the purposes for which the data were collected or for which they are further processed. [305]

RPAS operators must also inform data subjects that the collection of data is taking place, and then enable these subjects to access and eventually rectify the captured information, and in particular cases, even to block or erase their personal data.

Finally, RPAS operated by private individuals or by law enforcement authorities are still not regulated at the European level. However, they must respect Article 8 of the European Charter of Fundamental Rights, which recognises "the right to the protection of personal data", also saying that "such data must be processed fairly for specified purposes and on the basis of the consent of the person concerned or some other legitimate basis laid down by law. Everyone has the right of access to data which has been collected concerning him or her, and the right to have it rectified"[306].

2.3.U.S. Privacy and Data Protection Law related to RPAS

Unlike the European Union, the United States don't have a single Privacy and Data Protection Law applicable to all the states. In the U.S. privacy law is adopted on an ad hoc basis, only when certain sectors and circumstances require it. The U.S., at a federal level, has a sectoral approach to data protection legislation, with some industries that are covered, and others that are not. The protection mainly comes at the state level, where most states have enacted some kind of privacy legislation. [307]

Today, in the U.S., authorizations to fly civil RPAS are granted by the Federal Aviation

[305]EU Directive 95/46/EC, Article 6.
[306] Charter Of Fundamental Rights Of The European Union, (2000/C 364/01), Article 8.
[307] Dimov D., "Differences between the privacy laws in the EU and the US", 10 January 2013, http://resources.infosecinstitute.com/differences-privacy-laws-in-eu-and-us/.

Administration[308], and there are serious privacy concerns about drones becoming invasive and in breach of the Fourth Amendment.
The United States Constitution Fourth Amendment reads as follows:

The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

The Fourth Amendment is central to privacy law, and although it is often argued as protecting our right to privacy, some believe privacy is not expressly protected by it.[309]
Taking into consideration case law, which is relevant to drone surveillance and the Fourth Amendment, the *Katz v. United States* case has provided a standard applied to emerging technologies, which is still used today. Here the Court affirmed that if a conversation was recorded by law enforcement surveillance, in a phone booth, without a warrant, the incriminating tape was not admissible in Court, stating that “what a person knowingly exposes to the public, even in his own home or office, is not a subject of Fourth Amendment protection. But what he seeks to preserve as private, even in an area accessible to the public, may be constitutionally protected."[310]
In 1979, the *Smith v. Maryland* case strongly modified the way in which future Courts will decide RPAS Fourth Amendment cases. The Court asserted that a pen register recording the phone calls of a criminal did not violate the Fourth Amendment. It’s decision was based on the fact that the petitioner couldn’t “have any expectation of privacy” since the phone calls could have also been recorded by the phone company that “has facilities for recording this information”.[311] The case nullified the subjective expectation of privacy, replacing it with the presumption of being observed. Applying the Smith case interpretation of the Fourth Amendment to normal life, we should ask ourselves if a person’s expectation of privacy in his backyard is illegitimate. In fact, if a third party could easily be watching him (maybe peeking through the fence) he must assume the risk of intrusive observations. The

[308] Authorization isn’t needed for RPAS weighing “under 55 lbs unless certified by an aeromodeling community-based organization, and are not for business purposes”, Federal Aviation Administration, Unmanned Aircraft Systems (UAS) Frequently Asked Questions, https://www.faa.gov/uas/faq/.
[309] “Fourth Amendment: An Overview”, Legal Information Institute, Cornell University Law School, https://www.law.cornell.edu/wex/fourth_amendment.
[310] United States Supreme Court, *Katz v. United States,* Case 389 U.S. 347, Judgement of 18 December 1967.
[311] United States Supreme Court, *Smith v. Maryland,* Case no. 78-5374, Judgement of 20 June 1979.

serious problem comes with drones, because if we follow this logic we will always have to expect we're being watched.

