

THE MOVE TOWARDS SUSTAINABLE AVIATION

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ABSTRACT

This paper discusses how the aviation industry has been shaped by sustainability and examines how the aviation industry is progressing towards a more sustainable future. It compares the fuel usage of similar aircraft between aircraft manufacturers, Airbus and Boeing. The research also looks at how aircraft designs have evolved over time to reduce fuel usage and cut down carbon emissions. This can be seen in the fuel usage of aircraft. For example, if you compare the fuel usage of the Airbus A340 to the Airbus A350, the Airbus A350 uses significantly less fuel as it has improved engines and aerodynamics, allowing it to transport a similar number of passengers over a similar range. Airbus managed to make a better and far more fuel-efficient aircraft within 20 years.

The aim of this research study was to examine how the commercial aviation industry can promote sustainable aviation in the future through a mixed-method approach. First, by using a quantitative approach, the impact of all the aircraft designs of Boeing and Airbus for commercial aircraft carrying 40 passengers and above on fuel usage and CO₂ emissions would be compared, followed by a qualitative analysis explaining the varying fuel usage of similar aircraft and comparing which aircraft manufacturer holds the upper hand going into the future.

Introduction

The aviation industry leaves a huge dent in the environment each year. In 2019 alone, this sector contributed one gigaton of CO₂ emissions. With the growing demand for travel, this number will only rise in the years to come. The USA has the highest demand for air travel (Index Mundi, 2019). The demand in the country alone is 50% higher than that of the entire African continent. This leads to higher carbon emissions in the country, therefore majorly contributing to global warming. The aviation sector is also one of the worst to be in. This industry is threatened by a market failure that can lead to drastic changes. It has been a major contributor to global warming, it has negative or small profits, and it depends on government aid. This all can change once sustainable aviation is brought into the picture. If the industry is able to modify the aircraft by changing the designs or wingtips to increase fuel efficiency, costs can be cut leading to a higher scope for profits. The decrease in fuel usage will not only cut costs but also benefit the environment. Airlines are already making efforts to do this by reducing the weight of inflight magazines, trays, etc. Companies are also on the lookout to find alternate fuels for kerosene. Airlines like KLM and Air France are already using Sustainable Aviation Fuel (SAF), mixed with kerosene to fuel their aircraft (Poleri, 2022). French aircraft manufacturing giant Airbus has already patented designs for Hydrogen-powered aircraft (Airbus, 2020), so the future looks bright for the industry. However, there are going to be a great number of risks involved such as hydrogen being a flammable fuel. Turning the page to a new chapter in the aviation sector looks to be very interesting.

The aviation industry will come across major changes in the future, we will see unforeseen challenges and exciting new beginnings as the world looks to focus on sustainability. As the demand for air travel increases, flight numbers rise too which increases the carbon footprint substantially. Airlines face high costs too and often operate at a very low-profit margin due to fuel expenses (IATA, 2019). Sustainable aviation will not only make flying cheaper for passengers, but airlines too as operating costs will go down.

However, the path to reaching this point is very hard. As mentioned above, there is already ongoing research on this topic and aircraft manufacturers are also focussing on developing new aircraft that get us closer to net-zero carbon emissions from aircraft. There will be a lot of uncertainty over the topic of flying electric/hydrogen-powered planes. Electric flight hasn't gotten off to a great start as there was a crash in 2019 in Norway (Reuters, 2019) due to engine issues, thankfully, no one was injured. Despite this, another crash of a Siemens electric aircraft killed 2 as it caught fire in the air during a demonstration (Lambert, 2018). Great ideas don't become successful without failure as we saw with Elon Musk and Tesla or SpaceX (Mulnix, 2021).

