PRSS Pakistan Review of Social Sciences (PRSS)
ISSN : 2708-0951

ORGINAL ARTICLE

Sustainable Aviation: Global best practices for implementation in the Pakistani Aviation Industry.

Mohammad Haider Haroon, Dr Muhammad Umer, Anas Farhan Awan

Muslim Youth University, 128 Technologies & Advanced Air Mobility Institute

Abstract:

The concern of sustainable aviation has risen to be an area of focus as the entire aviation industry attempts to cut down carbon emissions as well as handles the issues revolving around climate change. This research paper analyzes the United Nations' best practices on aviation sustainability, which has newer technologies, uncommon fuels, and improved operational efficiencies, while giving concrete suggestions on the aviation industry in Pakistan. Based on primary research and global efforts undertaken by IATA, ICAO, the paper captures key initiatives such as CORSIA and biofuels promotion. These efforts have been tried and succeeded in several countries. The USA and Brazil have invested in biofuels, whereas Europe is ahead with hydrogen operated aircrafts and electric aviation in addition to supporting this initiative.

The need to decarbonize within the global aviation sector has necessitated sustainable aviation as a critical area for development and cooperation. This paper explores the applicability of global best practices in biofuels, hydrogen propulsion, electric aviation, and operational optimization to Pakistan's aviation industry. The aviation world is being set towards net-zero emissions by international efforts through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), IATA, and ICAO. These efforts will allow countries, such as the USA, which have the capability to harvest agricultural residues and algae, to reduce aviation's carbon foot print by as much as 80%. European countries are already leading the sector by developing hydrogen powered aircraft and electric vertical takeoff and landing (eVTOL) machines. The air traffic management (ATM) sector is advancing as well. AI incentivized route optimization and continuous descent operations are eliminating excessive fuel expenditure and emissions.

Pakistan's aviation industry does not adopt these practices even with its strategic geographic location and the unexplored opportunities it can utilize. The country's reliance on conventional jet fuel, aging fleet and underdeveloped green infrastructure makes it more vulnerable environmentally and economically. Take for example, emissions from Pakistan airlines have increased by 12% since 2015 due to growing passenger traffic by 10% annually prior to the pandemic, while not having any structure in place to facilitate biofuel blending or carbon offsetting. Airports are fossil fuel dependent and the contribution of renewable energy is less than 5% of the energy mix and the air traffic management is based on obsolete technologies. Such lack of engagement with prevailing international practices not only increases operational expenses, but also exposes the country to potential exclusion from climate-friendly trade agreements and funding.

In order to address these shortcomings, Pakistan needs to embrace sustainability policies which are proven to work elsewhere. Biofuels offer a low hanging fruit. The country produces over 50 million tons of agricultural waste which includes rice husks and sugarcane bagasse, which can be transformed into Sustainable Aviation Fuels (SAF) with the assistance of international biofuel companies. Truly, Brazil's achievement of expanding SAF production using sugarcane ethanol is a model that can easily be copied. At the same time, there is a need to align CORSIA offsets with Pakistan aviation policy framework, such as investing in reforestation in Khyber Pakhtunkhwa or Sindh as carbon sinks. There modernize air traffic control systems to reduce fuel consumption by 150%, as India did with Gatishakti program. Besides, solar energy can be harnessed at, to provide electricity to, Pakistani airports, especially Islamabad and Karachi,

which allow for these airports to be used more easily. Cochin International Airport's shift to 100% solar energy shows how the operations can become cost effective without emissions from electricity generation.

Due to its distinct position, Pakistan is able to function as a trade route between Asia, Europe, and the Middle East. This increases its chances of becoming a regional authority in sustainable aviation. By involving public and private partnerships along with global sponsors in the aviation industry, growth in hydrogen and electric aviation infrastructure is possible. For example, there can be deals with the Airbus Hydrogen Engine Development Program or with the Nordic Countries for trials for electric air craft. That would place Pakistan in the forefront with new technology. Such measures would lower pollution levels, while generating majorly skilled employment opportunities, and blooding supporting industries from renewable energy to advanced manufacturing.

In context with the Sustainable Development Goal 13 or climate action, this shift would bring multi- pronged advantages for them. Delivering 30% of SAFs by 2035 would result in an 1.8 million reductions to Pakistan's aviation emissions, while solar powered airports could cut energy expenditure by around forty percent. Furthermore, engagement in international carbon markets by means of CORSIA could potentially provide two to three hundred million in funding annually. By the year 2026, these initiatives and measures will enhance Pakistan's geopolitical standing, and will promote favorable trade terms with eco-conscious markets, like EU.

