International Journal Of Scientific And University Research Publication

ISSN No 312/422

Listed & Index with
ISSN Directory. Paris



Multi-Subject Journal

Volum : (13) | Issue : 212 |

INTERNATIONAL JOURNAL OF SCIENTIFIC AND UNIVERSITY RESEARCH PUBLICATION

Research Paper

CIVIL UNMANNED AIRCRAFT (DRONES) AND CRISES PREVENTION: AIRSPACE ORGANIZATION AND LEGISLATION IN EU, USA, AND LEBANON

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ABSTRACT **The main objective of this study is to represent how the International/ national regulations and the organization of the airspace can prevent future crisis especially after the growing role of RPAS / UAV industry in a remarkable way in both commercial and recreational markets. In this study we use the comparison method based on the concerns of Safety, security, spectrum, access to airspace, and regulatory considerations, especially in close proximity to aircraft and airports established by the EUASA (European Union Aviation Safety Agency) between the member states of the EU and others , the FAA air traffic policies and procedures of the operation of UAS in the USNAS (U.S. National Airspace System), and The DGCA who presents the Lebanese Aviation Regulations in coordination with the International Civil Aviation Organization (ICAO). And after the analyses the results show that Managing the airspaces presented in this paper, appears to be a national task that depends on the culture of the nation, and an international responsibility to control and improve the system by a continuous risk analysis and risk assessment, in order to finalize an efficient model which, reduce the residual risk of operations of the new spreader technology to the minimum level. Hence we can say that the special laws concerning the UAS still an attempting of a cumulative understanding that present a part of the prevention. The implementation of risk assessment and risk analysis leads to improve the legislations. More after the importance lies in setting up a mechanism for implementing those laws and find the capabilities to control the airspace from any intentional or unintentional misuse.**

KEYWORDS :RPAS, Drones, Safety, Security, Aircraft, Risk assessment, Airspace

INTRODUCTION

Remotely Piloted Vehicles (RPVs) or Unmanned Aerial Vehicles (UAVs) refer to the aircraft with no crew nor passengers on board, while the first one needs to be operated at a distance by means of radio or infrared signals and the second can be operated by largely automatic equipment that keeps by itself the level of speed, height, time and aviation functions.

Even before the first flight of the famous Wright Brother's in December 1903, the idea of flying, in general, was kept in mind by many persons and for too many reasons. One of them was for war winning purpose, as in Venice 1849 July 15, the Austrian general and inventor Franz Von Chateaus used the first recorded offensive use of air power from land and ships by an unmanned aerial balloons each one carried 24 to 30 pound bomb to be dropped with a time fuse over the besieged city (Morning chronicles newspaper, 29 August 1849).

Almost sixty five years later, and due to many engineering researches, Dr. Archibald Montgomery Low, invented the radio guidance system to be used by the Royal Flying Corps in the first unmanned aircraft during the WWI to respond and attack the German airships or Zeppelins that attacked London for the first time on 31 May 1915(Londonist, Accessed on 4 September 2020 at 18:22).

The research and development in Radio plane technology leaded to a rise of a specialized industry business in model planes. Many years later, and due to the available technology, it was obvious to see more effective usage of the UAVs in to many military and civil ways.

This paper highlights the civil use of drones, like commercial and recreational. Commercial ways UAV started in 2006, with the Federal Aviation Administration (FAA) drone permit, to become many popular in delivery methods usage in firms like amazons, and recently in the confinement during the pandemic of covid-19 in 2020. And as it was declared in China, by EHANG Company (www.dronethusiast.com, Accessed on 4 September 2020 at 22:10), this technology will be used as a passenger's taxi service in the few coming years.

UAVs can be useful for improving the way of living and, in the same time it can be used for immoral purposes (scenario of 9/11 with UAVs). Let's say, by driving a car all the concerns should be focused on the horizontal dimension and the height of a bridge that the driver is passing under, and never take in consideration any falling aircraft or airspace ship. Entering the UAV capabilities to the sky, with the enormous trendy number, introduce a new risk dimensions, that needs to be assessed periodically in order to understand that risk of the new operations in the common sky, to lower that risk by creating some ways of control and manage the new technology without endanger lives and properties.