Research Methodology

Aim:

- The aim of this research study was to examine how the commercial aviation industry can promote sustainable aviation in the future through a mixed-method approach. First, by using a quantitative approach, the impact of all the aircraft designs of Boeing and Airbus for commercial aircraft carrying 40 passengers and above on fuel usage and CO₂ emissions would be compared. As such, the following hypotheses were tested:

Null Hypothesis:

- There is no difference between the mean CO₂ emissions of the aircraft types of Boeing and Airbus.

Alternative Hypothesis:

- There is a difference between the mean CO₂ emissions of the aircraft types of Boeing and Airbus.

Data collection:

- In addition, bar graphs that the competing aircraft designs from Airbus, e.g., Boeing-737 vs. Airbus A320, would also be presented to delve into their SUSTAINABLY
- SOURCED FIBRES in greater depth.
- Second, under the qualitative approach, the evolution of the aircraft designs of both Boeing and Airbus over time towards greater environmental sustainability would be discussed and analysed through a presentation of the engineering elements.

Data Analysis:

- The data collected was organised in the form of bar graphs and conclusions were drawn from it. They were compared by how much fuel (kg/hour) is used by each plane model from each manufacturing giant (Airbus/Boeing).

Results

Qualitative section:

The aviation industry is one of the biggest contributors to global carbon emissions. This issue speeds up global warming and increases the risk of poor air quality, damages the ozone layer, and opens a plethora of other issues unless we do something about it (EPA, n.d.). Sustainable aviation is the way forward and we need to make drastic changes in this sector. Aircraft manufacturers and airlines have already begun taking steps toward reducing carbon emissions.

The French company Airbus has modified a few aircraft types by changing the winglet design by making it more curved, similar to a shark's fin (Airbus, 2011). This leads to lesser fuel used, benefiting the environment as well as saving money for the airline (Reuters, 2013). Boeing too has made its aircrafts' winglets more aerodynamic for the same reason, to use less fuel (Freitag & Schulze, 2009). Boeing has also implemented Chevron nozzles designed by

NASA in recent aircraft which again saves fuel, but it also makes the engine quieter, leading to less sound pollution (NASA, 2010).

Many airlines have also started reducing the weight of their inflight magazines or completely scraping them off to reduce the aircraft weight, which again reduces the amount of fuel needed. This small measure may not seem very big, but it can save millions of dollars per year for an airline (Martín, 2018). Some airlines like British Airways have also scrapped plastic usage to be more eco-friendly. This will also reduce the airline’s carbon footprint (Boon, 2020).

Looking to the future, manufacturers have already patented aircraft designs that will run on hydrogen or electricity or on another fuel compound that is more sustainable than kerosene. Airbus operated 2 flights with the A380 on the 25th and 29th of March in 2022 using 100% sustainable fuel derived from cooking oil (Young, 2022). This feat showcases the industry’s progress on sustainability and its potential to expand into something greater. The upcoming designs are more aerodynamic and should prove to be revolutionary by the next decade. In fact, one new manufacturer called Boom Supersonic has already designed a sustainable aircraft- Overture that is capable of traveling at supersonic speeds of up to Mach 1.7. (Boom Supersonic, n.d.). It can get you from New York to London within 3 and a half hours rather than 6 and a half hours. The greatest thing is that the plane will have net-zero carbon emissions! The company hopes to enter the commercial aviation industry by the end of the decade.

Quantitative Section:

Through the graphs and findings, one can see that Airbus has slightly higher fuel usage and carbon emissions compared to Boeing across most aircraft types.

