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RESEARCH ARTICLE

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FLYING GREEN: A SECONDARY DATA ANALYSIS ON CARBON REDUCTION STRATEGIES IN THE AIRLINE INDUSTRY

***[1]Dr. M. Saravanan and [2]C.J. Dhevarubha**

[1]Associate Professor & Head , i/c Department of International Business PSG College of Arts & Science Coimbatore – 641 014
[2]II M.Com (IB) Student Department of International Business, PSG College of Arts & Science Coimbatore – 641 014

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****Correspondingauthor:*** **Dr. M. Saravanan,**

ABSTRACT

As of 2023, the aviation industry accounts for approximately 2.5% of global energy-related CO_2 emissions, with its total climate impact estimated at around 4% when non-CO_2 effects are included. Following a dramatic drop due to the COVID-19 pandemic, emissions rebounded to nearly 950 million metric tons CO_2—over 90% of pre-pandemic levels. Despite improvements in fuel efficiency, the carbon intensity of jet fuel has not changed significantly, and demand for air travel continues to rise. This study examines the role of Sustainable Aviation Fuel (SAF) in addressing aviation's climate impact through secondary data analysis. SAF, produced from renewable feedstocks, offers up to 80% lower lifecycle emissions compared to conventional jet fuel. Technological advancements, such as Honeywell's Ecofining™ process, demonstrate the potential for scalable SAF production and integration into existing fleets. As the industry pursues net-zero emissions by 2050, SAF emerges as a critical transitional strategy, enabling immediate reductions without requiring major infrastructure changes.

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INTRODUCTION

A huge and ever-evolving sector, the aviation industry is essential to international trade, economic growth, and transportation. It includes commercial airlines, air cargo services, airport operations, aircraft manufacture, air traffic control, and maintenance services, among other facets of air transport. One vital sector that supports international trade, transportation, and economic expansion is the aviation industry. As the industry plans to support a near doubling of passenger and cargo numbers by 2036, demand for pilots, engineers, air traffic controllers and other aviation-related jobs is expected to rise dramatically. Aviation provides the only rapid worldwide transportation network, generating economic growth, creating jobs, and facilitating international trade and tourism.Aviation has become the enabler of global business and is now also being recognized by the international community as an essential enabler to achieving the UN Sustainable Development Goals. The most recent estimates suggest that demand for air transport will increase by an average of 4.3% per annum over the next 20 years.If this growth path is achieved by 2036 the air transport industry will then contribute 15.5 million in direct jobs and $1.5 trillion of GDP to the world economy. Once the impacts of global tourism are taken into account, these numbers could rise to 97.8 million jobs and $5.7 trillion in GDP. By mid-2030s no fewer than 200,000 flights per day are expected to take off and land all over the world.

Statement of the Problem: The airline sector contributes significantly to global greenhouse gas emissions, making up between two and three percent of global CO2 emissions. This environmental impact is anticipated to worsen as demand for air travel continues to rise, so intensifying the global climate issue. The burning of jet fuel, which has a high carbon content, is the main cause of these emissions. Despite initiatives to increase fuel efficiency, the industry's overall carbon footprint is still high. The difficulty is in identifying and putting into practice workable ways to drastically cut the carbon emissions related to air travel. To cut emissions, remove current obstacles to the adoption of sustainable technology, and move toward a more low-carbon and sustainable future, significant work and financial resources are needed.

REVIEW OF LITERATURE

Anshu Agrawal, 2020 in "Sustainability of airlines in India with COVID-19: Challenges ahead and possible way-outs" examined the significant disruptions caused by the COVID-19 pandemic to the Indian aviation sector, highlighting challenges such as reduced passenger demand, financial losses and operational hurdles. It discusses potential strategies for recovery and long-term sustainability.

Chavarria, A., & Garcia, J., 2020 in “Sustainability in the airline industry: challenges and opportunities “explored the sustainable challenges faced by the airline industry, particularly focusing on environmental impact and carbon emissions. It also discusses emerging opportunities in sustainable aviation fuels (SAF).