In conclusion, Pakistan can promote to economic prosperity and can ensure climate resilience under the umbrella of sustainable aviation initiatives and projects. Intergradation of biofuels, modernization of infrastructure, and through global collaborations, country's aviation sector can be transformed into model of innovation and sustainability.

Keywords: Sustainable Aviation, IATA, ICAO, CORSIA, SAFs, SDGs, Climate Action.

How to cite this: *Haroon MH, Umer M, Awan AF, Sustainable Aviation: Global best practices for implementation in the Pakistani Aviation Industry. Pakistan Review of social science. 2025; 06(1): 8-20*

Corresponding Author:

Mohammad Haidar Haroon

Muslim Youth University, 128 Technologies & Advanced Air Mobility Institute

Email: haider.haroon@gmail.com

- Received for publication: September 19, 20

Introduction:

The global aviation industry is both crucial to international trade as well as a region's GDP, but it is being challenged to mitigate climate change, all while trying to maintain its role in modern society. For Pakistan, a nation that contributes only around 1% of the world's emissions, the climate crisis is pressing. Pakistan is also the 5th most vulnerable country with regards to climate change. Thus, implementing green practices is a requirement in every sector, including aviation. As Pakistan develops, it is becoming increasingly strategically located and is seeing a rise in the middle class. The air transport sector will grow, but sustainability needs to be embedded within the economic model as it is not just an environmental obligation but also a matter of the nation's reputation.

The aviation industry worldwide is adopting a multi-faceted approach to decarbonization. Among the most notable strategies is the use of Sustainable Aviation Fuels (SAFs), which can lower emissions during the duration of the fuel's lifecycle by 80% in comparison to regular jet fuel. Major airlines and airports are also updating their fleets to include fuel-saving airplanes, implementing AI-powered route optimization, and developing electric and hydrogen propulsion technologies. At the same time, programs like the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of the International Civil Aviation Organization are focusing on both mitigation and collaboration and calling on member countries to procure emission offsets via planting trees or developing renewable energy sites. Airports globally are adopting renewable sources of energy, introducing measures to reduce
waste, and achieving carbon neutrality certifications such as the Airport Carbon Accreditation program.

Pakistan's aviation industry, however, is at the early stages of this green shift. The industry has expanded, having witnessed 10% annual increase in passenger traffic prior to the pandemic, but struggles with aging fleets, SAF infrastructure deficit, and a regulatory environment that has still not focused on emissions reduction. The country's airlines operate aircraft model that are 15-20 percent less fuel efficient than modern counterparts which increases their carbon footprints and operational costs. Furthermore, airports do not derive power from renewable sources at scale and the understanding of carbon offsetting remains rudimentary. Nevertheless, such obstacles are an opening for investment. Pakistan stands to benefit from integration of these practices as it would enable the country to operate in a sustainable manner and meet international benchmarks. This will enhance resilience and competition in Pakistan's aviation industry.

As an example, SAF production investment could utilize agricultural biomass in Pakistan, such as sugarcane leaves and rice hulls, and foster synergies between rural development and clean energy. Use of green bonds would finance fleet modernization. This would lead to lower fuel and fleet servicing expenditures in the long term. Some operational measures like Performance Based Navigation (PBN) to reduce fuel consumption could be done in partnership with the aviation community. Furthermore, Islamabad and Karachi airports could be the first to implement solar initiatives in Pakistan after the achievement of college solar powered international airport in India.

This paper looks into how Pakistan aviation industry best practices can be blended with global practices to achieve best structure for sustainability. It investigates the feasibility for SAF adoption, the possibility of technological innovation, CORSIA policy and systems alignment, as well as stakeholder engagement. In doing so, Pakistan can decrease its operational costs while improving global trade relations, and position itself as a pioneer of sustainable aviation in South Asia. The journey toward sustainability is not merely a choice, but a roadmap that ensures the industry's viability in an age driven by climate mitigation actions.

This paper seeks to study CORSIA initiatives, Advance Air Mobility and finally the Smog Billboard technology by 128 Technologies based in Pakistan.

