The Impact of Smart Flying Technologies on Passenger Experience, Operational Efficiency and Sustainable Solutions using XAI

by

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Dedication

My humble dedication of my thesis to dearest lordships Sri Radha Vrindavan Chandra, Vrindavan my dearest spiritual master HDG Srila Prabhupada, my mentors, whose unconditional blessings has been my strong pillar of support and anchor.

My son Shri Krishna currently pursuing Engineering in Biomedical Sciences at University of California Irvine, whose constant inspiration and endless questions in aerospace industry made me to consider his inputs and challenges for future and sustainable solutions for his and future generations.

This achievement would not have been possible without my parents and spouse love and encouragement.

I would like to thank my peers and teammates who stirred the curiosity of my research during the extensive interactions we had during my research journey. An ear to lend were my friends and colleagues on the listening mode during this long phase of this work.

I also dedicate this work to my mentor Dr. Hemant Palivela and advisors Prof. Dr. Lief Erik Wollenweber, Prof. Iva Buljubasic and Prof. Petra Pocrnic Perica whose guidance and expertise have shaped my intellectual growth. Your belief in my abilities inspired me to push beyond my limits.

Finally, I dedicate this thesis to the pursuit of knowledge itself, and to the countless individuals who paved the way before me. May this contribution serve to advance our understanding in the field of Artificial Intelligence and Digital Transformation.

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Lastly, I dedicate this thesis to all AI enthusiasts, as a testament to evolve more in the domain of AI that is endless.

ABSTRACT

The Impact of Smart Flying Technologies on Passenger Experience, Operational Efficiency and Sustainable Solutions

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2024

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Aviation industry is the foremost of adopting smart and sustainable technologies to enhance passenger experiences, operational efficiency and be future ready.

This study critically examines the transformative potential of smart flying and advanced technologies, focusing on their impact on key areas such as real-time baggage tracking, automated immigration systems, AI-based personalization, and operational workflows. Employing a mixed-methods approach, the research integrates quantitative data from 204 survey respondents participating from developing and developed countries, with qualitative insights derived from structured interviews with all personas like passengers, crew, pilots, and airport operations staff from diverse regions worldwide. The study's participants, predominantly from developing and developed nationals, representing key global aviation hubs, provide a comprehensive understanding of the challenges and opportunities associated with these technologies.

The findings highlight that 91.7% of participants prioritize digital and sustainable solutions for real-time updates on baggage and dependents' flight statuses, emphasizing

the demand for transparency and control during air travel. AI-powered solutions, such as predictive analytics for delays and queue management, were identified as critical in mitigating operational inefficiencies, reducing passenger anxiety, and improving resource allocation. However, challenges persist, including regional disparities in technological infrastructure, language barriers in non-English-speaking countries, and accessibility issues for elderly and digitally inexperienced travelers. Notably, 45.6% of respondents expressed the need for priority check-in services tailored to vulnerable groups, further underscoring the need for inclusive solutions.

There are few practical problems passengers face in the name of digitization. That is inconsistent push notifications at irregular intervals by airlines to their passengers regarding the gate changes, flight delays, updates on their baggage. The various channels of communication like their websites, mobile phones, display screens, call centers, etc. is making passenger confused and not sure which is right information and what to follow.

In the short window for them to act or enquire, few passengers land up in high stress and anxiety.

The study also reveals significant gaps in the global standardization of smart technologies, with fragmented implementation across regions. While passengers in developed markets enjoy access to advanced features like automated immigration and smart baggage tracking, respondents from emerging economies reported limited exposure to such innovations, often citing long wait times, ambiguous procedures, and unresponsive support systems as key pain points. The lack of multilingual interfaces and cultural adaptability further compounds these issues, particularly in international transit hubs where diverse passenger demographics converge.

To address these challenges, the research proposes a comprehensive framework to the adoption of smart flying technologies emphasizing the integration of ethical AI to ensure transparency, data privacy, and user inclusivity. Key recommendations include the development of standardized, multilingual platforms for real-time communication and tracking, the implementation of predictive analytics for seamless resource management, and targeted educational initiatives to enhance digital literacy among all age groups. The

study also advocates stronger collaboration between aviation stakeholders—including airlines, regulatory bodies, and technology providers—to establish global benchmarks and best practices for smart flying technologies.

The theoretical implication of the research lies in its application of Theory of Reasoned Action to understand user acceptance of digital tools, highlighting the interplay between attitudes, subjective norms, and behavioral intentions in shaping adoption patterns.

The practical contributions include actionable insights for airlines, airport authorities, and policymakers to optimize passenger experiences while achieving operational efficiency.

By addressing critical barriers and proposing scalable solutions, this study lay the groundwork for future research in the digital transformation of the aviation industry, with an emphasis on equity, sustainability, and innovation.

This thesis ultimately demonstrates that while smart flying technologies have the potential to revolutionize air travel, their success hinges on inclusive design, cross-regional standardization, and proactive policymaking to ensure equitable benefits for diverse traveler demographics globally. Emphasizing on the need of unified solution and synchronized communication on all channels of broadcasting updates is the goal of this research.

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INTRODUCTION

1.1 Background of the study

The phenomenon of globalization has led to a notable surge in worldwide corporate operations and a substantial need for air transportation, which facilitates easy global connectivity for both passengers and goods. Aviation has become an enabler of global business and is also recognized by the international community as an essential enabler to achieving the UN Sustainable Development Goals.

The aviation industry is growing fast and will continue to grow. The latest estimates suggest that the demand for air transport will increase by an average of 4.3% per annum over the next 20 years. These numbers are dazzling and reflect a dynamic sector which is great. This growing demand for air traffic brings with it, its own set of challenges which have important logistical implications in and around airports and their operations to ensure the infrastructure can support this growth. The reality is that to accommodate the forecast growth, drastic improvements need to be made to improve the efficiency of both airports and airlines and their operations. This needs innovation that should be futuristic and evolving. This research is dedicated to introducing smart flying technologies using digitization to enhance operational efficiency and improve passenger experiences.

Commercial, Cargo, Military, Business Jets, General Aviation contribute to overall traffic and expect to grow significantly by 10% year on year.

Commercial passenger aircrafts make up roughly 100,000 flights per day and bound to increase as world economy progresses year on year.
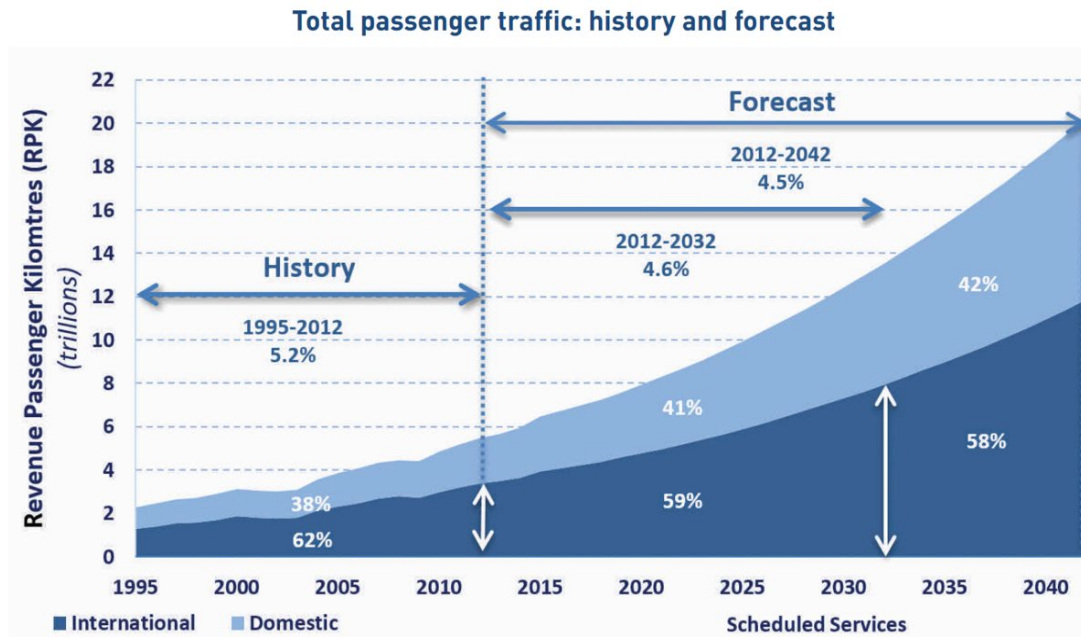
Figure 1: Dramatic growth in International and Domestic Flights estimated by ICAO

The aviation department is looking into several strategies to meet the rising needs, including strong connectivity, reduced prices, enhanced standards and systems, better equipment acquisition, and the implementation of sustainable procedures ranging from automation and artificial intelligence (AI) to biometrics and security. To meet demand, the operations level scale-up should also be at least linear.

1.2 Problem Statement

An era that witnessed drastic changes in technological advancement leading to the transformation in the airline and aviation industry. A huge amount of data regarding all the aspects of aircraft and airport operations could be collected which provides rich avenues and vast opportunities to improve the business and operation process and customer satisfaction in the aircraft/aviation industry. This study will help airlines optimize their operational excellence and enhance the customer experience using the latest technologies under the concept of Smart Flying.

Passenger as an ultimate end user, often seen encountering various challenges and assumes he can't voice out on the challenges he is facing since he has been silenced from the past that safety is airlines first priority and rest of things to be ignored. This was the case two decades back; however, things have changed now where airlines facing tough competition and increase their market share, opened up few services as add on payment basis. Eventually competitors provided the same services free of cost and gained more customers.

This way end user, passengers made use of the benefits as much as possible and eventually learnt to ask for more and value their money. Passenger service standards should be increased eventually by innovation and latest technologies.

Future trends demand personalized solutions and offerings which forces Airlines

Industry to be disruptive and position themselves on competitive edge. These demands

The airlines to move to analyzing passengers travel, their likes and dislikes. So big

data

analysis is the key.

Meanwhile, the booming of Machine Learning and Explainable Artificial Intelligence (XAI) makes it possible to reap the benefits of big data and create a huge impact on airline customers effectively. It has been widely accepted that AI and generative design play an even more important role in driving efficiency and coping with upcoming design changes as well as mounting market pressures for cost optimizations.

Explainable artificial intelligence is a set of processes and methods that allows users to comprehend and trust the results/output created by machine learning algorithms.

It helps characterize the accuracy of the model, fairness, transparency, and outcomes in AI-powered decision-making.

Explainable AI is crucial for any organization in building trust and confidence while putting AI models into production. AI explainability helps them to adopt a responsible approach to AI development.

1.3 **Research Objectives –** These are listed 5 research objectives this study aims at as

<u>Enhance Operational Efficiency through Digital Transformation</u>

The objective is to explore how integrating smart technologies like AI, IoT, and Blockchain can optimize airline operations, particularly focusing on <u>reducing costs associated with baggage handling, flight delays, and maintenance.</u>

Improve Passenger Experience during Travel

This objective aims to address the challenges passengers face, such as <u>baggage mishandling, delayed flights, and immigration bottlenecks.</u> The goal is to use smart technologies to provide real-time tracking, automated notifications, and efficient check-in processes.

<u>Streamline Immigration Processes with AI Solutions</u>

The objective is to leverage AI, particularly Explainable AI (XAI), to <u>facilitate preliminary immigration checks and documentation, reducing congestion at immigration counters enhancing security procedures.</u>

<u>Investigate the Application of Explainable AI for Prioritizing Baggage Handling</u>

This objective focuses on using <u>AI to categorize and prioritize the handling of baggage for passengers with tight flight connections, aiming to ensure timely baggage delivery and minimize delays.</u>

Examine the Cost-Benefit of Implementing Smart Flying Technologies

Objective is to analyze the potential financial savings and operational benefits that airlines can achieve by adopting smart flying technologies to handle increasing air traffic demands.

1.4 Significance of the study

An aviation industry needs to be equipped to handle the projected 3% year-on-year increase in demand, over the next 20 years. In its recent report on "Future of the Airline Industry 2035", International Air Transport Association (IATA) has recommended few technologies and factors that will define how the aviation industry is shaping up.

Airliners that are under constant pressure to increase their profitability also need to stop revenue leakages where they compensate for passenger's baggage due to it being delayed/lost/misplaced/damages.

Although airliners do not directly manage these operations, they are accountable for the ground handling personnel. Examined data from the U.S. Department of Transportation's Mishandled Baggage Report, which revealed that American Airlines mishandled 0.597% of the baggage it managed in 2020.

The significance of AI explainability is growing among business executives and policymakers. Approximately 68% of business leaders anticipate that customers will require greater transparency from AI within the next three years, according to the IBM Institute for Business Value Survey.

Machine learning models exhibit remarkable accuracy across diverse tasks and have achieved extensive adoption. The researcher's objective in conducting the survey is to concentrate on all categories of air travelers and to address critical questions about their travel experiences worldwide. The insights gathered from over 200 respondents are invaluable to this research, which seeks to make a case AI-enabled aviation "Smart Flying."

CHAPTER II:

REVIEW OF LITERATURE

2.1 Review of existing technologies in Smart Flying

Artificial Intelligence (AI) has significantly influenced aviation by enhancing efficiency, safety, and operational management. AI technologies are used for predictive maintenance, air traffic control, customer service automation, and flight optimization. These advancements promise operational excellence and improved passenger experiences.

Predictive maintenance is one of the most revolutionary applications of AI in aviation. Airlines analyze data generated by the sensors to anticipate equipment failures, enabling proactive maintenance. For example, Kabashkin, Susanin (2024) highlight the use of AI-driven predictive maintenance systems that have reduced downtime and operational costs. Similarly, Lansky et al. (2022) emphasize that AI models predict potential component failures, ensuring enhanced safety and extending the life cycle of critical systems. Such innovations address long-standing inefficiencies in maintenance operations.

2.1.1 AI-Powered Air Traffic Control

AI is pivotal in modern air traffic management, facilitating real-time analysis of air traffic data to minimize delays and enhance safety. AI-based systems predict congestion patterns, dynamically allocate resources, and improve airport operations. Fesenko et al. (2023) discuss AI-driven solutions that ensure seamless communication between air

traffic control and pilots, reducing human error and optimizing decision-making processes.

2.1.2 Passenger Experience

AI significantly improves passenger experiences by enabling automation and personalization. For instance, Chung (2021) notes that chatbots powered by natural language processing (NLP) simplify customer interactions, handling booking queries and check-in processes efficiently. Furthermore, AI analyzes passenger data to offer personalized recommendations, contributing to customer satisfaction.

2.1.3 Smart Materials in Aviation

Smart materials are reshaping aviation by introducing self-healing capabilities, adaptive structures, and lightweight composites. These materials respond to environmental stimuli, thereby enhancing performance, safety, and fuel efficiency.

2.1.4 Emerging Trends in Aviation Technologies

The aviation industry is increasingly integrating Internet of Things (IoT), blockchain and autonomous systems to achieve operational cost effectiveness and enhance safety protocols.

2.1.5 IoT and AI Integration

IoT-enabled systems collect real-time sensor data embedded in aircraft, facilitating advanced analytics through AI. Nasir et al. (2023) highlight the use of IoT in tracking aircraft health and improving predictive maintenance outcomes. These technologies reduce delays, improve safety, and enhance overall efficiency.

2.1.6 Blockchain in Aviation

Blockchain technology ensures secure and transparent data sharing across aviation networks. Dahmane et al. (2022) discuss how blockchain integrates with AI to enhance predictive maintenance by providing immutable records of aircraft performance. This synergy addresses critical issues like data security and operational transparency.

2.1.7 Autonomous UAV Systems

Unmanned Aerial Vehicles (UAVs) equipped with AI capabilities are revolutionizing cargo transport and surveillance. Alsamhi et al. (2019) describe collaborative smart drone systems that manage logistics in urban airspaces. These drones depend on machine learning algorithms to optimize flight paths, enhancing operational efficiency.

2.1.8 AI and Drones in Aviation

Drones, powered by AI, are becoming indispensable in aviation for applications such as cargo delivery, disaster management, and surveillance.

2.1.9 AI-Enabled Drone Systems

AI enables drones to operate autonomously, making real-time decisions based on environmental data. Palossi et al. (2021) discuss ultra-low-power AI systems that allow drones to perform complex tasks without human intervention. Such advancements are crucial for disaster relief operations and infrastructure inspections.

2.1.10 Applications in Surveillance

Drones equipped with AI-powered cameras are widely used for surveillance in smart cities. Thakur et al. (2021) highlight how AI-driven drones monitor urban areas, ensuring security and efficient resource management. These applications extend to airport security and border surveillance, further enhancing safety.

2.1.11 Smart Drone Logistics

The use of drones in logistics is transforming supply chain operations. Soliman et al. (2023) describe AI-based navigation frameworks that optimize delivery routes and reduce transit times. These systems enhance the efficiency of cargo transport in crowded urban environments.

Challenges in Implementing Advanced Technologies

Despite the transformative potential of AI and smart materials, several challenges hinder their widespread adoption in aviation.

Data Privacy and Security

Integration of IoT and AI in aviation involves handling vast amounts of sensitive data. Bera et al. (2021) emphasize the need for robust cybersecurity measures to prevent data

breaches. Blockchain technologies address these concerns by ensuring data integrity and secure sharing.

2.1.12 Cost of Implementation

The high costs associated with adopting advanced technologies pose significant barriers for smaller airlines. Mahmood et al. (2023) argue that while the long-term benefits are substantial, the initial investment in infrastructure and training is often prohibitive.

2.1.13 Regulatory Hurdles

The lack of standardized regulations for AI applications in aviation creates uncertainty for stakeholders. Kabashkin and Susanin (2024) highlight the need for clear guidelines to ensure the ethical use of AI in decision-making processes.

2.2 Future Prospects

The aviation sector's future lies in leveraging AI and smart materials to achieve sustainability, safety, and efficiency. Emerging areas of research include:

- <u>Bio-Inspired Materials</u>: Developing self-healing materials that mimic biological processes to enhance durability (Sharma & Srinivas, 2020).
- <u>AI-Driven Crowd Management</u>: Predicting passenger behavior to optimize airport operations (Chung, 2021).
- <u>Advanced Blockchain Applications</u>: Enhancing transparency in predictive maintenance systems (Dahmane et al., 2022).

XAI aims to make AI systems more transparent and understandable to human beings, allowing for better decision-making and accountability. In the airline industry, XAI can be used to improve decision-making process for flight scheduling and safety, providing a clear explanation for why a certain decision was made.

Generative design approach that uses algorithms and AI to generate multiple design options based on specified constraints and objectives. In the airline industry, generative design is used to design highly efficient and lighter aircraft components, reducing fuel consumption and emissions.

The combination of both, XAI and Generative design can enhance the use of AI in the airline industry by increasing the customer base, improving access to information, and making air travel comfortable and efficient for all stakeholders. Artificial intelligence (AI) has been increasingly applied in various aspects of the aircraft industry, including design, manufacturing, and maintenance operations to improve efficiency, reduce costs, and improve customer satisfaction. There are numerous AI-based use cases:

a) **Preventive Maintenance for Improved Aircraft Availability**:

By analyzing vast databases from aircraft systems, artificial intelligence algorithms help forecast maintenance requirements, prevent unplanned downtime, and increase aircraft availability, thus optimizing operational cost optimization.

b) **AI-Powered Flight Optimization: Fuel Efficiency:**

Driven by artificial intelligence, flight optimization software examines flight data to suggest fuel-efficient paths and flight profiles, hence greatly lowering fuel consumption and emissions in line with goals of cost-saving and sustainability.

c) **Component design optimization using AI:**

By creating virtual prototypes, assessing performance, and identifying possible improvements, AI helps engineers design aircraft components that make the aircraft safer and more efficient.

d) **Operations Efficiency:**

Supply Chain Optimization: By streamlining inventory control and lowering delays, AI helps control the dynamic demands of the aviation supply chain, thus improving logistics speed, accuracy, and cost-effectiveness.

e) **Improving Flight Safety Using AI-Based Risk Assessment:**

By constantly monitoring flight data, AI algorithms spot safety hazards in real-time and provide insights and alarms that might help to improve safety procedures and shorten response times, to enhance passenger confidence and safety directly.

f) **AI Chatbot Customer Service Automaton:**

By answering frequently asked questions and helping with bookings, cancelations and other searches, AI-powered chatbots provide 24/7 customer support, so enhancing passenger convenience and satisfaction.

g) **Maximizing Flight Plans to Minimize Delays:**

By considering factors including delays, fuel costs, and maintenance requirements, artificial intelligence (AI) is used to optimize flight schedules, thus minimizing disturbance and guaranteeing on-time performance.

h) **Detecting Fraud to Safeguard Airline Operations:**

By helping to identify and stop dishonest behavior including ticket, baggage, and loyalty program fraud, artificial intelligence protects consumer data as well as airline operations.

i) **Customized marketing to improve passenger experience**:

Through customized marketing, artificial intelligence examines consumer data to offer personalized travel recommendations including preferred destinations, hotels, and activities, hence improving the passenger experience.

j) **Monitoring Flight Safety Real Time**:

AI tracks flight data constantly, spotting possible safety concerns for ground staff and pilots and alerting them, so guaranteeing proactive safety precautions and reducing risks.

Smart flying leverages AI to analyze huge stacks of data such as flight schedules, weather patterns, and maintenance records to optimize operations and decision-making processes. IoT devices recommended to review the health and performance of aircraft in real-time,

allowing for proactive maintenance and reducing downtime. Automation technologies can be used to streamline processes, such as baggage handling and flight planning, improving efficiency and reducing costs.

Smart flying also includes the use of alternative fuels and electric propulsion systems to reduce emissions and improve sustainability. By using these technologies, smart flying aims to create a more efficient, safe and sustainable aviation industry.

A few examples AI providing the opportunities, drivers, aviation market size, growth.

