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Analyzing the market statement of airplane industry

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Abstract

The universal market of Commercial Aircraft is of the most major markets in all around the world and there are a lot of papers which are discussing about this subject because of importance of it.

This thesis structured around the commercial airplanes which is one of the most important segments in the aerospace industry. This thesis documents in three chapters which includes the introduction which is about the history of emerging airplanes and commercial airplanes and the technology change and the innovation in this industry and then the factors of competition and the market of commercial aircraft and also it shows the application of Michael porter's 5-Force model. Then in the second chapter, it describes the major players in the industry in all over the world which is describing in two parts, major players in the industry and the new entrants in the industry.

After all in the third and the last chapter as both Airbus and Boeing have functional product differentiation when it comes to their air-crafts. The Airbus and the Boeing are examples of two companies offering different products based on their vision for the future,and each aircraft is worth billions of dollars. Therefore this report it shows every detail about the existing duopoly between Boeing and Airbus who are dominating the market and at the end we can see the Future outlook of global commercial aircraft manufacturing and the conclusion.

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CHAPTER 1 Brief introduction of the World Airplanes and Airlines history and market and Commercial Airplane manufacturing industry and Technical Change in the Commercial Aircraft Industry

1.1 History of airplanes and how it changed world history

1.1.1 Timeline of commercial aviation and strategic turning points

Timeline of Commercial Aviation which includes the events and milestones regarding commercial development is:

- 1908: First passenger flight: Wilbur Wright takes an employee along for a ride
- 1909: Army Airfield established at College Park, Md., by Wilbur Wright, making it the longest continuously operating airport in the world today
- 1910: Orville Wright opens the first commercial flight school in Montgomery, Ala.
- 1911: Burgess Co. becomes the first licensed commercial aircraft manufacturer
- 1913: Silas Christofferson carries passengers by hydroplane between San Francisco and Oakland harbors
- 1918: National Air Mail service inaugurated
- 1919: KLM begins operation, making it the oldest carrier in the world still operating under its original name
- 1920: Sydney Airport opens for commercial service and Minneapolis-St.Paul International Airport opens for commercial service, International air service is offered by Aeromarine West Indies Airways between Key West, Fla., and Havana, Cuba

- 1922: First permanent airport and commercial terminal used solely for commercial flights opens at Flughafen Devau near Konigsberg, East Prussia, Aeromarine Airways of Cleveland, Ohio, is established as the first airline ticketing agency

- 1923: First transcontinental non-stop flight

- 1926: - Congress adopts the Air Commerce Act of 1926, which authorized the Secretary of Commerce to designate air routes, develop air navigation systems, and license pilots and aircraft, Deutsche Luft Hansa (now known as Lufthansa) begins scheduled service in Germany, First flight lands at Candler Field, today's busiest U.S. airport - Hartsfield-Jackson Atlanta International Airport

- 1929: Pan American Airlines inaugurates its first passenger flight from Miami to San Juan by way of Belize and Managua

- 1930: First female flight attendant, Ellen Church, is hired by Boeing Air Transport (now United Airlines)

- 1933: United Airlines begins flying coast to coast with a Boeing 247 flight lasting nearly 20 hours

- 1935: Boeing designs the 307 Stratoliner and the first commercial aircraft with a pressurized cabin, Amelia Earhart dedicates the Newark Airport Administration Building, North America's first commercial airline terminal

- 1936: Pan American inaugurates passenger flights across the Pacific Ocean

- 1939: Pan American begins transatlantic passenger service and New York Municipal Airport opens, later renamed LaGuardia Airport after New York Mayor Fiorello LaGuardia, who refused to deplane at Newark, N.J., because his ticket read "New York"

- 1940s : Many commercial airlines and airports go offline to commercial traffic to support World War II military efforts

- 1950: Transatlantic route is the world's most traveled air route
- 1952: De Havilland Comet becomes the world's first commercial jet airliner
- 1958: Pan American initiates its New York to London route with the Boeing 707 and Today's second busiest airport internationally, Beijing Capital International Airport, opens
- 1959: American Airlines offers first domestic jetliner flights with routes from New York to Los Angeles
- 1962: Attorney General Robert Kennedy swears in the first FAA pea ce officers, who act as air marshals on requested flights
- 1967: The modern-day FAA is established as part of the U.S. Department of Transportation
- 1973: The first female airline pilot, Emily Warner, flies as second officer for Frontier Airlines
- 1976: Concorde jet flies first supersonic passenger flight
- 1978: Airline Deregulation Act is signed into law, removing government control over fares, routes and market entry
- 1979: First frequent flier program introduced
- 1980: Almost half of total flights worldwide took place in the U.S.
- 1981: 11,400 air traffic controllers are fired by President Reagan after walking off the job on strike when labor negotiations fail
- 1993: First ticket-less travel becomes available
- 1995: Boeing produces twin-engine 777, the first aircraft produced via computer-aided design and engineering and First airline tickets are sold via the Internet

- 1998: Smoking is banned on all domestic flights
- 1999: First web-based passenger check-in and online boarding passes
- 2001: Transportation Security Administration established in response to September 11 attacks
- 2007: Airbus A380 enters commercial service capable of carrying 850 passengers
- 2009: Transportation Security Administration formally accepts airport scanners as the primary method of pre-flight screening and Branson Airport opens; designed by Burns & McDonnell, it is the only privately owned and operated commercial service airport in the U.S.
- 2011: Airbus announces signing of the largest aircraft deal in history based on aircraft ordered: 200 planes ordered by AirAsia [35].

1.1.2 History of airplanes

To discuss about the history of the commercial airplane manufacturing industry, we should at first explain the history of the development of the airplane. During the century XVIII a person focused the efforts in develop a machine lighter than the air to be able to fly, which was very difficult to do that, and unlikely to transport people. In century XIX, they tried fly with machines heavier than the air like balloons and blimps and after they came up with gliders, which could be controlled in the air for a while. In 1843, William Henson, an English inventor, made the first patent for a machine equipped with engines, propellers and a fixed wing, an aircraft. But it couldn't stabilize flight. In 1890, Clément Ader, a French engineer, built a plane he named Eole, which was equipped with a steam engine. Ader Eole got off on, but could not control the aircraft, or keep it in the air. In 1896, a prototype built by Langley made the first successful flight of a heavier than air aircraft. The name of the aircraft was Aerodrome No. 5 (Aerodrome Number 5). The aircraft flew for approximately one thousand meters, at a speed of 40 km / h. On November 28, another successful flight was made by Langley, with the

Aerodrome No.6 model. This managed to fly 1460 meters. However, the plane had taken off without crew. In 1901, Santos-Dumont designed, built, and flew the first practical dirigible, demonstrating that routine, controlled flight was possible. This "conquest of the air", in particular his winning the Deutsch de la Meurthe on a flight that rounded the Eiffel Tower, made him one of the most famous people in the world during the early 20th century. 1903, on a beach in North Carolina near Kitty Hawk, the Wright brothers effected what would be considered as the first flight of a flying machine controlled, powered and "heavier than air". The first airline to use the aircraft was Aircraft Transport and Travel in the UK in 1916, using the modified aircraft Airco DH.4 for 2 passengers with flights between Folkestone in the UK and Ghent in Belgium, later in 1916 the company acquired aircraft Airco DH .16 for 4 passengers. The first scheduled flight in history occurred in 1914, by the American Tony Jannus. Jannus used a seaplane to carry passengers and freight between St. Petersburg and Tampa, Florida, offshore of Tampa Bay. His seaplane had room for a passenger who paid five US dollars for the flight of 35 km. This air taxi, considered the first airline in the world, soon faced financial difficulties, and only lasted a few months.

Not long after it was invented, the plane came to be used for military services, in 1911. The first country to use planes for military purposes was Italy, whose planes attacked the Ottoman positions during the First Balkan War, performing the first bombing of an enemy column story. The aircraft technology has advanced greatly during the Both World Wars. Early in the first one, airplanes still carry only one person, the pilot, but then many of them have become capable of carrying an extra passenger. Engineers have created the most powerful engines, and aircraft whose aerodynamic created was significantly better than the pre-war aircraft. For comparison, at the beginning of the war, the planes were only 110 km/h. At the end of the war, many have reached 230 km/h, or even more. During the First World War Airlines started to operate, could be considered the first commercial activity evolving airplanes, even though it was much disorganized still and did in its majority by hydroplanes. In 1919 several companies were created, the Handley Page Aircraft Company which used aircraft Handley Page Type O with capacity for

19 passengers, in France two companies were created, Société Générale des Transports aériens and the Compagnie des Messageries Aériennes1. in 1920, Albert Plesman created the Netherlands Koninklijke Luchtvaart Maatschappij (KLM), currently the oldest company still in business, with Airco DH.16 aircraft and that made flights from London to Amsterdam. in 1923, was created in Finland the Aero Y / O (now Finnair), and was created in 1932 in Russia the Deutsch-Russische Luftverkehrs AG with flights between Russia and Germany, which currently uses the name Aeroflot. In 1923 two French companies merged creating the Air Union, Air France today. In 1926 was created the Deutsche Luft Hansa. These companies primarily used aircraft formerly used as bombers and fighters in the First World War to carry cargo and passengers. These aircraft were elegantly decorated and furnished. Even so, these aircraft were very noisy and not pressurized and conditioned. After the end of World War national postal agency of the United States used old military aircraft to transport mail between some American cities soon after the war ended. By 1927, the agency gave up to operate these flights, and instead, began hiring airlines for this service. Airmail had great then importance in the development of commercial aviation. In the 1930s, many airlines began operating on lakes and calm rivers, using hydrofoils, however, the development of increasingly powerful airplanes, and airports with runways long enough, made with the use of hydrofoils in most airlines ended throughout 1940. In 1930 decade a lot of improvements happened, such as: more power force (bigger and heavier plans), more efficient design, control equipment and cockpits, radio telecommunications technology, jet turbine. Also in, 1940 was developed the pressurized cabin, that's allowed the planes to maintain the oxygen levels and fly higher. After the end of World War II, commercial aviation began to develop into a branch of the military aviation. Companies producing aircraft began to build airplanes especially for civil aviation and airlines stopped using military aircraft modified to carry passengers. In some years after the war ended, several airlines were established in the world. The various commercial aircraft that were developed during and after the war, we can highlight the four-engine Douglas DC-4 and Lockheed Constellation. These aircraft were widely used for domestic flights passengers' middle distance. Even so, they needed to make stops for refueling on

transoceanic routes. In order to don't need to refuel, two American factories created turbo-propellers, thrusters capable of generating more than three thousand horsepower. These engines began to be used in the Douglas DC-7, Lockheed Super Constellation and the Boeing 377 Stratocruiser. The Stratocruiser was the first double-decker aircraft in aviation history, and also the largest commercial airliner until the arrival of the Boeing 707. Each of these aircraft could carry about 100 passengers between New York and Paris nonstop, at a speed of cruise 500 km / h. The British Royal Air Force produced the first commercial jetliner aircraft in aviation history, the De Havilland Comet. The Comet began to be used on passenger flights in 1952. The Comet flew at approximately 850 km / h, his cabin was pressurized and relatively quiet. The Comet was the beginning of a commercial success, and many airlines began ordering this aircraft. But two accidents in 1954, when both aircraft exploded just offshore, created serious doubts about the safety of the aircraft. Boeing launched the Boeing 707 in 1958, the first jet passenger successful. Engineers involved in the creation of the Boeing 707 have tried not to repeat the same mistakes made in the De Havilland Comet. The Douglas DC-8 and Convair 880 jets were released a few years later, although the commercial success achieved by both has been much more modest than the success achieved by the Boeing 707. A total of 1010 Boeing 707 were produced. Boeing, since then, it is the largest aircraft manufacturer in the world, the Boeing 737, whose production started in 1964, is the best-selling and successful commercial aircraft in aviation history. A total of five thousand Boeing 737 were produced, and the aircraft is still in production in recent times. With the success of traveling by airplane, The Boeing came up with the widebodies, that is a commercial aircraft that is produced with three rows of seats (with a couple of rows of seats near the window and a row in the middle) and two corridors, these aircrafts could fit more people. The first was the giant widebody Boeing 747, nicknamed the Jumbo, capable of carrying more than 500 passengers on a single flight. Many doubted that this aircraft would achieve some commercial success when released, and Boeing has gone through several economic problems during the development of the 747. Launched in 1968, the Boeing 747 was the largest commercial airplane in the world until 2005, when the Airbus A380 made your

first flight. The 747, breaking all expectations, became a major commercial success, serving in very dense routes. In 1970 came the first commercial tri-jet, the DC-10 and Lockheed L-1011, two intercontinental commercial aircraft produced by McDonnell Douglas and respectively by Lockheed. In the 1980s, a derivative of the DC-10, MD-11 from long range, would be produced. The first bi-widebody jet was Airbus A300, an airliner middle distance. Boeing countered with the Boeing 757 - Non-widebody, medium range - and the Boeing 767, one widebody long range. The Boeing 767 revolutionized commercial aviation - its long range, their low operating costs and reasonable passenger capacity (196) allowed regular flights using the fewest possible aircraft on transatlantic routes and routes previously impractical because of high operating costs and low number passenger. The Boeing 767 was responsible for popularizing transatlantic travel - throughout the late 1980s and throughout the 1990s, most 767s crossed the Atlantic Ocean on a daily basis than any other commercial aircraft added - and even in modern times, the Boeing 767 remains the most aircraft crosses the Atlantic every day, despite growing competition from newer and more modern aircraft. In 2005, the Airbus A380 made its first flight. It is currently the largest commercial airliner in the world passengers, exceeding the Boeing 747, which had held the record for 35 years. The Antonov An-225, Soviet-made, is the largest aircraft in the world since its first flight, held in December 21, 1988. [1,6]

1.2 *Market of commercial aircraft*

1.2.1 Commercial Airplane Market Outlook 2019 – 2038

Based on the newest Outlook of Commercial Market, we understand that opportunities which are continued for fleet productivity, product innovation and network expansion as this dynamic industry continues in order to evolve.

In 1961 from the first published market forecast, we anticipate that the number of commercial operators has raised to nearly 200 and passenger traffic has grown by a factor of nearly 70. More recently, since 2000, the universal airline network has expanded 2.5 times, while the productivity and innovation of industry have enabled travelers to fly for nearly 40 percent lower average fares in real terms.

A dedicated team here at Boeing pores over reams of economic, travel, airline and fleet data annually to project new airplane demand during the next 20 years. After near 60 years of publishing, the Boeing Commercial Market Outlook remains the industry standard as one of the most accurate forecasts and longest-published in commercial aviation.

Here you can see the forecast of market of each year and the playing out the role of tremendous market demand in different regions of the world and about the various segments of product and services [47].