Safety, is the first thing to be taken in consideration in any new technology. What is necessary to organize the Civil drones use to prevent mobile crisis? It starts by the knowledge of the subject, and the legislations to organize and authorize the operations, that may affect the others. In the beginning, this paper will take in consideration the understanding of the frame of what is expected to be introduced to our life in the few coming years, and that may cause any incident, or accident, or crises. Then, the international EU, US legislations and the Lebanese ones with no comparison because of the lack of the Geographical proportion. After that the perspective of the improvements to be introduced to the national command and control system in order to avoid any missus of the concept.

Crisis/Accident/Incident

In general a crisis is a serious threat affecting basic structures or values and norms fundamentals of a social system, which under high pressure and high uncertainty requires crucial decision making (Rosenthal, 1986). Crisis also can be defined as an uncertain situation caused by internal or external elements to the organization, and can be distinguished by knowing that the temporal element is essential to seize, act and establish all the capacities and the essential means to slow it down, then start again with a goal of leading the group towards at least one situation of stability and / or one or more opportunities (Matar, 2019). Anyone dealing with crisis will be confronted with a crisis typology sooner or later (Gundel, 2005). In order to analyze crisis situations and to introduce measures for crisis prevention and containment, it's a must to understand the crisis typology, which is a structured approach that helps constructing crisis scenarios, thereby streamlining possible actions and outcomes, also points to appropriate management and communication measures that can be introduced before, during and after a crisis (Björck, 2016).According to Gundle, the major problem with crisis typologies is that they always reflect our current knowledge and estimation of crisis events as we only can classify what we know. He proposed a four-area matrix based on two variables: predictability and influence, and defined predictability as to know any particular kind of crisis based on probability of previous experiences, like transport accident (Gundel, 2005).

Crisis management can be divided into three phases: pre-crisis phase concerned with prevention and preparation, crisis response phase

when management must actually respond to a crisis, and post-crisis phase looks for ways to better prepare for the next crisis and fulfills commitments made during the crisis phase including follow-up information (Coombs, 2007 updated 2014 revised 2020). In the book titled the communications in crisis time, authors suggested to divide the crisis cycle management into three levels that go deeper continuously going from level to other. A part of the first level based on before the event, and going further in a part of the second level preparation is a key word, and in the third level pre- impact is more considerable(Maisonneuve, Danielle; Saouter, Catherine; and Char, Antoine, 2012).

Based on their needs, national and international organizations improve the quality of their systems and services by learning from the history and upgrade scenarios based on anticipation of the future of what to be more susceptible or likely to happen. According to the Institute for crisis management, every crisis is unique, it's like a fingerprint (ICM, 2020).

1.1 Legislation & regulations

1.1.1 International regulations

It's basic to distinguishing Civil Aviation between the prevention by legislations and precautions in one hand, and the preparation by setting a system for signal detection or pre-alert in the other hand. Preparedness refers to measures taken to predict and, where possible, prevent, mitigate, respond and effectively cope with the consequences. It's a continuous and integrated process resulting from a wide range of risk reduction activities and resources that requires the contributions of many different areas, as the institutional development(IFCR, 2020).The concept of pre-alert, is based on a data collection, registration and analyzing to find a crisis patterns, that allows any organization to create or activate a sufficient standby cell or cells of managers at a higher hierarchical level to deal with the problem (Lagadec, 1991).Putting crisis planning and prevention measures in place is critical, there may be similarities to past incidents, but a crisis never occurs the same way twice(ICM, 2020). Signal detection is based on observation according to which most crises leave a trail of early warning signals (Bradley, 2013).

Back to 2001, in need of risk reduction, the Air Navigation Commission (ANC) requested education and awareness campaign on Runway Incursion (RI), upon such request, ICAO lunched in 2002 a program prevention measures on the subject that started with seminars to the distribution of two RI mitigation instruments like the ICAO Manual on the Runway Safety Toolkit in 2007 (ICAO, 2007).For risk prevention authorities have to be involved. Regional to local authorities must define and enforce the specific mitigation measures, states and transnational organizations are responsible of establishing regulations defining the principles and rules, international to national organizations strengthening the governance of risks (Le Cozanne, G.; Kervyn, t M.; Russo, S.; Speranza, C. Ifejika; Ferrier, P.; Foumelis, M.; Lopez, T.; Modaressi H. , 2020).

During the ICAO High Level Safety Conference (HLSC) held in February 2015, IATA highlighted the concerns of Safety, security, spectrum, access to airspace, and regulatory considerations, especially in close proximity to aircraft and airports, up on the growth in both commercial and recreational markets of the industry of RPAS/ Drones. In February 2016 a joint statement was released to raise safety awareness among users of RPA in Close Vicinity of Airports (IATA, 2020).

