COMMERCIAL DRONES

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I. INTRODUCTION

Drone or Unmanned Aerial Vehicle (UAV), as the Internet, invented for military purposes then organizations and individuals found their ways to utilize it (Anderson, 2012). Many leading companies, such as Google, Facebook and Amazon are racing to utilize drones, in their businesses. The commercial drones market has attracted companies from all types to invest drastically in it because of its diverse applications and promising future. The use of commercial drones has increased significantly in some European and Asian countries like UK and Japan. However, The U.S Federal Aviation Administration (FAA) has yet to establish regulations for operating the commercial drones (Ballve, 2015).There are many industries that have plans for employing commercial drones technology, but the focus of this report is to explore this technology in four applications: Farming, entertainment, delivery and logistics as well as filmmaking and photography. Potential benefits and associated risks with each application will be discussed in detail after displaying short background about the commercial drones market and technical details.

1.a Origin

Only when viewers spotted a chopper flying through a narrow shaded canal which wasn't possible for any helicopter, they realized that it's not a helicopter but a Drone. Military drones are used since the First World War, but the civilian and commercial uses of drones have expanded considerably in the last decade. Jeff Bezos, the CEO of Amazon said on '60 Minutes' that they will be using drones for packet delivering in the coming few year. This is when the world saw drones being introduced to the commercial world (John Lantigua, 2013). But Drones were already being used for limited commercial application like photography and agriculture. March 8th 2005 FAA approved the commercial usage of drones for Right Angle Photography, LLC. Since then the FAA has approved the commercial drone usage for hundreds of companies (Ben Popper, 2015).

1.b The Industry Market and Players

Civilian Drones market is worth 2.5 billion worldwide with an increase of 15-20% each year (Dillow, 2014). Moreover, the U.S commercial market of drones is projected to be $13.6 billion in the next years and five doubles this number by 2025 with more than one hundred thousand of job opportunities. (Jenkins, &Vasigh, 2013). According to Ballve (2015), the two biggest players in the global industry are DJI and Parrot. DJI is a Chinese company produces drones for hobbyist and commercial uses. Parrot is a French company that develops drones mainly for consumers. Anyone can buy its quadcopter toy from Amazon and fly it using a smartphone application (Anderson, 2012). In the USA, Boeing' subsidiary, Insitu, has developed its drone "ScanEagle 2" to enter the civilian drones market. Another American player is Airware, which develops drone software, hardware and cloud services for commercial drone business and creates application specific solutions. Furthermore, well-known companies like Amazon and DHL have experimented with drones for delivery. Also, Facebook through its project internet.org will use drones to offer free Internet to areas where there is no connection. On the other hand, Google has two projects for drones. One is similar to Amazon's package delivery project and the other is similar to Facebook' free Internet project (Ballve, 2015).

1.c Related Technology

Drones technology intersects with many other technologies. First, a distinction must be made between remotely controlled drones and autonomous drones. Remotely controlled drone requires a pilot that drives it from a distance, while autonomous drone is self-driven, which mandates the use of robotics. Many applications of drones depend heavily on the quality of images that are taken by cameras attached to them as well as the quality of data collected by sensors. Therefore, using stabilized video cameras with powerful capabilities to handle hovering circumstances, such as vibrating, is crucial. Transferring data from drones to ground and vice versa is usually done through radio transceivers that communicate using the same frequency. An important feature of drones is collision avoidance capability, which directs drones to change their altitude to a higher or lower level to avoid hitting objects. In addition to that, Global Positioning System is very important component of drones to be able to navigate in sky. Software, including operating systems and other applications, is the Mainstay of all other technologies (Ballve, 2015).

II. TECHNICAL DETAILS

To understand the potential implications of drones, brief technical background is needed. Drone technology is in an advance stage today in many fields. The sub parts that are used in making a drone altogether make it a powerful device. The components that are used mentioned below:

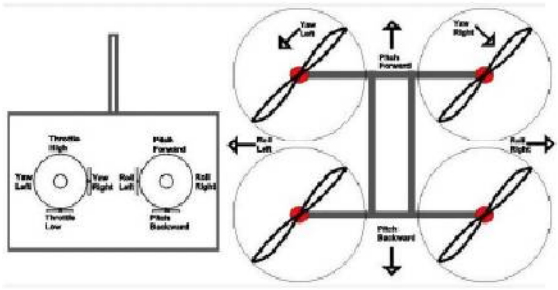
- **Propellers:** The pilot controls the propellers manually where the intensity of the spin is

proportional to the intensity of the movement of the drone.