Breakdown of Primary Participants

BY COMPANY TYPE

25%
35%
40%

■ Tier 1   ■ Tier 2   ■ Tier 3

BY DESIGNATION

30%
40%
30%

■ C-Level Executives   ■ Directors   ■ Others

BY REGION

10%
10%
45%
35%

■ North America   ■ Europe
■ APAC   ■ RoW
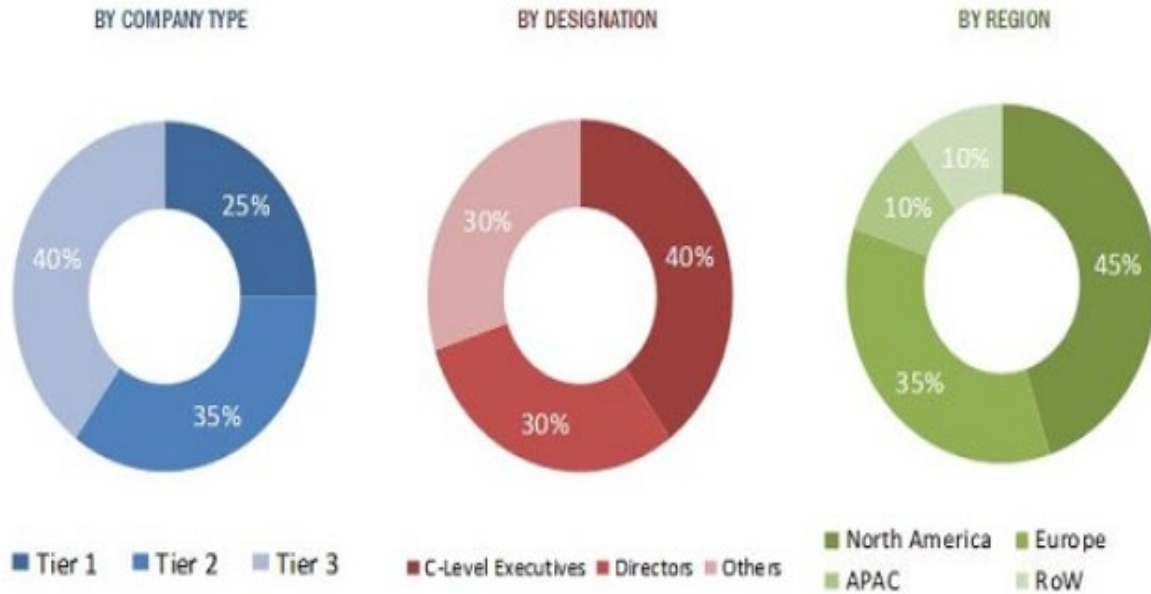
Note: The three tiers of the companies are defined on the basis of their total revenue as of 2017; Tier 1 = >USD 1 billion, Tier 2 = 500 million to USD 1 billion, and Tier 3 = <USD 500 million.

Figure 2.0: Breakdown of Primary Participants -Revenue split, region wise and leadership level considered for this study.

% of airlines with AI use cases currently implemented or planned by 2021

Use case	%
Virtual agents and chatbot	85%
Predictive analytics	66%
Targeted advertising/personalization	63%
Pattern recognition	54%
Brand perception improvement (eg. customer feedback analysis)	50%
Automatic scheduling (eg. of repairs/maintenance)	37%
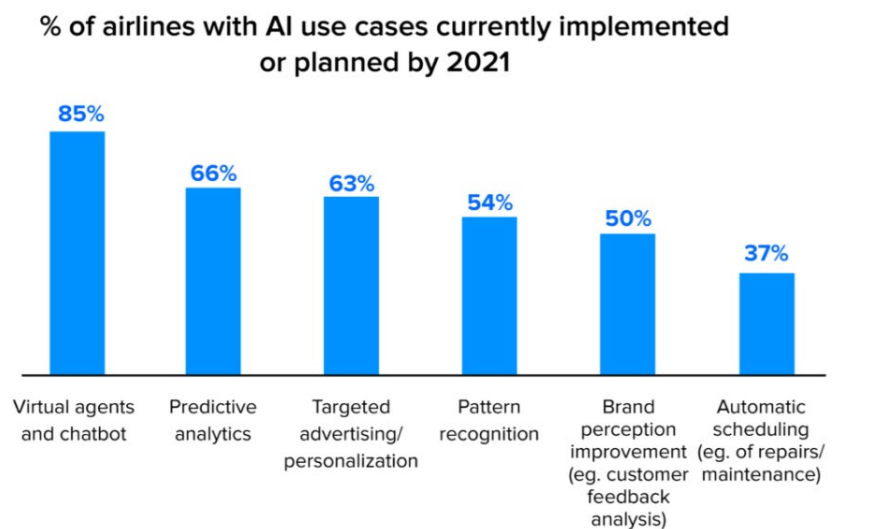
Figure 3.0: Percentage distribution of airlines with AI use cases

2.2 Theory of Reasoned Action

As per statistical data and internet surveys, it is evident that global airlines are connecting and touching numerous people from all over the globe and making flying an affordable and sustainable mode of travel. However, the scale of infrastructure development needed to handle many passengers, their baggage, visa processes, and check-in process does not match the scale at which the number of passengers is increasing. Airline staff and industry operate in a lean process.

Breakdown of Customer Complaints in the U.S. airline industry in 2019, by category

Category	Complaints
Baggage	2565
Reservation, ticketing, boarding	1823
Customer service	1703
Refunds	1568
Fares	1033
Disability	905
Other**	433
Oversales	376
Discrimination	107
Advertising	61

Figure 4.0: Chart of various customer complaints in 2019 categorically represented.

From this data, it is evident that the need for ease and urgency will arise as we progress to the next era of customer satisfaction and comfort for travelers of all ages. The use cases

defined here will eventually help us to encompass all the challenges of a common man traveling from point A to point B.

RFID baggage handling process for real-time tracking and mobile alerts –

This provides data about the passenger's luggage tracking from the initial point of moving them on the conveyor belt to the destination point. Every year, the airline industry incurs huge losses due to baggage loss leading to baggage clai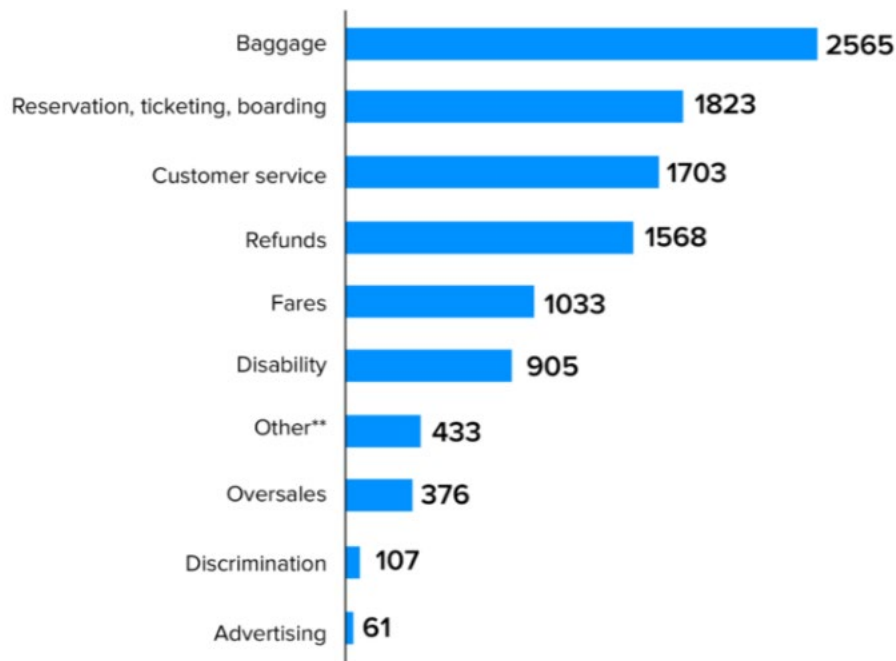ms. In 2020, U.S. airlines mishandled 2.70 bags per 1,000 passengers, which was a decrease from 5.57 bags per 1,000 passengers in 2019. This was due to the significant decline in air travel during the COVID-19 pandemic.

In 2019, U.S. airlines mishandled 5.57 bags per 1,000 passengers. This was a slight increase from 5.49 bags per 1,000 passengers in 2018.

In 2019, U.S. airlines reported 79.5% of mishandled bags as delayed, 14.5% as damaged, 5.5% as pilfered, and 0.5% as lost or stolen. In 2019, U.S. airlines reported receiving 3.3 baggage-related complaints per 100,000 empanelment.

Digital Solutions for Immigration Process –

The digital immigrants in all areas of workforce, digital empowerment is riding on both the training and onboarding they receive and, even more importantly, seamless support from UX/UI.

Given that 54% of the non-federal civilian labor force, fall between 40 years above.

one of the primary characteristics of digital immigrants is that they did not grow up using digital technology, it is tempting to frame the conversation around age. However, it's the individual resistance to or difficulty with digital technology as an individual employee rather than their demographics.

This should not be downplayed that almost every employee—no matter of their age on technological savviness—interestingly enjoy being on their smartphone constantly. No one reads any manual for a smartphone. Both the physical and interface designs are so

simple and intuitive that the natural action is to start using the device rather than read how to use it. One learns in a hands-on, discovery fashion.

The best practices for UI design are well-defined and should be applied to the creation and maintenance of digital products as well. When designing a solution, the UI/UX strategy is of the utmost importance.

Solution engineers align to keep simplicity as their guiding light—the KISS principle (keep it simple, stupid) need to be the rule during development, testing, and evaluation. For front-line workers, the instructions they receive need to flow in a descriptive, guided fashion.

The next step they receive must be definitive and exact. Formal trainings during the onboarding process is highly recommended, however employees should not have to refer to training materials to successfully use the digital solutions as they are assigned to the task.

Minimize the options and maximize the guidance. Multiple options should be avoided to keep guidelines simple. The UX of the digital solution should inspire confidence in employees, providing them with the on-demand training and guidance they need to be successful at their job.

With the constant increase in the number of illegal immigrants, XAI will be highly efficient in providing accuracy of minute details and confidentiality. Also, studies show that there is an ever increase of immigrants as the policy makers welcome new talents and opportunity seekers. The only solution is to adapt to the digital migration process, with passengers on board to be guided through quick videos to fill in their immigration details with a simple questionnaire that immigration officers would want to seek information and shreds of evidence to be provided on a digital application accessible on every individual's smartphone. IoT-enabled access to Immigrant officers should be able to assess the data provided by passengers still to reach their destination. Status quo can be provided to passengers regarding their immigration process and if they need to provide additional details, they have sufficient time now to provide them.

XAI is modeled to handle accuracy and detailed explanation that is trained for software applications like these dynamic scenarios.

Priority assistance for **Senior Citizens and Children who are minors** –

Full-fledged AI-trained models as customized Bot's should be made available for exceptions like this group of passengers which can be simplified questionnaires or families can help them fill it through apps available on the secured cloud. In current scenarios, cloud computing and access to a secured cloud are very viable approaches. Real-time responses and online editing should be available options. This would save time and effort for immigrant officers, avoiding the rush for transit flights, providing a relaxing customer experience, and XAI having to pre-check all the credibility of the passenger's travel history helping immigration officers take right and final decisions. XAI can probe for more information or provide recommendations based on the accuracy, and detailed responses provided or asked in the questionnaire. As a design principle, airport infrastructure is to be updated based on the customization required which is possible by a Generative Design principle. Various prototypes should help to come out with the final expected outcome as an iterative process.

2.3 Summary

As we witness the need for Digital Transformation in the airline and immigration front, its implementation would put various people's lives at ease, reduce human errors, and the need for intervention, increase customer comfort, and reduce turnaround time. Artificial Intelligence (XAI) allows all end users to implement the underlying working principles of decision-making processes. Use cases will be based on personas such as immigration officers, passengers, passengers' caretakers, staff, etc. will have to understand and respond based on their roles. As such the immigration officers will have to make critical decisions and recommendations whereas passengers just have to follow the questionnaire which may not be critical. XAI will be based on these use cases and programmed on deep

learning neural networks which will assess various parameters and be fed into the algorithm to help fetch the outcome that is ethical, confidential, and accurate.

A recent article by Symphony Solutions values artificial intelligence in the global aviation market in 2022 at USD 728.05 million. It is estimated to reach USD 23 billion by 2031. Figure 5.0 shows the main facets of the aviation industry where AI can play critical roles while figure 6.0 throws light on the role of AT|I specifically in ground operations.

The Main Applications of AI in the Airline Industry

Selling Tickets

Safety and Security

Feedback Analysis

In-flight Sales & Food Supply

Air Safety & Airplane Maintenance

Fraud Detection

Applications of AI in the Aviation Industry

Messaging Automation

Crew Management

Fuel Efficiency Optimization
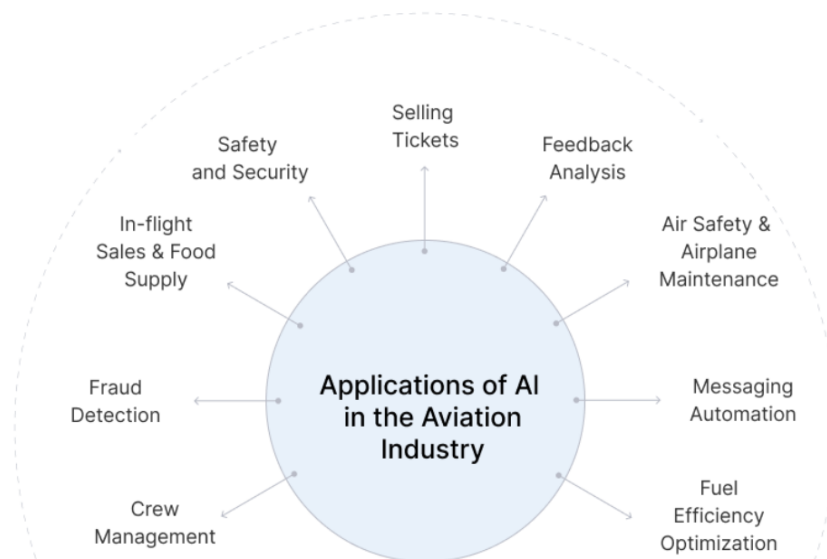
Figure 5.0 Main Applications of AI in the Airline Industry

AI IN AIRPORT GROUND OPERATIONS

- Chatbots and virtual assistants, powered by natural language processing (NLP), for improved customer service
- innovative AI-powered baggage check-in and luggage-handling system
- AI-driven biometrics and facial recognition for enhanced security and seamless check-ins

Figure 6.0: AI use cases in Airport Ground Operations
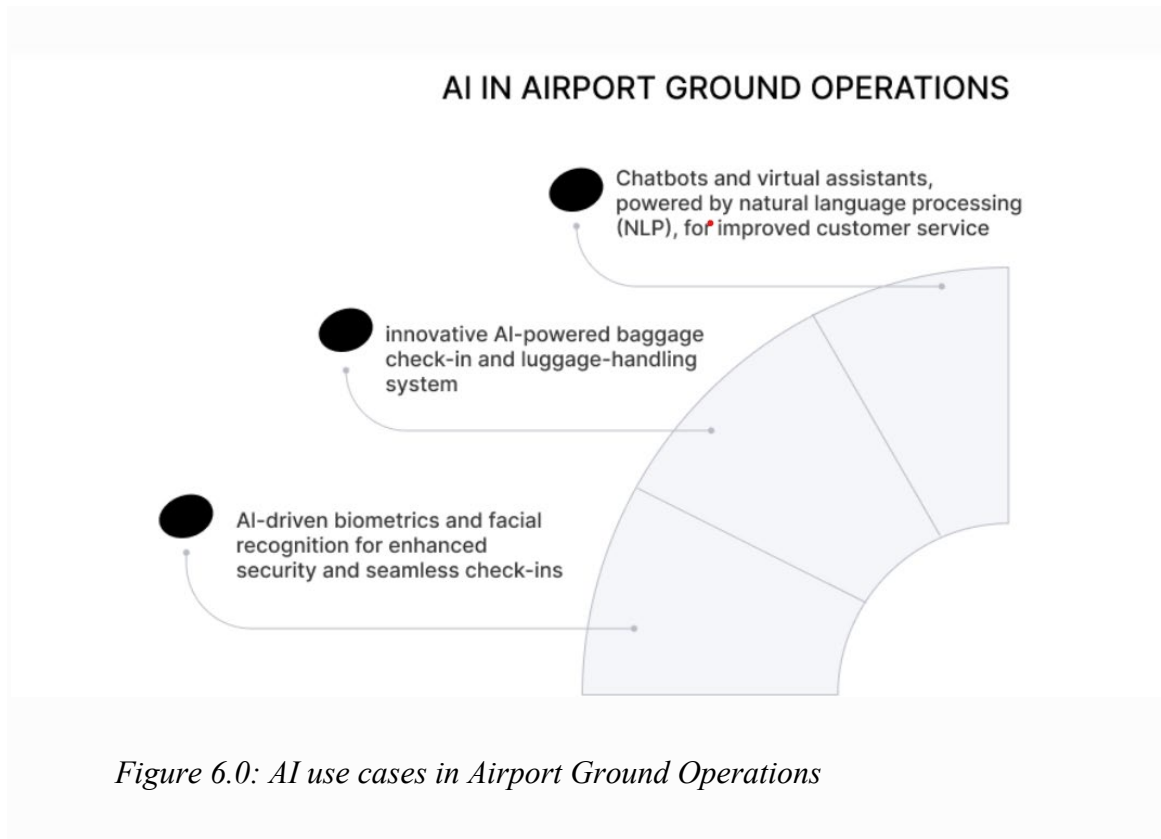
As AI services continue to make inroads in the aviation industry, its impact extends beyond current operations. Current study highlights emerging trends and potential future developments in AI in this industry.

Few instances of Airlines Industry like British Airways "Mission Control" integrates AI - driven weather rerouting, stand allocation and operational efficiency -raising punctuality from ~46% (2008) to ~86% in Q1 2025.

Another example is of Virgin Atlantic extended their AI -focused tech partnership to drive operational efficiency and personalized services.

Below table shows the key AI applications and benefits which addresses various domains.

Domain	Key AI Applications	Benefits
Maintenance & Ops	Predictive maintenance, route/crew optimization	Reduced downtime, fuel & staffing efficiency
CX & Support	Chatbots, biometrics, personalization	Faster service, higher satisfaction
Pricing & Ancillaries	Dynamic pricing, upselling	Revenue & conversion increases
Safety & Security	Screening, NLP analysis	Improved security, proactive safety
Innovation	Generative AI, virtual staff	Data insights, empathetic engagement

CHAPTER III:

METHODOLOGY

3.1 Overview of the Research Problem

Air travel, a luxury back became a norm gradually over the last decade, as it is all about robustness in travel and quick connectivity. Airports Council International (ACI) released a report recently called WATF – World Airport Traffic Forecasts 2023 -2052 at global, regional, and country levels giving deep insights on upcoming trends in Air traffic.

ACI advances the collective interests, acting as the voice of the world's airports and communities they serve and promotes professional excellence in airport management and operations.
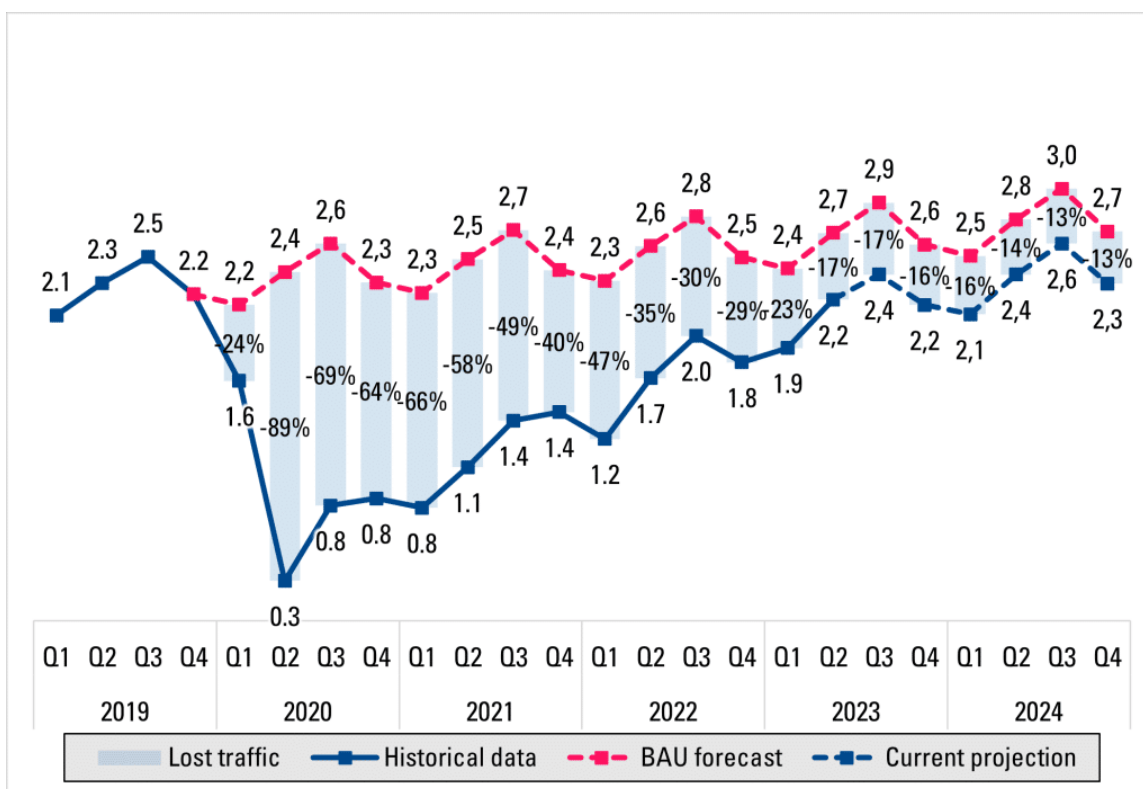
Figure 7.0: World Airport Traffic forecasts

Monthly global domestic and international passenger traffic 2019–2023
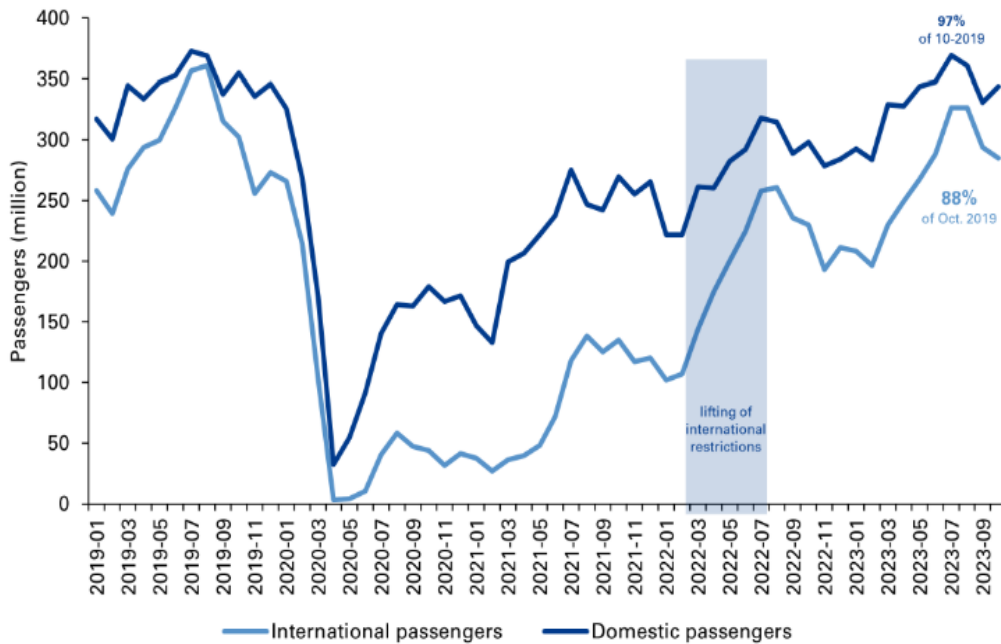
Figure 8.0: Monthly report of global and international passenger traffic

Inspite of uncertainties, global passenger traffic in 2024 as predicted surpassed the 2019 level for the first time.

since COVID-19, it reached 9.7 billion passengers or 106% of the 2019 level (12% YoY growth rate). The growth rate gradually accelerated in 2021 onwards as many countries recovered from COVID-19.

