AVIATION SECTOR: TECHNOLOGY AND INNOVATIONS

Shamashad Begum[1], Dr. Sumeet Suseelan[2]

[1] Research Scholar, Ph. D. in Aviation Management, CMJ University, Jorabat, Meghalaya, India.
[2] Research Guide, Dept. Of. Management, CMJ University, Jorabat, Meghalaya, India.
[1]Email: shams.counsel@gmail.com

A B S T R A C T

Innovations are being created to better every aspect of air travel, and the aviation sector is undergoing a technological revolution. New, state-of-the-art technology is taking off and revolutionising the market. Every part of flying is being fine-tuned to make it safer, more efficient, and more enjoyable for passengers. This includes the runway as well as the cockpit. The future of the aviation sector is being shaped by developing technologies, which has never been more dynamic. These innovations are changing the game and opening up a world of possibilities for new ideas. Some of these technologies are leading the pack and will undoubtedly alter the course of history.

Keywords: **Aviation Sector, Technology, Innovations**

Introduction

The aviation sector has always been at the forefront of innovation and technology, constantly pushing the envelope to improve passenger experience, efficiency, and safety. The aviation business is still advancing due to technology and innovation, which will shape air travel in the future by providing safer, more effective, and environmentally friendly options. The aviation sector has been greatly impacted by innovation and technology in the following important areas:

- Design and Materials of Aircraft
- Technology in Cockpits and Avionics
- Engine Technology

- Air Traffic Control

- Experience of The Passenger

- Maintenance Repair and Overhaul (MRO)

- Sustainable Aviation

- Urban Air Mobility (UAM)

1.1 AIRPORT TECHNOLOGY'S TOP SEVEN TRENDS

The newest developments in airport technology will surely change air travel like never before. In addition to improving the traveller experience, innovations in AI, metaverse, and sustainable development will propel airport company expansion. The aviation industry's trailblazers who choose to broaden their scope of innovation can look forward to these seven fascinating technological opportunities.

(i) Robotics and Automation

According to a survey by Mordor Intelligence, by 2025, the airport robot market is expected to grow at a Compound Annual Growth Rate of 15%. Under the general heading of "smart airports," investing in automation and robots will probably result in additional growth in this industry. Since smart robots can offer passengers information and assistance whenever and wherever they need it, they are essential in removing the need for human-manned workstations.

(ii) Chat GPT to Transform Consumer Experience and Improve Sector Functions

Several people have been using ChatGPT since its inception in late 2021, and they have been finding creative and novel ways to use the language paradigm. The announcement by Air India that it will be implementing GPT4 on its website to enhance the user experience, however, was the real turning point. At the CAPA India Aviation Summit in 2023, CEO Campbell Wilson stated that the language model would not be used in a "gimmicky" way, but rather that it will be applied to actually improve the airline's operations.

(iii) Sustainable and Unmanned Aviation

Advanced Air Mobility (AAM) gained public awareness in 2021, and results from a McKinsey study showed a considerable degree of interest. AAM firms went public, record-breaking investments were made, and manned AAM aircraft were in high demand. A new supply chain that prioritises quality control, certifications, and low volume production will emerge to speed up the production of

futuristic AAM. Growing interest will be seen in optimising maintenance, training, and infrastructure as Advanced Air Mobility approaches commercial production. This will help to guarantee a smooth transition for AAM clients and the industry at large.

(iv) Autonomous Systems in Airport Management

The best places to test advanced autonomous systems (AAS), the next generation of self-driving car technology, are airports. Modern technologies like computer vision, AI-powered object identification, and Light identification and Ranging (LiDAR) are utilised by these AAS to enable complete driving automation, doing away with the requirement for real-time monitoring or active physical control. AAS can handle a variety of airport use cases well.

(v) Advanced Location Intelligence & Data Analytics

Data and technology will play a major role in the decision-making processes of tomorrow's airports. Even with the wealth of data at hand, current approaches to managing the massive volumes of information frequently fail to recognise and address problems, leading to inaccurate estimates that do not account for the costs of delays that affect the entire system. Airport delays are a regular occurrence, but they can be easily avoided with the right strategy.

