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A Study on the Development of Aircrafts and Problems of Drone Taxis

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Abstract

The people have been obliged to continuously travel since the date of their existence. And travelling has brought along a diversification in transportation systems. In the initial periods, it had been travelled with automobile, train or ship. But since the ancient times, flying had been one of the biggest dreams of human beings. Many attempts had been made in the direction of this purpose. Thus, initially kites had been invented. Hot-air hydrogen balloon, glider, zeppelin, first controllable motorized plane, and jet motor planes being used today had followed-up the kite. Airline transport had been preferred much due to its advantages compared to other transportation types. And as the result, many investments and attempts had arisen regarding airline transport. Airline transport had become widespread along with the investments made and the developing technology, and new aircrafts had started to be produced.

Especially in recent times, pilotless, remote controlled unmanned aerial vehicles, in other words drones have started to be produced along with the development of technology. In the aviation sector, in which new developments are continuously occurring, drones have also been started to be improved since their production. Drones, which can be controlled remotely, and which can be used with / without pilot, are especially being used in military for military and tactical purposes. In addition, they have also been started to be used in civil life. In civil life, they have been started to be used for things such as aerial

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advertising shootings, observation of forest fires, control of energy transmission lines and transportation lines, environmental inspections and land surveying.

In parallel to the developing technology the usage area and usage frequency of drones are also increasing. It is inevitable that the drones, which are being planned to be used as air taxi in the following periods, will bring along some problems along with solving many problems. In this study, it has been urged upon the possible problems of drones which are being planned to be used as air taxi in the future, and suggestions have been provided.

Keywords: Aircrafts, Drone, Unmanned aerial vehicles

Introduction

Along with the development of technology, changes had occurred in the construction and design of aircrafts. The construction of the first plane produced was based on wood and impregnate. The flight controls were being performed with the assistance of steel wires. And today, they are being performed with the assistance of fibers (carbon, polyester etc. fibers), metal systems and other similar techniques, and composite materials. But in order to save fuel, it has been concentrated on finding lighter materials, and as a result a new material known as "metal foam" had been invented. Aircrafts are continuously changing and improving means of transportation in terms of construction, form and equipment. They are being preferred much due to its advantages especially regarding speed, and thus their usage is increasing day by day. Along with globalizing world and the rapid improvement of technology, airline transport sector had shown a great development, and flights to long-range distances had been performed. While flights taking just couple of minutes were able to be performed along with the aircrafts built in the initial periods, intercontinental flights are able to be performed by the aircrafts of the recent era.

Along with the developments in aircrafts, pilotless unmanned aerial vehicles that can fly without pilots had been produced. While these aircrafts that can be directed with remote control were initially being used only in military, they have started to be used also in civil life today. The aircrafts, which started their flight adventure along with kites, are sustaining their improvement by aircrafts having unmanned flight capability. In other words, unmanned aerial vehicles named as drones have started to be used at many enterprises. While they are being used for military and tactical purposes in military, they are being used in fields such as advertising shootings, environmental inspections, control of energy transmission and transportation lines, forest fire observations in civil life.

In this study, it has been spoken about the historical development of aircrafts, and some syllogies have been made about the unmanned aerial vehicles (UAV).

The legal dimension of unmanned aerial vehicles has been examined superficially. And then it has been urged upon drones which have not started to be used yet, which is production phase, but which is planned to be initiated, and forecasts have been made about the problems it will cause, and solution suggestions have been presented.

1. Development of Aircrafts

In the direction of the demands of humanity for sped, comfort and safety, researches which would cover a long period have been initiated in the domain of aircrafts. As the result of researches and various attempts, the idea that the human being may fly had been adopted, and many studies had been made on the subject. As the result of the studies performed, balloon had been invented, and the first flight with balloon had been realized. And then zeppelin, gliders and finally the planes had followed these developments. And among the planes, first the propeller planes, and then steam, piston planes, jet and rocket motorized planes had been invented. And the UAVs, as the most recently developed aircrafts, have took their place in aviation sector.