Country wise trend

Let us also understand the traffic trends from a region-wise forecast.

The graph shown in Figure 9 indicates that Latin America, Caribbean, the Middle East and North America are expected to reach traffic of 108%, 104% and 100%. Africa and Europe are predicted to be 96% and 94% of their 2019 levels to an average of 95%. Asia-Pacific shows the biggest increase from 52% in 2022 to 82% in 2023 to 130% by 2027.

Medium-term passenger traffic forecast by regions
(indexed, 2019 = 100)

Legend:
- World
- Africa
- Asia-Pacific
- Europe
- Latin America-Caribbean
- Middle East
- North America
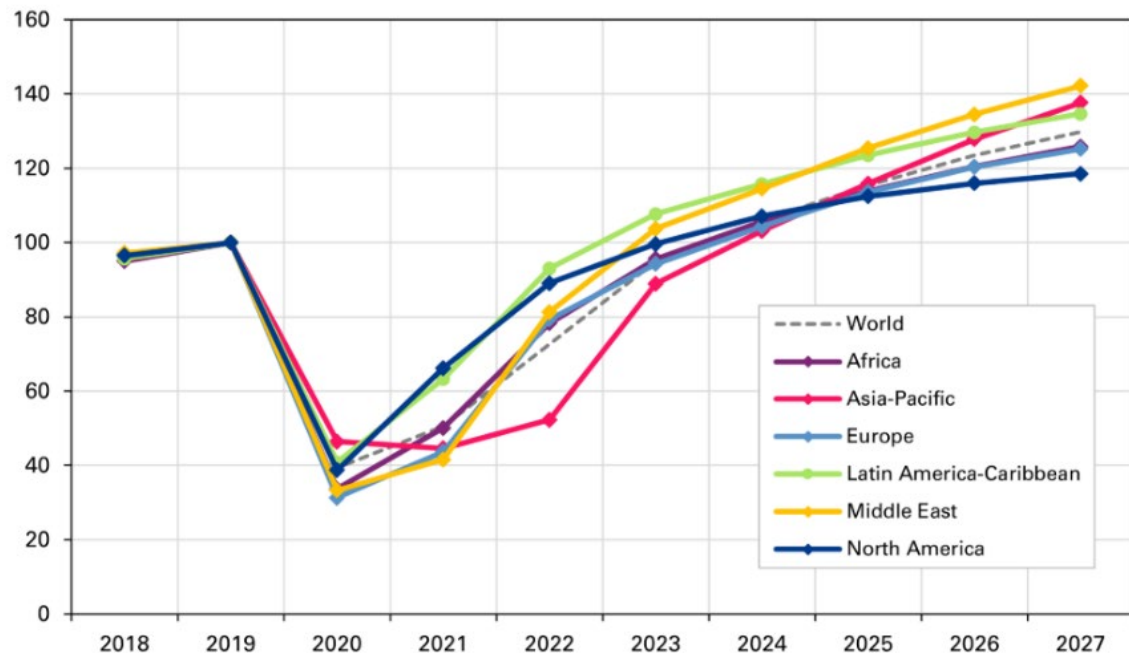
Figure 9.0: Traffic forecast by regions for medium-term passenger.

If we further assess the long-term global passenger traffic forecast that is shown below from 2016 -2052, we can observe a gradual increase which further accelerated post-pandemic.

From 2023 to 2042, total air traffic worldwide is expected to grow at a CAGR of 4.3% with a steep recovery gradient observed in the first 3 years (9.1% CAGR for 2023 to 2026), then converging to the pre-COVID-19 growth rate (3.6% CAGR for 2023 to 2052).

Global passenger traffic is expected to reach 20 billion in 2042, twice the projection of 2024.

In 2052, global passenger traffic is expected to touch 25 billion, approximately 2.5 times the 2024 projection.

Long-term global passenger traffic forecast 2016–2052
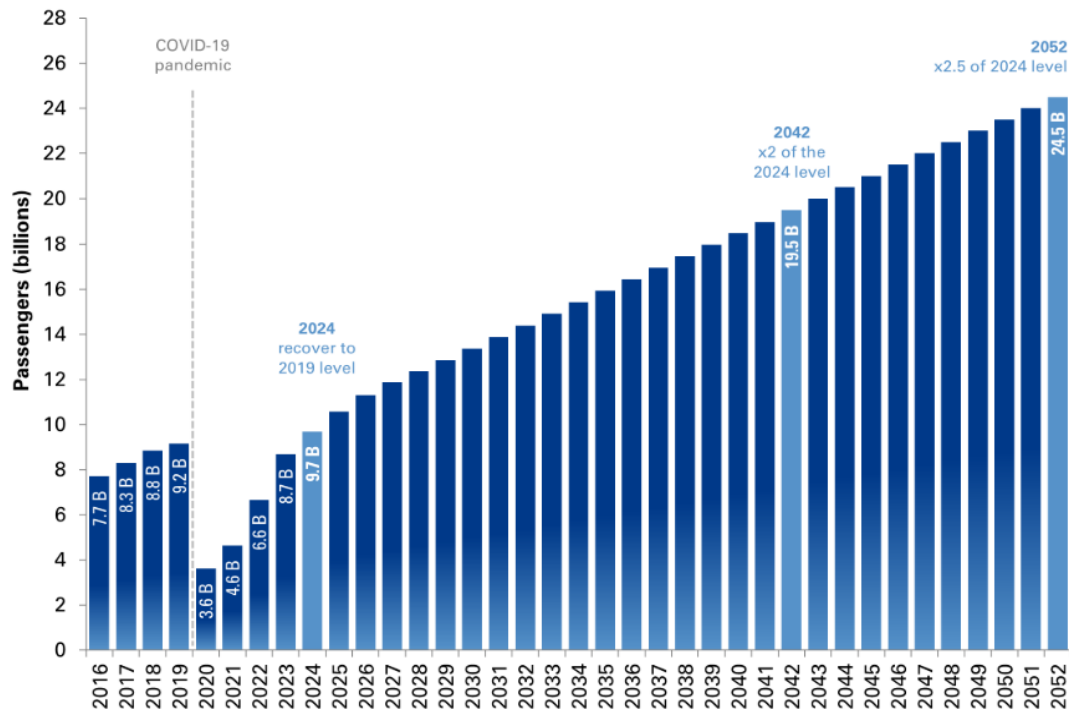
Figure 10.0: Traffic forecast for long term global passenger

Shifting the focus to domestic passenger traffic, during the pandemic the international passenger market was highly impacted than the domestic passenger market due to international travel restrictions.

Comparing long-term CAGRs, international passenger traffic is expected to steadily grow with a 5% CAGR from 2023 to 2042, while domestic passenger traffic is expected to have a 3.8% CAGR in the same period.

In 2042, 45% of all passengers are projected to come from the international segment, and 46% by 2052. This indicates the most pressing challenges of accommodating both domestic and international airlines and alludes to the soaring need for digital and smart solutions for managing air travel.

Figure 11.0: Long term international and domestic passenger traffic

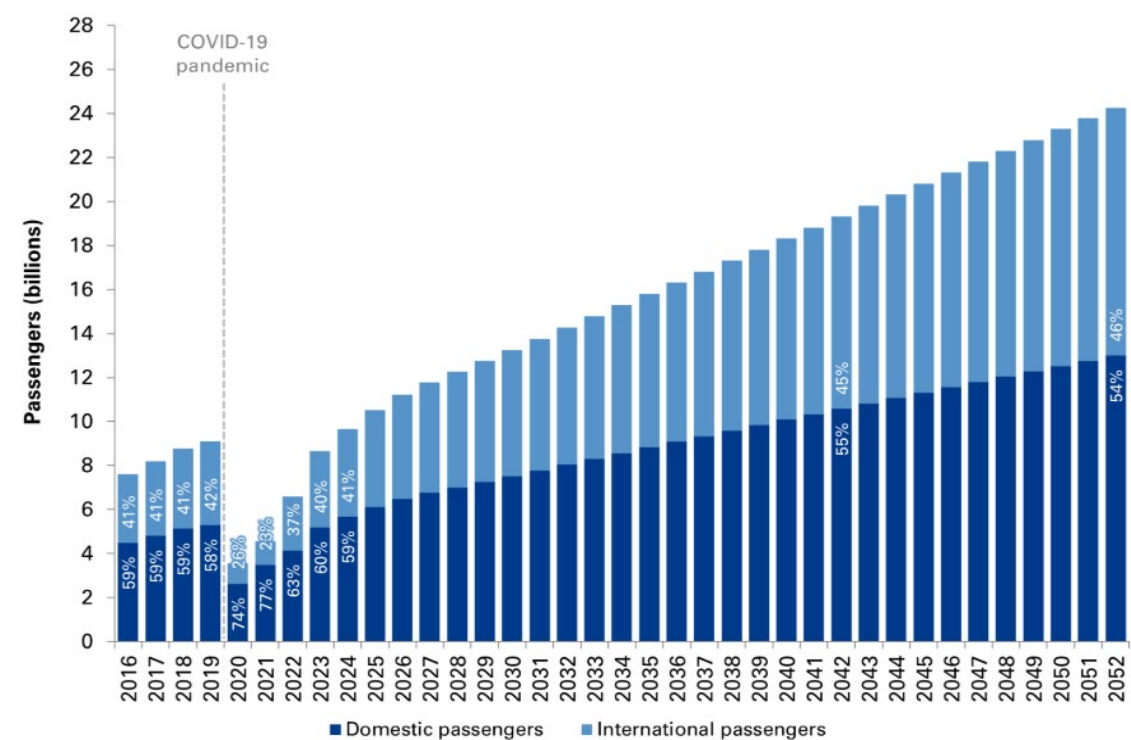| Rank	2023	2042	2052
1	United States	China	China
2	China	United States	United States
3	India	India	India
4	Spain	Indonesia	Indonesia
5	United Kingdom	Spain	Spain
6	Japan	Japan	Turkey
7	Turkey	Turkey	Japan
8	Brazil	United Kingdom	United Kingdom
9	Italy	Russian Federation	Thailand
10	Germany	Thailand	Vietnam
11	Mexico	Vietnam	Mexico
12	France	Mexico	Russian Federation
13	Indonesia	Brazil	Brazil
14	Russian Federation	Italy	Philippines
15	Canada	Germany	Italy
16	Australia	Korea	Korea
17	Korea	France	Australia
18	United Arab Emirates	Australia	Germany
19	Thailand	Philippines	France
20	Vietnam	United Arab Emirates	United Arab Emirates

Figure 12.0: List of Top 20 markets by total passenger traffic forecast

The countries listed in Figure 12 are the top 20 markets worldwide in terms of total passenger traffic forecast for 2042 up to 2062. The top three are China, USA, and India for 2023, 2042, and 2062, and hence, these markets must be the focus for early deployment of smart and efficient operations to handle huge numbers of baggage tracking and bring in the digital tracking process. Airport operations must be made sustainable to handle the massive demands of incoming passengers. Gen AI is the solution.

These studies strongly focus on the need for smart flying to enhance operational efficiencies. Huge transformation is required to handle the boarding process especially for senior citizens, children. Baggage tracking, Priority Check In, and the Immigration process, are the topmost addressed issues. There is a need for latest technology and business case to converge so that these processes can be streamlined and be made hassle-free and swift.

As airlines handle more quantity of passengers every year, it is also equally important to maintain the quality of end-to-end operations, most importantly focusing on user experiences of passengers.

The following section brings this need into perspective.

As the Airlines took to the skies again after the COVID19 pandemic, they clicked an opportunity to reset and focus on a challenge at the heart of their business: providing a great customer experience.

COVID pandemic pressed the airline industry to revamp many systems, in particular transforming how they communicate with customers, provide support and build loyalty. As per John Strong, professor of finance and economics at the William and Mary School of Business, it is important to recapture the human element in the services one delivers. He believes that the steep drop in travel costs and subsequent increase in airline passengers over past few years has been dehumanizing for travelers. The feeling of being in "cattle class" is real he said.

"The pandemic spurred airlines to rethink their operational standards to make the business more customer centric." Strong said currently customers are prepared to shell out more for air travel than what we have witnessed so far. "Airlines can respond in more creative ways" he says.

Digital Transformation here is a continuous journey and not a destination. Historically, the airline industry has embraced data and made changes accordingly. But to become contemporary and compete more effectively, they need to embrace new concepts, according to Ravi Simhabhatla managing director, industrial and transport, Google Cloud. He cautioned that this doesn't mean the latest shiny database or analytics tool. A veteran CTO of the airline industry Simhambhatla has seen his share of tech solutions come and go. Just like retail and other industries that moved fast to harness the power of data, the airlines data infrastructure has become very siloed. "Every department has their own software system, and they don't speak to each other, which means different teams struggle to share data" He described one approach to solve this problem which is concept of a "data mesh architecture" that allows for ingestion of data from all sources,

connecting the dots across the organization so that the business development and the operations teams can make smarter and quicker decisions.

The Fourth Industrial revolution, Industry 4.0, highlights that as the aviation industry focusses mainly on using digital transformation to drive advanced technologies like Big Data Analytics, IoT and Cloud Computing technologies, in parallel, it should also prepare for Industry 5.0 which would be dedicated to the sustainable solutions, customer experience, which often needs to be considered individually and would be personalized.

Figure 13.0: Journey of transformation

AI and machine learning algorithms revolutionize several aviation operations, from flight planning, scheduling to predictive maintenance and passenger services.

These technologies enable airlines to optimize routes, reduce fuel consumption, and personalize the passenger experience through data-driven insights and automation. This research is directed in a similar effort to provide Operational efficiency and enhance user experiences using Ethical/Explainable AI for the most fundamental use cases on baggage handling, priority check in and digital immigration services.

Cloud computing and IoT platforms with multiple layers of protection of data and passenger confidentiality are already extended to remove vulnerable cyber security threats.

So, from these studies we can clearly conclude that we are in great need of digital technologies to enable smart flying for passengers.

3.2 Operationalization of Theoretical Constructs

Theoretical Constructs**,** an explanatory concept is not itself directly observable but that which can be inferred from measured data. Examples like Intelligence, Motivation and Agreeableness. Since they are not directly measurable, constructs must be inferred from other (more measurable) indicators. They are more abstract since they represent big ideas and concepts. The below example illustrates an example of theoretical constructs like Intelligence that is measurable using various methods like IQ and Language Proficiency.
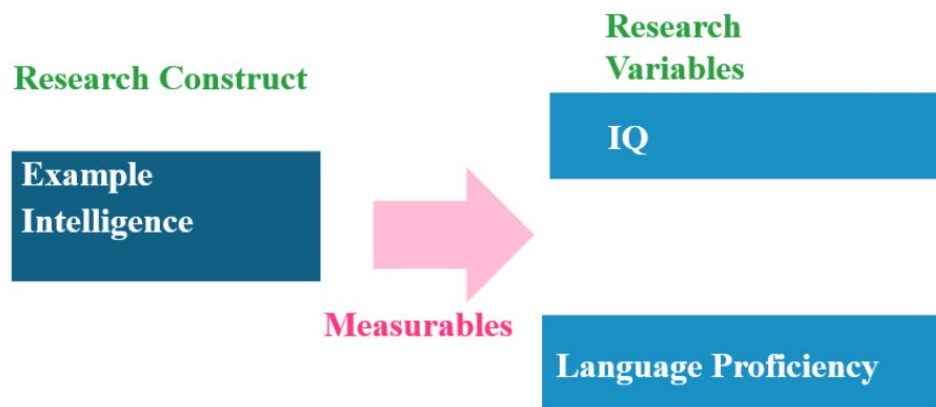
Figure 14.0: Diagram of Research Construct and Variables

Construct	Explanation
Capacity	The affective, cognitive, informational, material, physical and relational resources that can be mobilised by individuals and groups.
Accountability	Normative expectations of actors mobilised by others.
Process Limiting Factors	External factors that challenge a person's capacity to meet accountabilities
Negotiated obligations	A series of agreed tasks established through discussion and consensus

Figure 15.0: Parameters of construct – explanation

The researcher ensures that constructs are very clearly defined and can be operationalized. They are often the focus of qualitative research. Research variables which are instrumental is a phenomenon that is directly measurable and can take on different values or levels eg. Age, height, income, etc. are very specific measures within those concepts and are commonly the focal point within quantitative research. An experimental inquiry has three important types of variables an independent variable, a dependent variable and controlled variables.
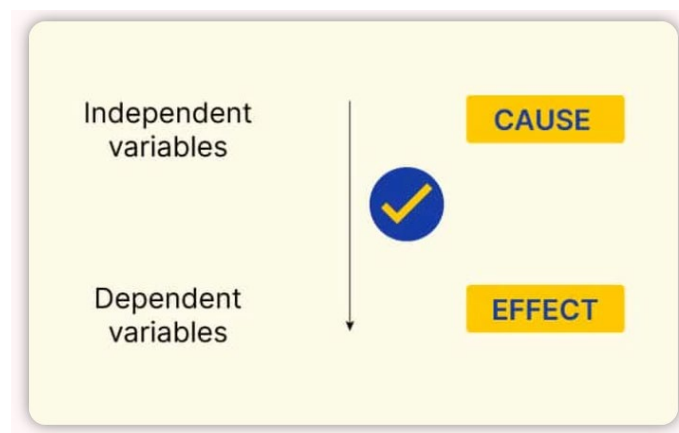
Figure 16.0: Diagram of Research Construct and Variables
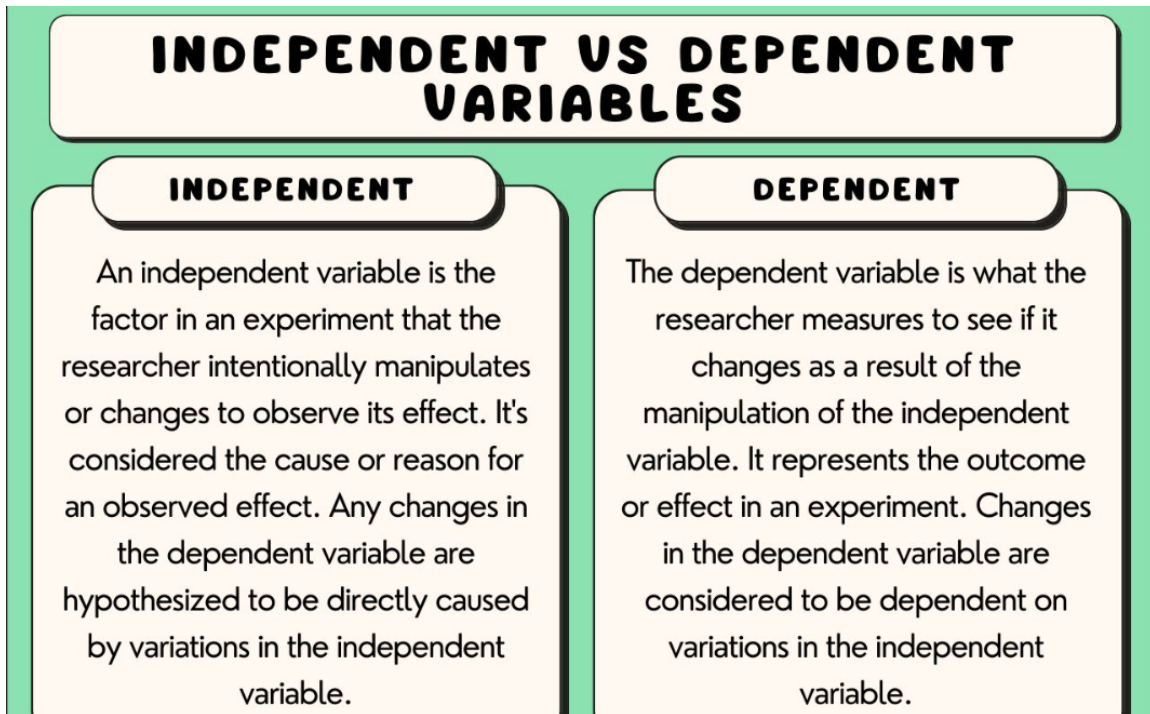
Figure 17.0: Independent vs dependent variables

Any researcher while implementing independent and dependent variables would use the underlying/ ground concept of cause and effect. The researcher probes the respondents in the survey questionnaire about the (independent variables) causes and effects (variables) during their air travel.