The *California v. Ciraolo* case brought the Smith case interpretation of the Fourth Amendment to the next level. The defendant in Ciraolo had a marijuana cultivation in his backyard, protected from observation by a private fence. Police officers flying "at an altitude of 1,000 feet" "identified marijuana plants growing in the yard", subsequently executing a warrant and seizing the marijuana plants. The Court ruled that "the Fourth Amendment was not violated by the naked-eye aerial observation of respondent's backyard" as long as the aircraft was in navigable airspace.[312] The same interpretation of the Fourth Amendment was given in *Florida v. Riley*,[313] with the only difference that here, instead of the plane, the marijuana cultivation was observed with a helicopter from a 400 foot altitude.

The *Dow Chemical Co. v. United States* case analyzed the possibility of aerial photography. The Court found that aerial photography, "within lawful navigable airspace", does not violate the Fourth Amendment as long as the employed equipment is commercially available to the public and the photographs do not reveal "intimate details as to raise constitutional concerns".[314] In another important case, the *United States v. Torres*,[315] the Court stated that extensive and indiscriminate video surveillance, like oral and wired communications, is a "hyper-intrusive" search, and "must meet a higher standard than mere "probable cause" in order to undertake the surveillance". [316] "Hyper intrusive" searches are overbroad (obtaining more information than the need for the purpose of the surveillance), they occur without notice, and are ongoing, posing unusual threat to human dignity. A last case to consider for our analysis is *Kyllo v. United States*, in which the Court held that the use of "a device that is not in general public use, to explore details of a private home that would previously have been unknowable without physical intrusion […] is presumptively unreasonable without a warrant".[317] The case was about an indoor marijuana cultivation which had been discovered employing thermal imaging devices, but although

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[312] United States Supreme Court, *California v. Ciraolo,* Case 476 U.S. 207 (1986), Judgement of 19 May 1986.
[313] United States Supreme Court, *Florida v. Riley,* Case 488 U.S. 445 (1989), Judgement of 23 January 1989.
[314] United States Supreme Court, *Dow Chemical Co. v. United States,* Case 476 U.S. 227 (1986), Judgement of 19 May 1986.
[315] United States Court of Appeals, Seventh Circuit, *United States v. Torres,* Case 751 F.2d 875, Judgement of 19 December 1984.
[316] Simmons R., "Technology-Enhanced Surveillance by Law Enforcement Officials", The Ohio State University Moritz College of Law, May 2004, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=539704.
[317] United States Court of Appeals for the Ninth Circuit, *Kyllo v. United States,* Case 533 U.S. 27 (2001), Judgement of 11 June 2001.

considering the modality of search as in violation of the Fourth Amendment it leaves open a loophole, allowing devices which are "in general public use" to be used without a warrant. The analysis of these cases gives us an indication of where today RPAS surveillance is allowed, and where instead it is going to be considered a privacy intrusion.

In the U.S., the possibility of a drone inundation of the skies is also alarming members of Congress. Zoe Lofgren from the Democratic Party, and Republican Ted Poe proposed the Preserving American Privacy Act.[318] Rep. Lofgren said, "This bill would ensure that drones follow strict guidelines to protect Americans' privacy while still realizing their practical applications for science, border security, public safety, and commercial development".

"Specific provisions governing the use of UAS in the Preserving American Privacy Act include:

- Government-operated UAS must obtain a warrant to collect information that can identify individuals in a private area;
- Government-operated UAS must obtain a court order and provide public notice beforehand to collect information that can identify individuals in defined public areas;
- The warrant and court order requirements are subject to exceptions for emergencies, border security, and consent;
- Private UAS cannot capture visual images or sound recordings of individuals engaging in personal activities in certain circumstances in which the individual has a reasonable expectation of privacy;
- State laws on the use of UAS in the airspace of the state are not preempted;
- Private and law enforcement UAS cannot use or operate UAS equipped with firearms or explosives in U.S. airspace."[319]

Of course, some states and cities are also working on their own RPAS legislation, such as Charlottesville, who's City Council "passed a resolution banning drones, becoming the first city in the country to pass a drone resolution".[320]

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[318] Wilhelm A., "The 'Preserving American Privacy Act' would ban weaponizing of drones, warrantless use", The Next Web News, 16 February 2013, http://thenextweb.com/us/2013/02/16/the-newly-introduced-preserving-american-privacy-act-bans-drone-weaponization-require-warrants-for-law-enforcement-use/.