(vi) Augmented and Virtual Reality

By 2025, the aviation augmented and virtual reality market is predicted to reach a projected value of USD 1,372 million, indicating a substantial growth trajectory. The aviation sector can use AR and VR technology for a variety of purposes, such as maintenance, training, and spotting possible threats. With the immersive and interactive approach that these technologies offer, the aviation ecosystem may be connected to enhance work efficiency and save costs.

(vii) Cloud, 5G and IoT

One of the biggest problems with air travel is the deteriorating infrastructure and the never-ending battle to keep up with the growing number of passengers. Year after year, lines grow longer, planes get overbooked, and airport space fills to capacity, overtaxing airport infrastructure and going above and beyond what is sustainable for travellers and airport stakeholders. The average terminal in the United States is forty years old, and by 2037, 8.2 billion people are predicted to travel by air worldwide. This shows how out of step passenger growth is with infrastructural readiness. Airports and airlines have worked together to improve their terminals in order to meet future demand in order to address this difficulty.

1.2 SYSTEM FOR AUTOMATED BAGGAGE HANDLING

Airports and airlines can save money and provide better service to passengers by installing automated baggage handling systems. These systems use technology to improve the efficiency, accuracy, and dependability of processing passenger bags. In today's airports, automated baggage handling systems are vital for increasing productivity, decreasing human error, and bettering the travel experience for passengers.

- **RFID & Barcode Technology:** RFID (Radio Frequency Identification) tags and barcodes that carry flight information and passenger details are attached to baggage tags.

- **Automated Sorting Systems:** Using barcode or RFID information, sophisticated conveyor belts and sorting devices automatically direct bags to the right location.

- **Baggage Screening Technology:** To guarantee that all bags are appropriately scanned for prohibited materials, automated systems combine with security screening equipment.

- **Real Time Tracking & Monitoring:** Automated solutions enable airport workers to swiftly detect and address any potential problems, such misplaced or delayed luggage, by giving them real-time visibility into the whereabouts of each bag.

- **Passenger Information System Integration:** For a smooth transmission of luggage information, automated baggage handling systems can be coupled with airline reservation systems.

- **Baggage Reconciliation System:** To make sure that every bag is present, these systems check the passenger manifest against the luggage that is loaded aboard each flight.

- **Effective Process for Baggage Claim:** By precisely sorting and delivering luggage to the appropriate baggage claim location, automated technologies expedite the baggage claim procedure.

- **Predictive Maintenance:** Predictive maintenance methods can be used by automated systems to foresee possible problems with sorting machines, conveyor belts, and other equipment.

- **Provide Robotic Support:** Robotic devices are being investigated by certain airports to help with duties like moving bags around the terminal or loading and unloading luggage onto

conveyor belts. Airport workers can work more efficiently and with less physical strain thanks to these robots.

2. PASSENGER EXPERIENCE & SATISFACTION

Airports are increasingly concentrating on passenger happiness and making their experiences unforgettable as the aviation industry undergoes continuous transformation. An outstanding travel experience for passengers is easily achieved through simplified check-in, efficient luggage processing, and faultless navigation. Optimal and quick check-in at self-service kiosks, tracking and matching of bags through baggage reconciliation, and monitoring of passenger movements and resource allocation through passenger flow management systems are all examples of the state-of-the-art technological solutions that progressive airports invest in. Travellers may relax thanks to these technical developments, which improve cleanliness and safety. These days, passengers may expect a more refined, efficient, and pleasurable trip thanks in large part to technological advancements that improve the whole passenger experience.

2.1 PASSENGER'S EXPERIENCE

How airlines and passengers interact at airports is called the airport passenger experience (PAX). This encompasses the full customer journey at the airport, beginning with ticket purchase and ending with baggage claim at the destination.

Due to a number of problems, including flight delays, overbooking, security check, wait times, and more, airports have unfortunately earned a terrible reputation among customers.

➢ **Importance of Passengers' Experience**

Airports may question the value of investing time, energy, and resources into improving passengers' experiences now that the subject is trending.