In the first step of crisis management, and for prevention reasons, it was necessary also to take in consideration some Anti-UAVs measures by the concerned organizations and the public authorities, which are responsible of the Civil Aviation within their area of responsibility. For that reason, IATA has Perform effective countermeasures that can be safely and legally activated in time to prevent a UAS from entering an area of interest, taking in consideration that countermeasures should not create unintended safety hazards and unmitigated risks to other aircraft and aviation infrastructures. Measures are a set of technological and operational tools that were developed and implemented following an appropriate safety assessment, like the radio-frequency (RF) signal analyzer, to detect, monitor, identify and record inappropriate or dangerous UAS activities, they may include some countermeasures like jamming or interrupting the Wireless Local Area Network (WLAN) signal which aimed to neutralize, or use of UAS interceptors trained like predatory birds to limit potential risks(IATA, Bulletin No.: UAS1/2018 Subject: Key considerations when protecting manned aviation from drones. IATA Information, 2018).

1.2 EU legislations

In need to guarantee a high level of aviation safety, in the developed air sector within the EU, some measures and rules of high standard were essential in the field.

Before 2003, the EU law relayed on the international aviation safety standard imposed by the ICAO (International Civil Aviation Organization), especially the principles relating to the investigation of civil aviation accidents (Esteban Coito, 2020). Ever since, the EASA took the effective responsibility of forming the basis proposals of cooperating regulations (EC) No 216/2008, and legislations concerning the airworthiness, air traffic management to prevent accidents.

With the increase of the air traffic in Europe, predicted to reach 14.4 million flights in 2035 (50% more than in 2012) (European Parliment, 2015/0277(COD)), and the wide-ranging of UAVs in Europe, the European Parliament and the Council of the European Union establishedEUASA (European Union Aviation Safety Agency) to improve the rules concerning the safety, the security, the environment protection between the member states and the others.

Following extensive discussions on the proposal between the Parliament and the Council, Regulation (EU) 2018/1139 was adopted in July 2018.This regulation focused on a wider union policy that introduced UAVs under a scope of regulations detailed in its annex ixthat converged on the essential requirements for the design, production, maintenance, operation, environment, registration, and marking. (Official Journal of the European Union L 212/1, 2018).

On12 March 2019 the Commission implemented Regulation (EU) 2019/945, which detailed the provisions for the operation of UAS as well as for personnel, including remote pilots and organizations involved in those operations. This regulation came into force on 1 July 2020 (Official Journal of the European Union L 152/1, 2019).The Commission Delegated Regulation (EU) 2020/1058 of 27 April 2020 amending Delegated Regulation (EU) 2019/945 as regards the introduction of two new unmanned aircraft systems classes C5 and C6.The Regulation presented the UAS operations in three categories and subcategories as follow:

'Open' category which should cover operations that presents the lowest risks to fly over, close, and far from people respectively in subcategories on the basis of operational limitations and technical requirements for UAS.

Subcategory A1, with a maximum speed in level flight of 19 m/s, exclusively powered by electricity, Maximum sound power level LWA as from entry into force 85 dB to become after4 years 81 dB, and if equipped with an on function follow-me mode UAS must be in a range not to exceed 50 m from the remote pilot. This subcategory is divided in two classes:

- Privately builtA1/ C0 < 250g of MTOM,
- A1/C1< 900g of MTOM the energy transmitted to the human head should be less than 80 J., equipped with a system that limits the height above the surface or above the take-off point to 120 mishap edges shall be avoided, equipped with a geo-awareness. Must have at least one green flashing light for the purpose of conspicuity of the UA at night to allow a person on the ground to distinguish the UA from a manned aircraft.

Subcategory A2/C2 (900g< C2 < 4 kg of MTOM), exclusively powered by electricity, with a geo-awareness function, and a Maximum sound power level LWA as from entry into force 85 + 18,5 leg dB to become after 4 years 81 + 18,5 leg dB(Where 'leg' is the base 10 logarithm), have a maximum attainable height above the take-off point limited to 120 m, and a safe horizontal distance may be reduced to a minimum of 5 meters from uninvolved persons. Unless UA is a fixed-wing, it must be equipped with a low-speed mode selectable by the remote pilot and limiting the ground speed to no more than 3 m/provide the remote pilot with clear warning when the battery of the UA or its command unit reaches a low level, in real time during the whole duration of the flight, the transmission from the UA using an open and documented transmission protocol.