[319] U.S. House of Representatives, "Reps. Zoe Lofgren and Ted Poe Introduce Bipartisan Bill to Protect Americans' Privacy Rights from Domestic Drones", Press release, 15 February 2013.

[320] Robertson M., "Charlottesville Becomes First U.S. City to Pass Anti-Drone Resolution", NBC29, 11 March 2013, http://www.nbc29.com/story/20963560/charlottesville-city-council-passes-anti-drone-resolution.

3. Policy recommendations to help ensure Privacy and Data Protection with civil RPAS

RPAS are sophisticated machines with a multitude of potential applications, many of which are being or still need to be developed. This is why an overarching framework would surely result inadequate and shortly obsolete. Many studies have been made to aid policy-makers in modifying the actual Privacy and Data Protection Law to fill the gaps created by new technologies. Given the enormous potential of RPAS, to adequately permit people maintaining their right to privacy, policy-makers must not only concentrate on integrating the actual legislation, but also focus on soft law measures and action items.

Before thinking about modifying the actual legislation we must consider that RPAS operators (both commercial and private), and industry representatives are often not completely aware of the Privacy and Data Protection Law obligations, therefore not respecting them. This is a problem for the citizens, which see their rights violated, for policy-makers, which lose peoples' trust not being able to guarantee the citizens' rights, for RPAS operators, which leave themselves open to penalties and liability, and for RPAS industry, which losing the trust of its clients will have a negative impact on its sales. For this reason, the development of training courses with high quality information, to help RPAS manufacturers and operators better understand, and consequently respect Privacy and Data Protection Law, is in the interest of everybody. Policy-makers should also give RPAS manufacturers and operators the opportunity to ask and receive free advice from government authorities on specific Privacy and Data Protection matters.

Thinking about which measures will reduce invasion of privacy we must begin from the collection of data. This should be done paying attention to the data minimization principle, limiting the "collection of personal information to what is directly relevant and necessary to accomplish a specified purpose", and retaining "the data only for as long as is necessary to fulfil that purpose". [321] RPAS operations must focus on data minimization features such as collecting information only when necessary, flying RPAS missions so to reduce the gathering of unneeded information, and avoid storing unnecessary information. To do this RPAS operators should also inform the public using dedicated websites, signposts in locations where RPAS are used, and information leaflets. If civil RPAS operators were subject to information and transparency protocols, being obliged to provide the public with

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[321] Data minimization definition, European Data Protection Supervisor, https://secure.edps.europa.eu/EDPSWEB/edps/site/mySite/pid/74.

the information on RPAS operations, civil use of drones would gain public acceptance much more easily. Transparency could really be reached if drones were to carry mandatory unique identifiers continuously transmitting to a public website their GPS location.[322] Such a system would enable citizens to know whether there are drones above them, also permitting them to identify the RPAS, their operator, and the channel through which they could find further information.

RPAS surveillance operations could use smart surveillance techniques, where the operator doesn't see every event, but only those selected by the machine for further investigation. The software could not only permit a drone operator to follow more drones, but it would also consent data minimization (only selected events are recorded). Software applications of this type would be an adequate way to prevent avoidable privacy intrusions. To make an example we can imagine a drone having to take a video in a specific location, with the software turning the camera off during the journey, avoiding any unneeded information gathering.