- **The Frame:** Frame of a drone connects all the components together.
- **Camera:** Drones come with camera, which allows them to record video on air or take photographs.
- **Electric Speed Control:** This component connects the motor and the battery. It sends a signal to the motor to control the speed of the spin.
- **The Flight Control Board:** The flight control board is the component which gives command for the operations of drones.
- **Transmitter:** This component is the remote control of drone. It sends signals to the drone which is understood by the receiver (UAVCoach, ND).

CAS (Collision Avoidance System), which was developed by NXP provides the drone with a virtual sensor, enabling the drone to build 'mental maps'. The sensor constantly assesses the environment in which the drone is operating. The CAS systems are capable of scanning ultra quickly helping in detecting the obstacles and prevent collision. Data from CAS and ITS can be combined, to foresee the danger and act accordingly (Dronelife News, 2014)

The four main controls of drones are Roll, Pitch, Yaw and Throttle described below in detail.



- **Roll:** Roll helps in left right movement of the drone.
- **Pitch:** Pitch helps in forward and backward movement.
- **Yaw:** Yaw rotates the drone clockwise or anti clockwise.
- **Throttle:** The Throttle gives power to the drone (UAVCoach, ND)..

III.COMMERCIAL DRONES APPLICATIONS AND THEIR IMPACTS

3.a Delivery And Logistics

Potential Impacts:

-Short term

While talking about logistics and delivery, one thing that comes to minds is the mode of transportation for delivering packages to different places. Till today we have various modes of transportation such as airways, roadways and waterways. Yet there are some problems with the existing modes, like remote places where there are no paved roads or railroads and places where roads are blocked with traffic or catastrophes. To overcome these issues, many companies have started planning to use drones as the new mode of delivery. In this field, drones will be utilized for express delivery of goods and urgent items, like laboratory tests and emergency supplies to isolated areas after natural disasters (Gonzalez, 2013).

In a recent research conducted by the National Aeronautical Center (NAC), it is found that the increase in fuel prices and the expected increase in international freight volumes have directed the attention toward using drones as an alternative mode of delivery. It is also found that more than 25 out of 60 logistics carriers think that drones will be used for shipping in the future, which most of them believe it is not far than 15 years from now (Green, 2014).

The C.E.O of Amazon, Jeff Bezos announced that amazon is testing the idea of using drones as the mean to deliver packages to customers in a T.V. Program show "60 minutes". Amazon also released an 80 second video, which highlighted this idea under the name of "Prime Air". Many strategic goals motivated Amazon to think of this project. First, "Prime Air" promises to deliver packages within 30 minutes, which would increase customer satisfaction and give Amazon more control of its distribution instead of depending on other carriers. Furthermore, "Prime Air" would allow Amazon to compete against any other instant delivery services from online or physical stores (Rubin, 2014).

Drones might be seen delivering items, such as drugs and food in addition to mail. Companies, such as TacoCopter, that delivers tacos to customers in San Francisco using unmanned helicopter, are very likely to use drones before the others (Rubin, 2014).

-Long term

While drone delivery to end-customers houses within short distances and to rural and isolated areas during emergencies time is more likely to happen in the near future, using larger drones for long flights, such as transferring stocks between warehouses, might be delayed. UPS, FedEx and other carriers could apply that in their operations; for example, large drone could be used to move huge payload to a certain area then to release smaller drones to deliver customers' packages (Rubin, 2014).