Subcategory A3 divided in four classes
- 4kg <A3/C3< 25kg of MTOM, and a maximum characteristic dimension of less than 3m,have a maximum attainable height above the take-off point limited to 120m,exclusively powered by electricity, unless it is a fixed-wing UA, have the indication of the guaranteed A-weighted sound power level LWA, equipped with a geo-awareness function, provide the remote pilot with clear warning when the battery of the UA or its command unit reaches a low level, in real time during the whole duration of the flight, the transmission from the UA using an open and documented transmission protocol, and a distance of at least 150 meters from residential, commercial, industrial or recreational areas.

-4kg<A3/C4 < 25kg of MTOM). The UAS must have CE class stamp identification label in order to fly in the fly zones. Flights must be in VLOS (Visual Line of Sight), at a safe horizontal distance of at least 30 meters, and a distance of at least 150 meters from residential, commercial, industrial or recreational areas.

A3/C5, Applicability may come into force in June 2022, to be an aircraft other than a fixed-wing unless tethered, geo-awareness function not mandatory, low-speed mode selectable by the remote pilot and limiting the ground speed to not more than 5 m/s, monitor the quality of the command and control link, and not include changes to the software of the class C3 UAS.

A3/C6, Applicability may come into force in June 2022, ground speed in level flight of not more than 50 m/s, geo-awareness function not mandatory, programmable operational volume, provide means to program the UA trajectory, monitor the quality of the command and control link, means to terminate the flight and to make correction maneuver span. C6 class highly depend on the flight control system that only the manufacturer can develop.

All subcategories in the Open category doesn't imply the request for authorizations unless in need to go beyond 120 meters above the closest point of the surface of the earth with natural elevations. The remote pilot must have a competency of an online training course followed by completed successfully online theoretical knowledge examination, and must be at least 14 to 16 years old or need a supervisor. All operations should effectively use and support the efficient use of radio spectrum in order to avoid harmful interference. EASA implemented on the commission delegated regulation (EU) 2020/1058 that, when placing on the market a class C5 or C6 UAS or a class C5 add-on, importers shall inform the market surveillance authority (Official Journal of the European Union L 232/1, 2020).

'Specific' category that has a characteristic dimension less than 3 meters, should cover other types of operations presenting a higher risk than the open category. The UAS operator shall provide the authority with an SOGARA (Specific Operational Ground and Air Risk Assessment) and propose a target level of safety equivalent to the safety level in manned aviation for the intended operation. An appropriate insurance cover will be in place for every flight if required by Union or national law. UAS operators should hold an LUC (Light UAS operator Certificate) with appropriate privileges to avoid any risk of collision with any manned aircraft and should discontinue a flight when it may pose a risk to other aircraft, people, animals, environment or property. The registration number, the technical features of the UAS, and the operator are mandatory for any operational authorization in this category. All UAS operated in this category should be equipped with a remote identification system. The UAS that are not required to register in Regulation (EU) 2019/947, should have a unique serial number, unless they are privately built (Official Journal of the European Union L 232/1, 2020).

'Certified' category which should cover other types of operations presenting a higher risk than the specific category. In this category the design, production and maintenance of UAVs are certified if it has a characteristic dimension of 3 meters or more, and is designed to be operated over assemblies of people, or if it is designed for transporting people, or if it is designed for the purpose of transporting dangerous goods and requiring a high level of robustness to mitigate the risks for third parties in case of accident. In addition to the certification of the aircraft the certification of the UAS operator as his competency are mandatory by the Delegated Regulation (EU) 2019/945 for any operational authorization based on the risk assessment in this category.

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Figure 1: Regulations presented the UAS operations regarding categories

1.3 US legislations

Referring to the49 U.S. Code Section 40103 (Sovereignty and use of airspace), the Federal Aviation Administration (FAA) had to develop plans and policy for the use of the navigable airspace efficiently, prescribe air traffic regulations, protect individuals and property on the ground, and preventing collision between aircrafts and any other objects(Legal Information Institute, July 5, 1994). In order to improve aviation safety and capacity, according to section 333 of the Public Law, the Secretary of Transportation was demanded to accomplish all safety studies and assessments necessary to set up some standards for operations and certifications of public unmanned aircraft systems that may operate safely in the United States airspace system (PUBLIC LAW, FEB. 14, 2012).

In 2015, the FAA submitted the notice N JO 7210.889, that provides information and guidance on air traffic policies and procedures of the operation of Unmanned Aircraft Systems (UAS) in the U.S. National Airspace System (USNAS) (U.S. DEPARTMENT OF TRANSPORTATION, October 27, 2015).