Given the difficulty of implementing in practice Privacy and Data Protection principles, a technological solution could be privacy by design. Privacy by design "consists to protect privacy by embedding it into the design specifications of technologies, business practices, and networked infrastructures, as default, right from the outset".[323]Such a technology could protect people's privacy by blurring individuals or objects in the images, anonymising or masking data, and data minimization. Privacy by design features will obviously need to be different, according to the needed RPAS use, making the preventive privacy protective implementations fitted not to the technology but to the use. The privacy by design benefits reside in selling a product conceived to anticipately protect people's rights. For this reason, it is a very clever solution, limiting possible unlawful use during RPAS operations.

Along with these solutions another recommendation would be obliging all RPAS operators to carry out a privacy impact assessment (PIA), and a data protection impact assessment (DPIA), also addressing ethical issues, which may rise on a case by case basis. These impact assessments could take into consideration not only the privacy and data protection issues, but also the ethical concerns arising during the RPAS operations such as protection from discrimination, freedom of assembly, freedom of communication and movement, the

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[322] International Working Group on Data Protection in Telecommunications, "Working Paper on Privacy and Aerial Surveillance", 54th meeting, Berlin, 2 September 2013.

[323] Cavoukian A., "Operationalising Privacy by Design: A Guide to Implementing Strong Privacy Practices", Ontario, December 2012.

right to dignity or even informed consent[324]. This instrument would permit the RPAS operators to correct their missions and their data collection procedures in advance, letting them identify early any privacy or data protection issues. This would also avoid them any costly postliminary solutions (such as obscuration of unnecessary data), or liabilities (for any breach in privacy or data protection laws). PIAs and DPIAs result particularly fit to this sector given the heterogeneity of the RPAS missions. In addition, impact assessment experts support the idea of rendering the PIA and DPIA results publicly available so to assist in building public trust in the RPAS industry, permitting it to show transparency.

Together with PIAs and DPIAs there should be the development of codes of conduct, which will permit the individuation of acceptable and unacceptable practices. Codes of conduct would have multiple advantages, permitting the RPAS industry to create a unanimous knowledge and expertise in the sector. RPAS operators would no more need to gain additional expertise, but would have a tool giving them the needed information about acceptable and unacceptable practices.

Finally, we must not forget the necessity of an adequate monitoring of the good practices. Especially in a sector as the one of RPAS, where so many possibilities entail unlimited legal, as well as unlimited illegal practices, we must ensure that Civil Aviation Authorities and Data Protection Authorities have the powers to monitor this new world, conduct investigations, and if necessary issue sanctions.

[324] Wright D., Friedewald M., "Integrating privacy and ethical impact assessments", Science and Public Policy, Vol. 40, No. 6, December 2013, pg. 755-766.

CONCLUSION

This thesis is an attempt to look at the fast developing world of RPAS in a comprehensive way, which is essential to understand and exploit their huge potential in the future, a future much closer to us than we think. Although the idea of drones flying autonomously in the sky may seem a sci-fi film to us, we are going to experiment it during the next two decades. This developing technology will change our lives like the internet, and will modify the world in a very particular way. Commencing from the Second World War, where drones were created for dull, dirty, and dangerous missions, we are presently assisting the stage of creation of regulations, where we are able to buy small drones in the shops, and we only see larger drones on the television. However, as soon as regulations will permit RPAS to access civil skies, the RPAS market will explode, and we will begin to notice these vehicles very often carrying out all sorts of duties, such as military operations, law enforcement, personal transport, earth mapping, infrastructure inspection, search and rescue missions, street patrolling, communication and broadcast services, monitoring of geophysical processes, and crowd surveillance. Buying an object on the internet and observing a drone deliver it on our front porch half an hour later will become normal for us. Seeing drones working in the fields, caring for crops in an efficient and cheaper way, and doing many other mansions, is going to be ordinary.