Associated Risks:

In the NAC' survey, logistics carriers expressed their concerns about the payload of drones and their ability to replace other shipping methods as a feasible alternative, which poses a technical challenge on drones' makers (Green, 2014). However, military

drones could carry more than 6,000 pounds to war locations. This implies that the payload weight is not a big obstacle for drones' designers, but it is big obstacle for safety since using larger drones poses higher threat of dangerous collisions. The safety concerns, particularly in high-populated areas, and law requirements that might limit flying drones within specific distances are the biggest challenges for this application (Ballve, 2015). Even though many people are expecting to see drones taking the place of FedEx and UPS soon, it is very optimistic expectation currently. Drones face other technical hurdles, like short battery life and inconstant location data as well as obstacles, such bad weather and aggressive birds. FedEx and UPS have already declared that this technology remains distant from market ready. Moreover, as per Amazon plan for their copter drones, 5 pounds packages would be carried for 20-mile round trip route. This task is unrealistic with the eight-rotor prototype, but Google' design seems more feasible, which is a hybrid drone with propellers and wings. However, recently Google canceled the prototype because it was unreliable, less wind-resistant and hard to control (Nicas, &Bensinger, 2015).

3.b Entertainment
Potential Impacts:
-Short term
Nowadays, any hobbyist can buy a drone for $1000 or less from amazon. DJI, Parrot and other manufacturers produce drones with similar features to military ones. These manufacturers also face fierce competition worldwide from dabblers who formed online community where they can share their ideas and develop drone designs (Anderson, 2012). It is not a strange scene to see one of these drones flying in the sky on weekends since the US law allows their possession, but they must stay underneath 400 feet within visual observable pathway and far from restricted areas. For hobbyists, the main uses of drones are experimentation, fun and photography (Ballve, 2015).

-Long term
The increase in number of hobbyists and their interaction in online communities, similar to what happened in the world of open sources software, would lead to advancements in drones designs and applications in terms of software and hardware. This might be the motivation for 3D Robotics, An American UAVs vendor, to make its OS open source (Anderson, 2012).

Associated Risks:
The society is highly concerned about the privacy invasion issues that might arise from consumer drones. Individuals may use drones to spy on their neighbors or other people. This possibility is worsened by the fact that high quality cameras that are designed by vendors, such as GoPro, soon will be attached to drones. Safety concerns are much more serious since these drones could jeopardize the life of people due to collision accidents or used by enemies to spy on government buildings or to perform terrorist attacks (Ballve, 2015).

3.c Filmmaking and Journalism
Potential Impacts:
-Short term
In the USA, the commercial drones usage is still banned, but permissions could be granted after submitting a request for exemption. According to Naylor (2015), till September this year about 1300 businesses have gotten approval from FAA to operate drones for commercial usage. Most of these exemptions are given to film production companies in Hollywood. In 2012, Drones used to shot James Bond movie "Skyfall" in Istanbul (west, 2015). Minimum concerns are linked with this industry because the drones will be flaying in filming locations only. Films, which half of their scenes at minimum were shot using drones, participated in the first drone film festival, which took place in New York in March 2015. Randy Scott, the organizer of this festival, said soon drones will be essential for every movie set (Burgess, 2015). However, the market of drones in this industry is not expected to be large compared to other applications (Ballve, 2015).

Various media organizations have started using UAV to gather images and information, for news and reporting. In dangerous situations, such as radiation, bombing, wars and natural disasters, drone equipped with cameras, sensors and GPS would be a great help in reporting without risking reporters' lives. The sensors attached to drones can collect and measure many types of data, such as weather, temperature and radiation. Another stimulus for drones' utilization in this field is their low cost compared to their benefits, which makes drones a preferable option over helicopters. Furthermore, drones can reach places where helicopters cannot go and capture images from different point view, for example take images for volcanoes or forest fires. The Daily, an American news corporation, was one of the pioneers to use drones in newsgathering. In 2011, The Daily used drones to shoot the North Dakota' flood and the tornadoes in Alabama (Syed, &Berry, 2014).

Among some universities, which have started their drones' experimentations and research work for journalism, the University of Nebraska-Lincoln drone journalism lab is the most well-known effort in this field (Culver, 2014). CNN is also testing drones uses in their work (west, 2015). With the existence of open airspace, competitive market accompanied by price reduction of drones and their accessories like sensors and cameras, news organizations would expand in drones' adoption for news gathering (Culver, 2014).