Within the two categories of US airspace, there is four types dictated, in the Pilot's Handbook of Aeronautical Knowledge, by the complexity of movements, nature of the operations, the level of safety, and national and public interest(FAA, Pilot's Handbook of Aeronautical Knowledge, 2016).The FAA rules apply to the entire National Airspace System, "there is no such thing as "unregulated" airspace",and UAVs operators should be aware of their flight legality, and allowed classes for their systems within the controlled and uncontrolled types only(FAA, Page last modified: 2018).That keeps the regulatory airspace within the four types listed below.

	Airspace
Categories **Types**	**Regulatory**
Controlled	A/B/C/D/E classes
Uncontrolled	G class/
	no authority Air Traffic Control min Visual Flight Rules
Special use	Confined activity/ Limitations: Prohibited areas (P-N°) Restricted areas (R-N°) Warning areas (W-N°) Military operation areas (MOAs) Alert areas (A-N°) Controlled firing areas (CFAs)
Other airspace	Local airport advisory (LAA) Military training route (MTR) Temporary flight restriction (TFR) National security area (NSA) Air Defense Identification Zones (ADIZ)…..

Figure 2: The requirements of the controlled and uncontrolled airspace classes only



According to the previous tables, flying a drone in the US is a process based on the knowledge of the rules of the sky. The system is based on the weight of the UAV, and the reason of the flights, for hobby or recreational, work, education, or public safety.Referring to the Code of Federal Regulations(FAA, 14 CFR Part 107 - SMALL

UNMANNED AIRCRAFT SYSTEMS, 2016 last modified: August 26, 2020 2:06:10 PM EDT), the Operating Rules of recreational small UAVs, clarify that the Remote pilot need a certificate for flying drones, or must be under supervision of a remote pilot in command that has a certificate, and who is considered directly responsible for the operation and for safety. One person may not operate or act as a remote pilot in command for more than one UAV at the same time. The owner should have an effective U.S. registration certificate, and his/her UAV must weigh less than 55 pounds, including payload, at takeoff. Operator must be in a good physical or mental condition and should never fly under the influence of drugs or alcohol. Operator must keep VLOS (Visual line of sight operation) to keep knowing the location, attitude, altitude, and all the information needed to prevent endanger life and property of another. No person may operate a UAV over a human being unless that human being is directly participating in the operation, or located under a covered structure.

Safety is a major concern, in order to prevent hazardous operation, it's not allowed for UAVs operators to drop objects or hazardous material, which endanger the life, or the property of another, or operate from a moving land or water-borne vehicle or aircraft. UAV shouldn't interfere with operations and traffic patterns at any airport, helicopter or seaplane base, also operating a UAS during night, or during periods of civil twilight is not permitted unless it has lighted anti-collision lighting visible for at least 3 statute miles. UAV operator must yield the right of way to all aircraft, and may not operate so close to another aircraft as to create a collision hazard, maintain effective communication with all participant, and scan the airspace operating area for any potential collision hazard. No UAV can operate in prohibited or restricted area, and in Classes B, C, D or within the lateral boundaries of the surface area of Class E airspace unless it has prior authorization from Air Traffic Control (ATC), only the Class G is allowed and with some limitations. The groundspeed may not exceed 87 knots (100 miles per hour),The altitude cannot be higher than 400 feet above ground level, unless the small unmanned aircraft is flown within a 400-foot radius of a structure; and does not fly higher than 400 feet above the structure's immediate uppermost limit, the minimum flight visibility, as observed from the location of the control station must be no less than 3 statute miles. The minimum distance from clouds must be no less than 500 feet below the cloud, and 2,000 feet horizontally from the cloud. Small UAVs operators have to pass an online aeronautical knowledge and safety test and carry proof of test passage.(FAA, 14 CFR Part 107 - SMALL UNMANNED AIRCRAFT SYSTEMS, 2016 last modified: August 26, 2020 2:06:10 PM EDT).

Small drones can fly for business under the part 107 guidelines, but they need more registrations with the FAA. Operator should be at least 16 years old, speaks and understands English, besides being in a good mental condition. Some of those operations are not covered by Part 107 and require a waiver like the operation of multiple small unmanned aircraft systems. In all ways, the FAA denies the carriage of property of another by aircraft for compensation or hire. An FAA approved knowledge test, and a Tracking Number (FTN) are needed in order to operate a UAS for business.