Figure 1: Global Overview of commercial Airplane Market Outlook

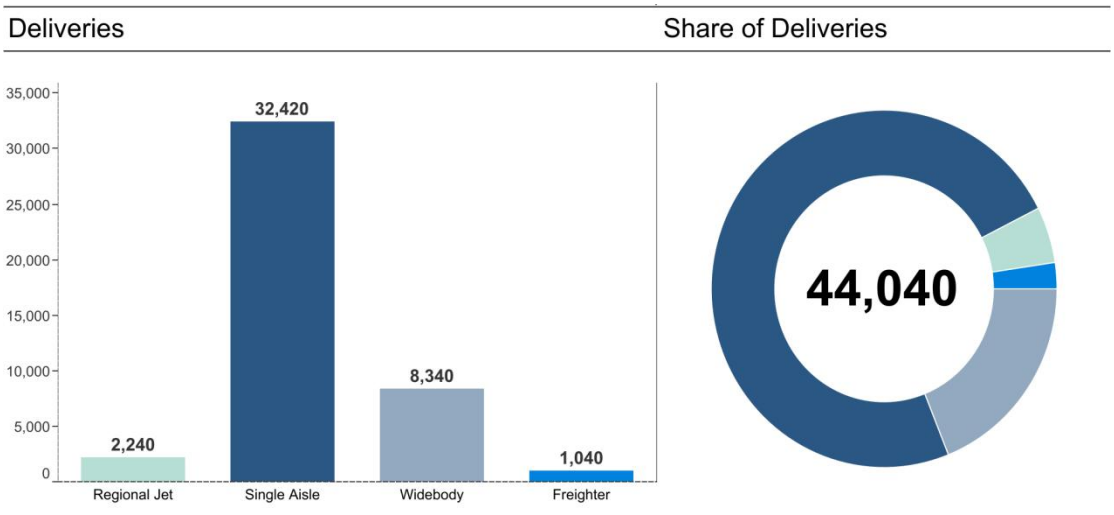


Figure 2: 44,040 deliveries

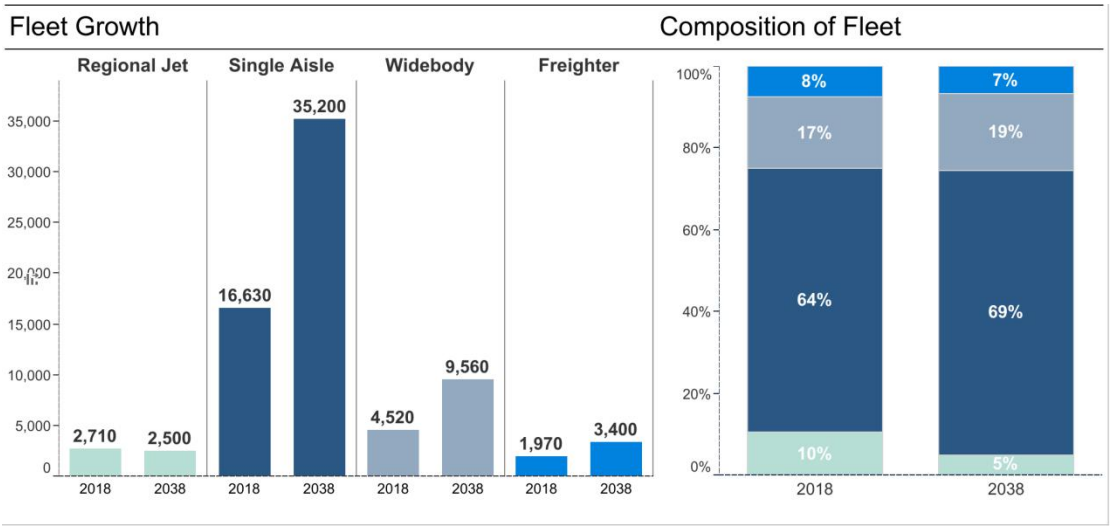


Figure 3: 3.4% Fleet Growth

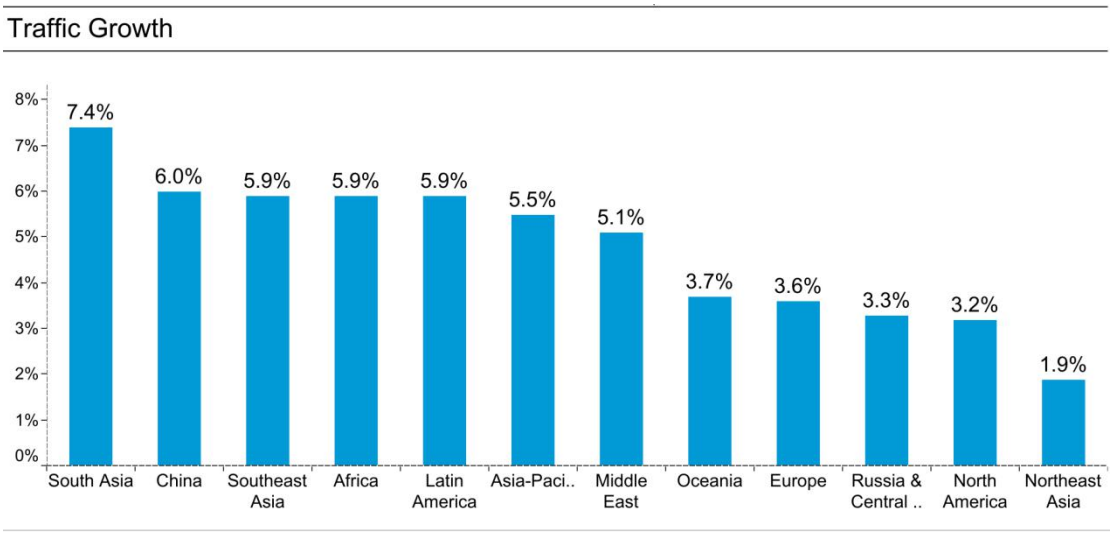


Figure 4: 4.6% Traffic Growth

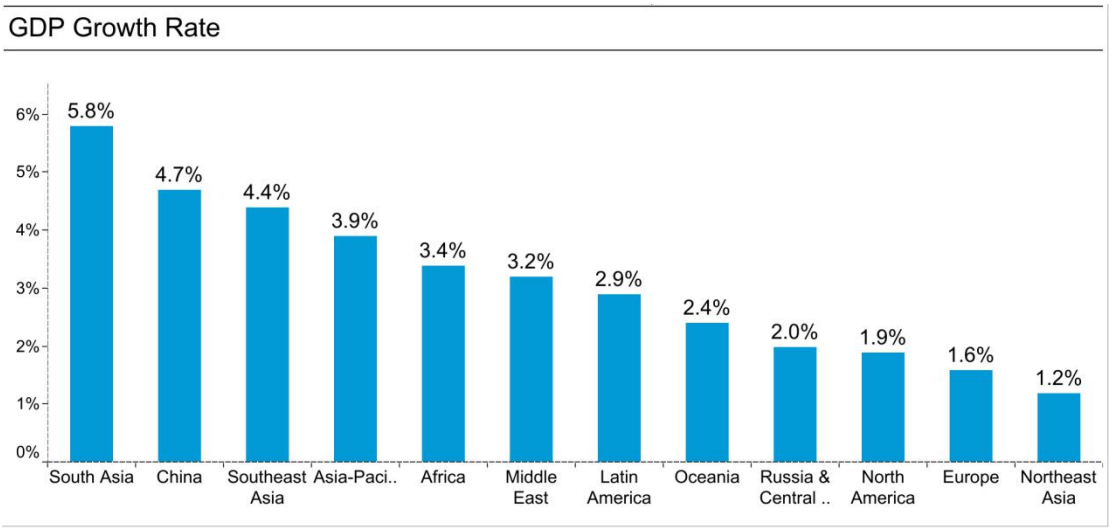


Figure 5: 2.7% GDP Growth

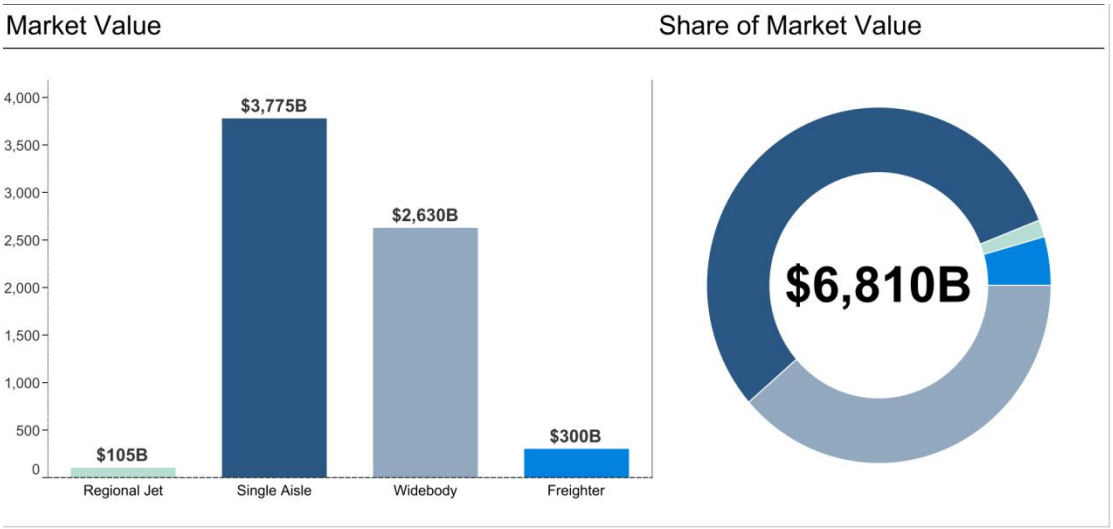


Figure 6: $6,810B Market Value

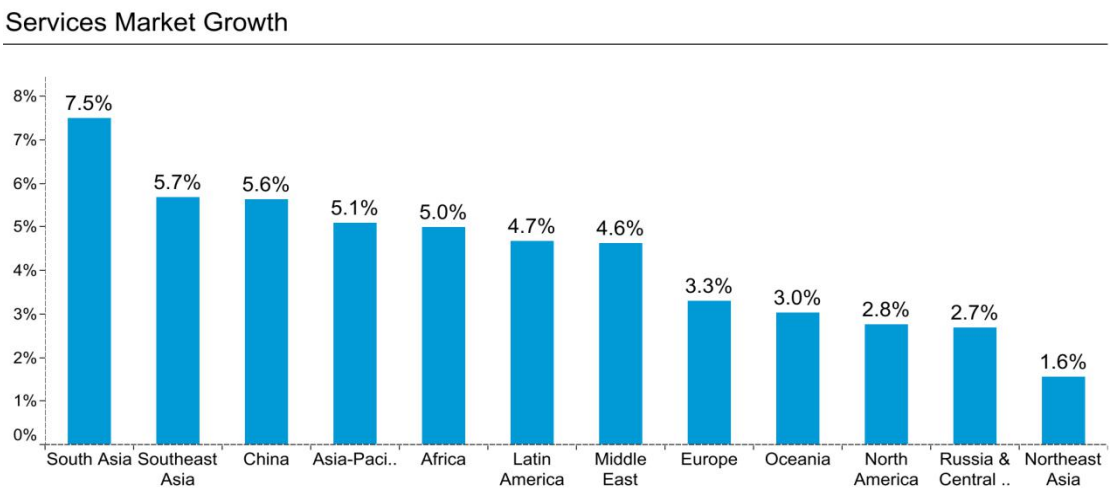


Figure 7: 4.1% Service Market Growth

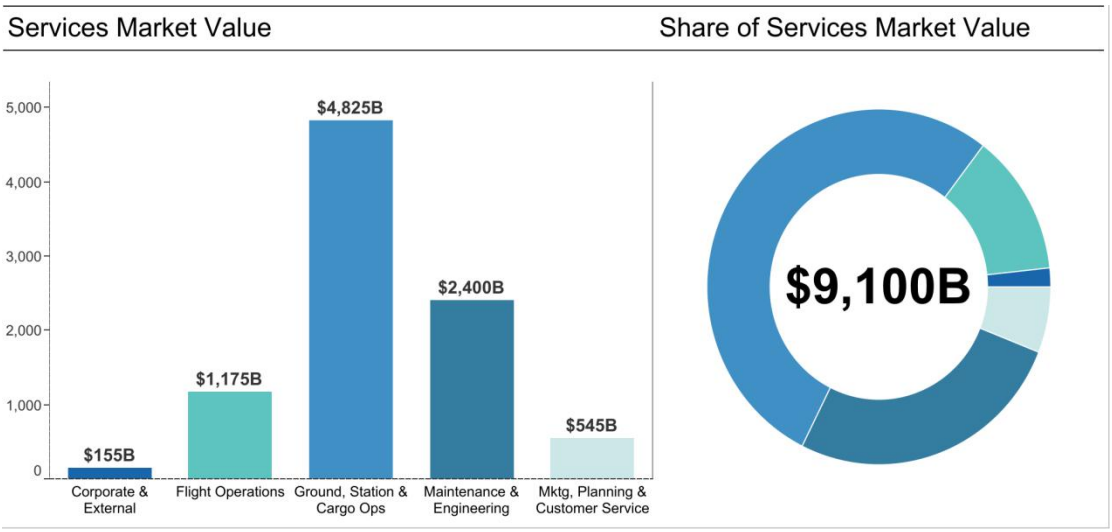


Figure 8: $9,100B Services Market Value

1.2.2 Market Drivers

Very important factors which affecting the market of the commercial aircraft include air travel or the demand of passenger, the prices of oil, cargo activity, economic growth cycles, national and international regulation (and deregulation), the rate of replacement and obsolescence of existing fleets and the availability of aircraft financing sources.

The competitive posture, performance and strategy of aircraft manufacturers, airlines, cargo operators and leasing companies like wars, political unrest, pandemics and some events which are extraordinary may also precipitate changes in demand and lead to short-term market imbalances.

Based on estimates which are internal, demand for 37,400 passenger and freight aircraft is forecast in the next 20 years with AsiaPacific accounting for 42% of deliveries. Recently, China and India emerged as momentous new aircraft markets. As a conclusion, Airbus wants to make more strong its commercial and industrial ties in these countries.

The carriers which are no-frills or low-cost in addition constitute a significant sector, and are expected to continue in order to grow around the world, specially in Asia, where markets which are emerging and continued deregulation have to provide raised opportunities. Demand for the range of Airbus of twin-aisle aircraft may also increase as some of these carriers develop While single-aisle aircraft continue to be a favourite choice for these carriers.

Overall growth. For air travel, The long-term market for passenger aircraft depends primarily on passenger demand, that is itself primarily driven by GDP growth or economic, fare levels and demographic growth. Air travel from 1967 to 2000 raised in each year, except for 1991 because of the Gulf War, resulting in an average annual growth rate of 7.9% for the period which measured in revenue passenger kilometers. Also Demand for the transportation by air proved resilient in the years following 2001, when consecutive shocks, including 9/11 and SARS in Asia, dampened demand. Nonetheless, the market recovered very quickly.

The financial crisis and the difficulties of global economic witnessed at the end of 2008 and in 2009, resulted in just the third period of negative traffic growth during the jet age, and a cyclical downturn for airlines in terms of traffic in both cargo and passenger, profitability and yields.

Recently, the growth regarding the demand of air travel has maintained solid momentum, supported by positive improvement in universal economic conditions through the year. Real GDP growth of the world is planned to be at +3.2% in 2018, and predict to remain positive with +3.0% in 2019 and +2.9% in 2020. At the end of 2018 preliminary figures released, by the International Civil Aviation Organization (ICAO) which confirmed that some 4.3 billion passengers made use of the universal air transport network for their business, the needs of tourism or for visiting friends and relatives (VFR) in 2018. The total passenger annually is up 6.1% compared to 2017 and the number of departures increased to around 38 million in the world. The passenger traffic globally, expressed in terms of total scheduled revenue passenger-kilometers (RPKs), posted a raise of 6.7% with around 8.2 trillion revenue passenger kilometers performed [41].

1.3 Technical Change and the development of industry structure in the Commercial Aircraft Industry

1.3.1 ABSTRACT

The commercial aircraft industry has compiled an extremely impressive record of performance in innovation and growth in output. This part assesses the impact of government policy during a fifty-year period upon innovative performance and market structure in the commercial aircraft industry. In general, this apparent success of government policies in supporting rapid technical change in the industry reflects the impact of these policies upon both the supply of technological knowledge and the demand for innovative aircraft designs. The success of this policy structure has implications for technology policies in other industries.

Judged against almost any criterion of performance-growth in output, exports, productivity, or product innovation-the commercial aircraft industry must be considered a star performer in the economy.

Government policies toward the commercial aircraft and air transportation industries have been partly responsible for this record of innovation and productivity growth. Government policy has influenced innovation in the aircraft industry

through its impact upon the demand for aircraft, in both the military and civilian spheres, as well as through direct support of research. The peculiar structural combination of high levels of producer concentration and fierce price and quality competition also reflects the influence of government policy through the provision of both a market and research funding for military aircraft. This government role has also encouraged the development of a vertically disintegrated industry structure, and an important role for subcontractors. [2]

1.3.2 Analysis of Technological Innovation and Environmental Performance Improvement in Aviation Sector

1.3.2.1 Introduction

The oil crises in the past have caused impressive improvements in fuel efficiency in all industrial sectors. Buildings, automobiles and and the other sectors invested in systems which are highly fuel-efficient and brought technological innovations which are about energy-saving. The aviation sector who are aircraft manufacturers and airlines, in addition made some efforts to improve fuel efficiency through high-lift wing designs, more advanced jet engines, and lighter air-frame materials.

It seems that the innovations in energy-saving aircraft technologies did not speed up, even during the oil crisis periods. The first oil shock was in 1973–1974 and the second one in 1978–1980 where periods in which only incremental improvements to aircraft technologies were introduced. The biggest improvement in aircraft fuel efficiency was made in the 1960s while the high oil prices in the 1970s and on did not provide manufacturers or airlines with enough incentives to promote a faster rate of innovation. At present with the background of concern of the world on global warming, in addition to the increasing oil prices, airlines want to make energy-saving innovations again in operations and technologies.

The factors that drove innovations in the sector of aviation have been technology-based approaches. Lee et al. and several studies before that revealed that aircraft technologies improved very fast in the 1950s and 1960s however the pace has slowed from the 1970s because of the limits regarding improvement of engine and aerodynamic efficiency.

An economic aspect of explanation is that airlines passed the high fuel costs on to passengers therefore the airfares increased during the 1970s and 1980s. The passengers were not sensitive about the price of ticket relatively because of the conveniences of travels which are faster. As a conclusion, the volume of air travel rather raised during that period of time. This is a trend which is very interesting since high fares are normally used to curb increasing traffic volume, but air passengers were pleased to pay much more for a faster mode of travel so as a result time savings.

In addition, Lee gave a society-driven explanation on why aircraft fuel efficiency improvement lagged that of other engineering systems or even aircraft noise reduction. It said that the levels of awareness of society regarding the impact of jet engine emissions on changing the climate or quality of local air was not enough high; So the industry of aviation did not invest in truly innovative energy-saving technologies in the aircraft systems.

Maybe the joint reasons mentioned above created the overall trend; therefore, we hire a historical analysis to examine the reasons behind the technological innovation which is relatively slow in aircraft fuel efficiency. The theory is that the industry had low incentives in order to innovate in the past while the awareness of green consumer is not high and is low. As sustainability is now a new mega trend and industry is trying in order to create it as a business strategy, and a future pathway to sustainable aviation will be discussed.

1.3.2.2 Aircraft Performance Improvement Trend

Here in this part we can see the summarizes of the the most important measures of aircraft performance and their recent trends from Lee et al. When judging and making decision about the efficiency of the system of an aircraft, it is more relevant to regard work in terms of passengers or payload carried per unit distance. The Energy intensity (EI) is a good measure in order to compare efficiency and environmental impact to other modes.

EI has two components which are: energy use (EU), and load factor (α), as described by Equation (1) where MJ stands for mega joules of fuel energy and RPK indicates revenue passenger-kilometers and ASK indicates available seat-kilometers. Energy

use is energy which aircraft consuming per seat per unit distance traversed, and is determined by aircraft technology parameters including engine efficiency. Energy use observed in operations of actual aircraft which reflects operational inefficiencies, like ground delays and airborne holding. The fleet average EU is of interest because it is the fleet fuel efficiency that determines the total energy use. Load factor is a measure of how the aircraft seats efficiently are filled and aircraft kilometers are utilized to create revenue. The result of raising the load factor is improving fuel consumption on a passenger-kilometer basis:

Equation (1):

$$E_I = \frac{MJ}{RPK} = \frac{MJ}{ASK} / \frac{RPK}{ASK} = \frac{E_U}{\alpha}$$

Because of the technological constraints in conventional jet engines, wing design and air-frame materials during the oil shocks in the 1970s, the technological innovations of aircraft were slowing down. The innovation's cost regarding more radical forms of aircraft was enormous, so the aviation industry was reluctant in order to invest in such technologies. It was more economical that in the near term, pay for higher oil prices. Simultaneously, it appears that government or society did not strongly demand more energy-saving technologies.