Methodology:

This study adopts a mixed-methods research design to comprehensively analyze global

best practices in sustainable aviation and evaluate their applicability to Pakistan's aviation sector. The methodology integrates qualitative and quantitative approaches, ensuring a holistic understanding of the sector's challenges and opportunities. Exploratory research identifies emerging trends, such as hydrogen propulsion and the adoption of Sustainable Aviation Fuel (SAF), while descriptive research examines Pakistan's existing infrastructure, policies, and emissions profile. Comparative case studies of successful international models—such as Brazil's sugarcane-based biofuel programs, India's solar- powered Cochin International Airport, and the EU's carbon pricing mechanisms—provide benchmarks for identifying transferable strategies. Secondary data is drawn from peer-reviewed studies on SAF production, hydrogen aviation, and carbon pricing, alongside institutional reports like ICAO's CORSIA guidelines, IATA's *Net Zero by 2050* roadmap, and Pakistan's National Aviation Policy (2023).
Government databases supplement this analysis, including agricultural waste inventories from the Ministry of Climate Change.

Qualitative data is thematically coded to identify recurring patterns, such as funding barriers or regulatory inertia, while a SWOT analysis evaluates Pakistan's strengths (e.g., biomass potential), weaknesses (e.g., aging fleets), opportunities (e.g., solar energy), and threats (e.g., climate vulnerability). Quantitative methods include lifecycle assessments (LCAs) using the GREET model to estimate emissions reductions from SAF adoption, assuming a 50% blending target by 2040, and cost-benefit analyses (CBAs) to evaluate the financial viability of fleet modernization, such as the return on investment for transitioning to fuel-efficient Airbus A320neo aircraft and winglet technology for aircraft.

Quantitative research plays a crucial role in analyzing the impact of smog on aviation and evaluating the effectiveness of solutions like the Smog Eating Billboard. By employing data-driven methodologies, researchers can measure the extent to which smog affects visibility, aircraft maintenance costs, and flight delays. Statistical models can quantify the correlation between air pollution levels (e.g., PM2.5 and NOx concentrations) and aviation safety incidents, allowing for predictive analysis of flight disruptions.

Controlled experiments and observational studies can assess how pollutants accumulate on aircraft surfaces and engines over time, affecting performance and longevity. Additionally, surveys and regression analyses can help determine the impact of smog exposure on the health and cognitive function of pilots and crew members.

The Smog Eating Billboard, developed by 128 Technologies, provides a practical case for quantitative assessment. Researchers can collect pre- and post-installation air quality data near airports to measure pollutant reduction. Flight operation metrics, including delay frequencies and reliance on Instrument Landing Systems, can be compared before and after implementation.

Furthermore, UAV navigation precision and sensor accuracy in polluted environments can be quantitatively analyzed through controlled trials. A cost-benefit analysis can evaluate the economic advantages of deploying air purification technologies in aviation sectors.
By applying statistical and experimental methods, quantitative research not only validates the necessity of smog mitigation strategies but also optimizes their deployment, ensuring maximum impact on aviation safety and efficiency.

Ethical considerations include anonymizing participant identities and cross-validating data sources to mitigate bias, such as triangulating PCAA reports with academic studies.

Limitations include gaps in Pakistan's aviation emissions data, necessitating extrapolation from regional benchmarks like India's Directorate General of Civil Aviation (DGCA) reports, and a survey sample focused on urban hubs like Karachi and Islamabad, which may underrepresent rural perspectives. Despite these constraints, the methodology bridges global sustainability frameworks with Pakistan's localized context, as outlined in the introduction, and builds on the literature review's case studies and theoretical foundations. By synthesizing diverse data streams, the research provides actionable recommendations for aligning Pakistan's aviation sector with international climate goals, as highlighted in the abstract, while

advancing Sustainable Development Goal 13 (Climate Action).

CORSIA: An initiative of ICAO focusing on sustainability

Introduction & Concept of CORSIA:

CORSIA stands for Carbon Offsetting and Reduction Scheme for International Aviation, which is an initiative of the International Civil Aviation Organization (ICAO), formally launched in 2016 to measure and mitigate carbon emissions by various airlines on a global scale. This is a historical initiative designed to counter global warming and climate change challenges while ensuring that carbon-neutral growth is ensured for the future of the industry.

Scale & Reach of CORSIA:

As of 1st January 2024, the first phase of CORSIA has been initiated, with over 126 nations contributing to it. As of 1st January 2025, the nations of Comoros, Mauritania, and Saint Lucia are in the process of contributing, which increases the number count to a total of 129 states. Despite the disruptions and decrease in the performance of the aviation industry during the Covid crisis, there has been a peak rise in global contribution to this initiative.