- Long Term

The founder of Nebraska drone lab believes that drones would provide four benefits in the future in the field of journalism: "aerial images, live-streamed video, digital mapping, and analytic data" (Culver, 2014,p.58).

Associated Risks:

Using a drone to deliver drugs or food supply during catastrophes is acceptable by public, but for streaming live game at a stadium might not be acceptable. Causing injuries to people or damages to properties are possible scenarios for drones' adoption. Moreover, the interpretation and credibility of images taken by drones could be affected since they will be out of their context, for example, in photographing a protest, drones could take many pictures of proponents and few for opponents that do not tell the truth about the actual number in both sides. More threatening is the privacy concern that media organizations would spy on people lives or help authorities in their surveillance activities (Culver, 2014).

3.d Farming

Potential Impacts:

-Short term

Drones usage in farming is invaluable. They are used to provide farmers with critical data about crops and soil, for example, sampling vineyards from aerial view to decide on whether grapes are ripped or not or whether soil has enough water or not. Monitoring health of crops or livestock settings and spraying pesticides, fertilizers and chemicals are some of the drones' duties in the field. Doing all that by humans for huge farms is costly and exhaustive. Ground checkup might not be precise as aerial monitoring and might not find problems quickly and timely. Developing countries might benefit a lot from this technology because drones can cover large farming areas with low cost (Moskvitch, 2015). One of the approved drones in the US is the eBee Ag, produced by senseFly for agriculture market (Ballve, 2015).

- Long Term

With the increase in world population and the need to larger volume of crops to feed them, larger farmlands are the solution. These huge farmlands require precision agriculture that relies on GPS and big data analytics (Moskvitch, 2015). "The term precision agriculture refers to the management of crops to guarantee efficiency of inputs like water and fertilizer and maximize productivity, quality, and yield. It also involves the minimization of pests, unwanted flooding, and disease" (Ballve, 2015, p.1). Drone technology would contribute to increase the harvests and minimize the usage of pesticide and water. Data gathered by drones would help farmers make important decisions to achieve "precision agriculture" (Moskvitch, 2015, p.3).

Associated Risks:

Drones would handle hazardous chemical that might jeopardize people safety. The possibility of hitting people, livestock or other objects might lead to a disaster. Furthermore, a person with bad intentions might use drones to spray some harmful chemicals or harm livestock (Moskvitch, 2015).

IV. COMMERCIAL DRONES RISKS

In the Short Term

4.a Regulation

The rules that regulate UAVs flights in the commercial arena are expected to issue in 2017 or earlier by FAA. Till that time, case-by-case approval is the only way to experiment drones for commercial purposes (Ballve, 2015). "The FAA is estimating that by 2018, there will be seventy-five hundred commercial drones in use in the national airspace" (Using Drones", 2014, p.267).Integration of drones into the aviation system should be carried out in a safe and appropriate manner and this integration should strengthen the United States drone industry. Privacy and security demanded by drone operations should be addressed carefully as the safety risk will be managed at National Level ("European Aviation Safety Agency", 2015). There are consequences to violate FAA regulations. Drone operators might be fined up to $15000, for unauthorized commercial drone usage. But, if the drone operations were not reckless then the FAA would issue warning letters only (Wright, &Yahn, 2015).

4.b Safety and Privacy Concerns

The fact that drones can collect data and take photos and videos scares many people since government or individuals can use them to spy on citizens and violate civil liberties. Pictures and videos are not the only data that can drones gather. Some drones will have the ability to eavesdrop on phone calls and data that transfer over the Internet (Ballve, 2015). Privacy is a legal right, but drones are just devices that can collect data like surveillance cameras and smartphones. Therefore, regulators should emphasis on the illegal activities rather than the tool used (west, 2015). On the other hand, safety concerns are driven by the fear of accidents and collisions, especially in high-populated cities. Many cases were reported where a drone crash caused humans injuries and properties damage, but few cases for death. The loss of control over drones is common because the data transmission between the controlling device and the drone could be interrupted. In addition to that, incidents where drones used to deliver illegal substances have occurred, for example, a drone used in Georgia to deliver tobacco into a prison (Preble, 2015). The list on criminal activities that may involve drones goes on, including terrorism. To conclude, privacy and safety concerns might delay the commercial drones usage in many markets, but these

concern might be mitigated by the advancement in the technology, such as collision avoidance system and software security systems.