Decrease in EI do not always directly imply much less environmental impact. In addition, NOX emissions become more and more difficult to bound as engine temperatures and pressures raise. These contradictory effects make it more difficult to translate between the expected changes in the performance of total system and the impact on air quality.

1.3.2.3 Drivers of Aircraft Technology Innovation

Three leading drivers have existed regarding aircraft technological innovation. One of them which is a major one was fuel cost. Since fuel costs account for 20% to as high as 50% of the direct operating cost of aircraft, both airlines and manufacturers are so interested in fuel-saving technologies which decrease their operating cost.

The second kind of driver is the current movement on global climate change and sustainability. During the last 10 years, the sector of aviation has received attention concerning the jet emissions' potential effect on global warming and local atmosphere. Because sustainability has become one of the most important issues for

the aviation sector, both aircraft manufacturers and airlines are concentrated on technological and operational means to decrease the climate impact of aviation.

The third and the last type of innovation driver for aircraft performance is social demand. The noise of aircraft was known to cause hearing impairment in the 1960s and public had demand for quieter aircraft. Governments reacted by phasing out noisy aircraft and finally nowadays aircraft are too much quieter than earlier jet aircraft. Contrarily, economy of aircraft fuel that is a surrogate measure of jet engine emissions which is mostly CO2, during the same period of time improved slowly. The low level of social awareness on aviation and climate issues is one factor for this phenomenon.

1.3.2.3.1 Economic Driver: Fuel Cost–Passenger Volume Relationship

In aircraft fuel efficiency, one of the main drivers for improvements is fuel cost. Attention that fuel efficiency in itself is not a goal of aircraft design however a means in order to achieve other targets, which are some targets like payload-range, speed and the performance of landing/takeoff. During the 1960s when oil prices make up a very big portion of the direct operating cost of airlines, fuel efficiency gain was the strongest. Airlines adopt actively advanced aircraft with greatly improved fuel economy when oil prices ascent. Note that there are other crucial reasons for the designers of aircraft in order to fuel efficient aircraft developing thoughtless of the costs of fuel. Fuel efficiency has a powerful impact on the objectives of major design for example, the performance of payload-range and landing takeoff performance regarding an aircraft. Each a hundred kilogram of fuel saved may add an surplus passenger on a given weight-limited range. In addition, ‘hot and high’ airfields limit takeoff weight for some particular flight-legs and each kilogram of fuel saved assists to decrease these kind of constraints. This is a basic and fundamental difference with cars, trains and ships, where volume and weight are constraining the design to a importantly less extend. These reasons cause the designers of aircraft to have a concentrate on fuel efficiency, even though when fuel prices are awaited to be low in the future.

As a conclusion, because of the slower pace of technological advancement in engine design, since the 1970s, aircraft innovations slowed down. The design of

aerodynamic and air-frame materials improved, just also at a slower pace. In the other word, aerodynamic, structure technologies and engine are approaching the limits of physics and therefore become really hard to achieve which means the achievement in a condition of higher cost and time investments. Another barrier was the long lead time in the development of the product and fleet turnover like the high cost associated with radical technological breakthroughs. Back to this essential issue that the order of airlines are more fuel-efficient aircraft when fuel costs are high, however the delivery only comes a few and even in some cases quite a few, years later, therefore they are not able to respond instantly by buying new aircraft. But they can retire aircraft which is older. Accompanying this trend was that by raising the income of passengers and increasing the convenience of air travel the passengers have willingness to pay more fares.

1.3.2.3.2 Sustainability Driver: Environmental Considerations Changing the Scene

Increasing the total amount of volume concerning air transportation has crucial environmental ramifications on a global scale associated with climate change and stratospheric ozone decrease. On local to regional scales, issues like noise, decreased air quality, roadway congestion, which is related to airport services, and local water quality are recognized as essential consequences of air transportation. There is more attention than ever before on the emissions that aircraft produce by the consumption of a dwindling fossil fuel supply.

For about two to three percent of global carbon dioxide (CO2) emissions, aviation fuel burn is responsible and aviation it is considered to be a quickest growing, which is important source of greenhouse gas emissions potentially. Universally, the accounts for aviation for about four to nine percent of the climate change impact of anthropogenic activities. Because demand for passenger and cargo air transportation continues in order to increase, the decrease of the environmental footprint of aviation becomes even more critical.

The primer responsible in order to monitor the aviation industry's emissions and noise reduction efforts and searching further options in order to decrease the affects of aviation on local air quality, community noise and the global atmosphere is the ICAO's CAEP. CAEP has set the standards of aircraft engine certification and phase-

outs of noisy aircraft, over the years. So many options for deduction of emissions have been projected that includes emission charges, higher fuel taxes, emissions trading, emission limits or emission caps, raised stringency of the certification standards, voluntary actions, retrofit mandates, demand management, and the theory of no action.

1.3.2.3.3 Social Driver: Pubic Demand

The external factors that are able to have some affections on the transition arena in aviation industry present future scenarios regarding the commercial aviation paradigm. These are the necessity on order to alternate the aviation industry towards a more sustainable aviation paradigm and technological innovation. The necessity is a consequence of a universal perception of the environment and is affected by society entirely. The more tangible and immediate factor is technological innovation because it directly affects the technological development of industry. It can be seen that in addition to influence by society, the technological innovation is driven from innovators. The current situation represents lowest scores on both factors.

By aim of achieving continuing improvements in aircraft fuel efficiency, like decrease in emissions of jet engine that adversely impact global climate and local air quality, there should be a powerful social pressure on the sector of aviation. Social pressure send out a signal to governments, which something is worrisome regarding human health and the environment. After that governments take action either through a command-control or incentive-based mechanism subsequently confirming scientifically the cause of the problem like the solution.

The calculator of emissions is able to “nudge” consumers on order to act more environmentally consciously. The trouble is that travelers via air do not appear to have easy means in order to behave environmentally consciously. The only way is that passengers travel less, but this will not be the case for most passengers. Government and industry must have collaboration in order to design practical means for air travelers by the aim of behaving in an environmentally conscious manner [42].

1.3.2.4 Conclusions

The improvements of aviation sector regarding fuel efficiency have slowed down since the 1970s due to the slower pace of technological advancement in engine, air-frame materials and aerodynamic designs. In product development and fleet turnover, The long lead time, like the high costs associated with radical technological breakthroughs were also major barriers. Due to the raised income of passengers and the more convenient in air traveling, can say that accompanying this trend was the willingness and passion of passengers to pay higher fairs. While because of the emissions of jet engine, scientific knowledge and public awareness and being informed about the impacts of aviation emissions on the global atmosphere are still low, manufactures of aircraft and airlines are presently raising more conscious of universal climate change. This is the crucial difference from the case of aircraft noise decrease, where strong public demand supported by scientific evidence of health damage caused by aircraft noise and subsequent government regulation in order to bound the operation of noisy aircraft have led to large decrease in noise around airports. So in order to expedite environmentally conscious innovations concerning sustainable the sector of air transportation, raised amounts of information and knowledge should flow between societal constituents and aviation industries, like governments, citizens, and civilian organizations.

To sustainable aviation, an pathway which is optimal is possible by building high consensus and high perceived need among stakeholders which are government, industry and passengers. With a high perceived need, it is simpler to commit much more resources by the aim of research and development of sustainable solutions. In aviation technology, the associated effort among the leading stakeholders could lead to a fast and robust transition [42].

1.4 Application of Michael porter's 5-Force Model

The manufacturing of aerospace is an industry which needs high technology geared particularly towards producing aircraft, guided missiles, aircraft engines, space vehicles, propulsion units, and related parts which are governmental work.

There are plenty companies which are manufacturers and suppliers that they have responsibility for building and supplying the air-crafts used today, although the industry of aerospace is hugely dominated and overcome by a few number large companies which have contract in order to produce aircraft with government and also private businesses that usually are airline and cargo transportation firms. These large companies, themselves, have subcontract with smaller companies aimed to produce specific systems and parts for their vehicles. In order to better figure out the amount of rivalry in thus industry there exists a framework for analyzing the level of rivalry inside the industry and the development of business strategy: The five force model of Porter. This common tool demonstrates the industrial organization (IO) economics to derive five forces which specifies the competitive intensity and so the attractiveness of a market.

The five forces model includes 1. the threat of new entry, 2. the power of suppliers, 3. the power of buyers, 4. product or service substitutes, and 5. the intensity of rivalry among competitors.

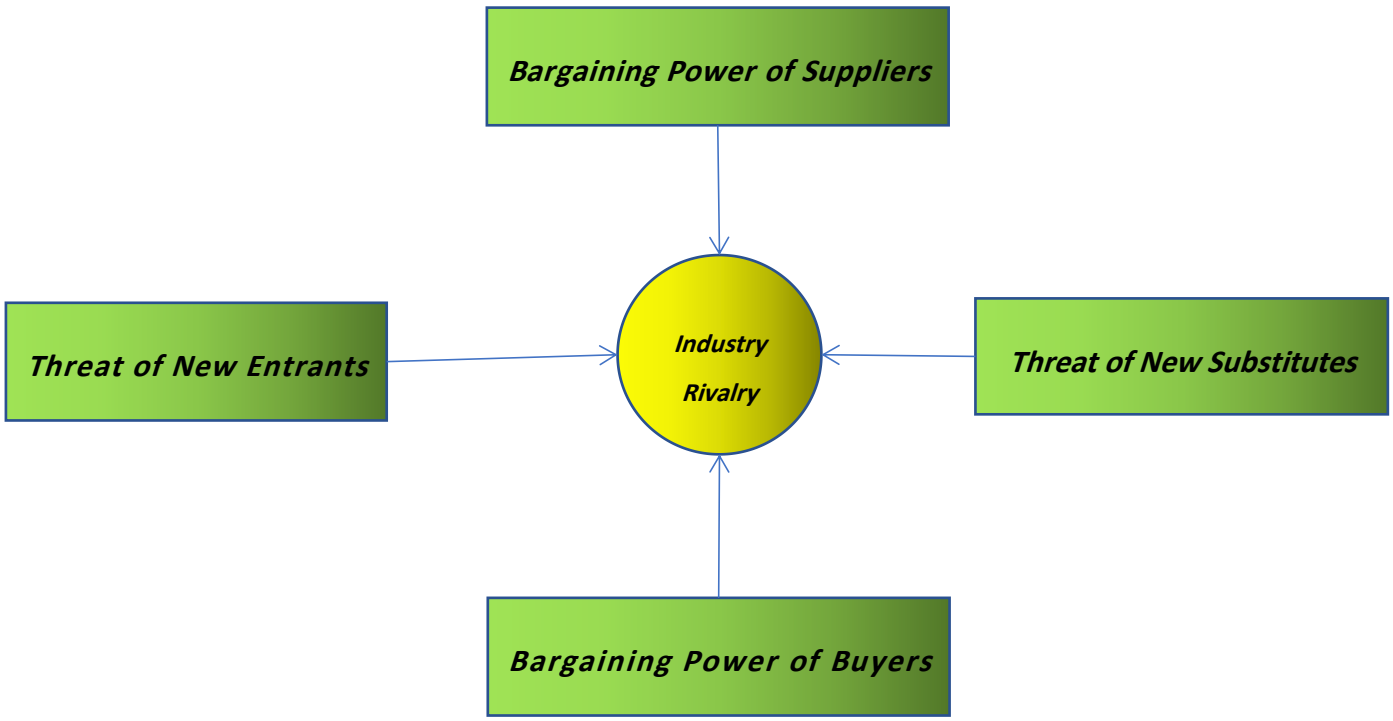


Figure 9: Five Force Model Framework

1. Threat of New Entrants

The manufacturing relate to aerospace industry is firmly established. There are just a few numbers and handful of big players in this industry. Because the costs of start-up for an aerospace manufacturing firm are sorely high and entering to this industry is too much costly, therefore the threat of new entrants is low. Here in this industry a huge sum of money should invested to reach the economies of scale, and in addition it is so hard to enter the market because of the existing firms already operating on cost and differentiation strategies.

The threat of entry into the commercial aerospace industry at the aircraft or engine manufacturer level is quite low. New airplanes and engines need sorely high amount of investments go along with huge risk and the inability to get a positive return on that investment for many years. However, the threat of entry at the level of aircraft or engine manufacturer is further decreased by various other agents. The manufacturing of aerospace has a long curve of learning or experience owing to its intricate operations of assembly and testing and its high content of labor performing complicated tasks. Firms just can understand this mentioned learning curve after too many years of continuously investment in R&D which is research and development. Sometimes maybe firms need subsidies of government, either indirectly through military contracts, to enter the industry or directly through grants-in-aid.

The estimation shows that in the industry Airbus one of the leaders received the amount of over $10 billion from European governments therefore it could get to a level where the firm can survive on its own.

Presently the aerospace industry in all over the world has some firms which are well-established within a plenty of resources to react versus any potential entrants.

There are less barriers to entry for potential manufacturers of subsystems or components, however still they are completely too many in comparison to the other industries. During past 10 years the manufacturers of aircraft and engine have been decreased severely the population of suppliers, which this happening makes it more

strict in order to enter the industry even as a subsystems or manufacturer of components.

2. Bargaining Power of Suppliers

Suppliers can affect an industry via their capability of increasing the prices or decreasing the quality of goods or services which purchased. The bargaining power of aerospace suppliers is really not that much strong. In fact there exists several suppliers in the market to choose them and so they have to have competition with each other on the market share.

In the industry of aerospace manufacturing when the buyers are searching in order to buy so this purchase would be an unlimited costly and expensive purchase therefore the price factor would be a really key factor in making decision of buyers. However there are some exceptions where a supplier may possess key some technologies which the other firm does not. Commonly, in this industry there are a lot of suppliers to select them for initial contractors.

3. Bargaining Power of Buyers

in the aerospace manufacturing industry the level of bargaining power for buyers is justly high. Most of the time, the companies of airline force a high rivalry between Boeing and Airbus which are well known aircraft manufacturers. Airlines have the orders of planes in a large numbers like China which is a country who is combining orders from the airlines that are state-run, can press for extravagant discounts from the prime contractors. The majority percentage of total sales of prime contractors is from these kind of orders.

So in this way purchasers are in a good and worth situation in order to reduce the price. The switching costs for aircraft and engines are very low, which this leads to raise the power of buyers. Some specialists of airline like pilots and mechanics as fast as possible can be trained on other planes and engines. In the early 1990s, The huge losses of most airlines made them more disappointed to decrease costs, which affected directly the prices of airplane and engine demanded by the airlines.

4. Threat of Substitute Products/Services

In the commercial aerospace industry the prime contractors like Boeing, an air-frame manufacturer and Pratt & Whitney, approximately there is no threats of substitute products for an engine manufacturers due to the uniqueness of an airplanes in speed and ability for travelling over water. For short distances over land, airplanes may sometimes compete versus automobiles and trains.

At the part or component level, the threat of substitute products exists and is mildly high in the aerospace industry. For instance, new technology and/or new materials can make outdated the materials formerly in common use in the construction of airplanes and engines. Some part of the industry is changing by the latest and greatest advances in technologies.

For instance at the end of the 1920s which is many times ago, in favor of duralumin, spruce was displaced. After the Second World War, some uses of aluminum displaced by titanium and also the medium strength steels and also carbon composites have disrupted the balance more recently again. Detached from the feasibility of resurgence in using the natural wood as the final in aero structure's sustainable manufacturing, this allocates the three major categories of material which are aluminum, titanium and carbon which is still do effort to achieve an optimum balance. Some variation like these are always being made for maintaining,current and competitive within the industry.

5. Intensity of Rivalry among Competitors

Severe competition have relationship with the various factors, based on Porter which includes; the number of competitors, product or service characteristics, rate of industry growth, amount of fixed costs, diversity of rivals, and capacity, height of exit barriers. Even though the industry of aerospace has just a limited number of prime contractors, rivalry is very high and severe because of the reasons that mentioned before. The firms of aerospace in desperation seeking for winning the big amount of orders from airlines by the aim of recovering their fixed costs which is so

high and their big investments required to develop new aircraft and engines. The industry's prime contractors has the same balance and also in their product lines have very little variation, that rises a lot the severity of rivalry. [1]

1.5 How competitive is this industry?

Competition. Airbus has been operating in a duopoly since Lockheed's withdrawal from the market in 1986 and Boeing's acquisition of McDonnell Douglas in 1997. As a conclusion, the market has been divided between Airbus and Boeing for aircraft's passenger of more than 100 seats. Based on the figures published by manufacturers for year 2018, Airbus and Boeing, each of them accounted for 50% of total commercial aircraft deliveries, respectively, 46% and 54% of total net orders, which is in units, and 56% and 44% of the total year end backlog (in units). 2018 was 16th year of Airbus in a row of raised production within the 800 deliveries. However, the aircraft manufacturing is an attractive industry by the high and improved technology high value nature of the business for participating, and besides Boeing, Airbus faces international competitors. Embraer which is regional jet maker, coming from the market which includes less than 100-seat commercial aircraft, keeps on in order to develop bigger airplanes and is running towards a strategic partnership with Boeing. In addition, some other international competitors from Russia, China and Japan will enter the 70 to 150 seat aircraft market in couple of years and nowadays are studying bigger types. Airbus SE and Bombardier Inc. Are in agreement of a partnership in relation to the C Series, In October 2017. Having received every needed regulatory approvals, Bombardier Inc., Airbus SE and Investissement Québec on first of July 2018 closed the C Series transaction effective and as a conclusion, the Company has needed a Limited Partnership majority stake in the C Series Aircraft. Two complementary product lines will be together by the partnership, the A220-100 and A220-300, targeting the segment of 100-150 seat market with an addressable market of minimum 7,000 new aircraft over the following 20 years in the segments that they are competing. The benefit of partnership of Mirabel-based from Airbus' global reach, procurement organization, scale and expertise in marketing, selling and

producing the A220. Momentous production efficiency are foretasted by leveraging the production ramp-up expertise of Airbus.