To operate a UAV that weigh 55 pounds or more, the Secretary of Transportation may grant exemptions to the relevant operating rules according to section 44807 that replaces section 333 exemption of the FAA Modernization and Reform Act of 2012 (PUBLIC LAW 1.–9. , FEB. 14, 2012), from October 5, 2020, till September 30, 2023, on a case-by-case basis, after determination of the characteristics of the concerned UAV(PUBLIC LAW, 2018). The world's largest drone, the Feihong-98 tips the scale at a large 5.25 tons. For drones weighing less than 0.55 pound, commercial drone pilots do not need any certification at all.(Neubecker, 2019).

1.4 Lebanese regulations

Since 1947 Lebanon has joined the International Civil Aviation Convention drawn up in Chicago in 1944, from which the International Civil Aviation Organization later emerged (Public Law, 2005).

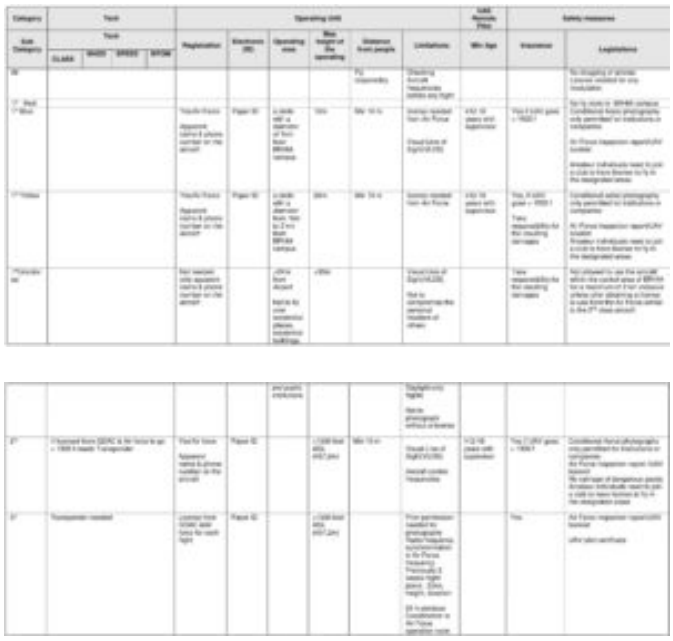
The Regulatory Decree number 1610 dated on 26 July 1971, has created the Directorate General of Civil Aviation (DGCA) associated to the Ministry of Public Works and Transport (MPWT),to supervise air transport and safety of air navigation, issue regulations related to technical investment of aircraft, monitor their implementation, manage civil airports, and other matters and affairs related to civil aviation. The DGCA coordinates with the International Civil Aviation Organization (ICAO), other civil aviation administrations, and other foreign airports in order to contribute to the development and build-up of the civil aviation sector(Ministry of Public Works and Transport, 2017).In 2002, the DGCA presented the Lebanese Aviation Regulations, revised later in 2006, in 2012, and in 2017 where the airspace is categorized under a Controlled, an Uncontrolled and a mixture of both, with a classification of seven

Airspace Categories	Classes	Operations	Types
Controlled The geographical locations, the horizontal and vertical limits of any airspace are specified in the Aeronautical Information Publication (AIP)	Class A	Transponder airspace IFR flight needs air traffic control clearance or an authorization issued by the Minister VFR authorization issued by the Minister	control area extensions control zones high level airways high level airspace low level airways terminal control areas transition areas
	Class B	Transponder airspace IFR flight needs air traffic control clearance or an authorization issued by the Minister VFR flight needs air traffic control clearance or an authorization issued by the Minister	
	Class C	Transponder airspace IFR flight needs air traffic control clearance or an authorization issued by the Minister VFR flight needs air traffic control clearance or an authorization issued by the Minister	
	Class D	Specified Transponder airspace IFR flight needs air traffic control clearance or an authorization issued by the Minister VFR aircraft shall establishes two-way radio contact with the appropriate air traffic control unit before entering the airspace	
	Class E	Specified Transponder airspace	
Uncontrolled	Class G		high level air routes low level air routes
Controlled Airuncontrolled The geographical locations, the horizontal and vertical limits of any airspace are specified in the Aeronautical Information Publication (AIP)	Class F (Special Use Restricted) Class F (Special Use Advisory)	IFR flight needs air traffic control clearance or an authorization issued by the Minister VFR specified in the Aeronautical Information Publication	restricted airspace advisory airspace military operations areas danger areas