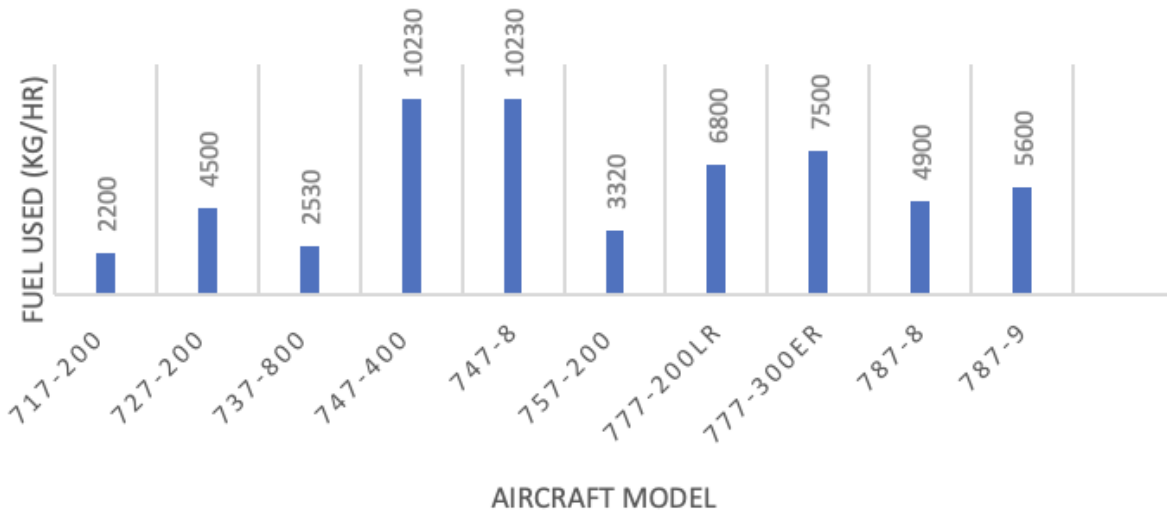


Figure 1: Boeing fuel consumption graph (Aircraft model and fuel used in kg/hr)

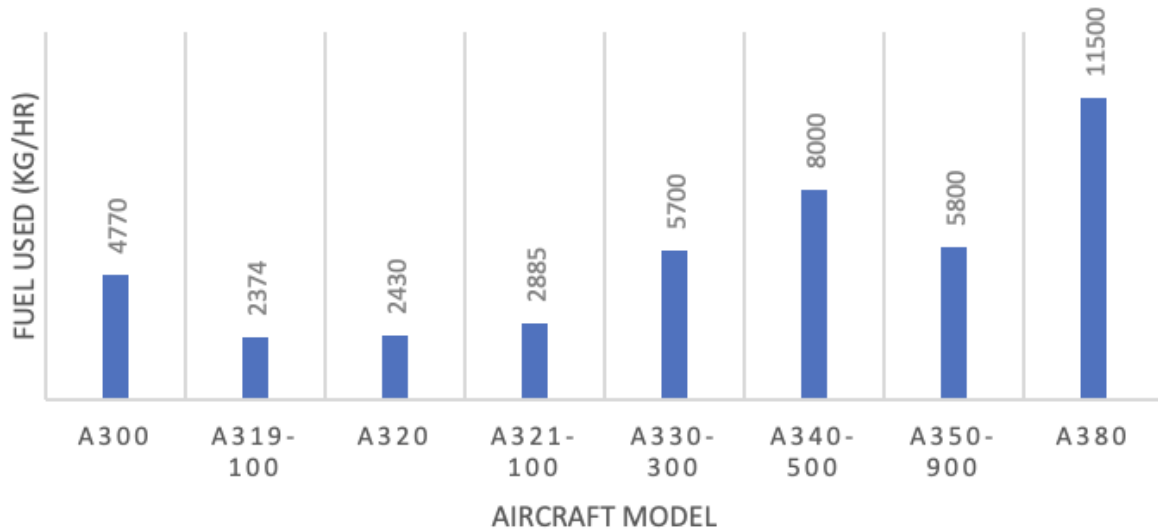


Figure 2: Airbus fuel consumption graph:
(Aircraft model and fuel used in kg/hr)

From this data, I was able to categorise my findings into the following aircraft types:

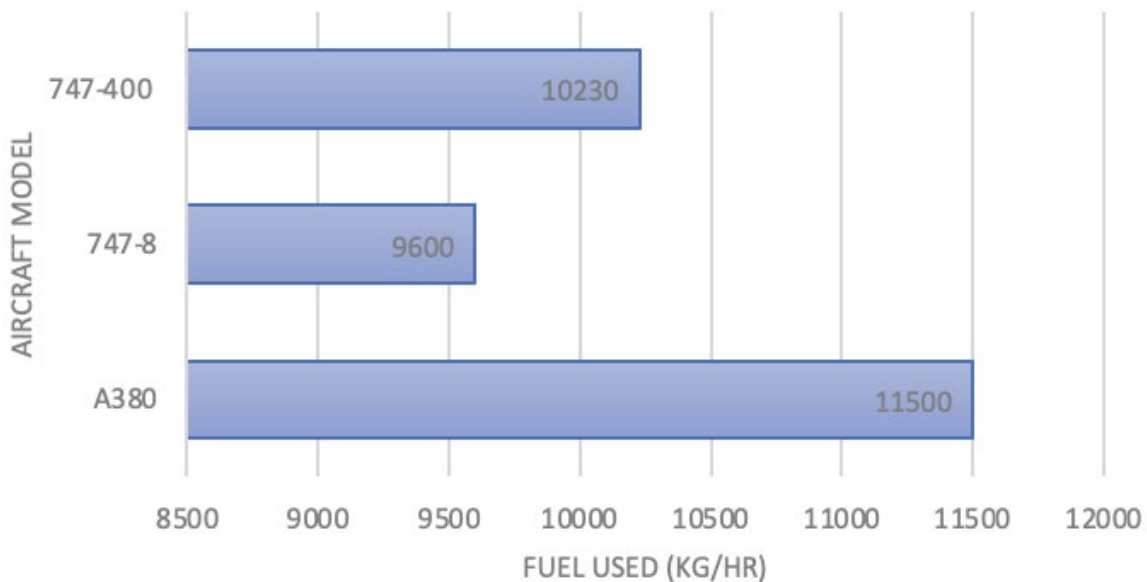


Figure 3: Double-decker long haul high-capacity planes:
(Aircraft model and fuel used in kg/hr)

Boeing is clearly ahead of Airbus here and that is due to the capacity of these aircraft. The Airbus A380 carries a lot more passengers than the Boeing 747, therefore it would need larger engines that would require more fuel. Plus, both of these aircraft are fading away as they're very fuel inefficient. Few airlines need such large aircraft for their services and most airlines can't afford these large capacity planes. COVID only added fuel to the ongoing fire where airlines were forced to retire many of these planes way before expected as they couldn't maintain them. It

would also be economically harmful as airlines lost billions of dollars in 2020 and recovering after that would've been hard.