Sr. No.	Independent Variables (Causes)	Dependent Variable (Effect)		Demographic data considered
1	Baggages Delay/Baggage Loss	# Anxiety, Lack of information		
2	Sending off aged parents/dependents/ children	# Ambiguity situation, impatience		
3	Flight Delays	# Seeking the regular updates, eagerness to board the flights, # Ambiguity if one can make to connecting flights, # Unknown course of next situations		Age Gender Country/Origin they belonged to
4	Flight Cancellations	# Helplessness, eager to get information		
5	Long waiting Queque	#Impatience, # Chances of missing connecting flights		
6	Immigration Interview process at transits	# State of suppressed mind set, # Fear of rejections or asking for additional documents,		
7	Launguage barriers in immigration interviews	# Stress on individuals, # Fear of rejection,		

Figure 18.0: Independent vs dependent variables

Research is a process of systematic and detailed investigation of facts employing various methods of interpretation, evaluation and analysis to arrive at a conclusion. Researchers, by using the research onion concept develop an appropriate research strategy.

The diagram Fig.19.0 below illustrates the factors that influence the selection of data collection methodologies and analysis procedures.
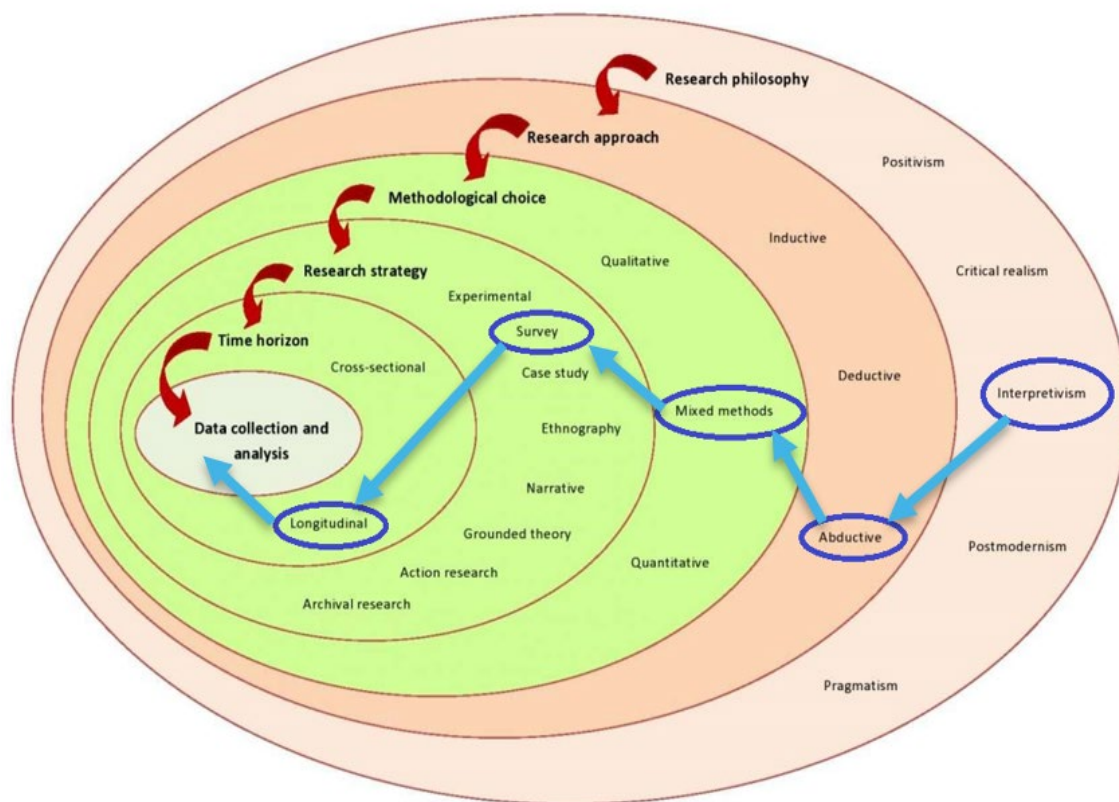

Figure 19.0: Research Onion (Source: Saunders, Lewis and Thornhill, 2019)

The current study is based on the philosophy of interpretivism. It is a philosophical approach that concentrates on the subjective meanings and interpretations that individuals attribute to their experiences and the social world. Interpretivism, also known as

interpretivist, involves researchers to interpret elements of the study, thus interpretivism integrates human interest into a study.

Accordingly, "interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments". Development of interpretivist philosophy is based on the critique of positivism in social sciences. This approach aligns with the topic of the research which assures to consider the user experiences, challenges, pain points, gaps that air travelers often been facing over a period of time.

Interpretivist approach is based on realistic approach of data collection such as interviews and observations. Secondary data research is very popular with interpretivism philosophy. In this type of studies, meanings emerge towards the end of the research process.

The researcher deploys mixed approaches to examine subjective experiences and perspectives, aiming to attain deep understanding of the participants pain points, user who took this survey. The researcher employs the abductive methodology, a highly advantageous way of conducting research, for conducting exploratory studies. In the present study, the researcher employs abductive reasoning to begin the initial assumptions and examination of the empirical facts and then generate probable explanations that closely align with the observed evidence.

The abductive methodology is commonly employed in qualitative research, particularly when phenomena demonstrate intricacy, numerous aspects, and contextual interconnectedness. The researcher is utilizing a flexible and open-minded approach to the investigation, recognizing the inherent unpredictability and ambiguity in the study process. The researcher used mixed methods research is a methodology that combines qualitative and quantitative research approaches at a time.

The mixed technique enables the researcher to enhance the understanding of intricate phenomena, validate the findings, and triangulate the conclusions by leveraging the qualities of both methodologies. Mixed methodology involves the collection and analysis of both qualitative and quantitative data and uses diverse techniques such as interviews, surveys, and document analysis of patents and sustainability reports.

This versatile approach allows the researcher to investigate research inquiries from various perspectives, encompassing both a wide range and thorough understanding of the topic being studied.

The mixed technique is highly advantageous for investigating research problems that possess multiple dimensions, complexities, and facets. The combining of qualitative and quantitative data is performed at several stages of the research process, encompassing data collection, analysis, and interpretation. The researcher deploys quantitative data to measure trends and patterns, but qualitative data offers context, significance, and explanations for the findings.

By employing triangulation, the researcher corroborates and confirms data derived from many methodologies, thus augmenting the credibility and dependability of their results. In the current research, the researcher uses research methodologies such as interviews, surveys, document reviews of patents, and sustainability reports to gather primary data and get profound understanding of diverse occurrences.

Interviews entail face-to-face or online meetings with participants from the relevant industries and regions, enabling the researcher to delve deeply into issues and collect comprehensive qualitative data.

Surveys, however, employ standardized questionnaires to gather quantitative data from a larger sample, allowing researchers to make generalizations about a wider population. In this study, the researcher employs a longitudinal time horizon, which entails a snapshot methodology and the collection of data over a period.

Longitudinal study helps researcher collect data from the same sample of population who are air travelers from their travel that could be in the recent past or current. These

studies help researchers to distinguish between changes that happened in the past and now if user experiences have changed in any way.

If there were any attempt to bring transformation to optimize the efficiencies to Airliners or not.

This time horizon approach is also called as cohort studies where these cohort express the need for the solutions for the repetitive problems like the survey attempts to understand their travel history and challenges associated with it.

3.3 RESEARCH METHODOLOGY

Research Philosophy:

- The study adopts an **interpretivist philosophy**, which focuses on understanding the subjective experiences, perspectives, and meanings attributed by air travelers, staff, and other stakeholders. The goal is to explore individual experiences, pain points, and challenges related to air travel and digital transformation in the aviation sector.

Approach:

- The methodology follows an **abductive approach**, which begins with observations and existing data on air travel experiences, operational inefficiencies, and technological trends. Researcher generates hypotheses and probable explanations based on empirical evidence, which are then refined through further investigation.

Research Design:

- The study uses a **longitudinal time horizon** to collect data over a period, allowing the researcher to analyze changes in user experiences and operational efficiencies over time. This approach helps identify if improvements have been made in response to emerging trends and technological advancements.

Data Collection Methods:

- The methodology incorporates a **mixed-methods approach**, which combines both **qualitative and quantitative data collection** techniques to gain a overview understanding of the research problem:
  - o **Surveys**: Standardized questionnaires collect quantitative data from a large sample of air travelers, covering various demographics, travel frequencies, and personas (e.g., passengers, ground staff, pilots). This helps in generalizing the findings to a broader population.
  - o **Interviews**: Face-to-face or online interviews with industry experts, frequent travelers, and airline staff are conducted to gather in-depth qualitative insights into the challenges faced and potential solutions.
  - o **Document Analysis**: Relevant documents, such as **patents, sustainability reports, and technology transformation studies**, are reviewed to identify existing solutions, innovations, and areas for improvement in the aviation industry.
  - o **Secondary Data Analysis**: Data from sources such as the **Airports Council International (ACI) World Airport Traffic Forecasts** and other reports on global air traffic trends are used to support the quantitative findings and provide context.

Data Analysis:
- The analysis involves **triangulation**, where data from different sources (surveys, interviews, documents) are compared and combined to enhance the reliability of the findings.
- **Quantitative data** is analyzed to determine trends and patterns in passenger experiences and operational issues, while **qualitative data** provides context, explanations, and significance behind the numbers.
- The **mixed-methods approach** allows for the validation of findings through the convergence of quantitative trends and qualitative insights.

Sampling:

- The study uses **purposeful sampling** to select participants who have relevant experiences in air travel, including frequent travelers, aviation staff, and industry experts. The sample covers various **demographics, regions, and age groups** to ensure diverse perspectives.

Research Questions:
- The research aims to address questions related to:
  - How digital solutions can improve operational efficiencies and passenger experiences in the aviation industry.
  - The challenges in existing air travel processes (e.g., baggage handling, immigration, flight delays).
  - The potential impact of integrating technologies like **AI, IoT, Blockchain, and Explainable AI (XAI)** in addressing these challenges.

3.4 Research Purpose and Questions

The research study aims to analyze the as on today status in Airline Industry and anticipation of Air travelers of all age groups, different regions of world, various personas of this industry right from passengers, pilots/first officers, ground staff and crew and air hostess , their experiences and challenges gives an insight that they is a strong need for this digital transformation.

This research purpose is to strongly address these gaps together on a common platform using XAI and further develop that for more use cases in future, may be regarding the entertainment info to passengers like their favorite movie options on their flights. These details are not still available for on boarded passengers.

The following research questions were designed to thoroughly investigate the existing gaps in the airline operations and efficiency and pain points of all air travelers from both local and global travelers.

Research Question 1: How would you rate a real time tracking experience of your valuable baggage and pets from conveyor belts and cargo planes on your smart phones/devices?

Research Question 2: Do you think digital solutions like Artificial Intelligence can be used to make air travel easier, quicker and give better user experience while also securing your travel data?

3.5 Research Design

Research design refers to the overall approach and structure of a research study (W.Paul Vogt, Gardner and Haeffele, 2012). It provides a detailed outline of the planned research and can be categorized as quantitative, qualitative or a combination of both.

Purpose of a research design is to provide a rationale for the study, define the problem statement and determine the methods and techniques to be used. It helps researchers make decisions about data sources, data collection methods, and data analysis techniques.

There are 5 types of research design like exploratory, descriptive or conclusive, experimental, correlational, and diagnostic. Researcher opts for conclusive research design for the below stated reasons.

Conclusive research design is used to determine an outcome which are practically useful in reaching conclusions or for decision-making. Research objectives and data requirements must be clearly defined in this type of study.

Outcome of conclusive studies in general have specific uses. Conclusive research design determines a path to verify and quantify outcome of exploratory studies.

Conclusive research design uses the application of quantitative methods of data collection and data analysis.

Conclusive studies inclines to be deductive originally and research objectives in these types of studies are achieved via hypothesis testing. Noteworthy is that "conclusive research is more likely to use statistical tests, advanced analytical techniques and larger sample sizes compared with exploratory studies. Conclusive research is more likely to use quantitative compared to qualitative techniques.

Conclusive research aids to provide a reliable overview of the population through the application of validated research instruments.

The interpretivist research philosophy focuses on the subjective understanding and interpretation of social phenomena, prioritizing the exploration of meanings, opinions, and perspectives held by individuals. Interpretivism proposes that the construction and shaping of reality are contingent upon human experiences and interactions (Ryan, 2018). This statement asserts that knowledge is contingent upon the surrounding conditions and influenced by society.

As a result, researchers must engage with individuals in their genuine settings to gain insight into their own experiences.

Interpretivist scholars utilize qualitative research methods, such as interviews, observations, and participant interactions, to reveal other perspectives.

In the current study, the researcher focuses to get below questions answered to provide the right solution.

- ✓ Actions, thoughts, behavior
- ✓ Challenges, difficulties, hardships, dilemmas
- ✓ Strategies, coping mechanisms, approaches, methods

Ideally interpretivism provides justice in aligning the researcher's motive by giving insight on specific, unique, and deviant-focused areas of interest in this kind of approach.

Major lowlights with interpretivism is subjective nature of this approach and the great room for researcher's prejudice .

Base line data produced from interpretivist studies should not be hypothesized as data is severely impacted by personal insights. Hence reliability and depiction of data is undermined to a certain extent.

Additionally, thanks to adoption of interpretivism, qualitative research domains such as cross-cultural differences in organizations, ethical issues, leadership and analysis of factors impacting leadership etc. are studied in a deeper level. Primary data generated via Interpretivism studies might be associated with a high level of validity because data in such studies tends to be trustworthy and honest.

The researcher aims to collect authentic data coming from direct sources. The survey aims at asking participants deep and specific questions about their experiences in certain well-defined instances. This would inspire highly self-validated responses.

Higher the amount of data from survey participants, nearer is the researcher to providing the right solutions. The abductive approach in research uses a form of logical reasoning to generate probable explanations or hypotheses to justify observable phenomena.

Abductive reasoning, as opposed to deductive and inductive reasoning, relies on formulating competent speculations or creative leaps to suggest the most likely explanation for a set of data (Paul, 1993).

The abductive approach is useful in research when current theories or models are inadequate for explaining observable facts or when examining novel or complex phenomena.

The abductive approach enables researchers to enhance comprehension and contribute to the accumulation of knowledge in their respective fields by generating speculation grounded in what is known today and further refining it through additional examination.

The researcher uses the abductive method as the favorable approach for this study from air travelers. They reason out for each of the question to get first hand experience information and probe for the details.

In a sense, making their responses more appropriate and relevant experienced by them alone, not routing to some experiences heard or witnessed.

Abductive reasoning, also referred to as abductive approach is set to address weaknesses associated with deductive and inductive approaches. Specifically, deductive reasoning is criticized for the lack of clarity in terms of how to select theory to be tested via formulating hypotheses. Inductive reasoning, on other hand, criticized because "no amount of empirical data will necessarily enable theory-building".

Abductive reasoning, as a third alternative, overcomes these weaknesses via adopting a pragmatist perspective.
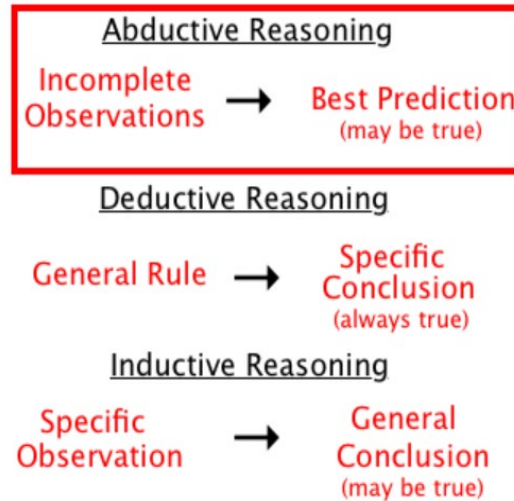
Figure 20: Research Onion (Source: Saunders, Lewis and Thornhill, 2019)

Mixed methodology research combines qualitative and quantitative research methodologies in a single study to gain a thorough grasp of intricate phenomena. Mixed methodology enables researchers to integrate the advantages of both methodologies, leading to triangulation of findings, validation of results, and enhanced understanding of study topics.

This methodology often entails the gathering and examination of both qualitative and quantitative data using techniques such as interviews, surveys, observations, and statistical analysis (Mackey and Bryfonski, 2018).

The application of mixed methodology is especially advantageous in tackling complex research inquiries, examining several viewpoints, and producing strong and sophisticated outcomes.

It provides researchers with the ability to personalize their research design to suit the unique requirements of their study, resulting in more comprehensive insights that enhance comprehension of the research subject.

The research methodology adopted is a multifaceted technique that integrates surveys, face-to-face interviews, and document analyses to thoroughly examine sustainable

practices in the aviation industry. Surveys provide a comprehensive viewpoint, enabling the gathering of quantifiable data on extensive sustainable efforts and perceptions among various stakeholders.

Direct interviews provide a comprehensive examination, enabling an in-depth awareness of the objectives, problems, and innovative approaches implemented by airliner companies in their digitization efforts. Furthermore, examining papers such as patents and technology transformation reports offers significant perspectives on concrete measures implemented by organizations, revealing their dedication, accomplishments, and future goals in the field of digitization.

The research strategy aims to unearth comprehensive viewpoints and valuable insights on innovative practices using AI within air travel operations by combining findings from many sources through triangulation.

The term "longitudinal time horizon" in research refers to a study design that involves collecting data over a period, creating a time dependent from few years in the past, current and future perspective of a particular event or situation.

Longitudinal research differs from cross sectional studies in that it collects data from a same group of participants or subjects at a long point in time.

This methodology enables researchers to evaluate the frequency of a condition, behavior, or attribute, as well as investigate connections or disparities across various groups within the population.

This approach helps researcher to understand the core challenges, if any improved steps were implemented or the same problem continues from past to present and to future.

This approach aims at the need for evolution of the solution or look for evidence in that direction. In the past 2019, few case studies were done regarding the baggage tracking using RFID but researcher could not take it forward to implementation as IOT had still not evolved.

Nothing much moved from there, survey outputs in this approach would expose such events where researcher is compelled to connect on the previous study if any.

This helps researcher to continue and deepen the solution to cater to the same problem that persists.

The current research design is an exploratory study that adopts an interpretivist philosophy. It employs an abductive approach and applies a mixed methodology that combines qualitative and quantitative methods. The research involves conducting surveys and direct interviews with air travelers and the airliners' operations teams.

Also, the researcher is reviewing documents such as patents and digital transformation reports from aviation companies to get an in-depth idea of the research problem and status. The study is conducted within a longitudinal time horizon.

3.6 Population and Sample and Participant Selection

In the context of research, the term "population" denotes the complete set of individuals, cases, or items that exhibit the specific qualities of interest and constitute the main focus of the study. The population refers to the broader group of people from which a sample is selected, and the research findings are intended to be applied to this entire group (Majid, 2018). The population can fluctuate based on the specific study topic and aims. Precisely defining the population is crucial to guaranteeing the validity and trustworthiness of the research results, as it establishes the extent and relevance of the study.

A sample is a smaller, carefully chosen group from a larger population that is investigated to provide insights and draw conclusions about the entire population. The selection is made to be a fair representation of the entire population, enabling researchers to draw reliable conclusions about the general population based on the sample's findings.

The choice of sampling procedures is dependent upon the research design and aims, with the ultimate goal of achieving a sample that faithfully represents the characteristics of the general population.

For instance, in the present aviation industry study, the researcher carefully selected a sample of individuals, irrespective of age, from different demographic and geographic areas to ensure inclusivity and accuracy in representation.

The present research population and sample were identified and selected from the following categories.

- **Domestic and International Travelers**
  - o **Personas like Passengers, Airport Ground Staff, Crew/Air hostess, First Officers/Pilots/ Immigration officers**
- **Purpose of their travel**
  - o **Age groups they belonged to like Gen Z, Gen X, Millennials, Boomers, Silent generations.**
- **If they travelled Solo or in groups with friends, colleagues, family**
  - o **Countries they belong to understand if technologically advanced and advancing countries had similar challenges or less challenges.**

Participant Selection

The process of selecting participants in research is a crucial element of research design that has a direct influence on the accuracy and consistency of research results. Participant selection in a research project entails the systematic identification and recruitment of individuals, groups, or instances that meet certain criteria as defined by the study objectives. Participant selection is influenced by various elements, such as the study topic, aims, 200 demographic characteristics, sampling method, and ethical considerations (Merriam and Tisdell, 2016).

Participant selection for the current study was conducted meticulously, taking into account the travel and airline related industries, as well as different demographics, with a primary focus on global challenges.

The direct interviews were conducted with experts from the Airport Authorities, frequent global travelers and related industries. The survey was open to the global population, all

age groups, all personas to share their travel experiences and challenges transparently over a period of time.

3.7 Instrumentation and Data Collection Procedures

Instrumentation in research encompasses the array of equipment and methodologies employed to gather data and quantify variables within a study.