Objectives

1. To access the current carbon footprint of the airline industry.
2. To investigate how Sustainable Aviation Fuels (SAF) contribute to a decrease in emissions.

METHODOLOGY

The data is collected through secondary data collection. Instead of performing original research, secondary data collection involves obtaining pre-existing information from published sources. Journals and articles are important sources of reliable, peer-reviewed material for both academic and commercial research, which makes them a useful instrument for gathering secondary data.

Analysis and Interpretation

Current carbon footprint: As of 2023, the aviation industry is responsible for approximately 2.5% of global energy-related CO_2 emissions, with emissions rebounding to nearly 950 million metric tons (Mt) CO_2, reaching over 90% of pre-pandemic levels. Along with emitting CO2 from burning fuel, planes also affect the concentration of other atmospheric gases and pollutants. They generate a short-term increase but a long-term decrease in ozone and methane and increased emissions of water vapor, soot, sulfur aerosols, and water contrails. While some of these impacts result in warming, others induce a cooling effect. But overall, the warming effect is stronger. Breaking this down, international aviation contributed around 492 Mt CO_2 in 2023. International aviation emissions more than doubled between 1990 and 2019, to reach a record high of 625 MtCO_2. The outbreak of COVID-19 and subsequent travel bans caused aviation emissions to plummet more than 50 percent in 2020 to levels last observed in the mid 1990s. Although emissions rebounded in the following years, they have remained well below pre-pandemic levels. International aviation accounts for roughly six percent of global transportation CO_2 emissions. While aviation accounts for 2.5% of global CO_2 emissions, its overall contribution to global warming is estimated at approximately 4% when considering factors beyond CO_2 emissions.Between 1990 and 2019, both passenger and freight demand has approximately quadrupled. More people are flying, and more stuff is being moved around. In 2019, passengers traveled more than 8 trillion kilometers, about the same as a light year. The carbon intensity of that fuel — how much CO2 is emitted per unit — has not changed at all. We used standard jet fuel in 1990 and are using the same stuff today. It has not gotten any cleaner. Biofuels and other alternatives are just a tiny fraction of global demand. If flying has become more than twice as energy efficient, and the carbon emitted per unit of energy has not changed, then the carbon efficiency of traveling one kilometer is also more than twice as high. In 1990, one passenger-kilometer would emit 357 grams of CO2. By 2019, this had more than halved to 157 grams.

The industry has set a goal to achieve net-zero carbon emissions by 2050, focusing on measures like adopting sustainable aviation fuels (SAF), enhancing fuel efficiency, and investing in new technologies. In 2024, SAF usage reached 1 million tonnes, more than doubling the 240,000 tonnes used in 2023. Projections for 2025 estimate SAF production to be 2.1 million tonnes, accounting for 0.7% of airlines' total fuel consumption. Absolute emissions in gigatonnes of CO2 are impacted by fuel burn, load factors, aircraft type and route operated, among other factors. The most significant emissions reduction, around 65%, is expected between 2030-2040 as SAF becomes more widespread. Further efficiency measures have the potential to enhance fuel efficiency by 30-40% by 2050.13

Emissions intensity, measured as CO2 emitted per passenger kilometre, is influenced by aircraft type and routes. In 2022, emissions intensity per passenger kilometre was higher than pre-pandemic levels due to demand being around 80% of 2019 levels.14 Emissions intensity is now decreasing in line with growing demand. However, aviation needs to reduce its emissions intensity to net zero by 2050, with over 70%15 of the reduction expected between 2030 to 2050 as SAF adoption increases alongside increased efficiency measures and offsetting. Emissions intensity is now decreasing in line with growing demand. However, aviation needs to reduce its emissions intensity to net zero by 2050, with over 70%15 of the reduction expected between 2030 to 2050 as SAF adoption increases alongside increased efficiency measures and offsetting.

What is Sustainable Aviation Fuel (SAF)?

SAF is an alternative to traditional Jet A and Jet A-1 fuel, produced from renewable sources instead of crude oil. It is a drop-in fuel, meaning it can be blended with conventional jet fuel and used in existing aircraft engines without modifications.