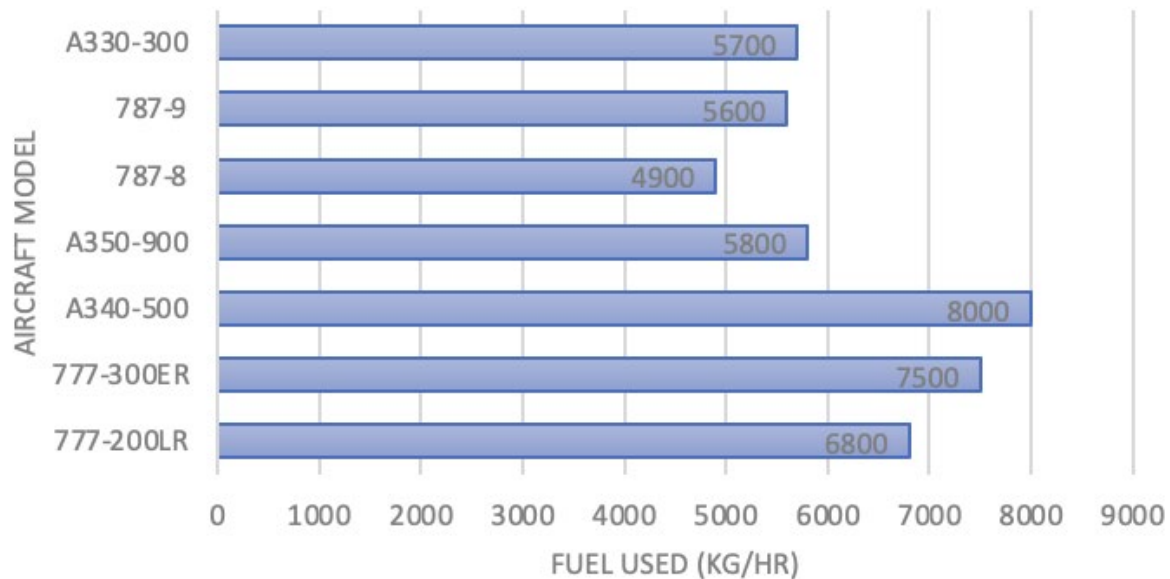


Figure 4: Long haul medium/high-capacity aircraft:
(Aircraft model and fuel used in kg/hr)

All these planes have different capacities and therefore varying fuel consumption and emissions. The A330, A340 and the 777s are almost as old as one another. The A340 has the highest emissions as it could carry the most passengers amongst the 4 aircraft and was a quadjet. The 777 competed with it and was much more successful as it was cheaper to operate. It allowed airlines to carry the same amount of passengers whilst being able to use only 2 engines. The A330 carried significantly fewer passengers and therefore is a competitor with the 787s with all planes being able to carry a maximum of around 300 passengers. The relatively new A350 is competing with the 787s and will be competing in the near future with 777Xs which are newer models of the Boeing 777. The A350 is advantageous over the 787-9 because it allows airlines to almost carry 100 more passengers for more or less similar fuel consumption. Plus, the Airbus A350 features curved winglets (wingtips) that allow it to use less fuel as they reduce vortex drag induced by lift. This drag can cause planes to use a lot of fuel and therefore the curved wingtips allow less fuel consumption and carbon emissions.

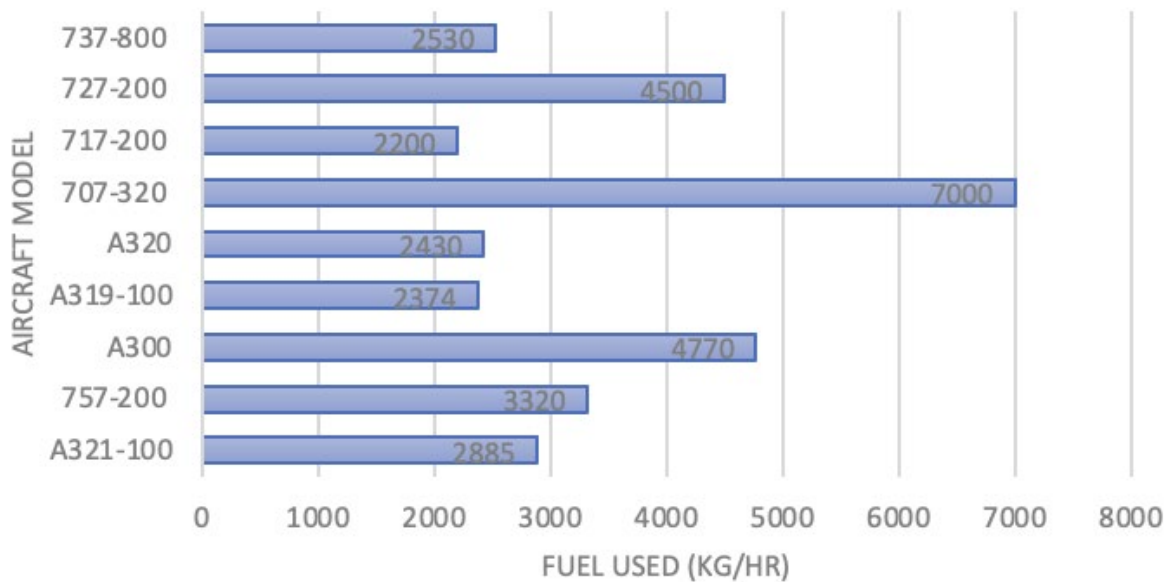


Figure 5: Narrowbody medium-haul aircraft:
(Aircraft model and fuel used in kg/hr)