Overall growth. Primarily, the long-run passenger aircraft's market depends on the demand of passengers for air travelling that at first it driven by GDO growth or economic, demographic growth fare levels.

Measured in revenue passenger kilometers, except for 1991 because of the Gulf War, air travel raised in each year from 1967 to 2000, the result of that was an average annual growth rate of 7.9% for the period. In addition, in the years following 2001, when successive shocks, demand for air transportation proved resilient, including 9/11 and SARS in Asia, dampened demand. However, the market recovered very fast.

The global economic difficulties and the financial crisis witnessed at the end of 2008 and in 2009, resulted in only the third period of negative traffic growth during the jet age, and a cyclical downturn concerning airlines in terms of yields, traffic, both passenger and cargo and profitability.

Lately, the growth of air travel demand remained solid momentum, which supported by positive improvement in global economic conditions all over the year. The projection in 2018 for the world real GDP growth is +3.2%, and forecast to remain positive with +3.0% in 2019 and +2.9% in 2020.

at the end of 2018, some preliminary figures released by ICAO that stands for the International Civil Aviation Organization, confirmed that some 4.3 billion passengers for their business used the global air transport network, tourism's tourism or for simply visiting friends and relatives (VFR) in 2018. The annual passenger total is up 6.1% compared to 2017 and the departures' number increased to about 38 million universally. World passenger traffic, expressed in terms of total scheduled revenue passenger-kilometers (RPKs), posted a raise of 6.7% with about 8.2 trillion revenue passenger kilometers performed.

Regulation / Deregulation. National and international regulation and deregulation of international air services and major domestic air travel markets have effectiveness

on passenger aircraft's demand also. The US deregulated its domestic air transportation system in 1978, followed by Europe in 1985. Recently, between the US and Europe the negotiation "Open Skies Agreement" between the US and Europe that became effective in 2008, allows all of the European or US airline to fly any route between any city in the EU and any city in the US. In addition, the other regions and countries are progressively deregulating, specially in Asia. There is a kind of expectation to this trend to be continue and facilitating and in some cases driving demand. Additionally, providing greater access to the market, which was limited before, maybe deregulation letting creation and growth of new airlines or models of airline, as has been the case with low-cost airline model, which raised in value through major domestic and intra-regional markets from deregulation.

Cyclicality. In contrast with some cyclicality in demand for airline, the goal of Airbus is having secure stable delivery rates from year to year, which supported by a powerful backlog of orders and a regionally diverse customer base. The backlog had at 7,577 aircraft at the end of 2018. Because of the careful backlog management, in order to production increases, close monitoring of the customer base and a prudent approach, Airbus with success has increased deliveries annually for 16 years running, even through 2008-2009 that the economic crisis happened.

Airline network development: "hub" and "point-to-point" networks. Leading airlines have sought to tailor their route networks and fleets to continuing changes in customer demand, succeeding deregulation. Consequently, most of the time where origin and destination demand prove sufficiently strong, airlines use direct or in the other word "point-to-point" route services. Nevertheless, where demand between two destinations proves insufficient, airlines have developed highly efficient "hub and spoke" systems that provide access to a far greater number of air travel destinations through one or more flight connections for the passengers. The system which has chosen the route networks in turn affects the demand of aircraft, as hubs permit fleet standardization around both smaller aircraft types for the short, high frequency and lower density routes that feed the hubs (between hubs and spokes) and larger aircraft types for the longer and higher density routes between hubs (hub-

to-hub), themselves large point-to-point markets. Because deregulation has led airlines in order to diversify the strategies of their route network, it has at the same time therefore encouraged the development of a wider range of aircraft to implement that kind of strategies.

Alliances. the pattern of airline network development has reinforced by the development of world airline alliances. A UK-based aviation industry consultancy, one-third of the world's jetliner seats being flown today are operated by just 18 airlines, based on the data from Ascend. In decade of 1990, the major airlines began to enter into alliances that gave access to the other alliance members' hubs and routing each alliance member, allowing airlines to focus their hub investments while extending their product offering and market access [43].

Also there are some other important factors in order to demonstrated that how competitive this industry is which are:

- Advertising

An airliner will not spend a really too much amount of money for the new airplane till they feel that they really need it and so at this moment they come to the manufacturer in order to ask for it.

- Innovation :

There are too many components like mechanical, electrical or digital components in a plane, therefore the result is that innovation would be something constant.

- Concentration

The number of airplanes manufactures is too low and so the profit which this market makes is not that split.

- Strategy

The construction of an airplane would be so complicated because it needs a huge amount of raw materials and in addition, it can be an impossible to rival according to the strategy that the manufacturer will has to be taken.

- Transparency

As the prices in airline industry is too high, so they need to be entirely be sure about the product and therefore the manufacturers require to be completely be clear and be transparent about their product. [1]

1.6 Does it meet the requirement of a global industry?

The industry of the aerospace manufacturing meet the needs to be a global industry.

The development of an rising integrated global economy marked, searching for easily trade and flow of capital, utilizing the foreign labor markets which are cheaper, outsourcing and expansion of consumer market.

This industry meet all these needs. Primarily this industry have competition in all markets, during the two world wars, every country that was in the war had to develop they own technology to build the aircraft for itself in order to defend its own country, for the most part in the second world war, which the most part of the battles was happening in the air. After that time, the usage of technology was in building the commercial airplanes and today it is observable that as there are airplanes in each part of the universe, from everywhere.

Secondly, across markets it gains economies of scale, all pieces and components are not made in the same place, looking for best prices, huge companies that are doing a kind of combat for decreasing the prices in order to maintain itself in the rivalry market, buying some parts from everywhere in all around the world. In addition, for building a plane a lot of parts needs, for example seats, engine, wings, screens, frame, software, etc. Therefore it can helps more and more the industry by the aim of being universal and so have their suppliers in any point of the world. For instance, The headquarter in Manchester United Kingdom, the Rolls Royce Company, produces engines for many various Aircraft manufacturing companies, like Boeing.

For the third which is last, but not least, in the various markets, there is not or few modifications. Airliners need a little modification on the planes, somethings like color of lights and color of the seats, principally for style and branding, that is a minor cause when talking regarding the construction of an airplane. [1]

1.7 Future outlook of Global Commercial Aircraft Manufacturing

After confronting numerous challenges, the industry of Global Commercial Aircraft Manufacturing has entered a new phase of growth. Industry players design, helicopters, manufacture overhaul and rebuild commercial planes, propulsion units, auxiliary equipment and parts. During the global economic downturn, growing unemployment, declining per capital disposable income and overall economic uncertainty affected negatively the leisure travel and weakened downstream demand from commercial air carriers. However, very fast economic growth and raised air travel in markets which are emerging, combined with the requirement to replace and old aircraft with new one, more fuel-efficient ones in the markets which are developed, has considerably raised demand for industry products.

As we can see here, in a projection and scheme of demand for the aircraft for the next twenty years we can see that there is one product that out-stands from the others, the single aisle, most used for regional flights.

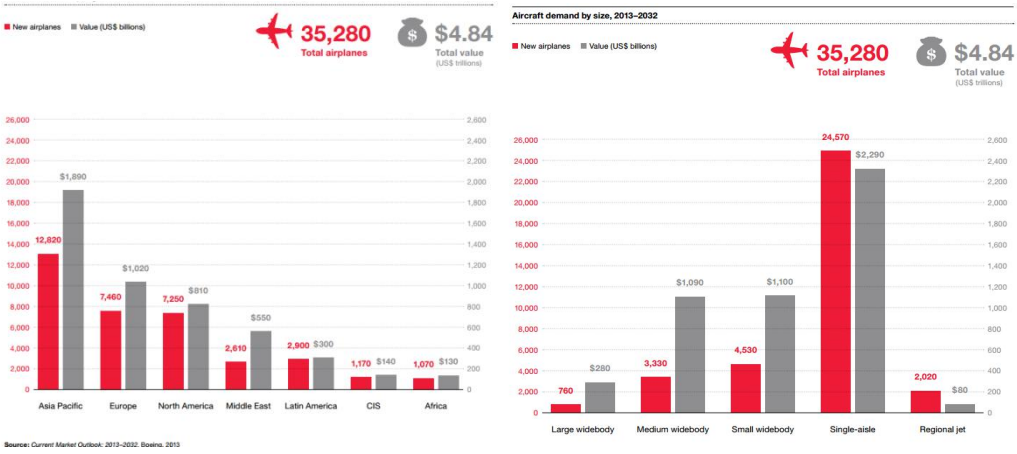


Figure 10: Aircraft Demand by region forecast and by size

And as demonstrated below, that is just because huge amount of orders come from the Asia pacific that is a developing area which perhaps is going to be a new center of business, as a result people will not have to travel that much distances to do their business and so doing most of the time only the flights which are regional ones.

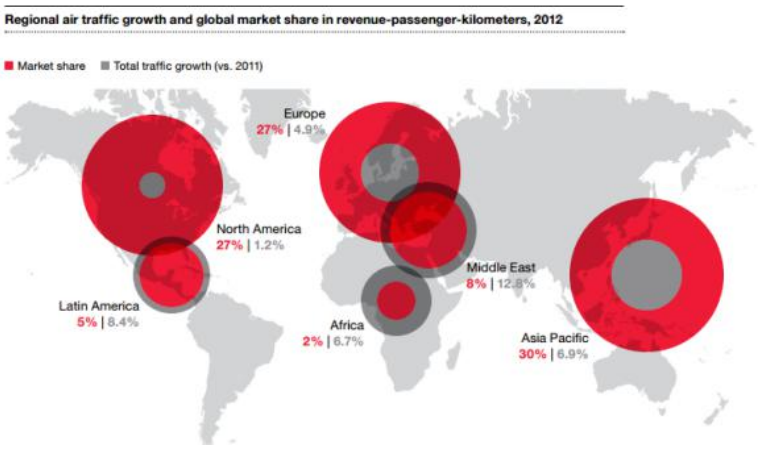


Figure 11: Regional Traffic Growth

The same what is happening also for the other industries we must concentrate on china which is a kind of threat however specialists declare that in almost fifteen years the country will take over the US place as the largest manufacturer of commercial air-crafts, whereas it has eligible workforce, the labors who are cheap and efficient and a supply chain which is very well-structured. In potential market the Chinese market is the biggest one and for the companies in order to use it has a lot of available technologies. Besides it has many important natural resources for the industry of aircraft manufacturing, like iron and magnesium.

Four big companies already have entered the Chinese market noticing the future points towards that direction. So we have Boeing getting in 2002, airbus in 2004, Bombardier in 2008 and Embraer in 2012.

But there are some problems China needs for prevailing by the aim of being the largest aircraft manufacturer, like the aviation is state owned and the fact is that this industry has a lot of intellectual property. In addition, there is a current shortage of pilots, airports congestion and the restriction of airspace by the military. [9]

CHAPTER 2 Major Players in the industry in all over the world

2.1. World's Top 5 Commercial Aircraft OEMs - Airbus SA, Boeing, Bombardier, Embraer SA, ATR

The universal market of Commercial Aircraft continues to be on a roll in one of its lengthiest aviation super-cycles being driven by strong tailwinds with strong demand drivers for growing air traffic, the factors who they are suppliers in form of introduction of re-engined aircrafts offering developed operating economics and multiple, desirable macroeconomic factors boosting air travel among most the most important parts of the world. The same has created a very big order backlog for the industry which is likely to translate into remarkable top line growth potential for the whole industry of aviation value chain over the subsequent decade. Next generation aviation turbofan engines, featuring a high bypass ratio and immense usage of innovations in technological part have just entered service over the recent years. The industry in 2018 has just seen the Entry into Service of three aircraft programs which were new, led by, Boeing's 737 MAX 9, Airbus A321 LR and Embraer's E190-E2. By the way, The spotlight in 2019 is going to be on the Boeing's 777X program which is scheduled to undertake its maiden flight in 2019 powered by the largest commercial turbofan engine ever which is the GE 9X.

2018 turned out to be the other year which is perfect for commercial aviation with both Boeing & Airbus producing air-crafts at frenetic rates for the customers of airlines. In 2018, Boeing & Airbus delivered a record total of 1606 air-crafts collectively with the U.S. giant's tally of 806 staying marginally ahead of Airbus' 800. The order intake for new air-crafts across OEMs has remained strong in 2018 with the combined order intake across Airbus & Boeing pegged at 1600+ air-crafts for 2018 demonstrating that the current aviation boom cycle is holding strong with sustained demand for new air-crafts from airlines. The profitability of Airlines continues to be strong contrary to the volatility and unpredictability in universal crude oil prices & slowing down of the growth regarding to world economic from the ongoing trade wars with the prospects for 2019 demonstrating that it is likely to be the tenth consecutive year of strong profitability for airlines translating into another

windfall year for MRO providers and the aircraft OEMs.

The traditional, enduring competition between Airbus and Boeing has gone to the next level with Airbus having gobbled up the C-Series program from Bombardier having rechristened it as the highly versatile A220 and Boeing in final stages of forming a business combination agreement with Embraer's commercial aircraft business which really lacks a modern, scratch up 21st century design aircraft, like the A220. In any case, Boeing faces a serious set of problems to deal with than its much more comfortably placed arch-rival with the grounding of global 737 MAX fleet over MCAS issues post two fatal aircraft crashes which pose a serious threat to Boeing's top line & financial going forward with decreased rates of production and the possible potential damages which are legal over lawsuits, emergence of the issues about the quality over the deliveries of the recent KC-46A tanker deliveries to the USAF and lastly the Trump initiated U.S.-China trade war is likely to sway the fastest and the largest growing aviation market in the world further towards Airbus which already has a substantial industrial presence in the country. Boeing has a really huge and difficult task for addressing these critical issues as well as challenges carefully to the satisfaction of the stakeholders involved given that it's 737 order backlog is worth almost 7 years of production and with the value of half a trillion dollars.

The perspective of the technology across industry, too, is evolving radically with the development of hybrid-electric motive force and propulsion technologies for commercial air-crafts; aimed at decreasing the level of CO2 emission drastically while scaling down the costs of operations substantially; likely to become a functional reality by the mid of the subsequent decade with some multiple industry teams across the globe laser focused on pursuing R&D on the electric propulsion technology which necessitates radical improvements in current generation of battery technologies. Evolving the (UAM) Urban Aerial Mobility is probable to prepare

The evolution of the Urban Aerial Mobility (UAM) is likely to provide a new combat front for the traditional Airbus-Boeing competition to unfold going forward with both aviation giants looking to catch a share of the extremely beneficial growth pie. In addition the developments on the UAM front are like providing a remarkable push

to commercialization and development of a range of game changing aviation technologies. The industry, however, is also being ready for the age of technologies which are troublesome, led by digitization, increasing manufacturing, the operating capabilities which are optionally manned and unmanned and artificial intelligence, in order to make majority of this running phase of demand raising.

Versus the existing dynamic moreover very fast evolution of industry and market prospect, the edition of that report in 2019 prepares a vast, precise holistic analysis of the overarching strategy concentrate across these Commercial Aircraft OEMs and overlooks into the plans being conceptualized and key strategies, had development and pursued by them for the near to medium term horizon to give navigate to them in their path via some challenges which are environmental specified by trade wars and the world economic growth which is slow while looking to drive growth for themselves in a booming phase for the industry. [4,5]

2.2 Major Players in the Industry

2.2.1 Boeing

Founder	William Boeing
Foundation	1916
Headquarter	Chicago, US
CEO	James Mcnerney Jr
Models	247, 737, 787

Current position:

Boeing leads the aerospace industry and is famous because of its military airplanes and also commercial airplanes manufacturing furthermore a lot of things like missiles, satellites, missile defense and launch systems. In addition, Boeing is the biggest manufacturer which is producing commercial and military airplanes. Boeing divided itself into 5 main parts: Commercial Airplanes, Boeing Military Aircraft, Global Services and Support, Boeing Capital Corporation and Network and Space Systems. The principal target of them is to continue to lead the industry in addition continue to create new and innovative aircraft and to response and cover all the customer's

needs which is increasing. Based on the Fortune 500 list, Boeing leads its rivals with the number 34 spot.