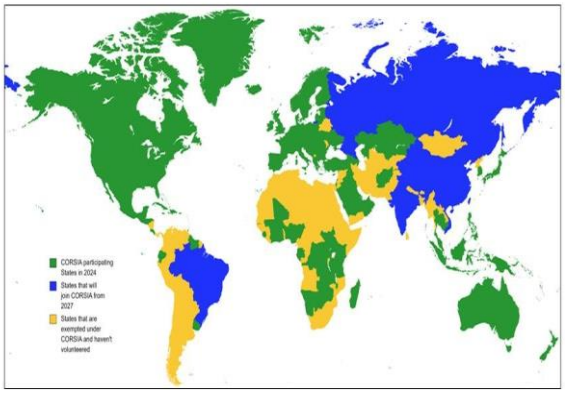


Figure-1: Contributing/Non-Contributing Nations

Commitments & Procedures of CORSIA:

The scheme of CORSIA consists of improving operational efficiency, developing innovative technology, and utilization of biofuels to promote sustainability on a global scale.

CORSIA advises airlines to calculate their carbon emissions by monitoring, reporting, and verifying their international flights. If their respective emissions exceed the **2020 baseline levels**, the airlines are required to purchase **carbon credits** as the offset of excess emissions. Each carbon credit is equivalent to one metric ton of carbon dioxide and can be only bought from projects approved by ICAO.

These carbon credits are derived from verified environmental projects, which tend to reduce or remove carbon dioxide emissions from the environment, such as;

- Reforestation/Forest Conservation

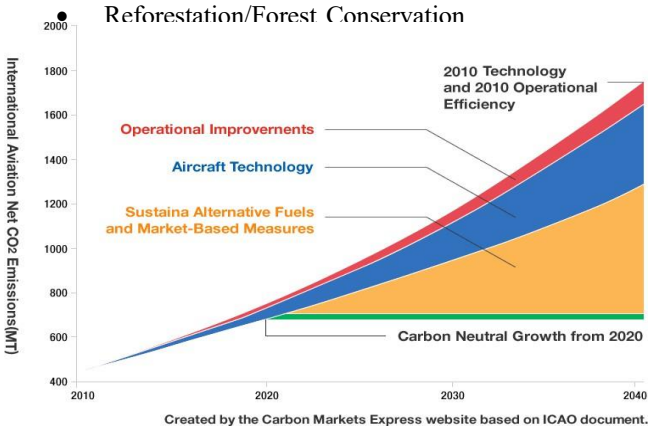


Figure-2: Growth Components of CORSIA

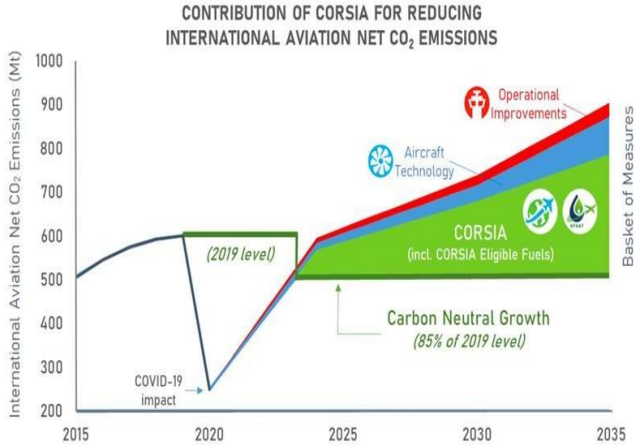


Figure-3: Disruption & Recovery during COVID ERA

Potential Benefits of CORSIA for Pakistan:

As Pakistan is one of the growing markets of aviation, with increasing

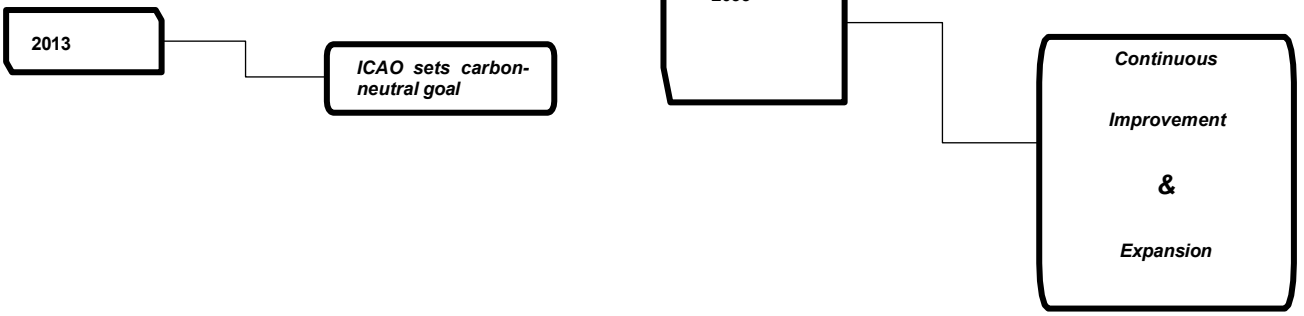
number of private airlines, contribution in CORSIA will boost sustainability within the aviation industry.