1.1. Invention and Development of Balloon

Considering the first studies in the domain of aviation, we are encountering the balloons. The invention of balloon, and studies on balloon are based on years 1782. Montgolfier had performed his initial trials in 1782, and he had put his stamp on history as the first individual succeeding to fly the balloon. As the result of continuing studies, the volume of the balloon had been extended, and balloon of 800 m^3 had been produced. In the initial periods, hot-air had been

obtained by burning wool and straw, and the balloons had been blown up by this method. Thus, it had been ensured for the balloons to elevate up to 1,500 meters. During the initial trial, the flight had been successfully completed despite burning of the balloon (Yalçın, O. citing from Kurter, A. 2016, p.7). Again in the same period, Professor Charles, who was a physics professor, and who was living in Paris, had decided to test the flight of balloon with hydrogen gas. As the hydrogen gas is lighter than air, the flight had been realized successfully. In addition, animals such as sheep, rooster and duck had been placed in the basket under the balloon, and the initial flight of a living being had been realized. And then in 1783, Pilatre Rozier had succeeded in staying for 4 minutes in the air by rising 25 meters with a balloon connected to rope. That flight is of great importance for aviation. Because it had been understood that the balloons could be used for military purposes. Thus, the studies on balloon had increased, and balloon of silk fabric had started to be sewn as being submerged in varnish. In addition, anchor had been included in the balloon as to be used during landing. In order to prevent the tearing of the balloon, the release of gas had been ensured by applying valve (Kansu, Y. Şensöz, S. Öztuna, Y.**1971**).

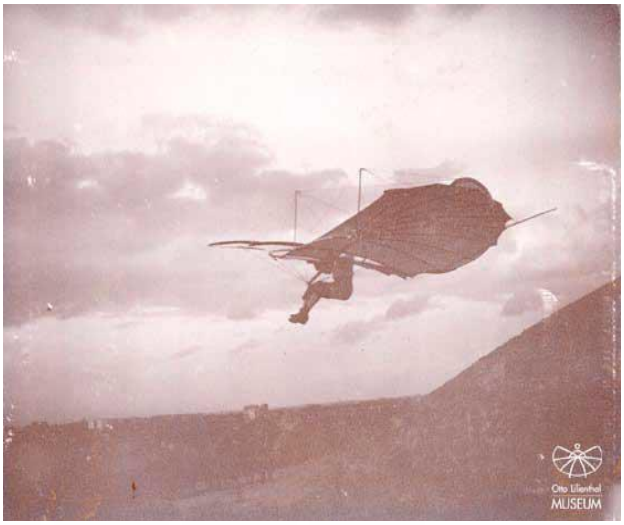
These principles applied by Professor Charles are still being applied on the balloons. These developments in the domain of aviation had continued as based in France until the first quarter of twentieth century. And then England had become acquainted with balloon, and had stepped in aviation. But in 1785, a balloon had caught fire and burned at 25th minute of flight, and the first aircraft accident had occurred. 2 people on the balloon had died. In the following periods, flights with balloons had continued. In between 1783-1900, 20,000 individuals in total had flown. The number of individuals who died at these flights is 20. And when considered as percentage, this figure is corresponding to a rate of one in a thousand. Thus, this rate is important in terms of safety and reliability of aviation. When it was reached to 1800s, balloons that could reach to a distance of 800

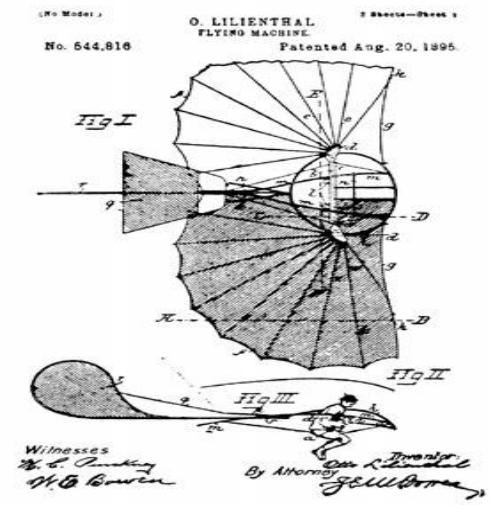
kilometers and that could stay in the air for 18 hours had been developed. In that period and in the following periods, the balloons had started to be used with military purposes. The balloons had been extensively used in military especially for observation purposes. Thus, the first practice of modern aviation had started with the balloons (Kansu, Y. Şensöz, S. Öztuna Y.1971).