Narrowbody aircraft are those we usually use for short-distance flights. Over here, Airbus has the advantage over Boeing as most of its aircraft consume less fuel than the Boeing ones. The Boeing 707 was made in 1954 and was the first jetliner Boeing ever made, therefore its fuel consumptions are much higher than the rest. Similarly, the 727 and A300 are very old aircraft too. Very few of them fly in today's world. The most popular aircraft here are the Airbus A320 and the Boeing 737. These are found almost everywhere, and they carry a similar number of passengers. Both aircraft have very similar fuel consumption rates, but Airbus has the edge in this one. The A320 family which includes the A321 and A319 surpassed the Boeing 737 family to become the most popular aircraft family in existence in terms of sales.

Conclusion

Through the report and detailed analysis of carbon emissions and fuel usage between the aircraft manufacturing giants, Boeing, and Airbus, I have been able to conclude that the aviation industry has made significant progress toward reducing fuel usage and carbon emissions since the first jetliner took flight. Even though Boeing does have a slight edge over Airbus in terms of fuel usage where their planes use slightly less fuel, there is a high possibility that Airbus will overtake Boeing in the future and will lead the commercial sustainable aviation industry. Airbus has already patented designs for Hydrogen-powered aircraft as mentioned earlier in the report which are likely to enter the industry next decade. Airbus also managed to test the Airbus A380, the largest passenger plane in the world using 100% sustainable fuel.

Even though the future seems bright for the industry, the solutions pose a variety of issues to the industry. For example, Hydrogen is highly flammable, and it'll be very risky to handle it as a fuel. Sustainable fuels however as an alternative are more feasible as they're safer, but they aren't able to offset carbon emissions completely. Better body designs and engines design seem like they're a much better option as they're going to be beneficial for the future and will be safer. However, this will be a costly way of reaching sustainability in the industry, but it is a better solution than using alternative fuels. People will most probably have concerns over new aircraft and fuels, but these are likely to fade away in the long term as they accept the development.

If sustainable aviation is able to pave the future for the industry, global carbon emissions will be reduced substantially as in 2019 alone, the aviation sector contributed 915 million tonnes of CO₂ emissions out of 43 billion tonnes of emissions from humans. If we are able to sustain carbon neutral flights, global CO₂ emissions will be cut down by approximately 2%, and these developments can be further utilised in similar industries including automobiles and space.

Implications of the study

Researchers, aviation enthusiasts and sustainability enthusiasts will be able to use this research to look back on how aircraft manufacturers have progressed over time in decreasing fuel usage which ultimately lowers their carbon emissions. Through this report, readers would also be able to understand and learn about the different solutions used to try to reduce the carbon footprint of the aviation industry.

Limitations

The following research was conducted with the help of strong sources that were related to this very field. Despite the credibility and accuracy of the information provided, the research data can vary for different aircraft as there are multiple subtypes for most aircraft mentioned. Secondly, the conclusions drawn from the graphs can be inaccurate as all aircraft have different seating capacities, so it is unfair to a certain extent to say that Boeing is currently leading the industry by having less fuel consumption. Thirdly and lastly, the future is unpredictable, and we cannot foretell what will happen in the coming years, so the concepts mentioned may never come to life or the ideas and innovation might differ from what it is in 2021.

Acknowledgements

I would like to extend my gratitude to my parents, family, mentors, and friends for helping me build a keen interest in the topic of aviation and for providing me with the exposure and opportunity to explore aviation from a sustainability point of view.

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