RPAS are not only characterized by their flexibility of utilization, but also for a multitude of competitive advantages when compared with current technologies. As a matter of fact, drones will be able to operate completely automated, and, thanks to computer based flights, operation costs will be reduced, pollution will be diminished, and pilots' deaths will be prevented. Apart from these benefits, RPAS will become a necessity by 2035 since there are various projections indicating that in less than twenty years from now many airports will be operating at their maximum capacity[325], meaning that with current technologies in 2035 millions of passengers will be unable to fly. RPAS, thanks to computer based piloting, are already seen as the only solution, enabling the skies to be filled with airplanes flying closer to one another without risking accidents.

This futuristic world leads towards a full automation of processes, where humans will jump

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[325] LUISS Business School, Studio Pierallini, "Terza Law Conference sull'aviazione", LUISS University, 16 June 2016.

from being “in the loop” to “on the loop”, where we will ask for a certain task, and the computer will execute it by itself, with us only being the controllers of the process. The future will be the world of the Internet of Things, where the many benefits for society will be accompanied by many risks that are to be accurately considered during the development of a RPAS regulation conceived to unlock this market.

Ronald Coase, in its interesting 1960 article “The Problem of Social Cost”[326], rightly justifying the need for legal rules by making reference to a cost-benefit analysis, understood how new technologies, and the development of new markets, such as trains in the past or RPAS in the present, will create nuisances for another party. These nuisances are not to be regarded, as often happens, as a fault of one party, but are more often symmetric conflicts between the interests of two or more parties. However, in considering the total effect, “as Frank H. Knight has so often emphasized, problems of welfare economics must ultimately dissolve into a study of aesthetics and morals”[327]. Thus, governments, acting as a super-firm in society, must take into account all the parties and rights, giving them an orderly importance to establish the rules for this new market. These economic laws are created because of the costs deriving from the market use, although, on the other side, we must keep in mind that the existence of these laws will determine the economic behaviour of the parties, with certain practices that will exist being allowed, and others that might never see the light.

The RPAS industry, whose economic behaviour is presently withheld by a lack of legislation, is a dynamic market, led by the United States and Europe, that is estimated to be worth $10.1 billion, and is expected to reach $14.9 billion by 2020, at a compounded average growth rate of 8.12% from 2015 to 2020[328]. Forecasts also predict that investments on RPAS will triple over the next ten years with a total of $93 billion, from the actual $4 billion in 2015 to $14 billion by 2024[329], and that 150,000 new jobs will be created in Europe by 2050. In this fast growing market however, the most astonishing growth comes

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[326] Coase R. H., “The Problem of Social Cost”, The Journal of Law & Economics, University of Virginia, Volume III, October 1960.

[327] Coase R. H., “The Problem of Social Cost”, The Journal of Law & Economics, University of Virginia, Volume III, October 1960, pg. 43.

[328] MarketsandMarkets, “Unmanned Aerial Vehicles (UAV) market research report”, October 2015, http://www.marketsandmarkets.com/Market-Reports/unmanned-aerial-vehicles-uav-market-662.html.

[329] Teal Group, “PRESS RELEASE: UAV Production Will Total $93 Billion”, 19 August 2015, http://www.tealgroup.com/index.php/teal-group-news-media/item/press-release-uav-production-will-total-93-billion.

from start-ups, with a market that has more than doubled every year from 2012[330].

Italy, understanding the opportunities this market will offer to the aerospace national industries, is the third greatest European exporter, and seventh on a global scale[331], with its €350 million RPAS industry, and over 500 companies involved[332]. Indeed, drones are already being employed for a multitude of services, increasing every day, and that will determine a continuation of the rapid market growth for the next decades. Italian industries are amongst the most projected towards the future, since they are not only developing RPAS, but also satellite services that will one day substitute ground stations, so to control aerial traffic in all weather conditions without losing communication.