Airport passenger experience can be improved and made more valuable in the following ways:

- Increased non-aeronautical revenue and happier customers are the results of superior customer service.
- The groundwork for a customer-centric strategy is laid when the client feels their voice has been heard.
- We can learn about the traveller's habits and anticipate their needs with its help.

- A smooth transition from one part of the airport customer journey to another is established by the passenger experience. For instance, the customer experience at the airport connects the check-in and security processes.

- Positively impacts people's views of their brand and attitudes towards it.

2.2 SKYTRAX'S RANKING OF THE WORLD'S TOP 10 AIRPORTS

Skytrax, the go-to site for airport rankings, polls millions of travellers every year to get their honest opinions. These surveys are a great way to get a feel for how well an airport is doing in terms of accessibility, facilities and amenities, customer service, efficiency and sustainability. The SkyTrax World Airport Awards have announced their 2023 winners, and among them are the following ten airports:

- **Singapore Changi Airport (SIN):** Reputation for efficiency, first-rate facilities, beautiful design, and innovative art displays.

- **Directorate of Health (DOH) Airport in Hamad:** Presents state-of-the-art technologies, art collections, and opulent lounges.

- **Tokyo International Airport (HND)**: Highlights cutting-edge terminals, a variety of eating options, and a firm dedication to passenger safety.

- **Incheon International Airport (ICN):** Renown for its easily accessible terminals, shops, and restaurants.

- **The airport in Paris, known as (CDG):** Provides a variety of services while being efficient and connected.

- **Airport in Istanbul (IST):** Remarkably large, with excellent service and a wide variety of shops and restaurants to choose from.

- **Airport Munich (MUC):** Prominent features include cutting-edge architecture, eco-friendliness, and first-rate amenities.

- **The Zurich Airport (ZRH):** Travellers are known to have a pleasant experience at Switzerland's busiest airport.

- **Airport Narita International in Tokyo (NRT):** Renown for its punctuality and ability to accommodate passengers with ease.

- **Barajas Airport in Madrid (MAD):** The primary airport in Madrid that links Latin America and Europe, guaranteeing a trouble-free journey.

3. ENVIRONMENTAL CONSIDERATIONS

The aviation sector must take environmental factors into account in order to reduce the negative effects of air travel on the environment, safeguard ecosystems and public health, adhere to legal requirements, and maintain corporate responsibility. For the aviation industry to remain viable and gain social approval in the long run, it is imperative that sustainable practices and technology are used.

- **Carbon Emissions:** Globally, aviation has a major impact on greenhouse gas emissions and adds to carbon emissions. In addition to other pollutants like nitrogen oxides (NOx), particulate matter, and water vapour, commercial aircraft also release carbon dioxide (CO_2). These emissions are a factor in air pollution and climate change, both of which can be harmful to the environment and human health.

- **Climate Change:** The concentration of greenhouse gases in the atmosphere rises as a result of the carbon emissions from the aviation sector, contributing to climate change. Numerous negative effects on the environment can result from climate change, such as increased global temperatures, altered weather patterns, ice caps and glaciers melting, an increase in sea level, and damage to ecosystems and biodiversity.

- **Air Quality:** Air quality in the vicinity of airports and in the communities surrounding them may be negatively impacted by aircraft emissions, especially nitrogen oxides and particulate matter. Particularly for those who live close to airports, poor air quality can make respiratory conditions, cardiovascular disorders, and other health problems worse.

- **Noise Pollution:** In addition to being annoying and disrupting sleep, aircraft noise can have serious negative effects on the environment and public health. It can also impair cognitive function. The mitigation of noise pollution by technical improvements, operational practices, and land use planning surrounding airports are among the environmental factors in aviation.

- **Impact on the Environment:** Airports and runways, examples of aviation infrastructure, can disrupt, fragment, and destroy natural ecosystems. These effects can be both direct and indirect. Land clearance is a common component of airport construction projects, which may

lead to the loss of biodiversity and wildlife habitats. Furthermore, aeroplane operations may disrupt local fauna.