1.2. Invention and Development of Glider

The non-motorized aircraft, that can take off due to its wings under suitable weather conditions, and that can fly for a long period, is being called "Glider". When the history of glider is considered, it is being observed that it is extending to 1800s. Sir George Cayley had designed for the first time in 1815 the glider that was heavier than air and that could fly with people. He had tried to measure the characteristic of glider by calculating what kind of friction and lift force was being applied under all kinds of weather conditions. In that measurement, he had used a twisted arm with a length of 1.52 m. (Başol, S. 2013:6). In the following years, Alphonse Penaud had been the person flying for the first time with structural balanced model plane. He had realized a flight of 11 seconds and 40 meters in total. That plane named as Phanophore has the qualification of being the first structural balanced non-motorized plane in history. In the following years, a German engineer Otto Lilienthal had invented the glider (1886), and had gained the title of the father modern gliding. (https://www.makaleler.com Access Date: December 23, 2018).

Picture 1. 1895 Glider of Otto Lilienthal





Source: Hosseini, K. History of Aircraft

The invention of glider, which is one of the most significant stages of transition to motorized planes, and flights with glider, had increased the wishes for aviation and flying.

1.3. Invention and Development of Zeppelin

Zeppelins are a kind of airship, and they are aircraft being used with the purpose of transportation. It is able to travel by forming driving power due to its motors. It has rudders enabling the direction in air. In its lower part, there is passenger cabinet used to transport the passengers. The inside of the zeppelins, which have the form of cigar, were being filled with hydrogen in the initial periods. But following the Hinderburg disaster of 1937, helium had been used instead of hydrogen. Zeppelins are within the group of aircrafts lighter than air (https://tr.wikipedia.org Access Date: December 23, 2018).

In 1851, Henri Giffard had built the first propeller powerful zeppelin in cigar form with a length of 44 meters whose inside was filled with gas, and which had 3 horsepower (2.2 kW), and which was operating with steam engine. (https://science.howstuffworks.com Date of access: December 23, 2018) And then in 1900, Ferdinand Von Zeppelin had invented the first hard airship. That zeppelin had been named as LZ-1 (Luftschiff Zeppelin). It had a width of 12 meters, and a length of 128 meters. It was containing 11,300 meter cubes hydrogen, and was produced of cotton fabric with rubber. It had internal combustion engine system. Its first flight had been realized in 1900 with a period of 20 minutes. (http://www.zeppelinhistory.com Access Date: December 23, 2018). By the beginning of 1900s, many zeppelin models had been built, and they had been used both in military and civil domains. (https://science.howstuffworks.com Access Date: December 23, 2018).

The usage rates of zeppelins, which were extensively being used in those periods, had decreased very much towards the end of 1930s. The costs of zeppelins, their slow speed, and their sensitivity under negative weather conditions had been indicated among the most significant reasons of that condition. Along with the Hindenburg explosion, and the progress in 1930s in aircrafts heavier than air, the use of zeppelins had been ceased (https://www.britannica.com Access Date: December 24, 2018).

1.4. Invention and Development of Plane

The civil aviation has an evolution starting with propeller planes, and progressing with steam, piston, jet and rocket motorized planes. Many trials and studies had been performed on flying since the past. The aircrafts lighter than air had been invented, and in the following years, that progress had been maintained by the invention of aircraft that were able to transport people and that were heavier than air.

When the development of planes since the initial studies is examined, it is being observed that the studies of George Cayley are important. He had generated 55 plane projects in total in between years 1796-1855. But it had been understood that additional force was required for flight. In between 1863-1865, Jean De Lowrier had built and had had registered its projects named as reaction engine, plane and rocket dynamic. And then he had started to make studies on motorized vehicles, and in 1878 Vicor Tanin had built a plane engine with a weight of 300 grams operating with compressed air. By that engine, the plane had reached an elevation of 1.5 m. In the following years (1894), Maxim Hiram had built a large plane, and had realized the first wind tunnel trial. And in the same period Otto Lilienthal had invented glider, and the need for engine power had came up for it to perform long flights (Kansu, Y. Şensöz, S. Öztuna, Y. 1971:83-85).