It involves the creation, advancement, and verification of instruments or measurement tools that are employed to collect pertinent information related to the study issue or objectives. Instrumentation is essential in research as it enables the systematic collection and measurement of data, which in turn facilitates the production of reliable and credible research conclusions.

Efficient instrumentation guarantees that researchers may precisely evaluate variables, experiment with hypotheses, and make significant contributions to the progress of understanding in their respective discipline.

The present study employs tools like direct interview methods, surveys, and document evaluations, such as patents and publications reports, to examine existing technologies and pertinent gaps.

3.7.1 Data Collection Procedures

The researcher identified the research gaps by conducting a literature review. Google Scholar, WIPO Patent scope website, the websites of the top Airlines and local airlines companies, google cloud, and the ResearchGate, ChatGPT were consulted as reliable data sources.

Google Forms have been used to develop the survey questionnaire, and direct interviews were conducted via WebEx, MS Teams, and Zoom meetings in addition to in-person interviews. The survey questions covered a wide range of issues, including the pain points and challenges one faces as a passenger.

All age groups and demographics across the globe spanning from Peru in South America to Auckland, New Zealand were asked for their opinions regarding the adaptation of a robust Digital Services implementation.

Thoroughly formulating questions guarantees their clarity, pertinence, and congruence with research goals; this empowers the researcher to identify significant data that effectively tackles critical research questions.

The implementation of Google Forms to generate a survey consisting of 17 meticulously designed questions to collect data relevant to research concerns signifies an organized and effective methodology.

The researcher derives advantages from deploying Google Forms, including its intuitive interface, adaptable query formats, and streamlined data collection functionalities.

The 17 questions chosen to indicate an extensive examination of multiple aspects pertaining to areas where Airliners can enhance the user experience of air travelers and add value in improving their operational efficiency.

These questions encompass viewpoints from a wide range of stakeholders, including expert individuals employed in Airline Industries, Airport Authorities, Staff, Immigration Officers, global trotters, Airhostess, Pilots, etc.

In addition, Google Forms provides various functionalities to streamline the process of survey response collection and dissemination, including email distribution, and social media sharing. Furthermore, the platform offers analysis functionalities and real time data visualization tools, which empower researchers to effortlessly trace data trends, monitor response rates, and generate reports.

In short, the application of Google Forms to generate and distribute an extensive survey concerning existing gaps in the airlines industry exemplifies a systematic and technology-oriented methodology for gathering data.

Through taking advantage of the platform's functionalities and active engagement with an international and domestic audience comprising industry experts and stakeholders, the researcher was able to amass substantial, varied, and practical insights that substantially propel the progression of understanding in the domain of sustainable industry practices.

In this data collection procedure, the researcher used data as well as methodological triangulation. Triangulation, as employed in research studies, encompasses making use of diverse data sources, methodologies, or viewpoints to substantiate conclusions, strengthen the reliability of research findings, and furnish a more all-encompassing comprehension of the phenomenon subject of study.

Triangulation in research entails the process of corroborating information derived from various sources or methodologies to bolster the dependability and credibility of the conclusions drawn.

The researchers were able to reduce the limitations and biases associated with single-method or single-source studies by employing triangulation.

Through the systematic examination of information from various perspectives, the researcher was able to authenticate findings, contradictions, and formulate more resilient conclusions. In its entirety, triangulation serves to strengthen the rigorousness and reliability of research findings, thereby augmenting the study's credibility and influence.

3.8 Data Analysis

In the present research, the researcher analyzed data from direct interviews, surveys, patent searches, and trending technology reports from the airlines industry. Firstly, the researcher analyzed the direct interview data. To address the selected research questions, the transcripts were compiled and analyzed.

The interview comprised a total of seven questions, and the responses were analyzed and correlated by query. Qualitative and Quantitative evaluations which is Mixed method research approach were used to address the research questions. Subsequently, the researcher analyzed the patents, which had been categorized by demographics, age groups, countries they belonged from and their travel experiences.

This was intended to determine if any country had already implemented any of the use cases that are highlighted in this survey and if the experiences and challenges were different from country to country.

This facilitated the researcher in determining the common solution to the existing problem areas spearheading the need for digital transformation.

The present analysis was conducted using mixed methods, as this approach gave a complete picture when compared to a stand alone quantitative or qualitative study, as it integrates benefits of both methods.

The researcher can fulfil all the 3 criteria, namely, generalizability, contextualization and credibility using the Mixed Method approach, thus fulfilling the research requirements.

3.9   Research Design Limitations

The present research was aimed at identifying the similarity in the challenges and pain points of air travelers across the globe and assessing the need of digital transformation to improve operational efficiency and enhance the user experience using XAI.

Considering the vast number of individuals who take up travel by air and the hesitance of participants to respond to the survey as well as direct interview requests, was a limitation. Some of the Immigration Bureau officials and pilots refused to respond to the queries, considering the confidentiality agreement with the respective departments with which they were associated.

The limitations of the research are the non-generalizability of the responses to a few of the research questions. Furthermore, considering the large number of request views for the survey as well as the direct interview, the response for direct interviews was 15% and response to survey was 85%. Almost 350 people were approached for their views across various countries and age groups and the survey link was shared as a consolidation on LinkedIn, WhatsApp and direct emails, out of that only 200 responded to the survey. However, considering 200 responses against the targeted 350 participants for the survey helps to mitigate this issue.

3.10 Conclusion

This chapter presents a thorough examination of the research framework, including numerous crucial elements. To begin with, the research problem is clearly defined,

emphasizing the particular concern or knowledge deficit that the research seeks to resolve. Following this, an explanation of the theoretical constructs that underlay the research is provided, detailing the conceptual frameworks that guide the methodology and data analysis used in the study.

The research clearly defines its purpose, providing a clarification of the broader objectives and aims that direct the study. Additionally, the chapter provides a comprehensive analysis of the complexities inherent in the research design, divulging the methodological framework employed and specifying the methods, procedures, and techniques that were deemed suitable for the study. Furthermore, comprehensive information is provided concerning the population being investigated.

The criteria used to select the sample and participants are clearly and comprehensively defined, providing insight into the factors and reasoning that inform the selection procedure. Additionally, the instruments that were employed to collect the data are detailed, delivering valuable perspectives on the measures, tools, or instruments deployed to acquire the pertinent information. The section provides a detailed explanation of the mode of data analysis, detailing the methods and processes employed to efficiently analyze and comprehend the gathered data. Finally, the research's limitations are explicitly acknowledged, considering the difficulties and restrictions that were intrinsic to the study's planning, implementation, and analysis.

CHAPTER IV:

RESULTS

4.1 Research Question: General Question 1

Survey questionnaire started with few demographic questions to capture data regarding participant age to understand if the younger generation like Gen Z, Millennials, Gen X, as well as the Boomers and Silent Generation had the same need of Digital Solutions during their air travel or if any of the categories showed any resistance towards digital evolution or faced any challenges to adapt to these changes. We observe that out of the 204 participants, most (70.3%) belonged to the 35–54 year age group, also categorized as Gen Xers. Gen Xers is also called as technologically adept, grew up during the transition of analog to digital technology witnessing the birth of cell phones and the internet.

Baby boomers contributed to 13.9% of the total participant population. These are early adapters to technology and are confident in using it. Present study shows that they are eager to learn and experiment.

Millennials who grew up with rapid digital changes and already using AI in daily lives, contributed to 11.4%. This immersion makes them open to integrating new technology.
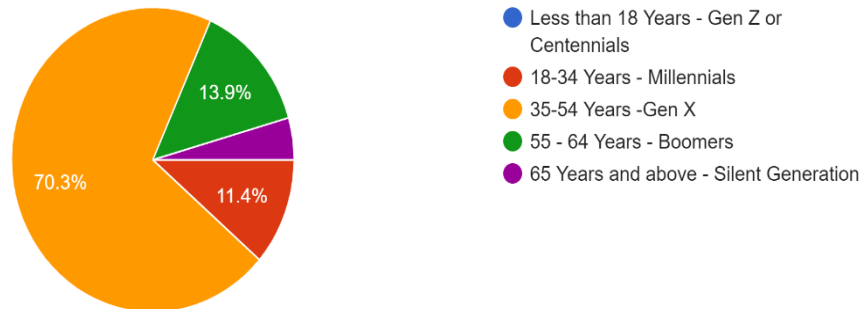
Age
202 responses

- ● Less than 18 Years - Gen Z or Centennials
- ● 18-34 Years - Millennials
- ● 35-54 Years -Gen X
- ● 55 - 64 Years - Boomers
- ● 65 Years and above - Silent Generation

70.3%
13.9%
11.4%

Figure 21: Pie chart of Air travelers categorized with respect to age groups that participated in the survey

Almost 4.4 % participation came from the Silent generation that considers digital services as a luxury and consider technology as a marvel. Thus, this survey has covered a broad and inclusive age-range of participants.

4.2 Research Question: General Question 2

Second generic question was designed to understand if the survey avoided gender bias in any form, and to know if the opinions coming from the male and the female populations were accurately captured along with their individual travel experiences. 68.8% of population were males and 31.3% were females. User experiences from these groups are very critical to know the past challenges that they have experienced are different pertaining to their scenarios they faced. Digital revolution, Innovation and transformation can only be a success if both men and women (diverse group) are part of developing it. We need participation of both women and men to create a technological base to avoid the risk of backlashing gender quality. The inputs from this survey thus address this most fundamental aspect of avoiding gender bias in the responses.
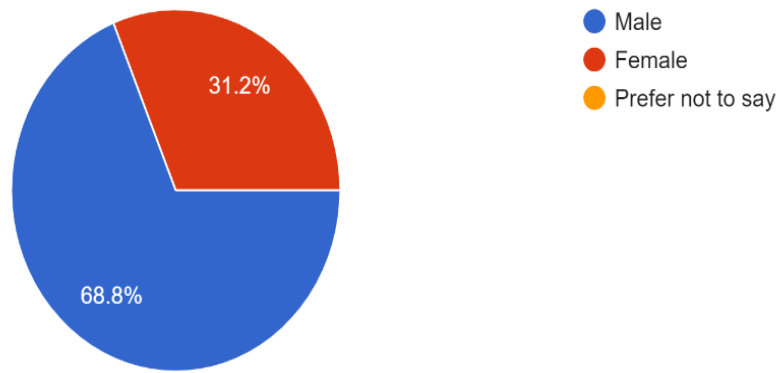
50

Gender

202 responses

● Male
● Female
● Prefer not to say

31.2%

68.8%

Figure 22: Pie chart of gender details of air travelers who participated in the survey

4.3 Research Question: General Question 3

Third generic question was to capture the regions/countries/ cities the participants belonged to. Out of 204 responses, the data shows they belonged to developing countries as mentioned in the table no. 2. 146 people (71.6%) participated when reach to most of them were either working in multinational companies, access to travel, exposed to frequent air travel challenges. Rest 28.4 % almost 58 of the crowd participated are from most technologically developed countries like USA, UK, Europe and Pacific countries. Countries like Australia, New Zealand which are pacific countries encompassing from highly developed cities like Melbourne and Sydney included are combined as Rest of Asia and Pacific for the ease of categorization.

Asian countries apart from India were also significantly covered for diversified inputs. Those countries are listed below like South Korea, Thailand, Singapore, UAE and South Africa encompassing major business hubs like Dubai, Riyad, Singapore with 18 as participation number.

14 people from Europe covering major business and economic hubs like Germany, France, Switzerland, Belgium and holiday destinations like Spain.

14 more from world's most developed countries like USA encompassing cities like Seattle, San Diego, etc. as captured in the table. Participants from UK, London having major transits too are covered. Canada is included too.

China could not participate due to the survey ban in the country. This justifies the voices of the personas, or the participants shares a global and a common challenge in the air travel sector towards need of digital transformation to enhance their user experiences and need of operational efficiency.

Referring to section 3.1, research study shared Top 20 markets/countries by total passenger traffic forecast for 2042, 2052 are mostly covered in this survey. These top 20 countries open the need for addressing the objective of this research.

Percentage distribution of survey participants

Canada 2.4%
Europe 6.8%
USA 7.3%
United Kingdom 3.4%
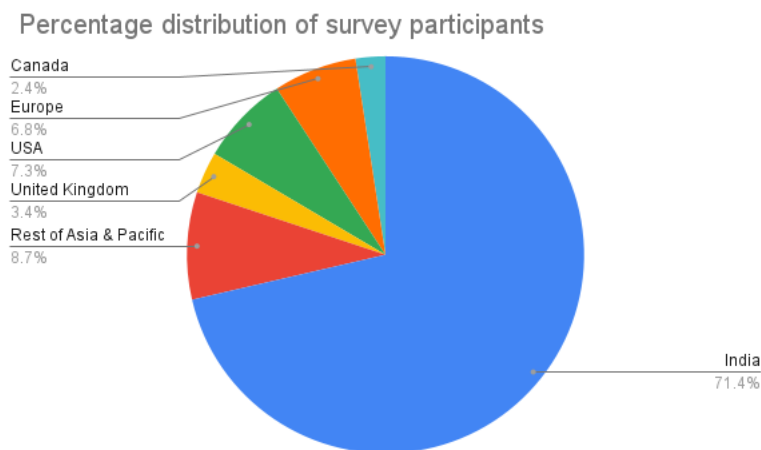Rest of Asia & Pacific 8.7%
India 71.4%

Figure 23: Pie chart of Air travelers from the various Countries participated in survey

Sr. No.	No. of Responses	Developing, Developed	Cities they belonged to

			Countries
1	146	India	Bangalore
			Delhi
			Hyderabad
			Goa
			Pondicherry
			Chennai
			Mumbai
Rest of Asia & Pacific			
2	18	UAE	Dubai, Riyad Saudi Arabia
		Singapore	Singapore City
		Australia	Melbourne, Sydney
		Africa	Nigeria
		New Zealand	Auckland
		South Korea	Aria, Ulsan
		Thailand	Pattaya
Europe			
3	14	Switzerland	Zurich
		Belgium	Antwerp
		France	Nice, Toulouse
		Germany	Bruchsal, Hamburg, Augsburg
		Spain	Madrid
		Sweden	Stockholm
USA			
4	14	Washington	Seattle, Everett
		California	San Diego
		Wisconsin	Milwaukee
		Arizona	Phoenix
		Massachusetts	Boston
		Maryland	Clarksburg MD

United Kingdom			
5	7	England	Leighton buzzard
		England	London
Canada			
6	5	Quebec Province	Montreal
		Ontario	Burlington

Table 2.0: Countries demographics of survey participants.

4.1.2 Research Question one

First question of the survey started with this question to understand the frequency of the participants who traveled within their country. Out of 204 responses, 202 people contributing 99% have responded that have travelled inside their country and rest 1% confirms that they have not travelled inside their country but they have answered that they have traveled outside their countries in the next question. This population is aware of the challenges, gaps they would have faced during their air travels. Survey also considered if they were frequent travelers which covered maximum of 58.4%, few were traveling less frequently which was 28.2% and those who rarely travelled were 12.4% .

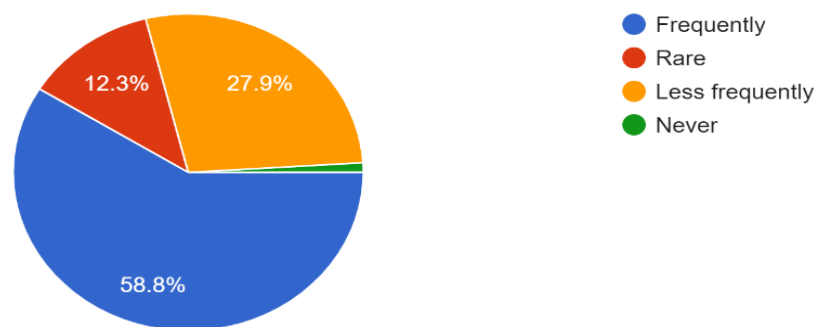1. How frequently you travel inside your country?
204 responses

Figure 24 : Pie chart of Air travelers those travelled frequently inside country

4.1.3 Research Question two

Second question considered if the same population also travelled outside their respective countries and allowed them to experience different scenarios in terms of baggage tracking, immigration services, priority check in and need of operational efficiency.

Survey also considered the frequency of their travel to know if the participants had enough understanding on the related questions in the survey. Below distribution shows that maximum percentage of 48.5% travelled once in a year, next highest is 24.3% who travelled more than 2 times in a year which may not be exactly in 6 months but in different time frames of the year, 15.3% travelled once in 6 months and 11.9% shared they never travelled outside their country. However, they voted for travelling inside their country referred above.

2. How frequently you travel outside your country?
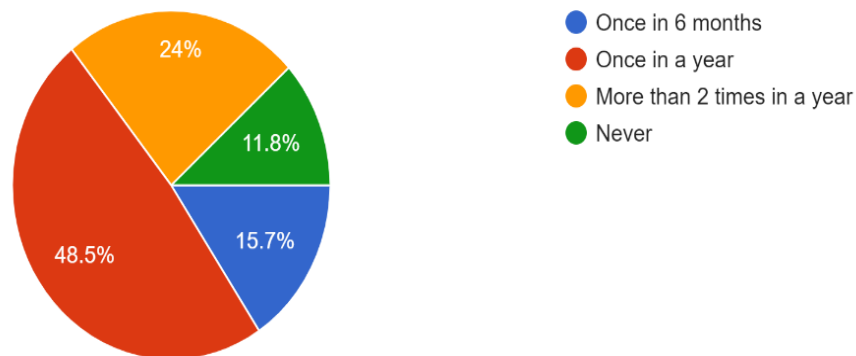204 responses

Figure 25: Pie chart of Air travelers those travelled frequently outside the country
This provides us good insight on the participants requirements and their experiences.

4.1.4 Research Question three

This question to identify each of the participants under this categorization of personas was intended to get deeper understanding of participants representing their views on the same scenarios as a passenger, crew/ air hostess/steward , first officer/pilot, airport ground staff and as immigration officer. 97% were passengers and 2.5% were pilots/first officer who also provided in person interviews, 2 % from ground staff, 1% crew/air hostess/steward from different airlines representing India, USA, Europe, 0.5% immigration office.

This way survey is able to provide us complete 360 degree feedback or inputs from air travel. This question covered all the personas related to this research.

3. You are participating this survey representing one or more of these personas
204 responses

Passenger	198 (97.1%)
Crew/ Air Hostess/ Steward	2 (1%)
Pilot/First Officer	5 (2.5%)
Airport Ground Staff	4 (2%)
Immigration Office	1 (0.5%)
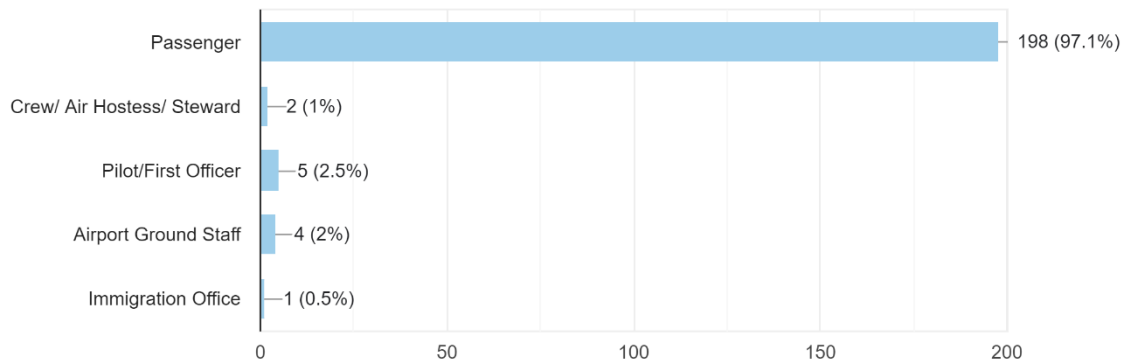
Figure 26: Chart of survey participants who represented various personas

4.1.5 Research Question four

Survey also captured the objective or the purpose of the travel of these participants, both international and domestic travel. Ideally below distribution provided higher percentage of 51 % travel reason as work related which is highly critical for both individuals and organizations. 31.4% travelled on leisure and 16.2% to visit their family and friends. 1.4% travelled to study.

4. What is the purpose of your international/domestic travel?
204 responses
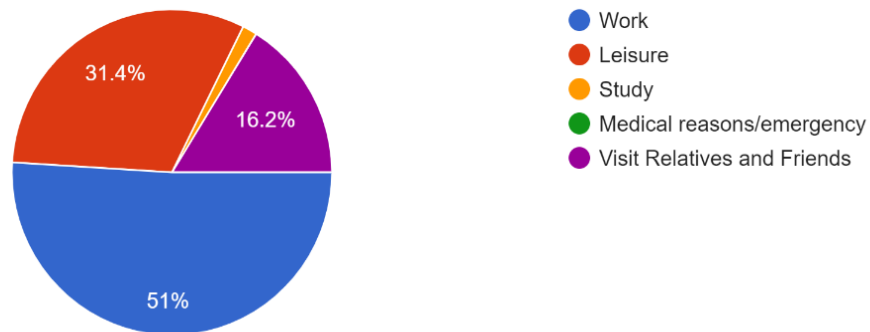
Figure 27: Pie chart of survey participants who travelled for various purposes

4.1.6 Research Question five

Following question was to understand how many of the participants often travelled as solo, with family/friends or with colleagues. Maximum percentage 0f 46.6% travelled with family/friends, 43.1% as solo traveler, rest 10.3% with colleagues.

This statistical data was collected to understand the comfort level of participants travelling in groups with known people, their voices, opinions, etc. are compared with those who travelled solo and with groups who have formal relationship like colleagues.