Some of the potential benefit, which can highlight Pakistan as an emerging sustainability economy includes;

- Implementing eco-friendly flight operation routes.
- Investment in Sustainable Aviation Fuels (SAF).
- Promotion of innovative technologies like low carbon emission engines and smart avionic systems.
- Attracting foreign partnerships for enhancing global surveillance.

Currently, Pakistan has five operational airlines, including the state carrier, Pakistan International Airlines "PIA", which collectively make up fleet of 62 aircrafts. As compared to rest of the world, managing carbon emissions emitted by such smaller fleet size is easily manageable by the regulatory and airline authorities.

By the year 2027, it will be mandatory for all the members of ICAO to be active contributor of CORSIA, and to prevent future penalties by buying carbon credits, Pakistan has golden opportunity to actively contribute to the CORSIA by the end of 2026.



Flowchart- 1: Timeline of CORSIA initiatives

AAM: A New Dawn for Sustainable Aviation

Introduction & Concept of AAM:

Advanced Air Mobility "AAM" is a concept of innovation within the aviation/aerospace industry, which covers the areas of enhancing transportation, logistics and emergency responses. AAM initiatives aims to operate with electric vertical take-off and landing (eVTOL) aircrafts.

Main areas of AAM include;

- Urban Air Mobility "UAM"
- Regional Air Mobility "RAM"
- Cargo & Freight Operations
- Medical & Disaster Services
- Regulatory & Infrastructure Development

Despite the fact integrating such initiatives with traditional air mobility systems is quite a challenge, regulations and embedding process are on their way. According to analyst and industry researchers, their projections indicate that AAM market will reach an estimation value of $1 trillion by 2040, which will encompass passenger transportation, cargo operations and emergency services. The concept is highly under consideration for globalization, as it focuses on aviation sustainability projects, and it is promoting R&D initiatives among various economies around the world.

Figure-4: ICAO First AAM Symposium (2024) in Montreal, Canada

Scale & Reach of AAM:

On foreign scale, AAM initiatives and projects are already being implemented, on beginner stages.

1. United Arab Emirates "U.A.E.":
2. U.A.E has been involved in developing air corridors, within their mega cities of Dubai and Abu Dhabi, for the purpose of air taxis and cargo drones. These routes are said to be operational by the year 2026. These cities are always operational ready for innovative projects, along which, AAM projects are one of them.
3. Director of Civil Aviation Authority Saif Mohammed Al Suwaidi stated that;
4. "*Air corridor mapping for piloted and autonomous air taxis and drones is a crucial milestone that will enable the seamless implementation of advanced air mobility into the UAE's infrastructure*"

Figure-5: Air Taxi in Dubai Airshow

1. China:

China has planned to introduce around 100000 eVTOL vehicles within six years, capable of serving as taxis, delivery vehicles, and personal transport.

According to *China Low Altitude Economic Alliance*, air traffic networks and ground facilities for flying vehicles are under development, and are expected to be completed within next two to three years. It is stated that over 100 enterprises, including major players like Geely and Ehang, are contributing to the efforts of China Low Altitude Economic Alliance, with forecasted growth of £326 billion by

2030.

Figure-6: Passengers ride on an eVTOL aircraft in Wenzhou City, east China's Zhejiang Province

1. United Kingdom "UK":

Civil Aviation Authority of United Kingdom, in collaboration with Department of Transport, has been involved in launching an AAM program, with purpose of embedding safety regulations and laws that aim to enable commercial eVTOL operations by 2026.
Future Air Mobility Consortium is a coalition of British aviation and technology companies, which is conducting studies and researches of possible AAM ecosystems using eVTOL aircrafts for flight tests and vertiport development.

CEO of Skyports, Duncan Walker, stated;

"Just as airports are critical to commercial aeroplane travel, vertiports are critical to AAM. Our Living Lab will be a central component of the consortium, enabling Skyports and partners to demonstrate end-to-end operations and test the complexities of developing a commercially viable AAM network in the UK."

Figure-7: Infographic mapping and demonstration of AAM ecosystem

Potential of AAM in Pakistan:

Pakistan can promote development of AAM initiatives and projects through Triple Helix Model (Industry-Academia-Government).

