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

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The main objective of this study is to represent how the International/ national regulations and the importance 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.

RPAS, Drones, Safety, Security, الكلمات
Aircraft, Risk assessment, Airspace

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 Gundel, 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).

مقدمة

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 led 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

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 Parliament, 2015/0277(COD)), and the wide-ranging of UAVs in Europe, the European Parliament and the Council of the European Union established EUASA (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 that 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).

On 12 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 after 4 years 81 dB, and if equipped with an on function follow-me mode UAS must be in

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,

National security area (NSA)
Air Defense Identification Zones (ADIZ).....

: Regulations presented the UAS operations regarding 1Figure categories

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

Class Airspace	Airspace	Flight Visibility	Distance from Clouds	Entry Requirements
Class A	10,000 ft MSL, 175,000, (2 miles radius 1000)	Not applicable	Not applicable	ATC clearance
Class B (Class B airspace encompasses specific airports including the airspace from portions of Class E airspace that extend beyond the Mode C/ Mode S 10000 ft MSL)	10,000 feet MSL	3 statute miles	Clear of clouds	ATC clearance
Class C (Each Class C area is individually defined)	Surface area = 1.25 NM radius. Outer circle with a 10 NM radius; the outermost circle 1,200 feet to 10,000 feet above the airport elevation with operational control tower	3 statute miles	1,000 feet above 300 feet below 2,000 feet horizontal	Two-way radio communications per se only
Class D (Each Class D airspace area is individually defined)	1,200 MSL feet above the airport elevation with operational control tower	1 statute mile	1,000 feet above 300 feet below 2,000 feet horizontal	Two-way radio communications per se only
Class E (Controlled airspace not classified as Class A, B, C, or D)	1. 10,000 feet MSL with bases = 10,000 feet MSL, unless base is 10,000 feet MSL. In some cases, airspace may be 1,200 feet AGL, other cases, 100 feet AGL. All airspace above 10,000 ft Class E.	At or above 10,000 feet MSL, 1 statute mile. Less than 10,000 feet AGL, 1 statute mile.	1,000 feet above 300 feet below 1,000 feet horizontal	None for VFR
Uncontrolled	1. The base of the underlying Class E airspace	1,200 feet or less above the surface, regardless of MSL, clouds/Ob, except as provided in section 91.119(d)	1,000 feet above 300 feet below 2,000 feet horizontal	None
	2. 100 feet or less above the surface, regardless of MSL, clouds/Ob, except as provided in section 91.119(d)	1 statute mile	1,000 feet above 300 feet below 2,000 feet horizontal	no authority ATC Minimum visual flight rules (VFR)
	3. More than 1,200 feet above the surface but less than 10,000 feet MSL, 1/2 mile	1 statute mile	1,000 feet above 300 feet below 2,000 feet horizontal	
Class G (The portions of the airspace that have not been designated as Class A, B, C, D, or E)	1. More than 1,200 feet above the surface but less than 10,000 feet MSL, 1/2 mile	1 statute mile	1,000 feet above 300 feet below 2,000 feet horizontal	
	2. More than 1,200 feet above the surface and is not horizontal above 10,000 feet MSL	1 statute mile	1,000 feet above 300 feet below 2,000 feet horizontal	

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

Airspace Regulatory	Categories Types
A/B/C/D/E classes	Controlled
G class/ no authority Air Traffic Control min Visual Flight Rules	Uncontrolled
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)	Special use
Local airport advisory (LAA) Military training route (MTR) Temporary flight restriction (TFR)	Other airspace

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.

استنتاج

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

- 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 A are 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 under 1500 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

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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 Navig
ATC:	Air Traffic
AIP:	Aeronauti
BRHIA:	Beirut
	Airport
BVLOS:	Beyond
DGCA:	Director
EASA:	Europea
EU:	Europea
FAA:	Federal A
FTN:	Tracking
HLSC:	High Le
ICAO:	Internati
ICAC:	Internati
IFR:	Instrumen
ID:	Identify Can
LAR:	Lebanese
Lg:	is the base

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