Orders & Deliveries. During the first quarter of 2018, Revenue Recognition Accounting Standard ASC 606 Information, Boeing adopted a new revenue recognition accounting standard (ASC 606) that among the other things, imposes extra criteria in order to recognize contracted backlog with customers on the far side of the existence of a firm contract to deliver. Apart from modifying the "ASC 606 Changes" line in the Net Orders table and adding the table below, this site has not been adjusted for the adoption of ASC 606 and reflects all orders for which we have a firm contractual commitment. For example, for a specific customer on this site aircraft identified that may not inevitably contribute to the totals for backlog and/or other amounts included in our financial statements. [47]

2.2.2 Airbus (Commercial Aircraft)

Founder	Lathière, Béteille, Ziegler
Foundation	1970
Headquarter	Blagna, FR
CEO	Fabrice Brégier, Tom Endess
Models	A300, A380, A320neo

Airbus is one the most striking aircraft manufacturers of passenger airliners in the world. By the aim of helping in order to shape the future of air transportation and drive steady growth in all around the world. Airbus looks for additive innovative technological solutions and very efficient sourcing and manufacturing possible, therefore airlines are able to grow and people can connect. Comprehensive product of Airbus line comprises successful families of jetliners ranging in capacity from 100 to more than 600 seats: the A220 Family; the A320 Family that is civil aviation's product line which is best-selling product and it includes the advanced A330neo; the double-deck A380 and the new-generation widebody A350 XWB. Across its aircraft families the solutions of Airbus ensure that aircraft share high commonality in some characteristics like on-board systems, cockpits, air frames and handling. This importantly decreases operating costs for airlines. The presence of Airbus is on top

of France, Spain, Germany and the United Kingdom, fully-owned subsidiaries in the United States, China, Japan, India and in the Middle East, and spare parts centers in Hamburg, Frankfurt, Beijing, Washington, Dubai and Singapore. In addition, Airbus has some centers of engineering and training some places like Toulouse, Miami, Wichita, Mexico, Hamburg, Bangalore, Beijing and Singapore, the same as an engineering centre in Russia. Also there are some stations for hubs and field service in all over the world. Airbus also has a immense network of suppliers around the world and also it relies on industrial co-operation and partnerships with major companies.

Strategy. The most important goal of Airbus is delivering strong results in a sustained manner, while commanding a further raised share of the universal commercial aircraft market over the long-term and expanding its offering of customer services. In order to achieve these goals, Airbus is actively:

In answering the needs of customers, Airbus is developing the most comprehensive line regarding products and it continuously is searching for developing and delivering new and innovative products by aim of meeting the need of customers and in addition to that it it is improving the quality of existing product lines. Many products entered into service in 2018:

A product which is the A321LR and is extending the capabilities of the A320 Single Aisle Family by the aim of remaining its position as the most improved and advanced and fuel efficient single-aisle aircraft family;

The other product, which is the A330neo that is new engine option and it is the new generation of the A330 Family;

The third product, which is the A350-900 ULR that is Ultra Long Range and is variant of the A350 XWB capable of flying up to 9,700 nautical miles;

The fourth and the last one is the A350-1000, which is the largest and latest wide-body in the twin-aisle category of Airbus.

In order to support the A350 XWB ramp-up and the other production raises, in 2019 with the first flight of the Beluga XL aircraft to enter into service, a new super transporter is under development.

In July 2018 the first flight relates to the Beluga XL took place. By expanding the customer services offering of Airbus they remains at the forefront of the industry.

Market of Airbus. Since 2000 the commercial aviation industry has been resilient to external shocks and traffic has grown X2.3. According to the some estimates, which are internal, during the period 2018-2037, Airbus has a growth rate of 4.4% per year. Airbus expects that passenger traffic will double in the next 15 years, as measured in revenue passenger kilometers, if the actual growth rate equals or exceeds this level.

In demand of airline, despite some cyclicality, Airbus aims to secure stable delivery rates from year to year which supported by a strong backlog of orders and a regionally diverse customer base. The backlog stood at 7,577 aircraft at the end of 2018. Close monitoring of the customer base and a prudent approach to production raises, throughout the careful backlog management and even through the economic crisis of 2008-2009, Airbus has successfully increased annual deliveries for 16 years running. [44]

2.2.3 Bombardier

Founder	Joseph Bombardier
Foundation	1986
Headquarter	Dorval, CA
CEO	Pierre Beaudoin
Models	CRJ 100, CRJ 700, Cseries

Current position:

In 1942 Bombardier started to come to the market as a snowmobile -manufacturer and by passing the time it has become one of the crucial producers of business jets and regional airliners in all over the world. After some years, the company developed its business of aircraft mostly through acquisitions, it bought some brands like Canadair, De Havilland, Learjet and Shorts. A company which is Montreal-based, in the last 15 years, has introduced several business jet models which includes the

Learjet 40 and 45, Challenger 300 and 605 and Global 5000 and Express XRS. The forthcoming Learjet 85 will be the first all-composite business jet.

2.2.4 Embraer

Founder	Ozires ilua
Foundation	1969
Headquarter	São José dos Campos
CEO	Frederico Curado
Models	EMB - 110, ERJ - 145, Ejet

Current position:

This is more than 30 years which Embraer is building the airplanes but it wasn't until 1994 when the government of Brazil privatized the company that the business took off. Nowadays, Embraer is the fourth-largest commercial aircraft manufacturer in all over the world. In 1999 Its ERJ 135/145 airframe which was eserving as the foundation for the company's first business jet, the -Legacy 600 was introduced. In the recent 10 years, Embraer by developing the Phenom 100 and 300 small-cabin jets, the Legacy 450 and 500 midsize jets and the Lineage 1000 bizliner has laid the foundation for a very strong push into the business jet market. A year a go, The longer-range -Legacy 650 was certified. [7]

In the period from 1950 to 1980 the developing of the Brazilian aircraft industry has been shaped by three ten-year plans. A government funded organization (CTA) sought in order to establish a teaching and training program for developing a support structure regarding the aviation industry in the first ten-year period. The second period required the establishment of technically strong local manufacturers. The last period was characterized as one of raising sophistication of locally produced power avionics, plants and aircraft systems, which will go into the products of Embraer.

Conclusion. Brazil concentrated on design knowledge when it developed a derivative of a small prop aircraft, before the creation of Embraer. This aircraft was successful. After that Embraer licensed manufactured a small aircraft while stressing design

knowledge while building on its domestic market. After that Embraer in the development path moved back to the phases of design. It has designed aircraft to increase size. The recent products of Embraer have all been recognized by Western aviation authorities. Incrementally, design capabilities of Embraer were improved. At first, it designed and then produced the EMB-110 that is related to the Nord 262 , which was under French guidance. Then, it developed a derivative of the EMB-110 that was the EMB-120. After that, it developed the EMB-145, using parts from the EMB-120. Eventually, it developed the EMB-135 and EMB-140 that they were both derivatives of the EMB-145. In the other word, from 1968 until 2000 which is 32 years, Embraer, moved into the design of more complex aircraft parts too much gradually. Moreover, it could capitalize on existing manufacturing experience by using existing parts and much commonality through derivatives. The catch-up in the 20–50 seat aircraft technology can be considered successful, specially because Embraer in this segment was able to innovate and move to jet aircraft. A crucial observation is that the development path of Embraer followed more that of a leader which is top-down rather than the so-called 'proven path' of a follower. Embraer survived with the support of government, despite continuous losses in the 1980s and for a large part of the 1990s. from 1994 Embraer was privatized also it has been profitable since 1998. For the first time, in 1999 Embraer received a substantial international investment from France. This investment was tied to efforts of French in order to sell its Mirage fighter aircraft to Brazil and also did not give any power for voting to the French. Recently, Brazil told illegally to halt subsidizing aircraft exports by the WTO which may have boosted the results of Embraer. Whether Embraer will be able to survive a long-term downturn while it has been heavily investing in the new ERJ-170/190 aircraft family remains a question. Figure 12 illistrates an overview of technology strategy concerning Embraer for different technologies and this figure includes the major industry related characteristics that caused problems [45].

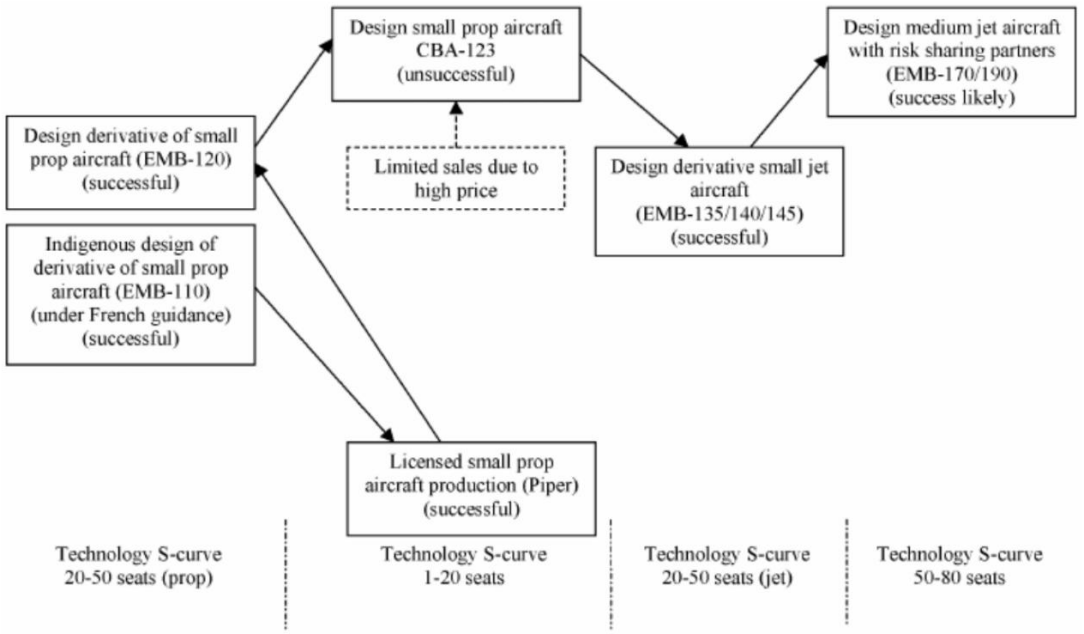


Figure 12: Strategy of Embraer - Brazil

2.2.5 ATR

ATR has developed a family of high-wing, twin turboprop aircraft in the 30- to 78-seat market that comprises the ATR 42 and ATR 72 and designed for three factors which are operational flexibility, optimal efficiency and comfort. The range of ATR is due to the family concept like Airbus, which provides for savings in training, , spare parts supply, maintenance operations and cross-crew qualification. Presently ATR is entering the cargo market as 2018 is the year of the launch of the ATR72/F (Freighter) with a brand new windowless fuselage, a forward LCD stands for Large Cargo Door and a rear upper hinged cargo door. By ending 2018, ATR had delivered 1,512 aircraft and the first delivery is planned in 2020 to FedEx.

Customer service. ATR has a universal organization of customer support committed to support aircraft all over their service life. Service centers and spare parts stocks are located in some cities which are Paris, Miami, Toulouse, Bangalore, Singapore, Sao Paulo, Auckland and Johannesburg.In addition to that the universal presence of ATR includes representative offices in Beijing and Tokyo. The asset Management of ATR addresses the market of second-hand aircraft by aiding in the financing and

placement of used and end-of-lease aircraft. Nowadays ATR Asset Management activity is marginal as since 2007 the market regarding leasing has powerfully developed.

Production. The fuselage/body of ATR is produced in Naples, Italy, and the wings of ATR are manufactured in Merignac near Bordeaux, France. Final assembly is doing in on the Airbus commercial aircraft production site which is located in Saint Martin near Toulouse. Some other operations like flight-testing, certification and deliveries also occur in Toulouse. ATR outsources some certain areas of responsibility to Airbus like information technology, wing design, manufacturing and flight-testing. [46]

2.3 New Entrants in the Industry

2.3.1 United Aircraft Corporation

Founder	State owned
Foundation	2006
Headquarter	Moscow
CEO	Sergei Ivanov
Models	MS21, TU204, II11

Current position:

The united Aircraft Corporation in 2012 provided 94 planes which 23 of them were civil planes and the rest of them which were 71 were military planes. The revenues of that year was totally over 170 billion rubles which in the other words was around 6.5 billion U.S. dollars.

The development of short-haul Sukhoi Superjet 100 was by Sukhoi Corporation jointly with foreign partners is the most promising Russian airliner. In 2008 the serial production of SSJ-100 was initiated. Till now, the amount of 38 Superjets have been manufactured. The condition of defence industry is really better. Russia is one of the most important and crucial leader in all around the world in this market for long time, particularly at that time that it comes to heavy fighters, like Su-30MK, several versions of which presently constitute the most part of the exports which are warplanes.

2.3.2 COMAC

Founder	State Owned
Foundation	2008
Headquarter	Shanghai, CN
CEO	Zhang Qingwei
Models	C919, C934, ARj21

2.3.2.1 Current position

The formation and operation of COMAC is based on the standards of modern enterprise system, and adopts an "Air framer-suppliers" model which focused on the design of aircraft, ultimate aircraft's assembly and manufacture, customer service and marketing, supplier management, and acquisition of certification. COMAC following the principle of "development with Chinese characteristics" and in the process of industrialization, marketing, globalization, and integration, appends great importance to technological progress and self-reliant advancement. The company efforts manufacturing large passenger aircraft which have some characteristics like more safer, cost-effective, comfortable and environment-friendly. COMAC has intent on build a large Chinese passenger aircraft independently that will soon be soaring through the blue skies [7]

2.3.2.2 The issues about the technology of the China's New Comac C919 Jetliner

The C919 is a comparatively new narrow-body jet which the Commercial Aircraft Corporation of China, or COMAC for short built it. In addition it's evidently the beneficiary of enormous operations of hacking tackled by the Chinese government and a government-affiliated hacking group, dubbed Turbine Panda. A series of recent U.S. Department of Justice (DoJ) indictments over the course of two years released which combined with CrowdStrike Intelligence's own research, has permitted for appalling visibility into a facet of China's shadowy intelligence apparatus.

A retained attempt by the Ministry of State Security (MSS) of China in order to create a network concluded cyber actors, MSS employees, and company insiders with intent of theft the key technology parts from the companies which China hired them in order to collaborate on the C919's design. CrowdStrike tells, all these

operations finally can be traced to the MSS Jiansu Bureau. Back in 2015, this is the same group thought to be responsible for breaching the Office of Personal Management (OPM).

2.3.2.3 Designing the C919

A decade ago it was already clear that China one day in the future would be a great market for travelling via air. Chinese knew that increasing per-capita GDP would affect domestic interest in flying and it results a low-cost narrowbody jet that would meet its own needs more efficaciously in comparison to a competing solution from Boeing or Airbus. The C919, while characterized as being years behind the latest jets from the Boeing / Airbus duopoly, in addition has really less cost of flyaway. To achieve its own plan for a jet, China integrated with a various foreign companies to produce different components.

Comac proclaimed in 2009 that it had chosen CFM International which is a joint operation between GE Aviation and French aerospace firm Safran in order to produce a variety of the LEAP-X engine, the LEAP-1C, for the C919. Simultaneously, Comac and another chinese business that was state-owned which is named the Aviation Industry Corporation of China (Avic) were seemingly tasked through designing a native Chinese design for the C919. Comac and Avic launched the Aero Engine Corporation of China (AECC) in August 2016, which produces a kind of engine called the CJ-1000AX but this engine has long been doubtful of being a copy of the LEAP-1C. Both engines share a great many questionable resemblances, for instance their dimensions and the sizes of turbofan blade. Primary activity CrowdStrike had seen in procurement for this robbery came when Turbine Panda aimed the Los Angeles company Capstone Turbine in 2010, only one month after CFM as the engine provider was chosen.

Crowdstrike writes:

“Though it is difficult to assess that the CJ-1000AX is an exact copy of the LEAP-X without direct access to technical engineering specifications, it is highly likely that its makers benefited significantly from the cyber espionage efforts of the MSS, which

will be detailed further in subsequent blog installments, knocking several years (and potentially billions of dollars) off its development time."

We have a lot of information about this particular status because of issuing the indictments by the Department of Justice against several individuals, containing "Sakula developer YU Pingan, JSSD Intelligence Officer XU Yanjun, GE Employee and insider ZHENG Xiaoqing, U.S. Army Reservist and assessor JI Chaoqun, and 10 JSSD-affiliated cyber operators in the ZHANG et. al. indictment." The details disclosed in these indictments have emphasized CrowdStrike's own investigation.

China continues to mount attacks against US assets, contrary to the public nature of indictments and events:

"A major facet of the current Sino-U.S. trade war is forced technology transfer, which Beijing has used to great effect by siphoning intellectual property from foreign firms in exchange for providing joint ventures (JVs) and granting access to China's lucrative market, only to be forced out later by domestic rivals as they grow competitive with state subsidies and support. Under current laws, the C919's foreign suppliers (many of whom were targets of TURBINE PANDA operations) are required to physically assemble components in China through a JV with COMAC."