1. Potential role of Industry in AAM:
   - Pakistan Aeronautical Complex (PAC) should contribute in development and testing of eVTOL prototypes in collaboration with local drone manufacturers.
   - Engagement with international AAM leaders should be encouraged, which includes Joby Aviation from USA, Vertical Aerospace from UK and EHang from China, in a form of investments and joint ventures.
   - Establishing with Public-Private Partnerships (PPPs) with the logistics providers, like FedEx, DHL etc., to operate AAM cargo drone projects, in association with Ground Handling Agencies, like Menzies, Dnata etc., for maintenance and certifications of eVTOLs.

Replica of foreign initiative:

U.A.E collaborated with Skyports for the development of vertiport infrastructure. Pakistan can replicate such initiative model by ensuring collaboration of PAA and NICAT with international vertiport developers.

Figure-8: NICAT, South Asia's first Aerospace Incubator

1. Potential role of Education in AAM:
   - Conducting R&D on AAM technology while ensuring updated training of engineers, pilots and aerospace professionals for the new industry.
   - Developing AAM research clusters and case studies within universities NUST, FAST, UET, Air University etc.
   - Introducing AAM specializations in engineering programs like aeronautics, mechatronics etc.
   - Building drone labs to train aspiring pilots through AAM flight modeling and simulations.

Replica of foreign initiative:
US universities like MIT, Stanford etc. collaborate with NASA on AAM research. Pakistan can replicate such initiative model by linking special technology zones (like NASTAP, NICAT etc.) with top universities like NUST, FAST, UET, Air University etc.

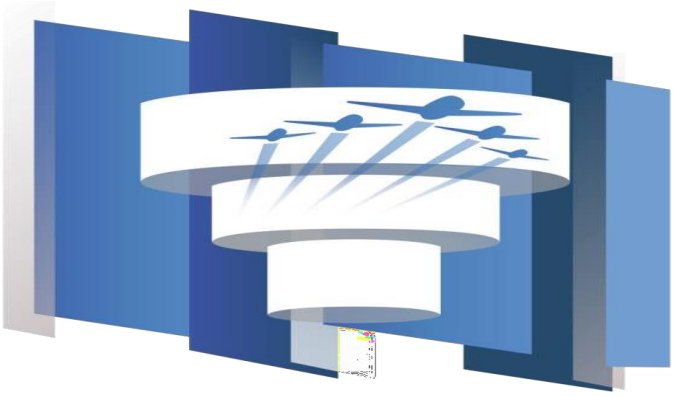


Figure-9: NASA's Airspace Working Group

1. Potential role of Government in AAM:
   - Development of AAM regulatory framework under the umbrella of Pakistan Civil Aviation Authority (PCAA).
   - Aligning regulations with certification standards of FAA's and EASA's eVTOL policies.
   - Creating boundaries by defining AAM air traffic management rules to ensure avoidance of airspace congestion.
   - Launching of Aerospace Venture Fund under the umbrella of NASTP and NICAT to support AAM startups and by providing them subsidies.
   - Integrating of vertiports in major airports (like IIA, JIA, AIIA etc.) and designating them as AAM pilot-operational zones.

UK government committed £300 million for AAM research initiative, titled as "*UK's Future of Flight Challenge*". Pakistan can replicate such initiative model by ensuring channeling of funds to NASTP and NICAT for AAM projects.

Figure-10: Future Flight Challenge quote

Smog's Impact on Aviation:

Reduced Visibility and Flight Disruptions:

One of the most immediate and critical effects of smog on aviation is the reduction in visibility, particularly during takeoff and landing. Airports in smog-prone regions, such as Beijing Capital International Airport and New Delhi's Indira Gandhi International Airport, frequently experience flight disruptions due to poor air quality. When smog levels are high, pilots must rely on Instrument Landing Systems (ILS) or other advanced navigation technologies to land safely. However, not all airports, especially those in developing countries, are equipped with Category III ILS, which allows for automated landings in near-zero visibility conditions.

Additionally, flight delays caused by smog lead to economic losses for airlines and inconvenience for passengers. A study conducted by the International Air Transport Association (IATA) found that poor visibility due to smog contributes to an estimated $1 billion in annual losses for the airline industry.

Increased Maintenance Costs:

Aircraft engines and airframes are highly susceptible to the corrosive and particulate-laden nature of smog. Prolonged exposure to high levels of particulate matter leads to accelerated degradation of turbine blades, increased carbon deposits in combustion chambers, and clogged air filters. Fine particles from smog can infiltrate an aircraft's internal systems, affect aerodynamics and reduce fuel efficiency.

Moreover, aircraft require frequent exterior cleaning in smog-heavy environments to prevent damage to their fuselage. Airlines operating in regions with persistent smog have reported increased maintenance costs due to frequent engine overhauls and the need for specialized coatings that protect against pollutant-induced corrosion.