➤ **Resource and Water Management:** Water and other resources are needed in large quantities for aviation operations in order to perform tasks like passenger services, firefighting, and aircraft maintenance. The aviation industry takes environmental factors into account by making an attempt to use less water, produce less waste, and manage resources sustainably.

➤ **Regulatory Compliance:** Global regulatory bodies are progressively putting policies in place to deal with environmental issues in the aviation sector. Environmental impact assessments for airport development projects, noise limits, fuel efficiency criteria, and emissions standards are a few examples of these rules. To operate legally and sustainably, airports, airlines, and other aviation stakeholders must adhere to environmental rules.

➤ **Public View and Corporate Accountability:** From the standpoint of business responsibility and public relations, environmental factors are also crucial. Customers that are concerned about the environment may favour airlines and airports that show a dedication to sustainability. Adopting environmental stewardship can improve an organization's standing with stakeholders, draw in business, and cultivate goodwill.

3.1 AVIATION AND ENVIRONMENT

The interaction of aviation with the environment is one of the main issues that industrialised civilizations must deal with. The amount of air travel is increasing every 15 years, and aviation was identified as one of the five industries with the greatest challenges to decarbonise in a report released in January 2019 by the industry-led Energy Transitions Commission. The environmental effects of aviation extend from its role in aggravating climate change to more localised problems like air and noise pollution near airports. In order to reach the environmental targets, set by the European Union and the reductions desired in the Paris Agreement, significant reductions in carbon emissions are necessary.

The recent declaration by the Government that the UK aims to eliminate its net impact to climate change by 2050 is a very positive start. For the next thirty years, emissions would need to be reduced by 3% year (of current levels), which is a reasonable and attainable goal. Reducing reliance on fossil fuels is essential for success, and significant technological advancements are needed in a number of

sectors, such as hydrogen, biofuels, synthetic fuels, and electrification.

In addition to developing approaches that can evaluate the whole system impact, taking into account economic and environmental aspects, as well as how rapidly such technologies may be adopted, will be crucial to this initiative's focus on technology development. Because of the intricate relationships that exist between society and aviation, a systems approach is necessary to guarantee a financially and environmentally responsible transition to sustainable growth in the aviation industry.

> **Worldwide Environmental Impact of the Aviation Industry: A Statistical Analysis**

Millions of people now use aeroplanes as their primary mode of transportation to get across nations and cover large distances quickly. The global aviation sector has grown rapidly due to a number of factors, including the rise of transcontinental trade relations and people's desire to travel. Over the past 15 years, there has been a nearly two-thirds rise in worldwide aviation traffic, with around 39 million flights being conducted in 2019. However, the environment pays a heavy price for flying due to carbon dioxide (CO_2) emissions and other pollutants. Over 900 million metric tonnes of CO_2 were emitted by commercial aviation companies in 2019, an increase from 627 million metric tonnes in 2004. The global coronavirus (COVID-19) epidemic in 2020 caused most passenger airline operations to be cancelled. As a result, CO_2 emissions from the aviation sector decreased by over 60% in 2020 compared to 2019.

- **Which Airlines Fly Green?**

    Individuals and international regulatory authorities are driving climate action, which incentivizes airline groups to respond and modify their long-term strategy for sustainable development. Studies and advancements have previously demonstrated cause for hope regarding aviation groups' emissions. Using sustainable aviation fuel on its Boeing 777F freight aeroplane, Lufthansa freight made the first environmentally friendly trip in history in December 2020 between Frankfurt, Germany, and Shanghai, China.

- **Public Views**

    Millions of people are merely unwilling to take on the burden of abatement because this environmental cost is hidden in ticket pricing. Growing public awareness of aviation's carbon footprint and the ongoing global climate change negotiations prompt a multifaceted strategy

to reduce the environmental harm caused by the aviation sector. To make flying more environmentally friendly and to provide alternatives to aviation for travel, including domestic travel, both individual airline firms and nations are participating in this respect. Roughly 39% of respondents to a 2020 study stated that they have only lately begun to focus more on the sustainability of air travel.