When the history of aviation is considered in modern sense, the first flight trials of Wright Brothers are coming into prominence considering the past knowledge. The Wright Brothers had their first plane fly in December 17, 1903, and that plane had been built as adhering to aerodynamic sound theory, and it had two propellers. The weight of the plane was 335 kilograms along with the pilot. In their

first trial, they had succeeded in flying for 12 seconds and 37 m, and in their following trials, they had succeeded in flying for 59 seconds and 260 m. Thus the idea of flying of objects which are heavier than air had been physically actualized, and it had paved the way for developments in the domain of aviation (https://www.herkesebilimteknoloji.com Access Date: December 30, 2018).

In the following periods, a very rapid development had occurred in the domain of aviation, and plane factories had been established and many plane models had been developed. Along with the use of planes especially during World War I, and their active role in World War II, the planes had been well developed, and new features had started to be added. While one-man planes were present in the initial periods, the seat capacities of the planes had been increased in time, and visible great changes had been made in their sizes. And the engine types had showed a great improvement from steam to piston engines, and from jet motors to rocket motors along with the developing technology and studies (Bakırcı, M. 2012: 342). While planes with a passenger capacity of 180 individuals were attracting great attention by the end of 1950s, today double engine planes with large body with a passenger capacity of 853 individuals are taking place at the forefront (https://www.airlinehaber.com Access Date: December 30, 2018).

By the advanced level of technology in today's conditions, significant changes are being made in the design and configuration of planes. Under normal conditions, the flights are being realized by the pilots controlling the plane. But recently, the rapid increase of the number of civil aircrafts, and increase of demand for airline transport have caused the arise of new generation planes. Unmanned, remotely controllable and pilotless planes had been produced, and their usage has become widespread. Unmanned aerial vehicles, in other words

drones which were extensively being used in military domain in the initial times have then started to be used also in the civil domain. And today, they are being used in each domain in a extensive manner.

1.5. Invention and Development of Unmanned Aerial Vehicles

Unmanned aerial vehicles (UAV) are vehicles that can be controlled with remote control, and that have no pilot in it. They are aircrafts on whose body load may be loaded and removed, and which can also direct themselves as autonomously. In other words, they are being known as drones. They had initially been used by Israel in 1970s. It is an aircraft which had come up due to the requirement of exploration and observation. During the Gulf War, two different UAV system of USA had been tried, and they had succeeded. By virtue of the UAVs in subject, real-time intelligence had been ensured, and they had been used in damage determination duties (Pakkan, B. and Ermiş, M. 2010:78).

Regulations in legal respect of UAVs, on whose usage importance is being attached in our country, are being formed and updated. According to article 2 of UAV instructions, the scope of unmanned aerial vehicles are

- *Flying in Turkish airspace,*
- *Not entering the government's unmanned aerial vehicles' space,*
- *Not being among the UAVs and systems being used only in the indoors,*
- *Not being among the unmanned balloons and similar systems which are connected to the ground, or to any platform,*

- *Not being an UAV whose maximum take-off weight less than 500 gr.* (Özkan, H. **2016:360).**

While the rules only regarding the allocated airspaces were regulated in the previous UAV instruction, in the 2nd UAV instructions, regulations regarding non-allocated airspaces had been made and added. Otherwise, the general rules of Turkish Civil Aviation were being considered for the non-allocated airspaces (Özkan, H. 2016:360). Moreover, in article 2 of UAV instruction, a regulation had been made for the UAVs which would be flown or operated at Turkish Airspace. The qualifications that the individuals who will be using or operating UAVs are required to have, and procedures and principles relevant to air traffic services had been updated (https://iha.shgm.gov.tr Access Date: December 30, 2018).

Along with the progressing technology, it is being planned to use the UAVs, in other words the drones as taxi. Despite arrangements and updates in many regulations regarding UAVs, no planning study is being anticipated for the drone taxis that are being planned to be used in the following periods. And in this study, assumptions are being made regarding the possible problems which may arise regarding the drone taxis.