The DGCA define the unmanned aircraft system as "model aircraft" which, the total weight does not exceed 35 kg (77.2 pounds), mechanically driven or launched into flight for recreational purposes and that is not designed to carry persons or other living creatures, also as a power-driven aircraft, other than a model aircraft, that is operated without a flight crew member on board called "non-piloted aircraft". In the same time, any aircraft that operate under a maximum speed of 91 knots is considered as A Category (Ministry of Public Works and Transport, Directorate General of Civil Aviation , Interpretation 2002). The registration of Aircraft does not apply in respect of an aircraft that is a model aircraft (UAV), and the operator must be equal or below 15 years old (Ministry of Public Works and Transport, Directorate General of Civil Aviation, 2016).

Even in the Civil Aviation, the Lebanese Army made instructions for

licensing the use of remote control aircraft (UAV) based on some articles of the Civil Aviation Safety Law No. 663 dated on 4/2/2005(Lebanese Army, 2017). Also, Instructions for licensing remote drones, Instructions for licensing the import of remote control aircraft, and the circulating controls for using the Lebanese airspace by all kinds of gliders (Lebanese Army, 2017). All information from those instructions are gathered and presented in the following table.



1.5 Perspective

Each and every country had its own legislations, and methods based on the understanding, usage, the known risks, and the perspective of the potential crisis. And we can divide these legislations into several points:

- The EU made a common rules of operations based on how to protect people at first, and the need of keeping up with the growth and the future of that production. The concept of use of the civil UAVs in the U-space system, takes in consideration the vertical axis with a maximum height of 120m, and a need for authorization to go beyond, while for the horizontal and lateral axis any UAV should keep a minimum distance of 150 meters from residential, commercial, industrial or recreational areas in some sub-categories in the Open category, with a limitation of speed.
- The US divided the airspace by the complexity of movements, nature of the operations, the level of safety, the national and the public interest. The concept of use of this airspace by civil UAVs, is to create a vertical escalated axis within the B, C, D classes, and some of class E, all shaped in a different form, which depends on the size, and importance of the class. To operate in any of this classes, a specific air traffic authorization is required. In between those classes, the horizontal and lateral axis represents many level also classed in G, and some of class E. Going upper of 14,500 MSL (mean sea level) some of class E and class Aare constantly horizontal, with no obstacles nor mixtures.
- Lebanon starts from BRHIA as the most important asset to protect from any misuse of UAVs in the airspace, taking in consideration the level of safety of operations, the air traffic control system, and the business continuity that has to be maintained in all circumstances. The horizontal axis, which is the radius of the circles, starts the first category from the airport campus with three colors till 2 km, to reach the uncolored zone. As a center point the airport campus is the origin of the red zone where it is to be considered as a no fly zone, going to blue till 1km from the campus, and yellow till 2 km from the center, where any flight needs a license. The vertical axis for this first category escalated within the colored areas from no fly, to 10m in the blue zone, to 20m in the yellow zone, and 30 m in the uncolored zone. Beyond that, there is two more categories to take in consideration, where in the horizontal axis the vertical level for the second category is under1500 feet, and upper with a need for transponder in the third category.
- The EU classify how to operate under the common sky, by dividing it to three categories, Open, Specific, and Certified. The legislations consider the weight of the UAV, as the most important value for classification in certain sub-categories going from C0 less than 250g to C6 less than 25 kg in the Open category. In the same category, the operator must be 14 to 16 years old or need a supervisor, a successful online training course, and an online theoretical knowledge examination. While in the Specific category, the major concern is the UAV to be under 3m, the operator needs an LUC (Light UAS operator Certificate), and a remote identification system. The last category, the Certified is the riskiest one where the UAS must be more than 3m.
- In the regulatory category in the US, there is four types, the controlled, the uncontrolled, the special use, and the other space. The system is based on the weight of the operating small UAV to be less than 55 pounds including payload at takeoff, and the reason of the flights, if recreational, for work, educational, or for public safety. To operate a UAV that weigh 55 pounds or more, the operator needs exemptions to the relevant operating rules from the secretary of transportation based each case.
- Lebanon has made a special operational instruction for UAVs that is not the same for other aircrafts operating under the same airspace. The need for registration is mandatory in all subcategories except the uncolored zone where an apparent name and phone number is sufficient. Operating in the third category needs a license from the Army and the DGCA while there is no need for license from DGCA in the other categories and sub. Any UAV operator has to take responsibility for the resulting damages, and insurance is an obligation to use the drone above 1500 feet.
- By categorizing, and classifying the airspace the EU dives in the details and make a clear understanding for operators and for the enforcement forces to implement the law. The US merge the UAVs into the operating system under the regulatory types that has a high level of revised and published laws. Operators in general need to have theoretical knowledge on the operating system in the geographical area, and a successful online training course as a first step of hazardous prevention. The Lebanese categorization of UAVs operations priorities the safety of the airspace starting from the centralized airport of BRHIA to go farther in geographical zones that presents a general framework, without going deeper in the technical specifications as classes, mass, MTOM, and speed.