The main thought behind starting to trade with China was that both sides who are US and Chinese customers would benefit like a win-win trade. This is true in too much ways but the most striking point is that there is a deep differentiation between the build of high performance parts of aircraft with enormous costs of R&D and manufacturing low-cost consumer goods. Such that components are the end product of many many years of research and manufacturing expertise. So far from having rivalry on a level playing field, it appears that China concentrated on stealing the information it needs in order to remove the gap between their companies and US companies, and after that limiting the access of US to its own market when it reached it's goal. [8]

2.4 Top industry issues and what companies are doing or can do

Pressing issues facing industry leaders include talent, innovation and globalization, therefore a host of other issues resonate with leaders interviewed for this paper. Below is a digest of top-of-mind issues presently and potentially challenging the preservation and expansion of a leadership in commercial aircraft — as well as implications of these issues and, most important, what companies can do to tackle them. [9]

Table 1: Issues, implications, actions

Issues	Implications for competitiveness	What companies are doing (or can do)
Talent	Companies are under pressure as they seek to secure the workforce they need to achieve increased production rates and continue to innovate. Talent — both the skilled technician and engineer ends — is hard to secure as the industry faces stiff competition from other industries.	Companies are being more proactive in forging ties with government and academia to attract, educate and train the next generation of manufacturers and to capture and pass on the knowledge of veteran specialists nearing retirement.
Innovation	Demand for "greener, smarter" aircraft and greater automation in manufacturing and inspection are exerting more pressure on suppliers to boost innovation and productivity while containing costs to maintain technological leads.	Aviation manufacturing companies can consider co-opting automation practices from other industries (e.g., automotive) and collaborate with emerging developers of technology (carbon composites, bio-fuels) and manufacturing processes to maintain a leading edge as innovators and to diversify their businesses.
Globalization pressures/ opportunities	Mushrooming demand for commercial fleets outside the area, especially in Asia, leaves manufacturers eager to sell to and expand in these markets through partnerships. Yet they need to build	To thrive globally, companies need to invest in securing and nurturing local talent and be vigilant when partnering with local firms, employing strict IP protection measures and careful

	a strategy that prevents new partners from turning into new competitors.	technology transfer strategies.
Availability of capital	Financing by export credit agencies and private sector lenders clearly drives not only OEM deliveries but also has a ripple effect throughout the aviation industry ecosystem and related industries.	Work collaboratively with lenders.
Cost of labor	As manufacturing spreads throughout the world and suppliers are more able to geographically decouple from customers, companies find greater leeway with fixed costs, including wages.	Companies are making long-term strategic re-locations in order to take advantage of wage arbitrage.
Cost management	Pressures to manage costs prompt suppliers to look on multiple fronts — from wages to health-care costs, automation, commodities, energy, transportation and maintenance, etc.	Companies that are innovative in managing costs — from the supply chain to operations — will be more competitive as customers weigh pros and cons of off-shoring and on-shoring to the US. Suppliers need to find ways to compete in a world where many orders are global and require quick, cost competitive fulfillment.
Energy costs	Volatile energy prices impact demand for aviation and leave energy-intensive sectors, including airplane parts and component manufacturing, vulnerable to energy cost pressures.	Companies are adopting energy management systems and processes to contain costs. Meanwhile, the sharp rise in shale gas and oil production in stabilizing energy and feed stock costs for manufacturers across the vast and diverse aircraft manufacturing supply chain.
Tax policy	Many companies promote an overhaul of the current tax code to be less complex and more competitive with global tax rates.	Companies can lobby about their tax.

	Depending on the state, corporate tax rates can exert considerable pressure on aircraft manufacturers' bottom line and can place suppliers at a competitive disadvantage.	
Regulations	Many companies cite the high cost of regulation as a competitive disadvantage	Companies can lobby their state and state representatives regarding the cost of regulation and regulation reform. Additionally, the cost of non-compliance can be considerable. Companies need to build more effective and efficient processes for compliance.
Infrastructure	An acute need exists to expand and modernize the critical infrastructure, including the network of airports, multi-nodal connections and air traffic control infrastructure. The success — or lack thereof — in developing air transport infrastructure will have important implications for the potential growth for aviation demand and of the commercial aircraft industry.	The commercial aviation industry will need to make greater strides in taking ownership of the successful development of air traffic initiatives as well as making efforts to support the development of a 21st century airport network.
Supply-chain innovation	The pressure OEMs face to increase production rates is trickling down through their supply chain, raising expectations for quicker and more cost-effective production, while ensuring world-class quality.	Manufacturers and suppliers that can adopt innovations that lead to quicker production lead times, improve quality and contain costs (e.g., through automation, robotics, additive manufacturing) will likely sharpen their competitive edge, emerging in each market in the world.

CHAPTER 3 Analyzing the duopoly between Airbus and Boeing

The competition among Airbus and Boeing has been defined as a duopoly in the very big market of the jet airliner from 1990s. This is the result of a series of mergers within the global aerospace industry, with Airbus beginning as a European association when the American Boeing wrapped McDonnell Douglas which was its former arch-rival, in 1997. The other fabricates, like Fokker in Europe, Convair and Lockheed Martin in the United States, and British Aerospace, were not capable to compete and efficaciously withdrew from that market.

In the period of 10 years which was from 2007 to 2016, Boeing has received 8,978 orders while it was delivering 5,718 and Airbus received some orders in amount of 9,985 while delivering 5,644. Both companies has regularly defended each other of receiving biased state assist from their governments, During their period of big rivalry. [10]

3.1. Competing products

3.1.1. Passenger capacity and range comparison

Boeing and Airbus have comprehensive ranges of products like single-aisle and wide-body aircraft which is including the variety of combinations of range and also the capacity. [11]

Table 2: Single aisle: Airbus, 737

Type	Length	Span	MTOW	pax	Range	List Price[48,49,50]
A220-100	35.0 m	35.1 m	60.8 t	100-120	2,950 nmi	US$79.5M
A220-300	38.7 m	35.1 m	67.6 t	120-150	3,200 nmi	US$89.5M
A319neo	33.8 m	35.8 m	75.5 t	120-150	3,700 nmi	US$101.5M
737 MAX-7	35.6 m	35.9 m	80.3 t	138-153	3,850 nmi	US$96.0M
A320neo	37.6 m	35.8 m	79.0 t	150-180	3,400 nmi	US$110.6M
737 MAX-8	39.5 m	35.9 m	82.2 t	162-178	3,550 nmi	US$117.1M
737 MAX-9	42.1 m	35.9 m	88.3 t	178-193	3,550 nmi	US$120.2M
737 MAX-10	43.8 m	35.9 m	89.8 t	188-204	3,300 nmi	US$129.9M
A321neo	44.5 m	35.8 m	97.0 t	180-220	4,000 nmi	US$129.5M

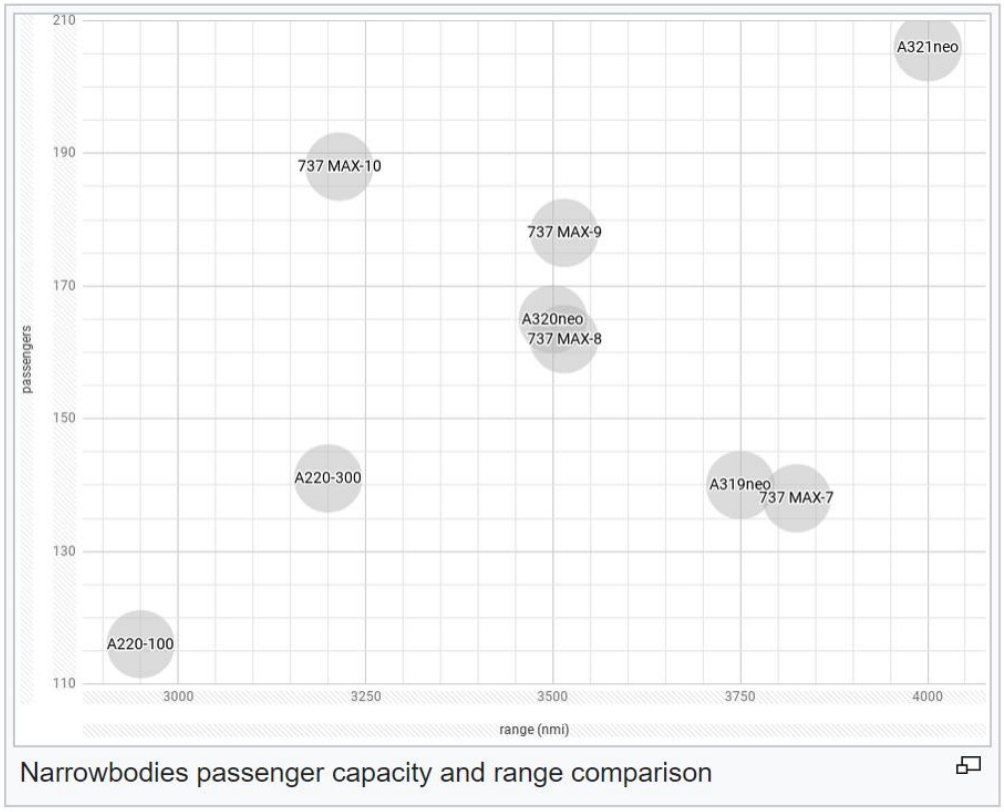


Figure 13: Narrowbodies passenger capacity and range comparison

The prediction of Flight Global fleet for the 2016–2035 period is 26,860 deliveries which are single aisle for a $1,360 Bn value at a compound annual growth rate of 5%, with a market share of 3% for Irkut Corporation which is 810, 4% for Comac which is 1070, 5% for Bombardier Aerospace which is 1340, 43% for Boeing which is 11550 and 45% for Airbus which is 12090; The anticipation for Airbus is 23,531 and for Boeing is 28,140. Both of them would have an immense majority of profits by single aisles, followed by legacy twin aisles suchlike the A330 and B777: Kevin Michaels of AeroDynamic Advisory calculates that the 777 classic have 20% and the 737 have a 30% profit margin. [12]

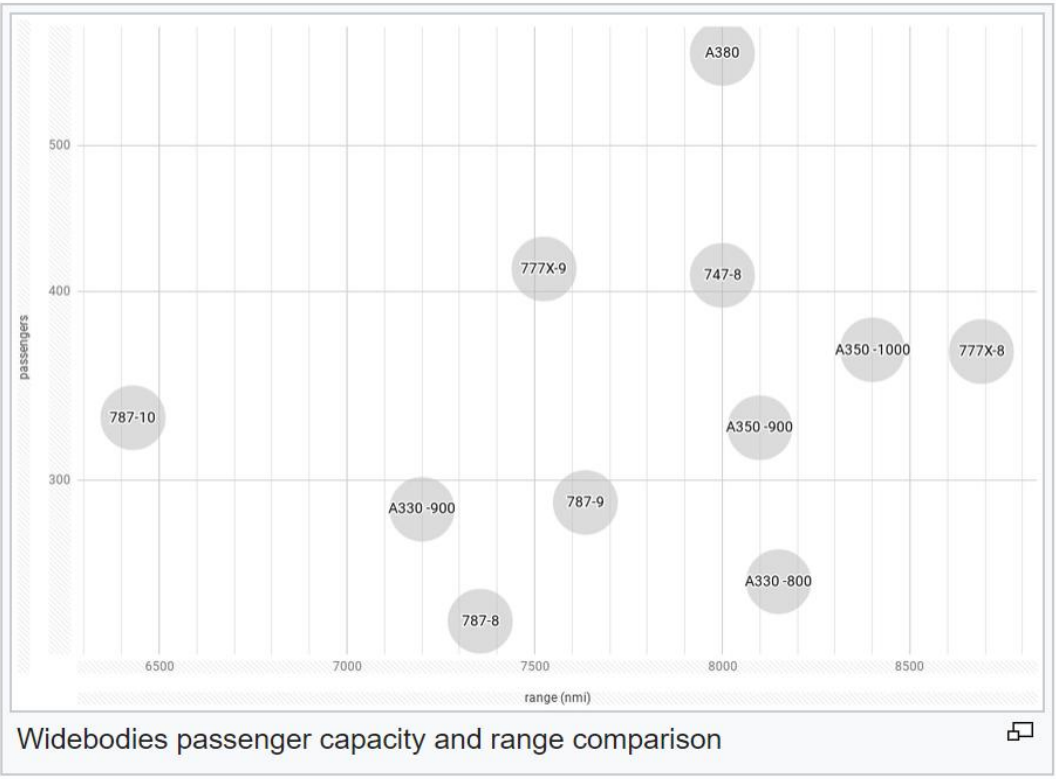


Figure 14: Widebodies: Airbus, 787, 777X, 747

The prediction of Flight Global fleet for the years between 2016 and 2035 for twin aisle deliveries is 7,960 for a $1,284 Bn value. They anticipate the market share of B787 is 31%, for the A350 is27% and for the 777 is21%, then the A330 and A380 each has 7% of market share. The orderbook for the Airbus was 1038 which is 41% and for the Boeing was 1,514 which is 59% ,In June 2017. [13]

Table 3: Capacity

Market	**North Atlantic [51]**		**Trans-pacific [52]**	
type	**1H2006**	**1H2016**	**2005**	**2015**
A310/DC10/MD11	3%	1%	3%	–
A320/B737	1%	1%	–	–
A330	16%	26%	3%	10%
A340	10%	6%	11%	1%
A380	–	3%	–	4%
B747	15%	9%	49%	10%
B757	6%	9%	–	–
B767	28%	19%	7%	7%
B777	21%	20%	27%	55%
B787	–	6%	–	13%

3.1.2. Cargo capacity and range comparison

Table 4: List price (USD)

Type	length	span	MTOW	capacity	range	list price (USD) [14]
A320P2F	37.6 m	35.8 m	78.0 t	21.0 t	2100 nmi	converted
737-800BCF	39.5 m		79.0 t	22.7 t	2000 nmi	converted
A321P2F	44.5 m		93.5 t	27.0 t	1900 nmi	converted
767-300F	54.9 m	47.6 m	186.9 t	52.5 t	3260 nmi	$203.7M
767-300BCF		50.9 m		51.7 t	3300 nmi	converted
A330-200P2F	58.8 m	60.3 m	233.0 t	59.0 t	4000 nmi	converted
A330-200F				70.0 t		$237.0M
A330-300P2F	63.7 m			61.0 t	3600 nmi	converted
777F		64.8 m	347.8 t	102.0 t	4970 nmi	$325.7M
747-8F	76.3 m	68.4 m	447.7 t	137.7 t	4120 nmi	$387.5M

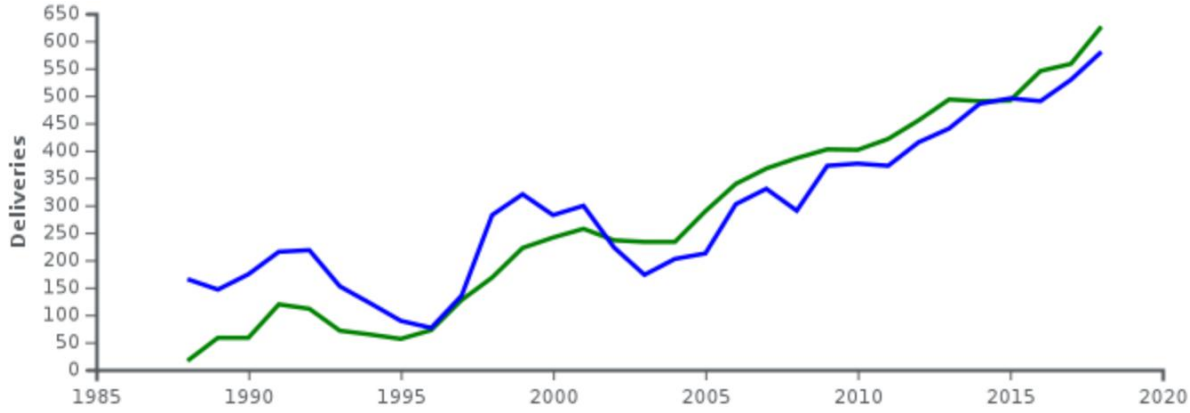
As Airbus builds the A330-200F which is the only new freighter, selling just 42 orders which only 38 of them already delivered, Boeing can keep producing the 767F, 777F and 747-8F and being almost the monopolist in the market while their traveller variants are not selling any longer.[14]

3.1.3. Airbus A320 vs Boeing 737

The best-selling jet airliner in 2002 was the Airbus A320 family , and in 2005-2006.[22] The 737NG has outsold the A320 in 2001, and in 2007.

The Airbus A320 family which is the Boeing 737 Next Generation, is still lagging overall with 7,033 orders against 7,940 in January 2016 while it outsold since its introduction in 1988. Since the A320neo family launch in December 2010, 4,471 orders received by Airbus, while from August 2011 till January 2016, the 737 MAX got 3,072. The neo had 3,355 orders in the same period of time. Boeing have 40.6% share of market of the re-engined single aisle market, while Airbus have a 59.4%, through August. There are some doubts for Boeing on the over-ordered A320 neos by new operators and expects to narrow the gap with replacements not already ordered. Airbus still had sold 1,350 A320neos more than Boeing which had sold 737 MAXs, In July 2017.

Concerning deliveries, Airbus since their certification/first delivery in early 1988, with another 6,056 on firm order has delivered 8,605 A320 series aircraft . Unlikeness, since late 1967 Boeing has shipped 10,444 aircraft of the 737 family with 8,918 of those deliveries since March 1988, and as of December 2018 has a further 4,763 on firm order. [15]



Green Line: Airbus A320 family deliveries [16,17]

Blue Line: Boeing 737 series deliveries [18]

Figure 15: Airbus A320 and Boeing 737 deliveries

When Boeing increasing the produce of 737 monthly from 47 in 2017 to 57 in 2019 and Airbus from 46 to 60, both of them regard being faster more despite the difficulty of supplier.

while Airbus have to deliver 3,174 A320neos compared with 2,999 Boeing 737 MAX through 2022, By September 2018 there were 7,251 A320 family ceo aircraft in service versus 6,757 737NGs. Airbus had sold to the inexpensive start-ups the A320 product very well and then was offering a selection of engines which made them more attractive for the airline companies and lessors in comparison to the single sourced 737, otherwise the engines of CFM are super reliable and trusty. The six month head-start of the A320neo let Airbus that before Boeing announced the MAX, rack up the amount of 1,000 orders . The A321 has outsold the 737-900 three to one, as the A321neo is again dominating the 737-9 MAX, to be joined by the 737-10 MAX. [19]

3.1.4. Twin aisles

In November 2017, International Airlines Group for its chief Willie Walsh, budget carrier Level had profit much and even more than from its two A330-200 lower cost of ownership than its 6t higher fuel burn which the amount of that was $3,500 on a flight of Barcelona-Los Angeles: it will present three more as there aren't adequate B787 pilots. Out of the 2,673 twin-aisle orders keeping out the Airbus A330CEO and quad engine planes which are the A380 and B747-8, Airbus had 1,070 which was 40% and Boeing had 1,603 which was 60%, In early 2018.[20]

Enabling the new paths between long distance city pairs by The ultra-long-range variety of new kinds : the 9,700 nmi Airbus A350-900 ULR moved in service in 2018 and the 8,700 to 9,100 nmi Boeing 777-8 is supposed in 2022. For the world's longest flight between New York and Singapore (8,285 nmi), the Airlines of Singapore planned to reintroduce it with an A350-900 ULR in 2018.