In the Long Term

4.c Technical Hurdles

Many technical hurdles if were solved would help the society and regulators to accept and trust drones usage. Collisions and objects avoidance is one area that requires more research and development. Currently, two methods are proposed: Image recognition and echolocation. In addition, some companies are working on"sense and avoid" technology that allow drones to automatically avert from close objects, DroneDeploy for example developed a software that scans and observers the airspace for obstacles continually (West, 2015). The ability to avoid hitting people and objects as well as changing the altitude accordingly is crucial to safety. Another area that needs more research is the drone generator power. The average flight duration of available drones in the market, such as the popular DJI Phantom 2, is about 30 minutes and the maximum payload size is one pound. For drones to takeoff, vendors have to produce drones that can fly longer. An attempt to do that has begun by a startup called Top Flight. It works on hybrid propulsion as a solution to the battery issue.Gasoline-powered generators would be carried on drones to charge batteries while flying. This would result in extension of flight duration to 2 hours on speed up to 35 miles per hour (Belfiore, 2015).

There are some features that would improve drones' feasibility. Geo-fencing is a feature that would keep drones away from restricted areas; this will help in avoiding law violations. Also, software security is very important to prevent unauthorized individuals from controlling drones and using them in criminal activities, such as terrorist attacks. In addition, virtual-reality piloting is a feature that would help flying drones far from the line of sight by using special cameras to simulate the real piloting experience (Ballve, 2015).

V. Suggestions & Future Vision

To mitigate privacy, safety and regulatory risks, public awareness is a necessity. Companies should collaborate to make people, especially decision makers, aware of drones' benefits. FAA's test sites are suitable places to display and prove the technology reliability and its capability. Drones vendors should take this in their responsibility since they are the biggest beneficiaries of removing the ban on their commercial usage. On the other hand, drones' owners that fly them for recreational purposes should obey the law and be responsible since incidents, like flying a drone close to the white house fence, would increase the fear and raise public concerns. In addition, rules makers should be more positive toward technological advancements and think reasonably of both negative and positive sides (West, 2015). Finally, The International Civil Aviation Organization, which is responsible for publishing international aviation standards and practices, could not set guidelines for drones' flight at low altitude. This is because no standardization exists in drone hardware or software industry followed by manufacturers (West, 2015).Drone Industry Standards Body was formed to solve this issue. It calls for manufacturers and public support as well to create industry standards that would make operating drones easer and safer while reducing risks associated with this technology. In addition to that, standers will help regulators to issue rules that govern commercial drones usage quickly and precisely ("The Drone Safety Council", ND).

A promising project that many researchers are working on is drones air traffic control system. NASA, FAA and other private companies have partnered to develop this project, which would create the base for controlling the commercial drones flights and insure safety (West, 2015). There are some startups that are working on the same field, for example, SkyWard is working on "drone dispatching and routing software that would treat drones like packets in the Internet by routing each unit to its destination via the optimal path while avoiding collisions" (Belfiore, 2015, p.1). Another company is Exelis, "which plans to add drone tracking to the system it built for the FAA and that is already in place for tracking manned aircraft" (Belfiore, 2015, p.1).

Regarding the future vision of the commercial drones market, many analysts see the future in "drones as services" business model and think that it will outstrip the drone hardware market itself. Once the FAA approves the commercial usage of drones, many companies and individuals like farmers would want to get advantage of drones' capabilities without spending on hardware and software or waste time to learn how to use them. The best solution for them would be outsourcing. This in turn will encourage companies to adopt "drones as services" model and start to lease drones and offer other services like data analytics. One of this model pioneers is Fly4Me, a Massachusetts-based startup that got exemption from FAA to employ drones commercially in aerial data gathering and research projects. The Fly4Me' website connects drone pilots with companies that need aerial data gathering (Dillow, 2015).

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