5.Do you travel solo or with family/friends/colleagues?
204 responses

Figure 28: Pie chart of survey participants travelled solo/family/colleagues

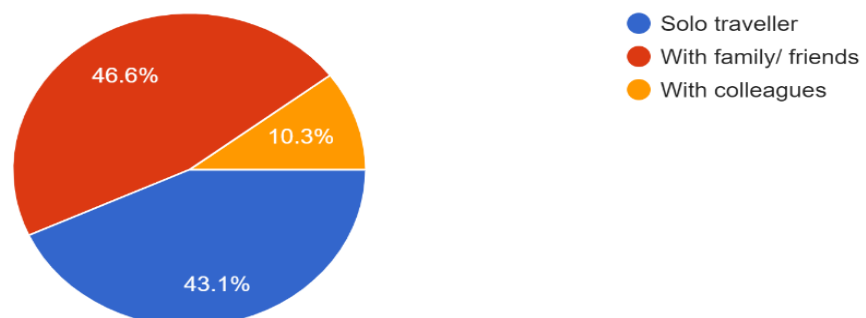**4.1.7 Research Question Six**

Were there any instances that your flights were delayed or missed your connecting flights and faced ambiguity/lack of information regarding your baggage? If yes, please share your experiences in few words.

Based on the responses, many passengers reported instances of delayed flights, missed connections, and a lack of information regarding their baggage. Common experiences included:

1. **Missed Connections Due to Delays**: Passengers frequently mentioned missing their connecting flights because of delays in the first leg of their journey. These delays were often caused by rough weather, technical issues, or airline-specific problems, leaving passengers stranded and uncertain about the next steps.

2. **Ambiguity Around Baggage Status**: Many travelers expressed frustration with the lack of real-time updates on the status of their checked baggage, particularly during transit. In some cases, passengers waited days or even weeks to receive their luggage, with little to no communication from the airline.

3. **Poor Communication from Airlines**: Several respondents highlighted that airlines did not provide adequate information about the reasons for delays, new flight schedules, or baggage whereabouts. These left passengers feeling "lost" and helpless in unfamiliar airports, especially when trying to navigate international connections.

4. **Inconsistent Airline Support**: Experiences varied widely regarding airline assistance during delays or missed connections. While some passengers received prompt support, others described chaotic situations where airline staff struggled to provide clarity or solutions.

5. **Stress and Inconvenience**: Many passengers recounted stressful experiences due to delayed flights and baggage issues, with some even having to buy new clothes or essentials because their luggage was not delivered on time.

Researchers consolidated the feedback with 99 of the respondents who answered as No, not yet and rest 105 of the respondents shared their deep experiences that left them traumatized in their own individual words in few cases, impacting their normal lives in few other cases.

These are the various use cases this research focuses to address to eliminate major communication gaps through connected data and providing real time information which will prepare the passengers well in advance even if they need to face operational challenges.

While operational data coming in advance helps airlines too be proactive and efficient.

4.1.8 Research Question Seven

Now the focused questions started with asking participants to rate a real time tracking experience of their baggage/pets on their smart devices. Results below convey that out of 204 responses, 200 of the participants voted positive for a real time tracking of their luggage and pets from conveyor belt accessible on their smart phones or smart devices.

This also conveys that there was no such feature/facility available as now from all the countries they have participated and voiced out for the need of digital services/transformation now.

With more and more air travelers want to connect and have robust end to end experience, airlines industry calls for such digital revolution.

7.How would you rate a real time tracking experience of your valuable baggage and pets from conveyor belts and cargo planes on your smart phones/devices?

204 responses
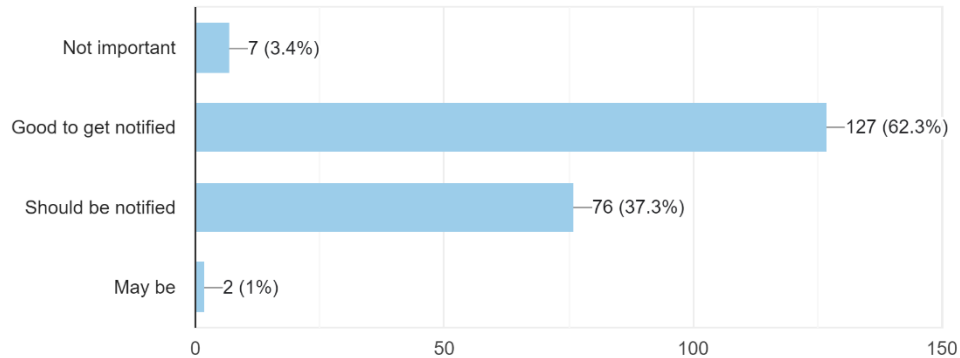
Figure 29: Chart on survey participants responses on real time tracking experience

Survey asked participants if they would feel good if they were notified, should be notified, not important and may be to be notified. 62.3% opted that it would be good to get notified,

37.3% felt that the real tracking of their belongings should be notified, highlighted the want of this digital update. 3.4 % of the crowd shared that it's not important for them and 2% opted for may be.

4.1.9 Research Question Eight

Following question was on the tracking their family members and friends basically their dependents. Researchers want to understand participants preferences.

This research captured that 86.8% of them voted Yes and only 13.2% voted No.

Majority of the participants identify this update would ease out lots of ambiguity when they bid off their aged parents, teenage kids, spouses, family and friends on long journey, first time travel, new destination, etc.

Sometimes peers travelling first time may also find this option helpful from the responses here. Peers travelling first time may also find this option helpful from the responses here.

8. I prefer airliners to provide flight status to my family/friends (dependents) who would want to be notified and vice versa?
204 responses
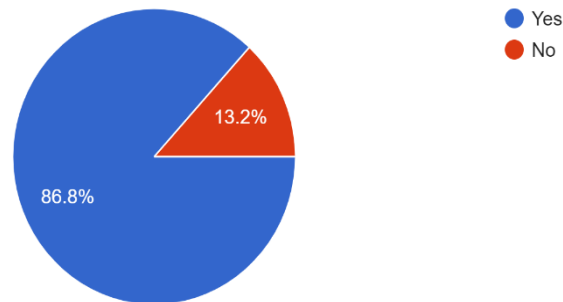
Figure 30: Pie chart on survey participants responses on flight status notification

4.1.10 Research Question Nine

This part of the questionnaire is now more focused on the priority check in especially for aged parents /senior citizens and children who often travel on their own due to circumstances that demand to do so.

Below responses signifies the importance of information as critical and how much the participants needed it for themselves, for their parents, for their children or all of the options. One more option not preferring this option was also provided by the researcher to understand what participants had to say.

Statistical data revealed that maximum participants 45.6% responded for all of the options which included that as individual he/she needed it for himself/herself, in addition to his/her parents and children. 16.2% needed the priority check in only for themselves, 34.8% opted for their aged parents, 14.2% thought its much needed for their children. While less of 9.8% felt that they don't prefer this option.

9.To avoid the above mentioned situations, I would prefer priority check in for me or my aged parents and children based on transit flights and connectivity?

204 responses
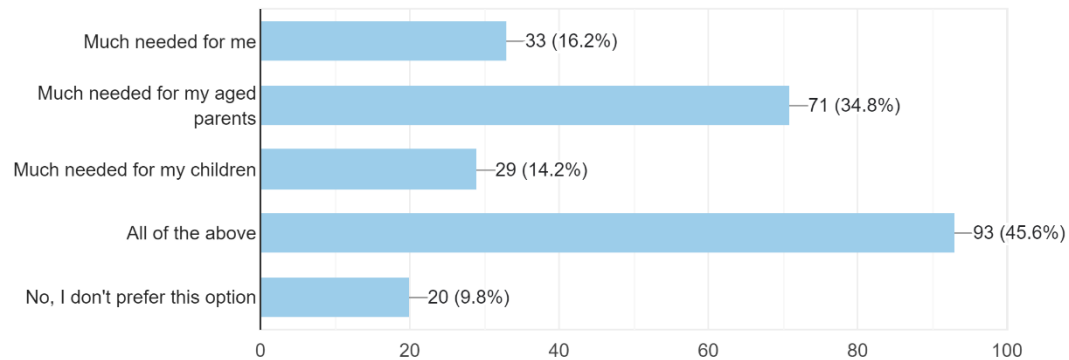
Figure 31: Chart on survey participants responses on real time tracking experience

4.1.11 Research Question Ten

10. For all of us, international travel needs lots of preparation and passing through Immigration system to a new country can be stressful after long flight? What were your challenging experience?

Please highlight if there were any issues you faced during the process?

Based on the responses, several challenging experiences during international travel were frequently mentioned:

1. **Long Immigration Queues**: Many travelers reported having to wait in long immigration lines, which was particularly difficult after a long flight. The lengthy waiting times were cited as a significant inconvenience, especially for elderly passengers, families with young children, and those with connecting flights.

2. **Stress and Anxiety**: Travelers experienced stress, especially when flying to countries with stringent immigration procedures (e.g., the U.S. or Europe). The ambiguity surrounding required documents, visa processes, and scrutiny from immigration officers contributed to feelings of anxiety and panic for some passengers.

3. **<u>Language Barriers</u>**: Communication difficulties arose in some countries where immigration officers or airport staff were not fluent in English. This made it challenging for travelers to understand instructions, ask for help, or clarify doubts.

4. **<u>Lack of Information and Guidance</u>**: Several respondents highlighted a lack of clear information or guidance at airports. This was especially problematic for first-time travelers, those unfamiliar with the immigration process, or passengers arriving at large and busy airports with complex layouts.

5. **<u>Inconsistent Processes Across Countries:</u>** Different immigration rules, processes, and document requirements across countries were frustrating for passengers. The lack of uniformity made it difficult to prepare adequately for immigration checks and caused confusion about what to expect.

6. **<u>Self-Service and Digitalization Issues:</u>** While some airports had digital self-check-in and e-gates, travelers still faced challenges with self-service procedures, especially if the systems were not user-friendly or malfunctioned.

7. **<u>Emotional and Physical Fatigue:</u>** The combination of jet lag, long flights, and the physical strain of standing in queues made immigration a stressful and exhausting experience for many travelers.

8. **<u>Time Constraints and Missed Connections:</u>** Some passengers mentioned that immigration delays directly led to missed connecting flights or caused panic as they had limited time to make their next connection.

These challenges underline the need for improvements in immigration processes, such as increased staffing, better information dissemination, digital transformation, and more consistent global standards.
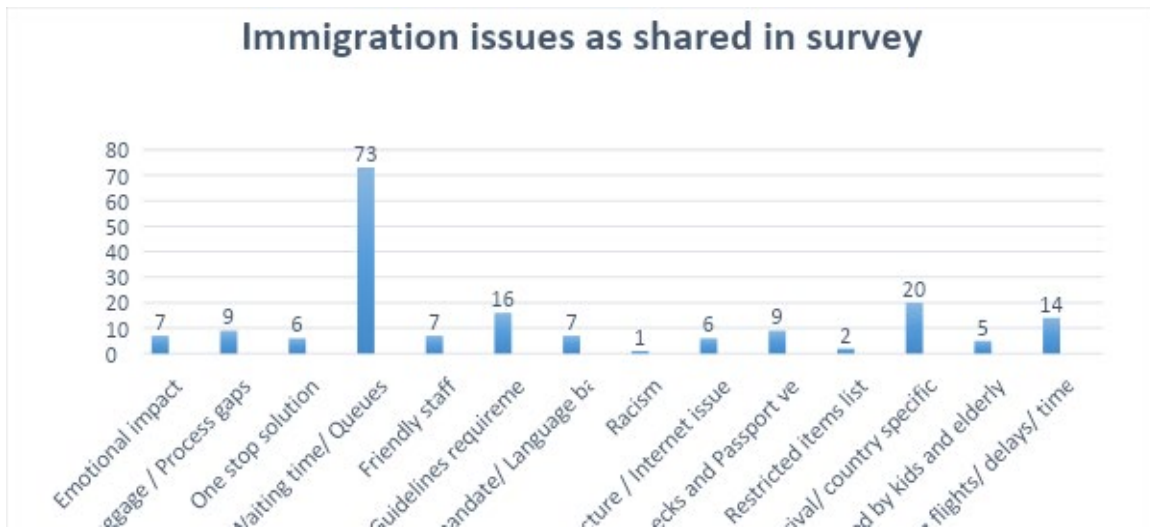
Figure 32: Responses from survey participants expressing their pain points on immigration

All the responses received from respondents are formulated in a table under boarder categories as shown here.

This helps us to focus on the research solutions and address the most impacted areas. Most of the problem areas, pain points shared are common across the regions and seeking for one platform solution enabling a smart and efficient use cases researcher is aiming to address through this Smart Flying using XAI.

4.1.12 Research Question Eleven

This question was framed to basically to understand if there any participants faced stress/ambiguity regarding the international travel and their preparedness. If they were worried about the outcomes.61.8% of them have voted as No and 27.5% as Yes and rest 10.8% voted as Maybe. Researcher to further probe more questions as what participants wanted to convey.

64

11.As an international traveler, have you faced ambiguity or stress regarding immigration interviews and outcome of the process for you or your family?
204 responses
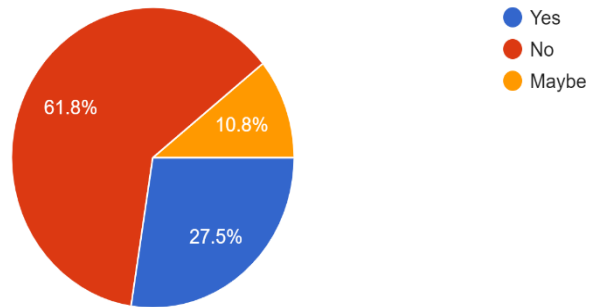
Figure 33: Pie chart representing the percentage distribution on respondents facing stress due to immigration process.

4.1.13 Research Question Twelve

Researcher highlights on most challenging scenarios like often faced challenges. Participants were asked if they found it easy, they were an option to provide a digital questionnaire/checklist in advance as he/she or dependents may not be conversant with latest immigration process of the country that they land in.

Most of the participants 77% answered as Yes, 15.7% as May be and rest 7.3% voted as No. So, evident that enabling this digital information is much needed for the air travelers.

With the participants across the countries, all ages, specific purpose of travel, demonstrate that they prefer this service for a better customer experience and making their air travel at ease.

12. For international travel, I find it easy if I/my dependents receive a digital questionnaire/checklists in advance as I/my dependents may not be conversan...igration process of the country I need to land in.
204 responses
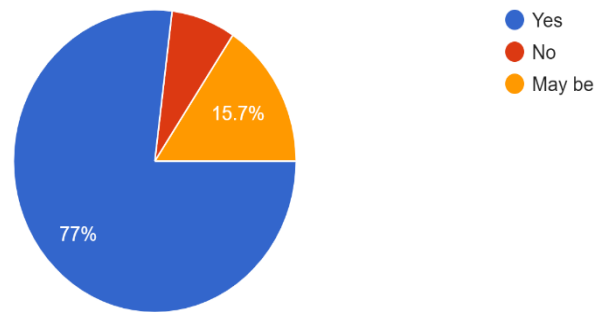
Figure 34: Pie chart representing the percentage distribution on digital services during Immigration.

4.1.14 Research Question Thirteen

Next question focuses on making air travel more global and removing language barriers that all air travelers should have faced at one point of time.

With world of connectivity and ease of globalization, participants with 90.2% prefer to have the digital questionnaire to be introduced as responded in previous question but with language preferences that they can select.

English being the common language may not be most preferred in Non English-speaking countries in Europe, UAE, India, Japan, Africa, etc. Minority of 9.8% only opted as No who may be from English speaking nations like USA, UK, Australia, New Zealand, etc.

13. As many international travelers and Immigrant officers may not be conversant with English, I like to have digital questionnaire/Check lists with the language preferences that helps me to fill in
204 responses
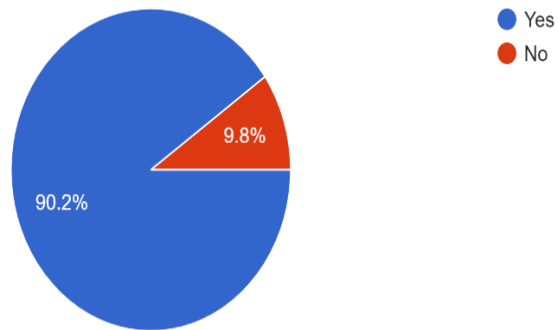
Figure 35: Pie chart representing the percentage language barriers they distribution on faced during immigration process

As a digital enabler, researcher wanted to understand if the participants preferred this feature of tracking their' s or their dependents immigration status online while they are in flight and before reaching their destination. Maximum responses of 91.7% shared as Yes and rest minority of 8.3% as No. Understanding the participants need, there is strong reason to push for this digital update.

4.1.15 Research Question Fourteen

14. I prefer to track the status of my/my dependents immigration status online
204 responses
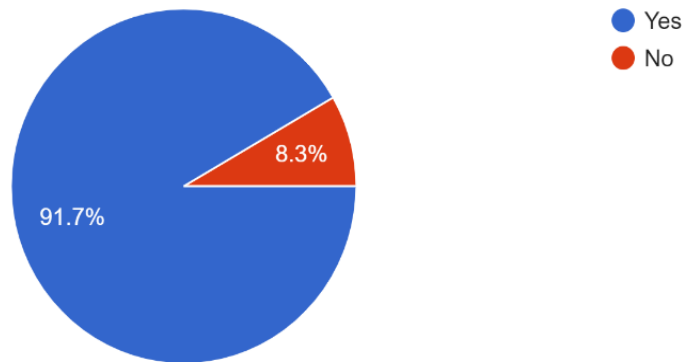
Figure 36: Pie chart representing the percentage online tracking of their immigration status

4.1.16 Research Question Fifteen

Have you faced any other challenges during your or your dependents travel to new or unfamiliar countries?

Please share any 2 pain points that can be helpful to include as an extension of this research

Respondents are candid in sharing their feedback to consider the below points like navigation apps in airports that can guide them to restaurants, choices of food, transit gates, terminal change, etc. Passengers have raised concerns on racial discrimination that they faced during their immigration/ boarding. This is a serious issue that legal authorities of aviation industry should ensure they bring in strict policies and a forum to share such incidents.

Many incidents brought light on Immigration Officers being rude, very strict, unclear and unreasonable interrogation. Few having distress on the outcome or even to attend such interviews. While it's a global and open culture to be promoted by all nations, such incidents will impact the travel industry leaving people with sour experiences.

4.1.17 Research Question Sixteen

Researcher wants to ensure if the objective of the digital offerings made enough impact on their needs by using concept of Artificial Intelligence. Survey aims on the questions related to enhancing passenger experiences and optimizing operational efficiency with quick turn around time, reducing connecting or transit time, reduce queue system at individual Immigration Bureau of the country. Every minute saved is dollar saved in air travel. Passengers need that their travel and personal data are secured and not breached at any point of time. Ethical AI or XAI is the most suitable solution and approach to bind the confidentiality and allow XAI to track the baggage/pets, track individuals/dependents flight status and immigration status. Advantages are extended to few more use cases to enable operations team to be more efficient and perform better. 93.1% voted YES and 6.9% said NO.

16. Do you think digital solutions like Artificial Intelligence can be used to make air travel easier, quicker and give better user experience securing your travel data?
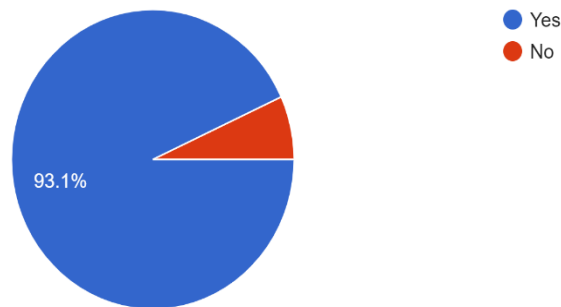204 responses

Figure 37: Pie chart representing the percentage

4.1.18 Research Question Seventeen

This question refers to capture future research opportunities in this domain as their user requirements. Participants have identified the list as follows which can considered as an area of extended research post this study on hand.

If you agree to make Air travel more seamless and effortless, what other benefits you would look for?

Based on the responses provided, the main challenges and problems faced by travelers during international travel can be summarized as detailed below.

The critical challenges faced by international air travelers is the persistent issue of the language barrier. Many respondents of this survey reported encountering difficulties in communication, particularly when airport staff, immigration officers, or service personnel did not speak English or spoke it with a heavy accent that was difficult to understand. This problem was especially pronounced in non-English-speaking countries, where even basic instructions were not available in English. For elderly travelers, solo travelers, and those unfamiliar with the local language, this barrier often led to confusion, anxiety, and a sense of helplessness. Misunderstandings during security checks, immigration interviews, could escalate stress levels and create a negative travel experience.

Another major source of frustration for travelers was the long delays caused by immigration queues, security screenings, and waiting times for essential services such as visa processing and baggage collection. These delays were particularly taxing after long-haul flights, when passengers were already fatigued and eager to reach their destination. For those with tight layovers or connecting flights, the delays often resulted in missed connections, forcing travelers to rebook flights, rearrange accommodations, or even cancel plans. The cumulative effect of these delays contributed significantly to travel-related stress and dissatisfaction.

The ambiguity surrounding immigration procedures further compounded the stress experienced by travelers. Many respondents expressed concern over the lack of clear instructions and the inconsistent application of rules across different countries. Some travelers reported encountering rude or uncooperative immigration officers, which only heightened their anxiety. The unpredictability of the process—ranging from the types of

questions asked to the documents required—left many feeling unprepared and vulnerable. This was especially true for first-time international travelers or those visiting countries with particularly strict entry requirements as well as the elderly traveling alone.

Managing travel documents was another common pain point. In countries with stringent entry regulations, travelers often struggled to keep track of multiple documents, including passports, visas, boarding passes, and health declarations. The fear of misplacing a crucial document or not meeting a specific requirement added to the overall stress. Several travelers recounted stressful experiences in this regard, highlighting the need for clearer guidelines and better support systems, potentially including smart AI solutions catered to the different segments of travelers.