Qantas for the Project Sunrise hopes to fly from Sydney to New York which is 8,650 nmi or London which is 9,200 nmi within four years and Air New Zealand wish to run to the U.S. East Coast: Auckland and New York are 7,670 nmi apart. The Singapore-New York A350-900ULR with only 161 seats will have a low density premium-focused configuration: 94 premium economy and 67 business.[21]

3.1.5. Airbus A380 vs Boeing 747

Both Airbus A380 vs Boeing 747 companies during the 1990s were searching about the practicability of a traveller aircraft bigger than the largest airline in operation which was the Boeing 747. Airbus later on launched the aircraft which was a full-length double-deck, the A380, ten years later while Boeing decided the project would not be commercially viable and developed the third generation 747, Boeing 747-8, alternatively. Thus, the Boeing 747-8 and the Airbus A380 are placed in a rivalry on the paths which are long-haul.

The efficiency of competition which claims by Airbus and Boeing seems to be inconsistent because they have the confusing methodologies and also any kind of

third party resources validated them. Airbus tells that the A380 have consumption per passenger as a 8% less than the 747-8I and on the other side, Boeing claims the 747-8I to be over 10% lighter per seat and have 11% less fuel burn per passenger, also with a decrease in trip-cost as 21% and a cost reduction in seat-mile of more than 6%, in comparison to the A380. The empty weight of 747-8F is anticipated to be 80 tonnes which is 88 tons lighter and also less fuel consumption per each ton within 21 percent less the cost of trip and 23 percent lower ton-mile costs than the A380F. The other independent analysis demonstrates that a fuel ingestion for each seat of 3.27 L/100 km for the A380 and 3.35 L/100 km for the B747-8I; a hypothetical re-engined A380neo would have achieved 2.82 to 2.65 L/100 km per seat depending on the options taken. Airbus insists that the longer range of the A380 while using up to 17% shorter runways. The A380-800 for the cabin floor space has 478 square metre (5,145.1 sq ft) that is 49% more than the 747-8, meanwhile, on takeoff, commentators noted the "downright eerie" lack of the noise of engine, with the A380 being 50% more silence than a 747-400. On 14 March 2013, Airbus delivered the 100th A380. As an option, since 2012 Airbus would offer a diverse with better and developed maximum weight of take-off letting for better range efficiency. Still it does not appear that which is the exact increase in maximum take-off weight. In order to receive and take this suggestion the Emirates and the British Airways are first customers. Airbus had the amount of 319 orders as of 2015, December. For the A380's passenger version and is not presently offering the A380-800 freighter. Production of the A380F has been stopped until the production lines of A380 have settled with no firm availability date. In October 2006, some of original orders of A380F specially FedEx and the United Parcel Service were canceled succeeding delays to the A380 program. Some customers of A380 launch switched their orders of A380F to the passenger version or converted to the aircraft of 747-8F or 777F. In July 2016 At Farnborough, Airbus notified which in a "prudent, proactive step," Opening in 2018 it expects to deliver 12 A380 aircraft for each year, less than from 27 deliveries in 2015. In addition, the manufacturer noticed that production might slip back into red ink on each aircraft produced at that time, even though it forecasts production will stay in the black for 2016 and 2017. By expectation of the firm which

is by healthy demand for the other air-crafts of them, it would let it to avoid job losses because of the cuts. [22]

Boeing company has some orders which the amount is 51 for the 747-8I passenger version also 69 orders for the 747-8F freighter as of 2014, June.

3.1.6. EADS/Northrop Grumman KC-45A vs Boeing KC-767

In March 2008, The declaration which Boeing had lost a US$40 billion refueling aircraft contract to Northrop Grumman and Airbus for the EADS/Northrop Grumman KC-45 with the United States Air Force drew angry protests in the United States Congress. Upon review of protestation of Boeing, The Government Accountability Office ordered the USAF to re-compete the contract which was ruled based on the tendency of Boeing. Afterwards, the whole call for aircraft was rescheduled and then canceled, with a new call decided upon in March 2010 as a type of the contract which is fixed-price.

Subsequently, on February 24, 2011, The winner between Airbus and Boeing was the latter. (Northrop having withdrawn) and US Aerospace/Antonov (disqualified), with an option which was the lower price. In fact, that price was really low and therefore in the market related to media they anticipated that the company could perhaps break even with maintenance and spare parts contracts and also they believe that maybe in this way Boeing would take a loss on the deal. That was revealed that projected development costs rose $1.4bn and will surpass the $4.9bn contract cap by $300m. For the first $1bn raise (from the award price to the cap), the U.S. government would have responsibility for $600m under a 60/40 government/Boeing split. Within Boeing being completely accountable for the extra $300m ceiling breach, Boeing would be responsible for a total of $700m of the additional cost, In July 2011.[23]

3.1.7. Small narrow-bodies

Airbus took some stake which the percentage of that was 50.01 in the Bombardier CSeries programme, In October 2017. In December 2017, Boeing confirmed that it

was holding discussions abut the airliner business of Embraer with them. On 1 July 2018, the control of the CSeries had taken by Airbus and they changed the name of that to the Airbus A220. On July 5, 2018, The Boeing-Embraer joint venture was declared for Embraer's airliners which the value of that was $4.75 billion, for which Boeing will invest $3.8 billion for 80%; approval is expected by the end of 2019. The competitor of the Embraer E-Jet E2 family was the Airbus A220 which they had rivalry with them. [24]

3.2. Modes of competition

3.2.1. Outsourcing

Because numerous number of the airlines in the world are entirely or partly are owned by the government, aircraft preparation decisions are mostly taken in addition to commercial ones based on the political criteria. In order to gain a competitive advantage, Boeing and Airbus have some effort in order to elicit this by subcontracting production of aircraft components or assemblies to manufacturers in the countries which they have the strategic importance .

As an instance we can mention that Boeing has maintained traditional relationships with the suppliers who are Japanese since 1974 including some Industries like Mitsubishi Heavy and Kawasaki Heavy which these companies have had increasing involvement on successive Boeing jet programs, a process which has helped Boeing achieve almost total dominance of the commercial jets of the Japanese market. Outsourcing was extended on the 787 to the extent that Boeing's own involvement was decreased to a little bit more than project management, assembly, design and test operation, outsourcing most of the actual fabrication all around the world. Boeing has since stated that it "outsourced too much" and that future airplane projects will depend much more on its engineering and production personnel of themselves.

Airbus has had less opportunity to outsource momentous parts of its production on the far side its own European plants somehow because of its origins as a consortium

of European companies. Nevertheless, Airbus in Tianjin, China opened an assembly plant for production of its A320 series airliners in 2009.[25]

3.2.2. Technology

In the 1970s Airbus wanted to have rivalry with the famous Boeing through its introduction of advanced technology. For instance, the A300 made the most broad use of some materials which are composite and still observed in an aircraft of that era, and by automating the function of the flight engineer's, was the first wide-body jet to have a two-person flight crew. The company who was the first to introduce digital fly-by-wire controls into an airliner (the A320) was Airbus In the 1980s.

Now with the presence a competitor to Boeing which is Airbus, both companies in order to have performance advantages in their products are using advanced technology. Most of these developments and improvements are about fuel efficiency and weight reduction. For instance, the first large airliner to use 50% composites for its construction is the Boeing 787 Dream-liner. The Airbus A350 XWB features 53% composites. [26]

3.2.3. Engine choices

The selection of engine acquirable is one of the most important elements in order to have a competitive advantage in the market of any kind of the airline. Generally, airlines tend to have a selection of at least two engines from the major manufacturers who are General Electric, Rolls-Royce and Pratt & Whitney. On the other hand, the manufacturers of engine prefer to be single source, and often succeed in striking commercial deals with Boeing and Airbus to achieve this.

The competition was developing between two sides in 2008 as Airbus selected the Rolls-Royce Trent XWB alone for the Airbus A350, while GE avoided a $1 billion development competing with its Boeing 777HGW exclusive GE90. Boeing rejected a Rolls-Royce engine for the 777X to favor General Electric's GE9X in 2013. In 2014, Rolls-Royce secured its exclusivity to power the A330neo with the Trent 7000. [27]

The other aircraft supplying a single engine offering consider the Airbus A220 (P&W GTF) or the Boeing 737 MAX (CFM LEAP); meanwhile the others with multiple sources include the Boeing 787 (GEnx/Trent 1000) or the Airbus A320neo (P&W GTF/CFM LEAP).

3.2.4. Currency and exchange rates

The costs and expenses of the productions of Boeing are often in United States dollars but these costs for Airbus are mostly in euro. When the dollar appreciates against the euro the cost of producing a Boeing aircraft increases relatively to the cost of producing an Airbus aircraft, and conversely when the dollar decreases relative to the euro it is a kind of advantage for Boeing. In addition, there are also some possible currency risks and benefits involved in the way aircraft are sold. Airbus, Although Airbus pricing most aircraft sales in dollars, it is more flexible and has priced some aircraft sales in Asia and the Middle East in multiple currencies but Boeing typically prices its aircraft only in dollars. Depending on the fluctuations of currency between the acceptance of the order and the delivery of the aircraft this can result in an extra profit or extra expense, if Airbus has purchased insurance against such fluctuations, an additional cost regardless.[28]

3.2.5. Safety and quality

Both aircraft manufacturers have great safety records on recently manufactured aircraft and also generally, both companies are well known regards delivering products which are well-engineered and high-quality. Both firms tend to avoid safety comparisons when selling their aircraft to airlines or comparisons on product quality by treaty. Most aircraft dominating the companies' current sales, the Boeing 737-NG and Airbus A320 families and both companies' wide-body offerings, have good safety records. Older model aircraft like Boeing 707, Boeing 727, Boeing 737-100/-200, Boeing 747-100/SP/200/300, Airbus A300, and Airbus A310, which were in order first flown during the 1960s, 1970s, and 1980s, have had higher rates of fatal accidents**.** According to Airbus's John Leahy, the problems of Boeing 787 Dream-liner battery will not cause customers to switch suppliers of airplane. The grounding of the Boeing

737 MAX following two high-profile crashes is also unlikely to significantly benefit Airbus at least short-term, as both the 737 MAX and A320neo production lines have backlogs of several years and changing manufacturers requires significant crew training. [29]

3.2.6. Aircraft prices

Airbus and Boeing publish the list of the prices about their aircraft but the actual prices charged to airlines differ; they can be challenging to find out and tend to be much lower than the list prices. Both manufacturers are engaged in a price rivalry to defend the share of their market.

The prices of the actual transaction may be less than the list prices as much as 63%, as reported in 2012 in the Wall Street Journal, giving some examples from the Flight International subsidiary Ascend: [30]

Table 5: Discounted list prices, 2012 [53]

Model	List price 2012, US$M	Market price	% Discount
Boeing 737-800	84	41	51%
Boeing 737-900ER	90	45	50%
Boeing 737-300ER	298	149	50%
Airbus A319	81	30	63%
Airbus A320	88	40	55%
Airbus A330-200	209	84	60%

Forbes magazine in May 2013, had a report which was about the Boeing 787 offered at $225 million was selling at an average of $116m that was a 48% discount which was a big amount.

For Ascend's Les Weal, Launch consumers acquire reasonable prices on heavier aircraft, also the large buyers who are Lessors benefit, like airlines as Singapore Airlines or Cathay Pacific since their brand and name gives credibility to a program. In its report which publishes annually, Air France cites a €149 million ($195 million) A380 which is 52% cut, while financial release Doric Nimrod Air notes $234 million for its A380 leased to Emirates in an October 2011. Teal group's Richard Aboulafia mentions that when Boeing was alone the of power pricing for the 777-300ER was

better in its long-haul, large capacity twin-jet market but this advantage dissipates with the A350-1000 coming.

Tiny orders are content with the amount of discount like 35–40% for Leeham's Scott Hamilton but sizeable airlines sometimes achieve 60% and customers with old ties with Boeing such as Delta, American or Southwest get a Most-Favoured-Customer Clause guaranteeing them no other customer gets a price which is lower. Wells Fargo demonstrates Southwest, the largest 737 customer with 577, got a unit price of $34.7 million for its 737 MAX order of 150 which is 64% discount in December 2011. Ryanair got 53% in September 2001 and claims to obtain at minimum amount equal to its last orders which was 175. The Airbus-Boeing WTO proceedings indicates EasyJet got a $19,4 million unit price on its A319 order for 120 in 2002, a 56% discount at the time, the same kind of rebate Lion Air got for its A320 order of 234 on 18 March 2013.

Each sale includes a rate which is escalation covering the cost of raw material and workforce rises and as a cost of acquisition indicates 15% of the 20 year total cost of ownership, in addition, discussions include the delivery date, financial incentives, fuel consumption guarantees, maintenance and training. The final price in large campaigns at Airbus is validated by a committee comprising sales head John Leahy, program director Tom Williams, financial principal Harald Wilhelm and CEO Fabrice Brégier who has the final cut. [31]

Those discounts in 2013 were presented again in Le Nouvel Observateur's Challenges.fr again with Ascend valuations: [31]

Table 6: Discounted list prices, 2013 [54]

Model	List price 2013	Market price	Discount
Boeing 747-8	351.4	145.0	59%
Airbus A320-200	91.5	38.75	58%
Airbus A330-200	239.4	99.5	58%
Boeing 737-800	89.1	41.8	53%
Boeing 777-300ER	315.0	152.5	52%
Airbus A380	403.9	193.0	52%
Airbus A320neo	100.2	49.2	51%
Boeing 737 MAX-8	100.5	51.4	49%
Boeing 787-8	206.8	107.0	48%
Airbus A350-900	287.7	152.0	47%

The Airways News showed discounted list prices for long haul liners in 2014 :[32]

Table 7: Discounted list prices, 2014 [55]

Model	List price 2014	Market price	Discount
Airbus A330-900neo	275.6	124.0	55%
Airbus A350-900	295.2	159.4	46%
Boeing 777-200LR	296.0	118.4	60%
Boeing 787-9	249.5	134.7	46%

Transasia Airways declared a commitment to four A330-800neos, list price $241.7m, for $480m or $120m each, on 24 December 2014. At the end of 2015, the sale and leaseback of new Airbus A350-900 from GECAS to Finnair value them at €132.5M ($144M)

For closing the gap of production between the new 777X and the B777 classic, Boeing is challenged by a $120m market price for the -300ERs. Rivalry pressure from the Bombardier CSeries and E-Jet E2 lead Boeing to pursue the development of the 737 MAX-7 despite low sales, and also for selling the Boeing 737-700 at $22m to United Airlines, 27% of the 2015 list price and well below what Embraer or Bombardier could offer for their aircraft.

As Moody's Investors Service estimates, on 29 April 2016, Delta Air Lines paid $40 million each for its 37 A321ceo order, an "end-of-the-line model pricing" of 35% of

the $114.9 million list price. Moreover, in September 2016, Air Caraïbes subsidiary French Blue received its A330-300 for $100 million.[33]

Table 8: Market prices, May 2016 [56]

Aircraft	List ($m)	Mkt Value ($m)	Discount	Seats	Mkt/Seat
A380	432.6	236.5	45%	544	434,743
B777-300ER	339.6	154.8	54%	368	420,652
A350-900	308.1	150.0	51%	325	461,538
B787-9	264.6	142.8	46%	290	492,414
B787-8	224.6	117.1	48%	242	483,884
A330-300	256.4	109.5	57%	277	395,307
A330-200	231.5	86.6	63%	247	350,607
A321	114.9	52.5	54%	185	283,784
A320neo	107.3	48.5	55%	165	293,939
B737-900ER	101.9	48.1	53%	174	276,437
B737-800	96.0	46.5	52%	160	290,625
A320	98.0	44.4	55%	150	296,000
A319	89.6	37.3	58%	124	300,806
B737-700	80.6	35.3	56%	128	275,781

This emerges in the accounting of manufacturers: in their reports which is publishing annually, Airbus has a backlog of 6,900 worth €1,010 ($1,200) billion at catalog prices while Boeing values its 5,700 airliners order book at $416 billion using the contractual prices, but when updating to more stringent IFRS-15 rules, Credit Suisse calculates it will be modified to €500 billion from 945. Airbus in its 2018 annual report will disclose its backlog value at the latest.

In January 2018, Airbus and Boeing raised their list prices by 2% and 4%, further obscuring pricing clearness as discount levels will increase and with the growing importance of aftermarket services, following the Power by the Hour engine maker model.

Hawaiian Airlines in February 2018, canceled its order for six Airbus A330-800s to replace them with Boeing 787-9s which had less price than $100–115m and this price was close to their production cost of $80–90m, meanwhile their typical price to sale is approximately $125m.

By decreasing the fuel price from $3 to $2-per-gallon in 2011-2014 the market values are pressured downward by mid 2019 and also the rate of low aircraft lease reaching less than 0.7% per month while lessors manage 45% of the deliveries. It is deteriorated for Boeing among the Boeing 737 MAX groundings: the value of a new 737 Max 8 was decreased from 49.1 million to $46.7 million by 5%, while a new A320neo stays at $49.1 million based on FlightGlobal affiliate Ascend. The A330neo was amended at a deduction of the 787's cost, therefore Airbus can vie sharply on price while the A330neo can almost match the 787's efficiency: Boeing had to discount the dream-liner to win recent deals and 787-9 values eroded from the low-$140 million range to the mid-$130 million range.[34]

3.3. Effect of competition on product plans

222 operators had been selected the A320 in Dec. 2008, amid these different operators which are low-cost, gaining ground versus the formerly well established 737 in this sector; it has also been selected as a substitution for 727s and aging 737s by a lit of full-service airlines like Star Alliance members United Airlines, Lufthansa and Air Canada. After dominating the huge market of aircraft for the period of four decades, the Boeing 747 then faced a challenge from the A380. In reply, Boeing had an offer which was the updated and stretched747-8, with more capacity, longer range and fuel efficiency. Some delays which were repetitious to the Airbus A380 program caused several consumers in order to cancel their orders in favour of the refreshed 747-8. Airbus notified the end of the A380 production later on the residual orders would be delivered, in February 2019. By June 2019, they had 154 orders of Boeing 747-8 and 134 of them were delivered, meanwhile 290 Airbus A380 were ordered and 238 orders among them were delivered.