2. Drone Taxis, and Possible Problems

Drone taxis have been designed as to pick up one or two passengers, and they are aircrafts which will perform passenger transportation at specific distances. The first drone taxis models had made debut in year 2016. The model that attracted the highest interest among the exhibited drone taxis is the EHANG184 model produced by the Ehang Company from China. These drone taxis are among the world's first taxis flying individually. Thus, the passenger will be able to go to the point s/he requires without the requirement for any pilot. Moreover, there are no joystick, control panel etc. materials within the drone taxis. Only a 12-inch tablet had been included in the taxi. For

this reason, following the passenger's command for the point of destination via the tablet, the drone taxis will take-off and will drop the passenger to her/his point of destination. Automatic pilot is overcoming the piloting operations such as take-off and landing. One of its biggest advantages is non-requirement of getting flight license by the passenger who will be using the drone taxi due to its autonomy of flight operations **(**https://www.muhendisbeyinler.net Access Date: December 30, 2018).

Drones taxis, that have computer support operating with great algorithms for eliminating human error, for saving time, and for realizing the trip in a comfortable manner, have many features. If it is necessary to list their features in general;

- Charge period of 40 minutes,
- Maximum take-off weight of 450 kg,
- Total passenger weight of 160 kg,
- 100 km/hour maximum speed,
- Elevation rate of 3 m/sec,
- Ability to rise to a maximum flight altitude of 2,000 m,
- Engine series gear width of 7.34 m (http://t24.com.tr Access Date: December 30, 2018).

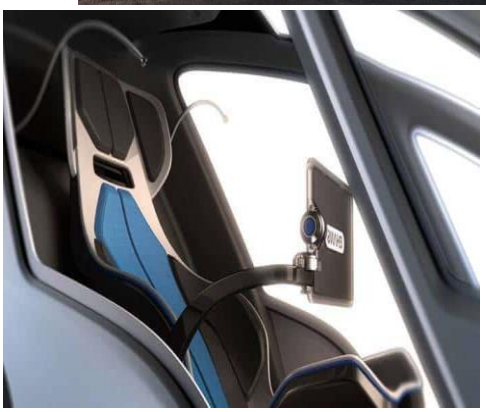
Drone taxis, that don't have a difference from normal drones in terms of flight logic, are allowing the flight opportunity for a single person by virtue of the cabinet it has. Currently, drone taxis models having only cabinets for 1 and 2 persons are available. It is being planned for the models, which were designed only for 1-2 persons in the beginning, to be developed for 4-6 persons in the following periods. And the drone taxis, which have 8 engines in total, are getting their power from electricity. It is being possible for it to stay in the air for 23 minutes at sea level with a passenger of 100 kg in average. This period is varying under changing weather conditions (https://www.elektrikport.com Access Date: December 30, 2018).

And in case of any danger or fault, the drone taxi is landing to the closest point by transiting to safe flight mode. Drone taxis, which can reach to a speed of 160 km., are able to cover a distance of 50 km. when there is completely full. And it is being planned for the control center of drone taxis to be present at an area of 40-50 km. determined within the city (https://webrazzi.com Access Date: December 30, 2018).

There is a small luggage compartment in the cabinet for storing back-packs or small goods. Also lightings inside and outside the cockpit, air-conditioner, 4G internet connection and doors opening in the form of seagull wing are available in the model. Drone taxis have 7 propellers in order to complete the flight in a secure manner against any possible problem to arise during flight in its first propeller, and in order to mitigate the effect of fault in the first propeller (https://www.muhendisbeyinler.net Access Date: December 30, 2018).

Picture 2. Model of Drone Taxi





Source: https://www.webtekno.com, https://www.muhendisbeyinler.net Access Date: December 30, 2018,

It is required to concentrate on the preferability in terms of the passenger of drone taxis which are being considered that they will provide ease in respect of transportation and traffic in the following years. It is obvious that saving in terms of time and traffic is inevitable. But having an autonomous system may greatly affect the preferability of such an aircraft in terms of the passenger. At this point, the trust of the passenger in the autonomous system is important. The lack of the passenger's ability to interfere in case of any flaw, or a fault to arise in autopilot will cause in the preferability rates of the aircraft. First, the impression of reliability of the autonomous system should be imposed on the passengers. The travel of a single person in

such an aircraft may cause uneasiness in the initial periods, and the passengers may exhibit an abstaining attitude on this subject. Thus, communicating in a correct manner to the passenger the issues of what kinds of reactions the aircraft would give in case of any flaw, and general information regarding the drones is very important at this point. The trust of people in autonomous systems is being very low especially in countries where technology resistance is high. For this reason, transition to this system after preparing the society for such an environment will be beneficial for the enterprises.