Adverse Health Effects on Crew and Passengers:

Smog is not only an external threat to aviation but also poses risks to those inside the aircraft. Ground personnel working in highly polluted environments are at risk of long-term respiratory ailments, while pilots and cabin crew may suffer from fatigue and reduced cognitive function due to prolonged exposure
to airborne toxins. Studies suggest that smog exposure leads to increased cases of headaches, dizziness, and impaired concentration, which could potentially affect flight safety.

Impact on UAVs and Military Operations:

Smog is particularly problematic for unmanned aerial vehicles (UAVs) and military operations that rely on precision navigation. High levels of atmospheric pollution can interfere with infrared and optical sensors used in drone surveillance and targeting systems. In military settings, poor air quality can obstruct reconnaissance missions, making it challenging to identify targets accurately.

Moreover, UAVs used for commercial applications, such as package delivery or aerial mapping, experience performance issues in smog-heavy conditions. Particulate matter can reduce the efficiency of onboard sensors, leading to navigation errors and increased risks of mid-air collisions.

Findings♦

Latest Engines:

Aircraft with the latest engines to be inducted in a fleet of Pakistani Airlines such as NEO (New Engine Option) which is 20 % fuel efficient.

Sharklet technology:

The technology of Sharklets should be introduced in Pakistani Airline Aircraft reducing emissions by 5%.

Figure-11: Airbus equipped with Sharklet Technology

Electric Aircraft:

Electric aircraft should be made to help diminish dependency on fuel.

Figure-12: New Eco-Friendly Class of Airbus Aircrafts

The Role of the Smog-Eating Billboard in Aviation:

Application Near Airports:

128 Technologies' Smog Eating Billboard is designed to actively remove airborne pollutants using photocatalytic technology. Deploying these billboards near airports can create cleaner air corridors, reducing the presence of smog in critical takeoff and

landing zones. By targeting high-traffic aviation hubs, this technology can contribute to better visibility conditions and reduce the frequency of smog- related flight disruptions.

Enhancing UAV and Avionics Performance:

For UAV operations, particularly in urban environments, maintaining clear airspace is essential for accurate data collection and safe navigation. Our Smog Eating Billboards, when strategically placed, can help improve air quality in UAV flight zones, reducing sensor interference and enhancing the performance of airborne electronic systems.

Reducing Environmental and Health Risks for Aviation Personnel:

By improving air quality in aviation environments, Smog Eating Billboards provide a safer workplace for ground staff, pilots, and cabin crew. Cleaner air contributes to reduced respiratory illnesses and enhanced cognitive performance among aviation personnel, leading to overall improvements in flight safety and operational efficiency.

Conclusion♦

Cutting-edge technology of Airbus A320 Neo aircraft and planes with sharklets can help reduce carbon emissions significantly by 20 and 5 % respectively helping in climate change.

As Pakistan is one of the growing markets of aviation, with an increasing number of private airlines, contribution to CORSIA will boost sustainability within the aviation industry.

Some of the potential benefits, that can highlight Pakistan as an emerging sustainability economy include;

- Implementing eco-friendly flight operation routes.
- Investment in Sustainable Aviation Fuels (SAF).
- Promotion of innovative technologies like low carbon emission engines and smart avionic systems.
- Attracting foreign partnerships for enhancing global surveillance.
- Currently, Pakistan has five operational airlines, including the state carrier, Pakistan International Airlines “PIA”, which collectively make up a fleet of 62 aircraft. As compared to the rest of the world, managing carbon emissions emitted by such a smaller fleet size is easily manageable by the regulatory and airline authorities.
- By the year 2027, it will be mandatory for all the members of ICAO to be active contributors to
- CORSIA, and to prevent future penalties by buying carbon credits, Pakistan has a golden opportunity to actively contribute to the CORSIA by the end of 2026.

Smog continues to pose a significant challenge to aviation worldwide, impacting flight safety, maintenance costs, crew health, and UAV operations. Innovative solutions such as the Smog Eating Billboard developed by 128 Technologies offer a promising approach to mitigating these effects. By deploying such technologies near airports and urban airspaces, we can take meaningful steps toward reducing the impact of smog on aviation.

As the aviation industry moves toward more sustainable and eco-friendly practices, integrating air- purification technologies will play a crucial role in ensuring safer and more efficient flight operations. 128 Technologies remains committed to pioneering sustainable innovations that contribute to a cleaner and more resilient aviation industry.