Several Boeing projects like the Sonic Cruiserwere adopted and then canceled. The Boeing 787 Dreamliner is the Boeing's current platform for fleet rejuvenation which uses technology from the concept of Sonic Cruiser.

At first, Boeing rejected producing a re-engined version of its 737 to rival with the Airbus A320neo family launch planned for 2015, believing airlines would be looking towards the Boeing Y1 and a 30% fuel saving, instead of paying 10% more for fuel efficiency gains of only a few percent. Industry sources believe that the 737's design results re-engining extremely much more expensive for Boeing than it was for the Airbus A320. However, there did

demonstrate to be huge demand. Southwest Airlines, who use the 737 for their whole fleet which is 680 on order or in service, said they were not capable to wait for 20 years or more for a new 737 model and threatened to convert to Airbus. Finally Boeing bowed to the pressure of airline and approved the 737 MAX project in 2011, arranged for first delivery in 2017. [36]

3.4. Orders and deliveries

For Boeing it took 42 years and 1 month to deliver its 10,000th 7series aircraft which the time period was from October 1958 to November 2000, and it took 42 years and 5 months to achieve the same milestone for Airbus that was from May 1974 to October 2016. The deliveries of Boeing markedly exceeded that of Airbus throughout the 1980s. In the 1990s, this lead narrowed strikingly but Boeing remained ahead of Airbus. Airbus supposed the lead in narrow-body aircraft in the 2000s. little discrepancy remained between Airbus and Boeing in both the wide-body or narrow-body categories or the range on offer by 2010. [37]

Table 9: Orders and Deliveries by Product

Manufacturer	Class	Product	2018			Historical Deliveries
			Orders	Deliveries	Backlog	
Airbus	Narrow-body	A220	135	20	480	57
		A320	541	626	6,056	8,605
	Wide-body	A300				561
		A310				255
		A330	27	49	295	1,439
		A340				377
		A350	40	93	659	235
		A380	4	12	87	234
	Total		747	800	7,577	11,763
Boeing	Narrow-body	707				1,010
		717				155
		727				1,831
		737	675	580	4,763	10,444
		757				1,049
	Wide-body	747	18	6	24	1,548
		767	40	27	111	1,133
		777	51	48	431	1,582
		787	109	145	622	781
	Total		893	806	5,951	19,533

Annual net orders and aircraft deliveries by Airbus and Boeing Commercial Airplanes, respectively, since 1989. [11]

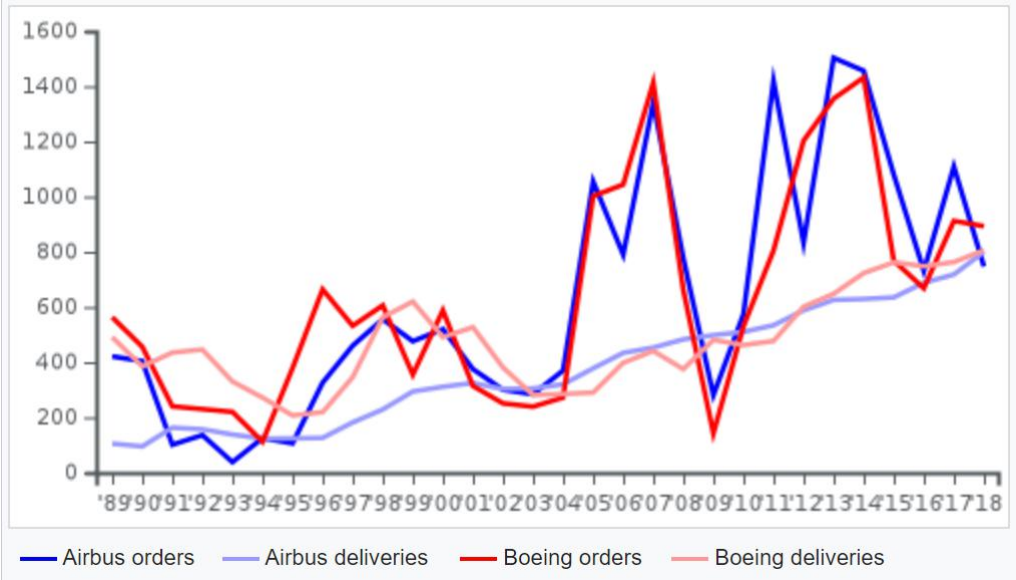


Figure 16: Annual net orders and aircraft deliveries by Airbus and Boeing Commercial Airplanes

Table 10: Deliveries by decade and fuselage type (through Dec 31, 2018)

	Narrow-body	Wide-body	Boeing	Narrow-body	Wide-body	Airbus	Ratio B:A
1980s	1,747	624	**2,371**	74	402	**476**	4.98:1
1990s	2,466	1,232	**3,698**	1,068	563	**1,631**	2.27:1
2000s	2,974	966	**3,490**	2,983	827	**3,810**	1.03:1
2010s	4,182	1,808	**5,990**	4,500	1,228	**5,728**	1.05:1
Total	**14,489**	**5,044**	**19,533**	**8,662**	**3,101**	**11763**	

Table 11: Commercial airliners still in operation

	707	717	727	737	747	757	767	777	787	Boeing	A220	A300	A310	A320	A330	A340	A350	A380	Airbus	Ratio B:A
2006	68	155	620	4328	989	996	862	575		**8593**		408	199	2761	418	306			**4092**	2.09:1
2007	63	155	561	4583	985	1000	880	640		**8867**		392	193	3095	481	330			**4491**	1.97:1
2008	61	154	500	4761	955	980	873	714		**8998**		387	194	3395	553	330		4	**4843**	1.86:1
2009	58	142	442	4928	947	970	864	780		**9131**		376	188	3737	607	345		16	**5269**	1.73:1
2010	39	147	398	5153	915	945	863	858		**9318**		348	160	4092	675	342		30	**5647**	1.65:1
2011	10	130	250	5177	736	898	837	924		**8962**		296	121	4392	766	332		50	**5957**	1.50:1
2012	2	143	169	5357	690	860	838	1017	15	**9091**		262	102	4803	848	312		76	**6403**	1.42:1
2013		148	109	5458	627	855	821	1094	68	**9180**		234	84	5170	927	298		106	**6819**	1.35:1
2014		154	87	5782	585	812	795	1188	163	**9564**		216	71	5632	1020	266		136	**7341**	1.30:1
2015		136	69	6135	571	738	765	1265	186	**9965**		207	62	6050	1095	227	5	167	**7813**	1.28:1
2016		154	64	6512	515	688	742	1324	423	**10422**		210	47	6510	1154	196	29	193	**8339**	1.25:1
2017		154	57	6864	489	689	744	1387	554	**10938**		211	37	6965	1214	176	92	212	**8907**	1.23:1
2018		148	44	7310	462	666	742	1416	675	**11463**	39	212	31	7506	1265	159	185	223	**9620**	1.19:1
	707	**717**	**727**	**737**	**747**	**757**	**767**	**777**	**787**		**A220**	**A300**	**A310**	**A320**	**A330**	**A340**	**A350**	**A380**		

3.5 Controversies

3.5.1 Subsidies

Boeing has constantly made a stand over launch aid in the form of credits to Airbus, meanwhile Airbus has ratiocinated that Boeing receives some subsidies which are illegal through research contracts, military and tax breaks.

Harry Stonecipher who after was the CEO of Boeing in July 2004 accused Airbus of abusing a 1992 bilateral EU-US agreement regarding large civil aircraft support from governments. Airbus is given repayable launch investment (RLI), called "launch aid" by the U.S. from European governments with the money being paid back with interest, plus indefinite royalties if the aircraft is a commercial success. Airbus claims that this system is completely compatible with the 1992 agreement and with the rules of WTO. The agreement regularities lets that until 33 percent of the program cost to be met through government loans which are to be fully gave back in 17 years plus the interest and royalties. These kind of loans are held at the lowest interest

rate which is equal to the cost of government borrowing plus 0.25%, which would be below market rates available to Airbus without the support of government. Airbus asserts that since the signing of the EU-U.S. agreement which was in 1992, it has repaid more than U.S.$6.7 billion to the European governments and this amount is 40% more than it the amount that it has received.

Airbus argues that pork barrel military contracts which is the second largest U.S. defence contractor awarded to Boeing and they are in effect a form of subsidy. The government of U.S. support of technology development through NASA in addition prepares support to Boeing. Also Boeing has received support from local and state governments in some products like the 787 which these products are the recent products. Airbus's parent, EADS, itself is a military contractor and is paid in order to build and develop projects like the Airbus A400M transport and different other military aircraft.

United States and European Union in January 2005, trade representatives Robert Zoellick and Peter Mandelson agreed to talks aimed to solve some tensions which are raising. These conversations were not prospering, with the quarrel becoming more acrimonious rather than approaching a settlement. [38]

3.5.2 World Trade Organization litigation

The United States filed a case versus the European Union for providing subsidies to Airbus which are supposedly illegal on 31 May 2005. One day later the European Union filed a complaint against the United States protesting support for Boeing.

The tensions increased, owing to the support for the Airbus A380, soared toward a trade war which is potential as the launch of the Airbus A350 neared. The preference of Airbus was the A350 program to be launched with the aid of the loans from the state covering a third of the costs of development, although it stated it will launch without these loans if required. The A350 will compete with the most successful project of Boeing, the 787 Dreamliner, in recent years. EU trade officials questioned the funding's nature provided by NASA, the Department of Defense, and specially the form of Research and Development (R&D) contracts that benefit Boeing; also funding from US states like Washington, Kansas and Illinois, in order to

development and launch of Boeing aircraft, in particularly the 787. A temporary report of the investigation of WTO into the claims made by both sides was made in September 2009.

The WTO ruled that European governments financed Airbus unfairly, in March 2010. In September 2010, a preparatory report of the WTO found that the unfair payments of Boeing broke the rules WTO and should be withdrawn. The finding of WTO which was in two separate parts and issued in May 2011 it found firstly, that the US defence budget and NASA research grants could not be used as vehicles to subsidize the civilian aerospace industry and that Boeing must repay the amount of $5.3 billion of illegal subsidies. Secondly, the WTO Appellate Body partly overturned an earlier ruling that European Government launch aid constituted subsidy which was unfair, agreeing with the point of principle that the support was not aimed at boosting exports and some forms of public-private partnership could continue. Part of the $18bn in low interest loans received would have to be repaid finally; however, there was no instant need for it to be repaid and the exact value to be repaid would be set at a future date. Both parties claimed conquest in what was the world's largest trade argumentation.

Airbus, on 1 December 2011 reported that it had accomplished its commitments under the WTO findings and called upon Boeing to do likewise in the coming year. The United States was disagree and had begun complaint procedures prior to December, stating the EU had failed to comply with the DSB's recommendations and rulings, and requesting authorization by the DSB to take countermeasures under Article 22 of the DSU and Article 7.9 of the SCM Agreement. The European Union had request about the matter be referred to arbitration under Article 22.6 of the DSU. The DSB agreed that the matter increased by the European Union in its statement at that meeting be referred to arbitration as required by Article 22.6 of the DSU however the US and EU on 19 January 2012 jointly agreed to withdraw their asking for arbitration.

On 12 March 2012 the appellate body of the WTO released its discoveries which confirms that the subsidies to Boeing was illegal whilst confirming the legality of repayable loans made to Airbus. The WTO presented that Boeing had received at minimum $5.3 billion cash subsidies illegally at an estimated cost to Airbus of $45 billion. In addition $2 billion in state and local subsidies that Boeing is set to receive have also been announced illegal. Boeing and the US government had six months to change the way government support for Boeing is handled. On 13 April 2012, At the meeting of DSB, the United States informed the DSB that

it intended to execute the DSB recommendations and rulings in a manner that respects its WTO rules and obligations and within the time-frame established in Article 7.9 of the SCM Agreement. The European Union complimented the US attempt and noted that the period of 6-month stipulated in Article 7.9 of the SCM Agreement would expire on 23 September 2012. Both the European Union and the United States informed the DSB of Agreed Procedures under Articles 21 and 22 of the DSU and Article 7 of the SCM Agreement on 24 April 2012.

On 25 September 2012 the EU had request to discuss with the US, because of the alleged non compliance of the US and Boeing with the WTO ruling of 12 March 2012. Also the EU on 27 September 2012 requested the WTO to approve EU countermeasures against USA's subsidy of Boeing. The WTO authorized to make a panel to rule on the disputed compliance this was at first to rule in 2014 but is not now expected to complete its work before 2016 due to the complexity of the case. The EU wants permission to place trade sanctions of up to 12 billion US$ per year versus the USA. The belief of EU is this much amount represents the damage the subsidies which are illegal of Boeing cause to the EU.

On 19 December 2014 the EU had request of WTO in order to mediate consultations with the US over the tax incentives which gave by the Washington's state to large civil aircraft manufacturers which they believed violated the earlier WTO ruling, on 22 April 2015 at the request of the EU a WTO panel was set up to rule on the complaint. The incentives of tax which gave by the state of Washington and believed to be the largest in US history outstripping the former record of $5.6bn over 30 years awarded by the state of New York to the producer of aluminum Alcoa in 2007. The $8.7bn over 40 years motivation to Boeing to produce the 777X in the state which includes $4.2bn from a 40% decline in business taxes, £3.5bn in tax credits for the firm, a $562m tax credit on buildings and property owned by Boeing, a $242m sales tax exemption in order to buy computers and $8m to instruct 1000 workers, The claim of Airbus is that this is larger than the budgeted cost of the development program belong to Boeing 777X and the EU argues amounts to an whole publicly funded free aircraft program for Boeing, the regulation and legislation was an extension of the duration of a program of tax break given to Boeing for Dreamliner development that had already been illegally ruled in 2012 by the WTO. Boeing defends the claim by arguing that everyone has the availability of subsidies however for an aircraft to qualify for the tax breaks a company must manufacture aircraft wings and carry out all final assembly for an aircraft model or variant exclusively in the state.

In September 2016, The WTO recognized that Airbus did not have treatment the harm to Boeing from subsidies which were illegal, and the EU instantly appealed for a final decision in late spring 2018. The expectation of Boeing was that the decision of 2016 will be largely maintained with sanctions between $10 to $15 billion, which could be levied by punitive tariffs by the government of U.S., but the EU would retaliate forcefully. The EU case against Boeing filed as a countersuit lags the U.S. case and the decision on Boeing's appeal will not come out until late in 2018 or even in 2019. Both are exposed with a backlog of 1,340 Airbus orders in the US and 644 Boeing orders in the EU, but this is mitigated as many are from lessors, to be delivered elsewhere, and the assembly line of Airbus is in Alabama.

On 15 May 2018, in its EU appeal ruling, the WTO concluded that the A380 and A350 received some subsidies which are aberrant through repayable launch aids or low interest rates, like prior airliners, which could have been avoided. Boeing asserted conquest but Airbus countered it is thin with 94% of the complaints rejected, as launch aids are legal but at market interest rates, not lower: contravention will be corrected. US tariffs, may take up to 18 months to get WTO approval, perhaps on other industries, but EU could retaliate over Washington State 787 subsidies and tax breaks for the 777X. The U.S. will trace penalties and punishments if an agreement cannot be reached but is willing to reach with the European Union a settlement.[39]

3.5.3 Proposed tariffs

The U.S. Government announced that it would pursue penalties by placing tariffs on European Union goods over Airbus' improper subsidies, in an obvious act of revenge, on 9 April. As a response, Bruno Le Maire, the financial minister of France, told that a "friendly" solution should be made. The U.S. Government on 1 July proposed more tariffs for the same reason.

At the same year on 24 September, it was announced that the WTO would authorize the U.S. to place the tariffs. The WTO presented that the $8 billion USD of EU goods could be influenced by the tariffs.

On 30 September the WTO notified the punitive tariffs' allowed level, approximately $5-10 billion down from the $25Bn asked for, after that the USTR should issue a list of products to be taxed from year-end. By mid-2020, the WTO is slated to specify the allowed EU punitive tariffs, as the EU claims $20Bn in damages. It would harm both sides, with Boeing having the

most to lose as US Aerospace and defence exports to Europe totals $30.5Bn, while imports are $23.6Bn.

The WTO confirmed US tariffs on $7.5 billion worth of European goods on 2 October.[40]

3.6 Conclusion

Affordable, reliable, and safe air transportation is important to quality of life and economic growth. The global transportation infrastructure would be enhanced by the addition of a truly high-speed transportation element. The technological challenges to commercial supersonic flight can be overcome, as long as the development of key technologies is continued. Without continued effort, however, an economically viable, environmentally acceptable, commercial supersonic aircraft is likely to languish.

The industry of aircraft manufacturing requires skilled labour concerning aircraft production and design also it need huge investments that are tied up during long time due to long design lead-times, long production lead-times and cyclical market demand. Therefore, aircraft manufacturers have to be able to sustain long periods of time that means several years where they may face high expenditures but too much limited income. Finally, aircraft in order to be able to become more profitable, have to be sold in large quantities. Typically, this requires that they are sold internationally, which is requires approval of international aviation authorities like JAA and FAA and in addition to that it also need universal customer support.

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