A second issue is how the air traffic will operate. The unmanned aerial vehicles are generally flying dependant on the air traffic controllers. But as the drones are aircrafts serving as taxis, it is not being known yet to what kinds of a regulation they will be subjected to. It is only being known that the control center will be present at an area of 40-50 km. determined within the city. It is also important whether the drone taxis would cause any congestion in terms of air traffic along with stepping in of drone taxis in the sector. But not making them fly from very high elevations is giving rise to a new problem despite solving the previous problem. The drones flying at close-range will cause sound and noise pollution.

Finally, its cost in terms of the passenger is a subject being wondered. Such a system has an advantage that cannot be ignored in terms of speed and time under today's conditions. But it is being wondered whether people from each segment will easily use this system or not. Drone taxis are creating many question marks in minds due to lack of initiation of their use. But by the advanced level of technology under today's conditions, it is obvious that answers will be found for these questions, and that developments and improvements will be made in that direction.

Conclusion and Suggestions

The people have imaged flying since the very past. They had performed many studies in order to actualize their wishes. They had made drawings by watching the flight principles of birds, and had made inventions in the direction of such drawings. The flight adventure starting with balloon had continued along with the invention of glider and zeppelin, and then it had been understood that an additional force was being required for flying. And as the result of this, motorized planes had been invented. In the direction of this request, many studies, and the efforts and toils of many scientists had been in subject.

In the continuously developing and growing aviation sector, the planes –being the lead actors of aviation- had also continuously developed and evolved. The planes, that are enabling us to actualize transoceanic trips under better conditions and in short periods of time, are becoming more modern and rapid day by day. Along with the development of technology, the planes –produced by top-tier techniques- have started to be encountered with autonomous systems today. Autonomous systems, that are being used for a long period, has gradually started to make its presence felt also in daily life. The UAVs, that are especially being used in military, have also started to be used extensively in civil aviation under today's conditions. The use of the UAVs, in other words the drones -which can fly without pilot and which can be controlled remotely- is gradually increasing in civil domains such as aerial advertising shootings, organization shootings, forest fire observations, control of energy transmission and transportation lines, environmental inspections and land surveying. And the drone taxis, that we recently encounter, are among the final examples in which developing technology is meeting with aviation. It is being expected for the drone taxis, which have not started to be used

yet, to be opened for use in the following years. Thus, assumptions are being made over a specific model in the article. In our article, it had been urged upon the problems of drone taxis which will provide great benefits in terms of time, and alternative solution suggestions have been presented. It is being assumed that the usage rate of drone taxis will be low at regions where resistance against technology is high, and that it will not be trusted in such autonomous systems. In addition, lack dependence of the control of aircraft to any pilot, and its mobility via autonomous systems will create tension and anxiety on the people. It is inevitable that the passenger being alone in the aircraft will experience an increased tension and anxiety in case of a possible flaw, or in case of any problem in the autopilot system. But the non-requirement of any license for using the drone taxis may an indicator that passengers will easily use this aircraft, and that it is designed in a simple manner. One of the most significant problems is how the air traffic flow will be ensured. Their movement via the towers –to which the standard aircrafts are dependant- will cause the normal air traffic to be more crowded, and will cause complexity. And management from another center is requiring a long planning and study.

Despite the problems of drone taxis, which are being known yet and which are being anticipated, they have advantageous aspects. It will be a very useful transportation vehicle in health sector as it is able to land on any ground during landing and take-off, and in case this can be legally ensured. Especially it will be able to be ensured for the ambulances –at regions with high population density, and which are unable to reach the point of destination due to the problem of traffic- to reach the point of destination in a short while by the assistance of drone taxis.

The developments in the domain of aviation are continuously continuing along with the advancing technology. Along with

increasing demand in airline transport, the aircrafts are being renewed, and they are being encountered as new generation aircrafts.

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