CONCLUSION

Managing the airspaces presented in this paper, appears to be a national task that depends on the culture of the nation, and an international responsibility to control and improve the system by a continuous risk analysis and risk assessment, in order to finalize an efficient model which, reduce the residual risk of operations of the new spreader technology to the minimum

level. By reducing the risk, the production of UAVs will increase, and maybe more functions to appear especially with the fifth generation of the internet that will lead to more complex function to deal with by any management system. In parallel to complexity and details, the legislations need to be improved and updated in too many fields that covers the quality of the product, the continuous control of the operations, the need to reach a certain level of performance, the financial effects on the economy, and the most important variable is the safety. The key success of a viable risk management is the understanding of the UAVs capabilities, and maneuvers, to build a key performance indicator as a detector of any deviation from normality that can start the control measures to contain the situation from the beginning and before getting worse.

The use of the Civil Unmanned Aircraft under the open sky, is a subject that has a lot of branches to be taken in consideration by any nation. The exponential growth of this sector put the nations under the responsibility of organizing the national and the international airspace. This paper presents the legislations and the organization of the skies of many nations based on different approaches to prevent crisis in the Civil Aviation under their airspace. The EU laws, takes in consideration the level of safety, and relay on the specific technical specifications to classify UAVs, tallow conditional operations within the other categories without any interference or endanger of lives or properties. The US just introduce the UAVs in the system as a part to operate within each class, with all the obligations of aircrafts. Lebanon adopted a special approach, without any regard to technical specifications nor to the operating system. The UAVs operational system put BRHIA in the center as the most critical point to organize, and to manage the airspace over and around to prevent crisis. Going from the centralized system to the open national airspace with some limitations under the Lebanese Army regulations. The special laws concerning the UAS still an attempting of a cumulative understanding that present a part of the prevention which is the first step of the crisis management. The implementation of risk assessment and risk analysis leads to update the knowledge and thereafter improve the legislations. More after the importance lies in setting up a mechanism for implementing those laws and find the capabilities to control the airspace from any intentional or unintentional misuse. This paper presented the white use of the civil unmanned aircraft vehicles, the legislations and the organizations, without turning to the military use nor the intentional harmful use.

In comparing apple to apple, this paper is not to compare the small Lebanese country to the EU nor to US. It's just an understanding to the existing and evolving systems with the new technology that invade our present and prepare the future to come. The need of a better comprehension of UAVs requires more researches and ideas constructed on the analysis that result of the development of knowledge in this sector.

Acronyms

ANC: Air Navigation Commission	LUC: Light UAS operator Certificate
ATC: Air Traffic Control	LWA: Sound Power Level
AIP: Aeronautical Information Publication	MTOM: Maximum takeoff Mass
BRHIA: Beirut Rafic Hariri International Airport	MSL: Mean Sea Level
BVLOS: Beyond Visual Line of Sight	MPWT: Ministry of Public Works and Transport
DGCA: Directorate General of Civil Aviation	RPAS: Remotely Piloted Aircraft System
EASA: European Aviation Safety Agency	RF: Radio Frequency
EU: European Union	RI: Runway Incursion Organization
FAA: Federal Aviation Administration	RPV: Remotely Piloted Vehicle
FTN: Tracking Number	SOGARA: Specific Operational Ground and Air Risk Assessment
HLSC: High Level Safety Conference	STS: Standard Scenario
ICAO: International Civil Aviation	UAV: Unmanned Aerial Vehicle
ICAC: International Civil Aviation Convention	UAS: Unmanned Aircraft system
IFR: Instrument Flight Rules	USNAS: U.S. National Airspace System
ID: Identity Card	VLOS: Visual Line of Sight
LAR: Lebanese Aviation Regulations	VFR: Visual Flight Rules
Lg: is the base 10 logarithm	WLAN: Wireless Local Area Network

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