- **Prospect**

One of the main reasons airline companies are unable to come to a legally-binding agreement on how to mitigate potential environmental catastrophes is that environmental conservation is a public goods problem, with each airline corporation having an incentive to stray from global obligations. The level of CO_2 emissions from international aviation climbed 2.5 times between 1990 and 2019, showing an alarmingly high growth rate, despite global efforts for climate action. International aviation is predicted to emit 1.5 billion tonnes of CO_2 by 2050 if airline groups do not make significant environmental protection efforts, based on a forecast with two post-coronavirus (COVID-19) scenarios. Only in China are carbon dioxide emissions predicted to quadruple between 2019 and 2050, reaching 371.6 million metric tonnes of CO_2 emissions by that time.

4. REGULATORY & POLICY FRAMEWORKS

The aviation sector functions within a multifaceted regulatory and policy environment encompassing global, regional, and national domains. To guarantee the efficiency, sustainability, safety, and security of air travel, a number of international organisations, governmental authorities, and regulatory bodies have built these frameworks. These international legislative and policy frameworks offer a thorough framework for overseeing the aviation sector and advancing safe, secure, and environmentally friendly air travel worldwide. To handle new issues, harmonise laws, and encourage the ongoing development of international aviation standards and practices, cooperation between governments, regulatory bodies, international organisations, and industry stakeholders is crucial.

- International Civil Aviation Organisation
- Chicago Convention
- International Air Transport Association (IATA)
- Bilateral Multilateral Air Service Agreements

- European Union Aviation Safety Agency (EASA)

- Environmental Regulations

- Aviation Security Regulations

- National Aviation Authorities (NAAs)

4.1 INNOVATION AND REGULATORY REQUIREMENTS IN THE AVIATION INDUSTRY

Flying is now safer and more effective than ever thanks to new technological developments and industry innovation, which is continuously taking place in the aviation sector. But as the aviation sector innovates, there are dangers and difficulties that must be resolved to make sure that security and safety are not jeopardised. Regulations have been implemented to deal with these hazards and difficulties. I will discuss how laws can encourage the growth of innovation and the effect that regulations have on innovation in the aviation sector.

- **Firstly**, it's critical to comprehend how legal restrictions affect innovation in the aviation sector. From the engine to the cockpit controls, every part of an aircraft requires approval and certification from aviation authorities including the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA).

- **Secondly**, this uncertainty may significantly affect how quickly innovations are made. Even if they think a different approach will produce a superior process or product, manufacturers and designers could be reluctant to stray from the norm. Innovation may be halted as a result, losing the competitive advantage.

- **Thirdly**, by giving regulators and developers a framework for cooperation, laws can foster innovation. An illustration of this is the Aviation Innovation, Reform and Reauthorization Act (AIRR Act).

- **Fourthly**, another strategy that governments are employing to promote innovation and the advancement of new technologies is the creation of regulatory sandboxes.

5. CONCLUSION

A nation's economy is influenced by the aviation sector in many different ways. It stimulates employment, trade, tourism, business connectivity, regional development, innovation, and foreign

exchange profits. Governments and policymakers frequently adopt policies and investment plans to support the sustainable development of the aviation sector and optimise its economic advantages because they recognise the strategic relevance of aviation. A nation's economy benefits greatly from the aviation sector in a number of ways. Millions of individuals work in a variety of capacities for airports, airlines, aircraft manufacturers, and other companies worldwide, such as pilots, cabin crew, maintenance technicians, airport employees, and aviation professionals.

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D. AIRPORTS VISITED

I visited the following Airports for detail study of infrastructure, facilities & technology:

- **ORD –** O'Hare International Airport, Chicago
- **YYZ –** Pearson International Airport, Toronto

E. MUSEUMS VISITED

I visited the following Museums to have detail knowledge of Aviation Industry, history Aircrafts & Airports and impact:

- *HAL Heritage Centre & Aerospace Museum* – Bangalore

F. INTERVIEWS

- *Mubin Bajighar***:** Technology Consultant – Numatech Solutions LLC, New Jersey, US; Ex-CTO Terminal Holdings, Abu Dhabi.