Certain challenges were more pronounced for specific groups, such as the elderly, and individuals with disabilities. There was a notable lack of adequate support services for these vulnerable populations. Elderly travelers often faced difficulties navigating large airport terminals. Similarly, families traveling with young children struggled with long queues. Travelers with disabilities frequently encountered barriers such as inaccessible restrooms, and insufficient staff training in handling special needs.

In addition to these issues, travelers also faced confusion due to inconsistent regulations across countries. Security check procedures, carry-on luggage policies, and visa requirements varied widely, leading to uncertainty and delays. For instance, an item allowed in carry-on luggage in one country might be prohibited in another, catching travelers off guard and sometimes resulting in confiscation of personal belongings.

Technical and logistical problems, though less frequent, had a significant impact when they did occur. These included unclear signage, difficulty locating airport amenities, challenges in exchanging currency, and problems accessing transportation. Baggage-related issues were also common, with travelers reporting lost luggage, long waits at baggage claim, and inadequate assistance from airlines during disruptions such as flight delays or cancellations.

Cultural restrictions and dietary limitations posed additional hurdles. Some travelers found it difficult to adhere to their cultural or religious practices due to restrictions on certain food items or behaviors in specific countries.

These challenges underscore the urgent need for improved communication, better support for vulnerable groups, streamlined immigration and security processes, and the integration of smart technologies. Artificial intelligence, in particular, holds great promise in transforming the air travel experience by offering real-time translation, personalized assistance, and predictive solutions to minimize disruptions and enhance traveler satisfaction.

4.2 Comprehensive analysis of survey results

The survey provides extensive insights into various aspects of air travel experiences, emphasizing the need for digital transformation to address pain points mentioned by the survey participants and improve efficiency as well as air travel experience. The details of, and findings from the survey responses are as detailed. The first few questions were aimed at understanding the age, gender distribution of the demographic and to classify them based on their potential receptiveness to new technology such as the proposed smart AI.

The majority (70.3%) of participants were gen x (35-54 years) technologically adept individuals who progressed witnessing the trannformation from analog to digital. Baby boomers (13.9%) showed enthusiasm for learning new technologies, while millennials (11.4%) were already well-versed in ai and digital services. Silent generation (4.4%) viewed digital solutions as a luxury but expressed curiosity.

Gen X and millennials form the key demographic for adopting digital solutions, as they are already comfortable with technology. Baby boomers' willingness to learn and adapt creates an opportunity for tailored education and user-friendly interfaces. Although only 4.4% of the travelers who took our survey were in the silent generation, several of the

issues that impact air travel experience and cause stress to the passengers have maximum effect on the elderly. Hence, any technology that is adopted must account for the silent generation's challenges with technology to ensure inclusivity, effectiveness and widespread impact.

Flight status information	18-34 Years - Millennials	35-54 Years - Gen X	55 - 64 Years - Boomers	65 Years and above - Silent Generation
Yes	100.0%	87.4%	69.0%	100.0%
No	0.0%	12.6%	31.0%	0.0%

Table 3.0: Voice of all generations regarding the ask of flight status- distribution for t-Test

Obtaining real-time flight status information seemed important to all participants. Interestingly, all the millennials (the youngest responders) and the silent generation (the oldest among the responders) wanted to have access to flight information while ~87% of Gen X found this information critical but only 69% Boomers felt it necessary to possess this information (Table 3.0)

After analyzing the survey responses, we found that the data was not unbiased concerning gender, as 68.8% of participants were male, less than 50% of that were female (31.3%). While male perspectives dominate, capturing female experiences is critical to developing gender-inclusive solutions. Addressing unique travel challenges faced by women, such as safety concerns during solo travel, could enhance the experience for this demographic. Although the concerns of the female survey participants have been captured and they voice the expected issues such as safety concerns during solo travel, it must be noted that

the number of female participants in this survey is limited and may not have captured all the concerns of the global female air traveler community.

Flight status information	Male	Female
Yes	83.8%	93.8%
No	16.2%	6.3%

Table 4.0: Gender distribution on the flight status information

The responses were largely gender neutral (Figure 38), with males and female responding with similar trends to questions 5 through 16 wherever Yes/No responses were needed. However, we observed differences in stress over immigration process ambiguity, and a student t-test performed using the GraphPad Prism version10 software, revealed that females experienced greater stress and ambiguity during the immigration process as shown in the graph below.

Table 5.0: Detailed analysis on t-test conducted and outcome on immigration status

This survey had a diverse geographic representation in terms of the location of the participants. Majority of the participants (71.6%) were from developing and developed countries including technologically advanced countries (USA, UK, Europe, Australia). Several of these passengers often flew via main hub cities of air travel such as Dubai, Singapore, Sydney and London.

This diversity highlights that we have captured a global perspectives on air travel challenges through our survey and obtained a global outlook on air travel pain points.

This also means that the solutions we suggest should both common global challenges and region-specific nuances, like language barriers or cultural expectations.

Upon analysis of the travel frequency of the participants and their personas, we find that we had an almost equal division of frequent domestic travelers (58.4%) and those who travelled internationally at least once a year (48.5%). Among these, 97% were passengers, with the rest representing crew, pilots, and ground staff.

The participation of airport and airline staff in the survey makes it unique in its ability to assess air travel challenges from both sides of the equation, the customer end and the service provider end thus giving us a 360-degree view of operational challenges.

This provides the opportunity to come up with a holistic solution to benefit both parties and to make the air travel experience stress-free.

We observe that as expected, frequent travelers are more likely to identify nuanced pain points, making their feedback crucial for refining digital solutions.

Travelers embarked on their journeys for a variety of reasons, with 51% indicating work as their primary purpose, followed by 31.4% who traveled for leisure, and 16.2% who were visiting family. These differing motivations significantly influenced traveler expectations and preferences.

 Work-related travelers tended to prioritize efficiency, punctuality, and streamlined processes to minimize disruptions to their schedules. In contrast, leisure travelers placed greater value on convenience, comfort, and a stress-free experience that allowed them to fully enjoy their time away.

 Hence, digital solutions need to be designed to cater to these varied requirements. This underscores the importance of such surveys as a first step to capture widespread and varied information in order to find an inclusive solution.

Purpose of travel	18-34 Years - Millennials	35-54 Years -Gen X	55 - 64 Years - Boomers	65 Years and above - Silent Generation
Study	20.0%	0.0%	0.0%	0.0%
Work	28.0%	53.8%	65.5%	11.1%
Leisure	48.0%	46.2%	31.0%	77.8%

Table 6.0: Percentage distribution of survey participants from various Generation with regard to purpose of their travel considered for t-Test

Figure 39: Graph showing purpose of travel analysis

Purpose of travel	Male	Female
Study	2.1%	3.1%
Work	59.9%	29.7%
Leisure	38.0%	67.2%

Table 7.0: Gender distribution for t-Test

When classified by gender, we found that while there was an equal proportion of men and women travelling abroad/ internally to other cities to study, men (59.9%) tended to travel more for work as compared to women (29.7%) while more women undertook leisure travel as compared to men (Table above).

Group dynamics also played a crucial role in shaping travel experiences. Approximately 46.6% of respondents traveled with family or friends, 43.1% traveled solo, and 10.3% journeyed with colleagues. Each group presented unique needs and challenges. Families often required assistance with navigation, and logistics, while solo travelers were more concerned with personal safety, ease of communication, and access to support in unfamiliar environments.

Air travelers frequently encountered a range of challenges that disrupted their journeys and heightened stress levels. Common issues included missed flight connections due to delays, the absence of real-time baggage updates, long and slow-moving immigration queues, and inconsistent regulations across countries.

In addition, many respondents reported stress during immigration procedures, citing language barriers and a lack of adequate support for special category such as the elderly, children and individuals with physically challenged. These challenges underscored the need for more inclusive and responsive airport services.

Real-time updates on baggage and flight status were identified as key solutions to reduce uncertainty and improve the overall travel experience. Furthermore, standardizing

immigration processes and offering clearer guidance could significantly alleviate anxiety, especially for those who require additional assistance.

There was overwhelming support among travelers for the integration of digital tools to enhance transparency and convenience.

A striking 98% of participants expressed interest in real-time tracking for baggage and pets, emphasizing the importance of knowing the location and status of their belongings and loved ones throughout the journey. Similarly, 91.7% of respondents wanted access to online immigration tracking, while 86.8% supported the ability to track dependents, such as children or elderly family members.

These preferences highlight a strong demand for digital solutions that offer real-time updates and personalized information. Features such as multilingual support, customizable notifications, and user-friendly interfaces could address many of the pain points travelers currently face. By leveraging technology, airports and airlines can create a more seamless and reassuring experience for passengers.

Immigration procedures emerged as a major source of frustration for many travelers. Long queues, inconsistent procedures across different countries, and poor communication from immigration officers were frequently cited as recurring problems. These issues not only delayed travelers but also contributed to heightened stress and confusion, particularly for those unfamiliar with the process.

To better prepare for these challenges, 77% of respondents expressed a desire for digital checklists that outline immigration requirements, while 90.2% supported the option to customize language preferences. These findings suggest that digital tools—such as pre-arrival checklists, real-time immigration tracking, and language support—could significantly enhance traveler preparedness and confidence. Simplifying the immigration experience for special groups, including the elderly and non-English speakers, should be a top priority for international travel hubs.

Figure 40: Responses analyzed for survey questions categorized developed and developing countries on need of digital solutions.

Figure 41: Responses analyzed for survey questions categorized developed and developing countries on need of AI solutions

The integration of artificial intelligence (AI) into air travel operations received strong support, with 93.1% of participants endorsing its use for improving operational efficiency, baggage tracking, and immigration management. AI-driven solutions have the potential to transform the travel experience by automating routine tasks, predicting delays, and providing personalized assistance.

Our data also shows that irrespective of the economic development of the countries that the travelers were from, all the responders were in support of the inclusion of digital, AI-driven solutions for improving the air travel experience.

However, the adoption of AI must be accompanied by a commitment to transparency and data security. Travelers emphasized the importance of ethical AI practices,

particularly through explainable AI (XAI), which ensures that automated decisions are understandable and trustworthy. Building traveler confidence in digital systems will be vital for the successful deployment of AI in the aviation sector.

Participants also offered valuable suggestions for future improvements in air travel. These included the development of navigation apps to help travelers find airport facilities more easily, the enforcement of strict policies against racial discrimination, and efforts to improve staff behavior and customer service.

Such enhancements would not only improve efficiency, also contribute to a more inclusive and respectful travel environment.

There is considerable potential for AI to be integrated into diverse areas of the travel experience, from airport navigation to incident reporting systems. Addressing social and cultural challenges—such as discrimination and unequal treatment—will be critical in creating a travel ecosystem that is welcoming and accessible to all.

Conclusion

The survey results highlight the pressing need for digital transformation in air travel. As global travel continues to rebound and evolve, the demand for smarter, more responsive systems has never been greater. By addressing pain points like real-time tracking, immigration inefficiencies, and language barriers, airlines can significantly enhance customer satisfaction.

These issues, if left unresolved, leads to frustration, delays, and a diminished overall travel experience. Ethical AI and inclusive design will be key enablers for delivering seamless, stress-free travel experiences.

AI technologies, when implemented responsibly, can automate routine processes, provide personalized assistance, and ensure accessibility for all types of travelers, including those with special needs. These findings provide a strong foundation for designing targeted, user-centric solutions in the aviation industry.

They also underscore the importance of continuous innovation and feedback-driven development to keep pace with evolving traveler expectations. This is just the beginning of the sustainable solutions that airlines can upgrade based on upcoming market demands and customer needs.

By investing in scalable, adaptable digital infrastructure now, airlines can future-proof their operations and remain competitive in an increasingly tech-driven landscape.

CHAPTER V:

DISCUSSION

5.1 Understanding the demographic

Here the chapter shares detailed discussion of the survey outcomes, examining the demographic characteristics of the participants and their responses to research questions. These outcome were analyzed to identify trends, derive corresponding outcome and share learnings on the challenges faced by air travelers. The discussions aim to contextualize these findings considering the research objectives and to explore the implications for digital transformation in the aviation sector.

The survey reached out to approximately 300 participants globally through structured and semi-structured interviews conducted via one-on-one interactions and digital platforms such as LinkedIn, WhatsApp, and Google Survey Forms. A total of 204 participants provided complete responses to all 18 compulsory questions.

The respondents represented a diverse demographic. The largest group (70.3%) belonged to the age range of 35–54 years, categorized as Generation X. These individuals are technologically adept, having experienced the transition from analog to digital technology. Their comfort with digital tools makes them key stakeholders in adopting aviation-related digital solutions. Baby Boomers (13.9%) emerged as eager adopters of technology, highlighting their confidence in learning and experimenting with new tools. Millennials (11.4%) are highly accustomed to AI and other digital innovations, reflecting their openness to integrating advanced technologies in air travel.

Silent Generation participants (4.4%) viewed digital solutions as a luxury, emphasizing the need for inclusive strategies to cater to all age groups.

Irrespective of age, gender, or the country that the travelers hailed from, 95.63% responders were in support of being able to track, in real-time, their valuable baggage and pets from conveyor belts and cargo planes on their smart phones/devices.

The 9 participants who did not believe that real time tracking was important were Boomers or belonged to the silent generation.

These participants were either infrequent travelers or those that travelled frequently within their country but not internationally. Hence, their opinions may stem from not having experienced long international travel with one or more transits.

As expected, only Millennials were found to be travelling for educational purposes (20%). 48% of Millennials travelled for Leisure and 28% for work. Among the GenX participants there was an almost equal proportion traveling for work and leisure.

This gap widens in the older participants with 65.5% Boomers traveling for work while this drops to 11.1% in the Silent generation with a consequent increase in travel for leisure in this population (77.8%). Among the participants, females tended to travel more for leisure and to visit family (67.2%) than for work (29.7%), while this trend was found to be flipped in males, with 59.9% participants traveling for work and 38% traveling for leisure or to visit family/friends. In all the age-groups, an average of >79% participants were in favor of priority check-in for themselves, their aged parents and children especially when there was transit involved.

All the Millennials and the participants >65 years of age wanted to know their flight status. While 12.6% and 31% respectively of the Gen X and Boomers did not think knowing flight status information was critical.

This response appears to be gender driven as 94% female travelers found this information critical as opposed to 84% males.

The smart solutions offered must cater to the specific needs of all segments of travelers. For example;, personalized flight status alerts as well as delay alerts, clear fare breakdowns, and country-specific visa and documentation guidance would be helpful.

In the case of people travelling for work, AI could be used to integrate their meetings schedules to send alerts on flight information and how it would conflict with their current itinerary.

Similarly, AI could integrate the company reimbursement policies with the flight fares and classes to optimize the best itinerary for the traveler. The leisure traveler whether solo or with family and friends are always on the lookout for safe, family-friendly lodging and activities.

AI could use information such as traveler age, interests and group size to make optimized suggestions.

Male participants constituted 68.8%, while females accounted for 31.3%. The gender balance ensured that both perspectives were adequately captured, with specific emphasis on addressing gender-related challenges in air travel. These demographics establish a foundation for analyzing the varying needs and challenges of air travelers in adopting digital solutions.

Irrespective of age, gender, or the country that the travelers hailed from, 95.63% responders were in support of being able to track, in real-time, their valuable baggage and pets from conveyor belts and cargo planes on their smart phones/devices. The 9 participants who did not believe that real time tracking was important were Boomers or belonged to the silent generation.

These participants were either infrequent travelers or those that travelled frequently within their country but not internationally. Hence, their opinions may stem from not having experienced long international travel with one or more transits.

5.2 Inferences from the research questions

First research question was focused on the frequency of domestic air travel among participants. The survey revealed that 8.8% of participants traveled frequently within their respective countries. 27.9% traveled less frequently, while 12.3% rarely traveled. A negligible 1% reported never traveling domestically.

This 1% is in a unique position to help us identify problems specific to international travel that people traveling domestically may not have encountered.

Most participants were experienced domestic travelers, suggesting they have firsthand knowledge of the challenges and inefficiencies within local air travel systems. Their insights provide a valuable foundation for developing and refining digital solutions tailored to domestic travel scenarios.

The second research question examined the frequency of international travel among participants. We found that 48.5% traveled internationally once a year, making it the largest segment. 24% traveled more than twice annually. 15.7% traveled once every six months. 11.8% had never traveled internationally.

A substantial proportion of participants (88.2%) had engaged in international travel, making them well-positioned to provide insights into common challenges such as immigration delays, baggage tracking issues, and operational inefficiencies.

The findings underline the need for robust digital systems to enhance international travel experiences.

The third research question sought to understand the various roles and personas represented in the survey. Participants identified themselves as 97.1% passengers, 2.5% pilots/first officers, 2% ground staff, 1% crew members, and 0.5% immigration officers.

The overwhelming majority of respondents were passengers, providing direct consumer perspectives on air travel challenges.

However, the inclusion of airline and airport staff enriches the dataset by offering insights into operational inefficiencies from a service provider's viewpoint.

The survey responses helped us identify specific needs of each stakeholder while also understanding the shared pain points.

The fourth research question that investigated the reasons behind participants' air travel identified 51% as professionals who traveled for work while 31.4% traveled for leisure.

16.2% were visiting friends and family and only 1.4% traveled to study abroad or for other educational purposes.

Work-related travel emerged as the most common purpose, highlighting the critical need for efficiency, reliability, and minimal disruptions in air travel systems. Leisure and family-related travel, although less time-sensitive, demand stress-free and convenient services to enhance customer satisfaction.

This research question goes hand-in hand with the next question to understand traveler needs based on travel companionship.

Almost equal percentages of passengers travelled alone (43.1%) or with family and friends (46.6%) while 10.3% traveled for work with colleagues.

All three of these categories of travelers have distinctly different needs that need to be understood and catered to. The solo traveler's top priority is always safety and support as and when needed.

 Passengers traveling with family and friends are on the lookout for real-time alerts about hotels and flights and delays if any. They are also looking for the best yet most affordable deals.

Hence, it is imperative the AI solutions consider all these factors to produce all-inclusive versatile digital tools to address diverse travel scenarios.

Participants were asked about their experiences with flight delays, missed connections, and baggage handling issues. The key themes that emerged include, flight delays and missed connections.

Delays often led to missed connections, with inadequate communication from airlines exacerbating the problem. The next major challenge faced was with regard to ineffective baggage handling.

Issues included lost, delayed, or damaged baggage, along with poor tracking mechanisms. Lack of communication stemming from insufficient updates about delays, cancellations, or baggage status created stress and uncertainty.

These findings underscore the need for real-time tracking systems and improved communication channels to address operational inefficiencies and enhance customer experience.

The majority of our survey participants (62.3%) expressed a strong preference for real-time updates on baggage and pet status. An additional 37.3% felt these updates should be mandatory.

Hence, there is a clear demand for robust tracking systems accessible via smartphones, emphasizing the role of digital solutions in reducing traveler anxiety and improving transparency.

We found also that the ability to have real-time information about their flight itinerary was significantly more important to female travelers compared to male travelers irrespective of their travel reason, travel companionship or region of origin.

Evident consensus was observed between all survey participants who were international travelers with regard to immigration challenges faced.

The study revealed several pain points during immigration. These included but were not limited to long queues and understaffed counters, language barriers and inadequate guidance, complex visa and document requirements without clear instructions. These challenges highlight the need for standardized immigration procedures, multilingual support, and digital checklists to streamline processes and reduce stress for travelers.

Although the immigration process ambiguity-associated stress was trending higher among travelers from developing regions of the world (mean=1.712) compared to travelers from developed regions (mean=1.578), these gaps were not statistically critical (Student t-test, p value = 0.0752). None of these responses were significantly different between respondents from developed or developing regions. Therefore, the survey shows a global positive response to the belief in the ability of AI to potentially improve various facets of air travel and overall enhance the air travel experience.

To the next research question regarding preference for priority check-in, nearly half (45.6%) of participants favored priority check-in for themselves, aged parents, and children. Specific needs for parents (34.8%) and children (14.2%) were also emphasized. Priority services for vulnerable groups, such as the elderly and children, are essential for creating an inclusive and supportive air travel ecosystem. AI-based solutions for priority check-in can benefit all stakeholders.

It can help with versatile digital tools to address diverse travel scenarios for the passengers. For the airline staff, AI assisted priority check-in process can be made seamless by setting clearer eligibility rules, reduced manual checks, better resource allocation. This is also beneficial to the airport operations teams by ensuring smoother passenger flow, improved passenger satisfaction that in turn leads to fewer escalations.

Participants overwhelmingly supported (93.1%) the use of AI to enhance air travel experiences, citing benefits like reduced wait times, improved baggage tracking, and streamlined immigration processes.

Ethical AI-driven solutions can significantly enhance operational efficiency and customer satisfaction, provided they address concerns about data privacy and security. Additionally, the survey participants suggested several areas for future research where AI assistance can lead to improved air travel experience.

These included addressing racial discrimination during immigration. Developing airport navigation apps. Improving food options and cultural accommodations. These suggestions emphasize the importance of addressing both technological and social challenges in air travel.

Conclusion

The discussions highlight critical areas for digital transformation in the aviation industry. By addressing operational inefficiencies, enhancing communication, and leveraging AI, the industry can create seamless and inclusive travel experiences for all demographics. The findings provide a comprehensive foundation for implementing innovative solutions tailored to the evolving needs of air travelers.

CHAPTER VI

SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

6.1 Summary

This section concludes the research by taking a holistic perspective of all the essential findings that corelate the significant discoveries that correspond to the objectives and the questions. Thus, the the core values and contributions.

Additionally, this would audit the constraints of the research and provide superior insights for further study that aims to shed light on the need of enhancing operational efficiency and user experience due to high demand in airline travelers.

This research study emphasizes the transformative role of Explainable AI (XAI) in airline industry, stressing on optimizing operational efficiency and enriching passenger experience.