Key Benefits:

- Reduces CO_2 emissions by up to 80% over its lifecycle.
- Uses non-fossil feedstocks, reducing dependence on crude oil.
- Improves energy security by diversifying fuel sources.
- Enhances fuel efficiency due to a higher energy density than conventional fuel.

Role of sustainable aviation fuel (SAF): Sustainable Aviation Fuel (SAF) is a renewable alternative to conventional jet fuel that significantly reduces aviation’s carbon footprint. It is made from sustainable feedstocks, such as waste oils, agricultural residues, and even captured CO_2, offering up to 80% lower lifecycle emissions compared to fossil-based jet fuel. As the airline industry aims for net-zero carbon emissions by 2050, SAF is expected to play a crucial role in achieving this goal.

How SAF Reduces Carbon Emissions

Lifecycle Emission Reduction: SAF reduces carbon emissions across its entire lifecycle, from raw material sourcing to combustion.

Conventional Jet Fuel: Extracted from crude oil, refined, transported, and burned—releasing large amounts of newCO_2 into the atmosphere. SAF: Made from renewable sources like waste oils, biomass, and captured CO_2, so the emitted CO_2 was already part of the natural carbon cycle.

Direct CO_2 Reduction

- SAF produces the same amount of CO_2 per unit burned as fossil jet fuel, but the key difference is that the carbon comes from renewable sources rather than underground fossil reserves.
- SAF also reduces sulfur and particulate emissions, improving air quality.

Example

- 1 ton of conventional jet fuel emits 3.15 tons of CO_2 when burned.
- SAF made from waste oils can reduce 2.5 tons of CO_2 per ton of fuel used.

Avoiding Non-CO_2 Climate Impacts

Aircraft emissions at high altitudes create contrails and nitrogen oxides (NOx), which contribute to global warming beyond just CO_2 emissions.

- SAF burns cleaner, reducing soot particles that contribute to contrail formation.
- Some SAF pathways lower NOx emissions, reducing their impact on ozone and climate.

FINDINGS

1. In 2023, aviation emissions reached 950 million metric tons (Mt) CO_2, about 90% of pre-pandemic levels.
2. International aviation alone contributed 492 Mt CO_2 in 2023.
3. Improved aircraft efficiency has halved emissions per passenger-kilometer from 357g in 1990 to 157g in 2019.
4. SAF usage grew from 240,000 tonnes in 2023 to 1 million tonnes in 2024, with projections of 2.1 million tonnes in 2025 (still just 0.7% of total airline fuel).
5. The biggest emissions reductions (65%) are expected between 2030–2040, driven by SAF adoption.
6. SAF is crucial due to its drop-in compatibility, non-fossil feedstocks, and ability to reduce both CO_2 and non-CO_2 climate impacts.

Suggestions

- Rapid scaling of SAF production and infrastructure — supported by policy incentives, public-private partnerships, and investment in feedstock innovation — is essential to reach net-zero by 2050.
- Airlines should invest in next-generation aircraft with better aerodynamic design.
- Using SAF to lower soot and NOx emissions significantly contributes to aviation's climate impact.
- Promoting carbon offsetting programs for passengers and cargo operators can also help manage carbon emissions.

CONCLUSION

The imperative for sustainability in the airline industry has never been more urgent. As global air travel continues to expand, driven by increasing population mobility and economic globalization, the environmental impact of aviationparticularly its carbon footprinthas come under growing scrutiny.the aviation industry has embarked on a critical journey toward decarbonization, embracing technological innovation, operational efficiency, and policy support to achieve a more sustainable future. The path to sustainability in the airline industry is complex and multifaceted, requiring the integration of technological innovation, operational refinement, regulatory alignment, and consumer engagement. While significant challenges remainparticularly in scaling sustainable fuels and transitioning to zero-emission aircraftthe progress achieved thus far provides a foundation for continued transformation. The industry's ability to adapt and evolve in response to environmental imperatives will determine not only its future viability but also its contribution to global climate goals. By prioritizing sustainability and embracing innovation, the airline industry can chart a course toward a cleaner, more responsible future in aviation.

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