References♦

- International Civil Aviation Organization. (n.d.). Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). ICAO. Retrieved February 17, 2025, from https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx
- International Air Transport Association. (n.d.). CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation. IATA. Retrieved February 17, 2025, from https://www.iata.org/en/programs/sustainability/corsia/
- Ministry of the Environment, Japan. (n.d.). Climate Change

Mitigation and ICAO's Market-Based Measures. Retrieved February 17, 2025, from http://carbon-markets.env.go.jp/eng/mkt-mech/climate/icao.html

- International Civil Aviation Organization. (2018). CORSIA actions and timelines. ICAO. Retrieved February 17, 2025, from https://www.icao.int/Meetings/CORSIAHQ18/Documents/6_2_CORSIA_Actions_Timelines.pdf
- International Civil Aviation Organization. (n.d.). CORSIA Buddy Partnerships. ICAO. Retrieved February 17, 2025, from https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Buddy-Partnerships.aspx
- Federal Aviation Administration. (n.d.). Air Taxis and Advanced Air Mobility. FAA. Retrieved February 19, 2025, from https://www.faa.gov/air-taxis
- Advanced Air Mobility International. (n.d.). About Us. Retrieved February 19, 2025, from https://www.aaminternational.com/
- MundoGeo. (2024, September 13). ICAO urges international community to act on fostering the deployment of advanced air mobility. Retrieved February 19, 2025, from https://mundogeo.com/en/2024/09/13/icao-urges-international-community-to-act-on-fostering-the-deployment-of-advanced-air-mobility/
- Aerospace Testing International. (n.d.). Commercial eVTOL aircraft service to launch in Dubai by 2026. Retrieved February 19, 2025, from https://www.aerospacetestinginternational.com/news/drones-air-taxis/commercial-evtol- aircraft-service-to-launch-in-dubai-by-2026.html
- Reuters. (2025, February 13). UAE begins mapping corridors for air taxis and cargo drones. Retrieved February 19, 2025, from https://www.reuters.com/world/middle-east/uae-begins-mapping-corridors-air-taxis-cargo-drones-2025-02-13/
- The Sun. (n.d.). China plans flying cars and taxis. Retrieved February 19, 2025, from https://www.the-sun.com/motors/12985345/china-plans-flying-cars-taxis/
- China Daily. (2024, August 7). China advances in flying car development. Retrieved February 19, 2025, from https://www.chinadaily.com.cn/a/202408/07/WS66b35e8da3104e74fddb8eac.html
- UK Civil Aviation Authority. (n.d.). Advanced Air Mobility Challenge. Retrieved February 19, 2025, from https://www.caa.co.uk/our-work/innovation/advanced-air-mobility-challenge/
- Future Air Mobility. (n.d.). Shaping the future of air mobility. Retrieved February 19, 2025, from https://futureairmobility.com/
- Munafa Marketing. (n.d.). National Incubation Center for Aerospace Technologies. Retrieved February 19, 2025, from https://munafamarketing.com/national-incubation-center-for-aerospace-technologies/
- NASA. (n.d.). Advanced Air Mobility (AAM) Portal. Retrieved February 19, 2025, from https://nari.arc.nasa.gov/aam-portal/airspace/
- UK Civil Aviation Authority. (n.d.). Future Flight Challenge. Retrieved February 19, 2025, from https://www.caa.co.uk/our-work/innovation/future-flight-challenge/
- The AGP Aero. (n.d.). Future Flight Challenge. Retrieved February 19, 2025, from https://theagp.aero/future-flight-challenge/
- International Civil Aviation Organization (ICAO). (2021). Environmental report 2021:

Aviation and air quality. Retrieved from https://www.icao.int

- International Air Transport Association (IATA). (2020). The economic impact of flight delays and cancellations due to weather and air pollution. Retrieved from https://www.iata.org
- National Aeronautics and Space Administration (NASA). (2019). The impact of air pollution on aircraft engines and performance. Retrieved from https://www.nasa.gov
- World Health Organization (WHO). (2021). Air pollution and its effects on public health and occupational safety. Retrieved from https://www.who.int
- European Union Aviation Safety Agency (EASA). (2022). Air quality and its effects on aviation safety and operations. Retrieved from https://www.easa.europa.eu
- United Nations Environment Programme (UNEP). (2022). Innovative solutions for air pollution control: Case studies from around the world. Retrieved from https://www.unep.org
- United States Environmental Protection Agency (EPA). (2021). Fine particulate matter (PM2.5) and its impact on human health and infrastructure. Retrieved from https://www.epa.gov
- 128 Technologies. (2024). The Smog Eating Billboard: A sustainable innovation for air purification. Retrieved from https://www.128technologies.com.pk