Experts in the field say the development of RPAS regulations to permit access to the civil skies is nearly a race, and many governments are fully aware of the economic advantages of being the first to create a complete regulation. In particular, the first countries creating regulations will set standards that may be followed by other countries according to harmonization principles. This way, "first move" country industries will have an advantage on the licensing of new technologies, while "second move" country industries will have to pay for registered patents of technologies they have unjustly been limited from developing first. It is while I write this conclusion that the American Federal Aviation Administration has enacted a complete small RPAS regulation which will be effective in August 2016, including all pilot and operating rules, for drones with a take-off mass inferior to 25 kg[333], and that the European Commission is speaking of being able to initiate integration of drones, with a take-off mass superior than 150 kg, in the civil skies by the end of this year.

The Italian industry and government organizations have very well comprehended the need of being a "first move" country, thus speeding up the creation of regulations and standards both at a national and European level. What I believe to be the best solution for Italy, and for all the States of the European Union, would be to create a uniform and harmonized legislation, not only for RPAS with a take-off mass superior than 150 kg, with lighter RPAS operations regulated by national Civil Aviation Authorities, but for all weights and categories of RPAS. This strategy, which is currently being discussed by member States of the European Union, would bring with it important advantages for both the European

[330] Drones Startups, "A snapshot of today's startup environment exploring commercial drones", February 2016, http://drones-startups.silk.co/.
[331] Eurosmart, "Unmanned Aerial Vehicle Market by Region", 2012.
[332] Doxa Marketing Advice, Mirumir, "Survey on the Italian Drone Industry: Profile of sector companies", Dronitaly, 25-26 September 2015.
[333] Federal Aviation Administration, "Unmanned Aircraft Systems", 22 June 2016, https://www.faa.gov/uas/.

industries and citizens. It is through a harmonized legislation that we will achieve the benefits deriving from a uniform legal certainty in all European States, with European industries able to build RPAS on the base of a unique standard applicable to all member States, operators flying drones over Europe following the same rules, reduced insurance costs, and cheaper RPAS expenses for citizens. However, to adopt such a legislation, numerous issues must be tackled, and a multitude of actions should be taken.

First of all, legislators must establish the airworthiness and certification requisites RPAS will need to possess in order to be safely and securely integrated in the civil airspace. This must be done in the view that they will be implemented in an existing air traffic system, hence legislators must ensure system interoperability, and analyse the potential impacts on the air traffic system and its operational and regulatory environment. These regulations, to reach public acceptance of RPAS introduction into our daily lives, will need to grant some RPAS safety and security standards certifying RPAS to be safe as, if not safer, than manned aircraft. Thus, for the security and safety of flight operations, there is the necessity of implementing robust data links, security controls and approvals before take-off, cyber security systems, fail safe and design construction requisites, automatic landing procedures in case of loss of command and control, detect and avoid technologies, and interoperability standards.

Secondly, together with the enactment of safety and security regulations permitting RPAS access to the civil skies, governments must communicate with all potentially affected parties, considering the study of aesthetics and morals together with the impacts on the nations' economy. It is on the issues of liability, and of privacy, that the game for RPAS public approval is really going to be played.

The European Union already has an insurance aircraft regime, that is disciplined under the European Regulation n. 785/2004. This regulation has proved itself to be adapt for humanly piloted planes, and applies to both manned and unmanned aircraft, so that RPAS are not left without minimum insurance requirements. However, this regime is based on maximum take-off mass bands (MTOM), which were thought for manned aircraft, and might not result suitable for RPAS. Although experts are still divided on the matter in absence of statistical data, we must recognize there are some relevant differences between manned and unmanned aircraft, and that the integration of specific RPAS insurance requirements will be an essentiality.

Specifically, the relevant differences reside in the lighter weight, and location of the operations. Since RPAS are usually much lighter than the average manned aircraft, not necessitating of a pilot, nor a cabin and the instruments for an on-board pilot, they will commonly only have to respect the minimum insurance requirements set for the lowest MTOM band. This may not be a problem if RPAS were prohibited from flying over densely populated areas and crowds, and there will certainly be many limitations in relation to these dangerous flights, but such restrictions should be strictly and severely enacted. Instead, many RPAS are being specifically designed and produced to be employed above densely populated areas and crowds, such as those used by police for the surveillance of crowds, and video recording of important events.

In addition to this, article 2 of the European Regulation n. 785/2004 tells us the "Regulation shall not apply to" "model aircraft with an MTOM of less than 20 kg". This is an issue, especially because there is no common definition of "model aircraft" in the European Union, and each Member State has to define autonomously what a "model aircraft" is. This legal vacuum is being quickly filled by the states giving a proper definition of "model aircraft", and regulating further minimum insurance requirements for light RPAS. However, a full harmonization of minimum insurance requirements reaching up to the "model aircraft" would be important in order to achieve a completely harmonized RPAS regulation, and all of the economic and legal certainty benefits deriving from it.

Lastly, privacy protection could be the greatest issue at stake, both for the creation of appropriate regulations, and for the proper tools and ways to guarantee their respect. Looking at the future, we must ask ourselves how RPAS are going to impact on our everyday lives, and if the world is going to become like living in a "Big Brother". Current privacy and data protection laws are, in fact, only adequate in theory because they were born inadequate in practice. Today, law violations mainly represent data coming from our computer activity, which is sold by large companies such as Google and Facebook[334], although tomorrow these companies could obtain recording of nearly all our activities. As a matter of fact, if today we want to protect our privacy, despite the fact it is already very hard and it would mean sacrificing the use of technology, it is still possible. Tomorrow, with the existence of drones, this will be absolutely impossible since we will live in a world where all our activities will be seen, and only laws will guard our privacy and data protection rights. The solution to this is certainly not impeding the use of new technologies, even though I believe this to be the hardest issue to be adequately solved.

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[334] Rusconi G., "Il business dei dati personali: ecco il nostro prezzo per il marketing", Il Sole 24 Ore, 14 June 2013, http://www.ilsole24ore.com/art/tecnologie/2013-06-13/business-dati-personali-ecco-183457.shtml?uuid=AbUwxl4H

RPAS are sophisticated machines in continuous development, for which an overarching framework would surely result inadequate and shortly obsolete. For this reason, to protect the citizens' rights to privacy and data protection, governments should not only concentrate on integrating the actual legislation, but also focus on soft law measures and action items. The first action that policy-makers can make to reduce privacy violations consists in limiting the gathering of data. This can be done through a series of measures, such as data minimization features permitting the collection of information only when necessary, information and transparency protocols, and smart surveillance techniques embedded in operating software. Nonetheless, given the difficulty of monitoring law compliance to Privacy and Data Protection principles, a technological solution could be privacy by design. Privacy by design features are a very clever solution to protect citizens from violations of their rights because RPAS would be directly produced with characteristics studied to limit unlawful use during operations. Other helpful solutions can be privacy and data protection assessments conducted by RPAS operators, and the development of codes of conduct consenting the individuation of acceptable and unacceptable practices. Still, especially in a sector as the one of RPAS, where privacy laws are often violated, we must ensure that Civil Aviation Authorities, and Data Protection Authorities, will have the powers to monitor this new world, conduct investigations, and if necessary issue sanctions.

At the end of this analysis it is evident that the advent of RPAS will be an important part of our future, and will be a game changer for our lives and economy. Technologies are ready and waiting for regulations to finally access non-segregated civil airspace, offering us many, and until now only imaginable, new services. For Italy, in front of the complexity and worldwide dimension of this phenomenon, will be of paramount importance to sustain a strong public and private investment in this field, being part of the major RPAS projects that are launched in the near future, maintaining a tight link with the European and US technological and legislative development, and trying to be a driver in the process of uniform definition of standards and regulations.

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