Hence implementation of transparent and interpretable AI models, airlines stakeholders arrive at better decision making, increased operational reliability and improved passenger satisfaction. All these gains result from XAI's capability to shed light on AI -driven decisions imparting greater trust among users and regulators.

 In relation to the literary sources, the researcher discovered gaps in the limited research in defined use cases of baggage loss, no study yet done to provide digital solutions focusing on efficient operational process in immigration checks across all the countries and no study regarding priority seating done yet.

Research focused on deeper study to reach out to all highly technologically advanced countries and cities and the one is yet to.

 This ensured good mix of participation. The researcher adopted mixed methodologies of interviews, patent searches, operational report reviews, and surveys to gather information globally.

Major populated and business hubs like London, Singapore, Dubai, San Francisco, Frankfurt, Delhi were considered for this study.

This research has provided significant insights into the current trends, problems, and possibilities regarding the adoption of digital solutions using XAI. Through an in-depth survey and research, the researcher discovered different degrees of challenges, pain points, user experience, operations limitations that both passengers and airlines faced. To provide holistic view, various personas like passengers who are end users, Pilots, Cabin Crew, Airport Ground Staff, Airline Operations Team were all interviewed to get the right frame of picture. Findings share the need of implementing latest technologies and applications to meet the market demand that will only be rampant in coming 30 years.

Market survey prediction and aviation industry experts opinion aims to open more operational routes connecting more business hubs as highlighted already in Chapter 2 Table 2.0 The results of the interview, survey, indicate an increasing acknowledgment of the significance of digitization need in enhancing operational efficiency and user experience by XAI protecting the data.

Nevertheless, there are major threats of data protection due to cyber security vulnerabilities to map passengers' confidential data from hand phones to secured airlines cloud or databases. Similarly to immigration bureau data centers and cloud access.

There are strong firewalls of multiple layers and code locked data centers that can be used with multilayered data viruses filtering which needs investment from various stake holders like IT Department and infrastructure and server set ups which would need timely maintenance and monitoring and upgrades.

This must be in place as a high-level requirement but airlines, airport authorities and immigration bureau should collaborate to identify the gaps for a robust process set up. Explainable AI key characteristics play a vital role to reinforce the digital solutions

Survey highlighted that 91.3 % responded for digital solutions like AI will make their travel seamless, easier, seamless and enhance user experiences. Airlines operations has implemented AI in areas like engineering, predictive maintenance, asset management, fuel efficiency, etc. use cases highlighted in Literature Review.

With number of global and domestic travelers increasing, it should not be difficult for them to implement or extend the services to baggage status tracking, priority check in for reserved groups like aged people and teenagers or rest of the use cases recommended.

a. <u>Interpretation of these results in context</u>

- Consistency with established research - In comparison of these findings with previous studies are consistent highlighting AI's transformative significance and potential airlines operations like predictive maintenance applications and reducing aircraft downtime, this research confirms XAI's role augmenting Immigration digitization processes, reliability and accuracy of baggage handling, seating prioritization, etc. Similar findings were published or reported by other researchers who identified AI driven predictive maintenance and enhance personalised passenger experiences.

- Possible reasons for unexpected results or anomalies – Two noteworthy anomalies emerged highlighting the limited direct influence of XAI on immediate passenger satisfaction index (scores) and Immigration digitization processes.

  When XAI enhanced clarity and trust, passenger satisfaction gains were indirect and less immediate than operational improvements. This deviation may result from passengers prioritizing substantial experiences (comfort, punctuality) over explanations provided during their one-on-one interactions with automated services.

- Another anomaly is regarding the sensitive information that AI needs to handle with great confidentiality and cross border, regional compliance and regulatory data at various sensitive layers. AI systems ability to be ethically considerate and provide unbiased decisions is poor. So, this biased nature of AI needs human intervention.

  Therefore, AI systems must be programmed and implemented in an integrated dimension avoiding bias also discrimination. All the passenger's data that is confidential can't be shared on a public domain and there may be hesitance from

public to AI powered systems, especially in sensitive areas like immigration, requiring transparency and clear communication. While AI can automate many processes human oversight and decision making are still essential especially in complex situations.

6.2 Implications

Theoretical Implications - Contributions to Existing Theories

This research contributes significantly to theoretical discussions by substantiating and developing theories related to technology acceptance and human AI interaction models in high-risk industry like aviation and airlines. Outcome of this study supports the Technology Acceptance Model (TAM) by confirming that transparency greatly improves user acceptance and reduces resistance toward automation technologies. Also, this study challenges previous assumptions that operational transparency directly correlates with immediate user satisfaction, recommending the necessity of more meaningful theoretical frameworks.

Insights into new perspectives and frameworks –

An evaluative theoretical implication is the proposition of an extended XAI framework adoption tailor made for airline industry and services. This new framework integrates explainability, building trust, passenger perception, operational efficiency providing a structural path for upcoming studies and practical implementation. This underestimates the significance of phased role specific approach to XAI deployment in airline industry.

This research has broad implications that are important for stakeholders in the airline industry, aviation authorities, aviation/airlines policy makers, information technology, cybersecurity and other related industries. This research presents a detailed narrative of the present scenario of the passenger experiences who are critical for generating revenue and enhance aviation business.

This research report can be considered when airlines and related industries are drafting digital initiatives and implement make this solution accessible to individuals. Individuals like air traveler can use this report to have self-awareness on what solutions are possibly

made if they can access these solutions at an incremental level, findings of this research to guide their sustainability plans and product innovation projects. Understanding the present state of sustainable materials adoption and the factors that impact it can assist stakeholders in overcoming obstacles and taking advantage of new opportunities. Regulatory authorities and policymakers can use the findings of this research to influence rules and regulations that encourage the use of digital solutions in immigration bureau and airline operations. The degree of awareness and disparities can be effectively considered for the customized policies region-wise.

 Policymakers may promote positive change and speed up industry-wide transformation by encouraging sustainability practices, supporting research and development, and establishing user experience goals.

Customers are crucial to driving demand for the industry. The findings of this study can empower customers to make well-informed services prompting them to educate themselves on digital solutions.

The research highlights the significance of adopting more passenger centric applications and practices in influencing the future direction of the digital innovation. Stakeholders may collaborate to overcome difficulties and leverage the opportunities outlined in this research to develop a more sustainable, resilient, and data protected solutions.

Additional Theoretical and Managerial Implications

 At a comprehensive platform, the key downside of AI is ubiquitous which is also predominantly represented by independent AI studies in and for Airline efficiency. AI is not frequently integrated amongst airline partners and in relation to a myriad organizational protocols due to access to complete operational insights related data availability, henceforth broadcasting the function of organizational silos and downside of data management, data exchange and integration in inter-corporate procedures. Consequences of our study on scientific and managerial implications can be integrated to implement and study aviation management. Also, in air passenger transport. Research objectives identified implements NLP, until now NLP applications were constraint to

virtual assistants and chat bots. While NLP is implemented here, it's maximal potential is not made utilitarian. Developed research indicates that NLP is one of the most trusted AI applications to ease and improve human- machine interactions**.** For instance, NLP techniques can be programmed to analyze aviation happenstances and safety reports. Since massive airports deal with approx..600 aviation incidents reports per month, NLP sources a window to derive details to fasten decision making, thereby providing data of potential consequences**.** It provides help to identify defects in the aircraft and schedule periodic aircraft maintenance.

The later application of concrete Learning AI techniques is limited. This is an iterative process like trial-and-error method. This can't be implemented in mission critical operations like air traffic, but can be opted for revenue management, ground operations. Moreover, all AI use cases are individualistic and relevant to specific function, though such structural networks of airlines and their epicenter of transportation and logistics showcase platform for inter- departmental AI applications in our study.

For instance, the airline group Lufthansa introduced the 'Operations Decision Support Suite' (OPSD) that deploys AI to consolidate and analyze data (such as crew availability and locations, passenger demand, maintenance status and weather) to recommend various use cases to human controllers for decision-making support from Lufthansa report 2023.

 Lufthansa reports that 90 % acceptance rate of suggested scenarios that AI makes the right decisions, OPSD can also pull related data for controllers to ensure more informed decisions.

An example for cost optimizes decisions is to know if an aircraft owns or uses leased engines, as leased engine is more expensive, as a detail that was not incorporated in the decision-making by operators prior to OPSD.

Associated networks of suppliers, partners and customers generate large datasets, an opportunity for AI tools for big data analysis.

Finally, a dive into executional reports showcase that the implementation of AI applications is swiftly utilized thus these highlights illustrate a concrete platform for further studies.

A contemporary, that has been ignored in the realm of academics aims to implement ESG, environmental sustainability be it reducing carbon emissions via aircraft route optimization or waste reduction in catering.

The recent reports of Euro control 20220, indicate high is carbon emissions stemming from air traffic management inability account for appox.6% of all airline carbon emissions in Europe, stressing airline managers to reduce in efficiencies.

As a result, Lufthansa Group of Aviation, used their OPSD and AI analysis to improve flight operations across multiple airlines. In parallel, deployment of smaller planes to reduce carbon emissions as per their 2023 report.

Whereas Airbus is designing an AI -supported food scanner tracking in-flight catering, with 1.5 kg cabin waste and per passenger and 20% of unused food (IATA, 2002), AI helps to optimize the food supply, planning and waste management.

So, it's very evident that this is the most emerging field and help analyzing customer satisfaction and service quality that is essential in like customer centric industry as airlines. Implementation of NLP and sentiment analysis techniques assist in deciphering the emotions and sentiments of customers from textual data, instructing airlines with areas of improvement.

6.3 Limitations

Methodological Constraints

Outcome of this study must be interpreted within methodological constraints especially with limited sample size of 220+ passengers across the globe and the scope of data. Questionnaire could be very limited to ensure that survey participants used sufficient

bandwidth and to use their span of 20 mins attention. There could be probability that few didn't express as much it is required thinking it may be one of their problems alone and not worth expressing in a public survey like this.

On personal interviews, when airline pilots and staff were approached, they declared few of these survey questions were related to sensitive to their profession and wanted to stay neutral. So, in this way responses captured may not be 100% accurate but results drive us to converge at a point on the need of digitization and improvement in processes.

Researcher's limited ability to reach out to global travelers representing every country is highly impossible. Hence, represented as developing and developed countries to strike a balance capturing their critical problems. Also, distribution of percentage of various personas may not be equal, but since this is mainly focused on passenger experiences, researcher ensures to consolidate all responses are used appropriately for analysis.

Due to inherent restrictions in airlines industry on data availability and hypothesis across diversified operations across airlines might be limited. Also, in addition to this the measurement tools depends highly on qualitative feedback from stakeholders inducing to potential biases.

Other influential variables

There are few variables that could have impacted the results that are external factors like listed and explained here.

> Airline specific factors like corporate culture, financial resources, existing technological infrastructure significantly impact the successful implementation and results of XAI applications. In addition to this passenger demographic variables such as age, technological familiarity, race, cultural differences could also shape perceptions and acceptance of XAI enables services.

> Multiple stakeholders involved to drive common agenda of customer satisfaction and operational efficiency, motto to enhance profitability and improve revenue

> Huge data handling coming from various interorganizational and cross functional departments on common data formats and platform, framework suitability coming from various domains like Public, Private, etc.

- Unstructured, unorganized data flow that needs data mining, data cleaning, call for Big Data handling and analysis
- Cybersecurity to be on prime focus and hence IT infrastructure calls for huge investment on triple firewall security and limited access to most secured data like air travel routes which can't be shared on public domain or to all departments. In case it's leaked to third party stream it would be a big threat to safety of passengers, assets. Misuse of data at huge risk
- Air traffic information and weather radar information are commonly shared by qualified technical experts which again needs decoding, or interpretation also needs permission from regional air transport committees.
- Policy makers and Innovation teams must come together. Policy makers priorities are safety of passengers in all aspects, but they are also seeking support on automating few repetitive tasks which are not safety critical.

Impact on Interpretation

These limitations suggest caution in universally applying the study's conclusions. Further interpretations should count in for variability in data availability, airline operational diversity and regional regulatory practices, highlighting the need for future empirical validation.

6.4 Recommendations for Future Research

Future research should systematically consider these limitations by employing broader, deeper and diversified datasets. Cross sectional studies to capture the better evolving impact of XAI on operational efficiency and passenger experiences.

Also, comparative cross regional analyses could reveal important cultural and organizational factors influencing XAI adoption and effectiveness.

The researcher presents the objectives for future research from findings of this study to enhance passenger user experience and operational efficiency and in the airline industry.

GEN AI has been many options to address future use cases to be accommodative and confident in addressing upcoming demand of the airports related infrastructure.

Incremental applications can be developed initially to perform fool proof testing and release it as prototype using trial data as a starting point.

By analyzing the research trends, patterns, and changes in airline practices, researchers can understand the lasting effects of AI and digital solutions and thus identify areas for ongoing advancement.

Findings provided by participants are evident that passengers highlighted the need of access to right information, ease of using information on fingertips, quick access to the information, smart applications to interact with them, provide one stop solution making their travel seamless and effortless.

These requirements will only grow that can help the industry assess its overall efficiency performance. Furthermore, studies on consumer viewpoints, beliefs, and actions on these applications can be assessed regularly through thorough behavioral research regularly. Studying consumer preferences, decision-making processes, and willingness to pay for these AI driven and digital solutions can guide marketing tactics, airline positioning, and market segmentation.

These research findings can also be considered for directing innovations towards XAI driven next generation applications.

Today's "Passenger experience requirements" revolve around delivering a seamless, comfortable, personalized, accessible and transparent journey from booking to disembarkation while emphasizing health and sustainability. Interestingly these standards are backed up by regulations (especially for accessibility and disruption management) driven by evolving passenger expectations.

Consistent information at all channels are mandate for passenger's user experience enhancement.

Often passengers voice out for an empathetic staff while they interact with the ground staff and crew.

As a researcher, complete efforts justify in paying careful attention capturing Passenger's

Voice via Research Surveys and Personal Interviews. And study deeply talks about almost all the topics here.

Area	Today's Requirements
Before flight	Easy check-in, clear pricing, accessible info
Seating	Algorithmic optimization, comfort-based regulations
Onboard	Connectivity, entertainment, cabin comfort
Service	Personalized, empathetic, transparent
Accessibility	Full compliance with disability regs
Disruption handling	Quick rebooking, care, and communication
Health/Sustainability	Cleanliness, touchless, eco initiatives

Figure 42: Overview of Use cases and latest requirements of customers

 # Seamless Check In & Boarding –

   a. self-service, mobile check in, biometric systems to speed up processes and reduce crowding.

   b. Real time flight updates and clear information – (display boards, apps, multilingual announcements) are essential

 # Efficient Seat Selection and Cabin Comfort –

   a. Airlines use advanced seating algorithms to optimize seat assignments for groups, families and preference matching

   b. Regulations and expectations around minimum leg room and recline are evolving for safety and comfort

#Inflight Comfort and Connectivity –

   a. Focus on ergonomic seat design, memory foam, lumbar support and modular layouts

   b. Most airlines now offer wi-fi streaming, entertainment and responsive support

#Service Personalization and Empathy –

   a. Airlines leverage data analytics for tailored meal choices and entertainment

b. The human touch – empathetic staff interactions and responsive support across channels -drives loyalty

#Transparency in Fees and Disruption Responses

a. Clear disclosure of all charges and extra services standardization

b. Passengers expect prompt support during disruptions, including rebooking, accommodation, meals and updates

Accessibility and Inclusivity

a. Airlines must comply with disability rights regulations (eg. U.S, ACAA, EU PRM, India DGCA, etc.) by offering pre-booking assistance, boarding, seating and in-flight support

b. Provisions include wheelchair services, champion seating, accessible info formats

Health, Safety and Sustainability

a. Airlines now emphasize sanitized cabins, reduced physical contact, and eco-friendly practices like cycling and fewer single use plastics and meet ESG goals.

b. ESG (Environment, Social Governance) goals are driven as global initiative to safe environment and save planet for next generations. This is applicable to all industries and Industry 5.0 drives this as mandate requirement now. This is aimed to promote sustainability, ethical practices, and responsible governance within aviation industry. Common goals are reducing greenhouse gas emissions, through fleet modernization and adopting fuel efficient aircraft. Researchers and academicians are working towards fuels chemical composition that can help reduce the carbon di-oxide emission, alternative fuels, implement sustainable aviation fuel (SAF) programs. Invest in newer, more environment friendly aircraft technology. Reduce water and waste consumption and promote recycling initiatives.

Airlines need to prioritize safety, security and ethical conduct and hence meet all the governance requirements of regulatory, policies defined to ensure build trust and confidence of the passengers.

Further study in disruption handling and sustainability in aviation industry is becoming the basic norm and airlines are appointing outside consultants to advise them. So anyone taking this research ahead will be benefited due to opportunities laid down here and future of the Passenger service standards will be shaped by innovations and regulatory advancements. This is one such industry where there should strike balance between Passenger's satisfaction and profitability. Hence an opportunity for deeper study in overall of operations, technology advancement and be sustainable.

Future research to address the below Implications

Practical Implications – The observations and findings can be directly applied to improve real world aviation practices like digital immigration checks, operational protocols, passenger engagement strategies, standard operating procedures (SOP's) and training programs. Airlines and aviation industries can leverage XAI to implement proactive maintenance schedules, real time route optimizations, fleet management, transparent customer services, loyalty programs and offers, etc. Practitioners should integrate explainability features into automated systems to improve user acceptance and facilitate smooth human AI collaboration. AI lacks cognizant abilities and hence needs human intervention in events of critical decision making.

Recommendations for Practitioners and Stake holders –

SOP's to be updated regularly as compliance requirements and should be part of the training programs. Scheduled and regular training programs focused on deep understanding and deep interpreting AI decisions should be implemented with top down approach across all departments and SPOC's for departmental heads, so

called as stake holders. Promoters or Practitioners are encouraged to develop user centric XAI's interfaces curated to diverse needs for all purposes and personas. Also stake holders should focus on investing in robust and accuracy of data infrastructure and secure explainability steps to make overcome the risks associated with adversarial threats or biased decision making.

Future study should focus more on how different training approaches and interface designs influence user acceptance decision making in practical aviation settings.

Policy Implications - The findings hold significant implications for aviation policy, particularly in shaping regulations surrounding AI transparency and accountability. Regulators use insights from this study to establish clear guidelines for XAI deployment, ensuring compliance with international safety standards promoting transparency as a regulatory requirement. Policy reforms can also stress on mandatory AI -driven aviation systems to ensure fairness, accountability and ethical usage.

6.4 Conclusion

This research on operational efficiency and enhancing passenger experience using XAI indicates the digital revolution in airline industry which is highly niche. The outcomes highlight the growing understanding and significance of AI among passengers along with the challenges and opportunities that are linked to the incorporation of XAI In tracking baggage, dependents travelling, immigration status, etc.

The researcher employed a mixed-methods approach to evaluate the viewpoints of different stakeholders from various parts and professions across the globe, revealing the wide range of factors that impact the adoption of digital solutions. Continued research, collaboration, and innovation are crucial for advancing progress in creating a more sustainable solution.

We witness there are small local apps driven by small IT vendors who work in silos and not associated with bigger picture of integrating all the pain points of the passengers on one application where passengers are getting benefited as one stop solution for baggage handling, priority seating, immigration checks and processes, user experience enhancement are addressed here using ethical AI.

It's a unified solution and helps passengers to have holistic insight and experience seamless travel for them and their dependents. We are brining attention to airline industry to be inclusive of all ages, race, languages, cultural, ethnicity, languages, etc.
As passengers also change airlines for a long-distance international destination, they change their connecting flights and most of the time different airlines. Each airline again have different applications and few of them don't have. This is again leaving passengers helpless and no where to go for vital information.

We observe that this survey voicing for a tangible solution called One -Stop Solution or a Unified Solution where these airlines talk to each other for the benefit of providing one simple application.

The airline industry may improve its data security, open to go more digital which we already are seeing the transformation, technological breakthroughs, and involving the entire spectrum of stakeholders making it smart flying.

This offering should be consistent service across all channels, websites, mobile, airport and call center. Today the updates and critical information is highly inconsistent and puts passengers into more anxiety as mobile pushes out a latest gate number by particular airlines passenger is travelling, then there is an announcement of gate change. Now passenger is perplexed and not sure what to do next.

Digitization on contrary of reducing passenger's anxiety and enabling his travel experience, it is perplexing passenger what to consider and what not?

So, this research ensures the authentic and latest information at all point of time to passengers and their dependents.

As opined by few of the frequent travelers, they want entrusted and authenticated information to end their panic and anxieties.

As a final conclusion, This research contributes to the overall discussion avoiding passengers standing in long queues for immigration checks, baggage loss and tracking, airlines to accommodate baggage claim, track them manually from various transit, passengers missing their connecting flights due to long queues at immigration counters, information missing on delayed flights, the whole anxiety to be removed and ensure airliners are giving a truly pleasurable experience to air travelers. This can ensure a smarter and sustainable future for the air travel industry and for society.

Synthesize Key Findings

As explained above these studies highlight the transformative role of XAI in airline industry by demonstrating its substantial impact on operational efficiency and passenger experiences. These key outcomes stress again on transparency and interpretability in AI driven decisions significantly enhancing operational reliability, decision accuracy and take holder trust with limited direct influence on immediate customer satisfaction, XAI indirectly fosters passengers trust and long-term satisfaction by providing transparent explanations for automated decisions. The research identifies the gaps and insights associated with incorporation of XAI in specific use cases like baggage handling and tracking, management of dependents traveling, digitization for immigration processes and passenger experience enhancements.

Significant Contributions

Research highlights major contribution to airline, aviation and technology acceptance literature by introducing structured, role specific XAI Adoption Framework explicitly tailored for airline and aviation industry contexts. It validates and expands existing

theoretical models such as Technology acceptance Model (TAM), by highlighting the crucial role of explainability in driving user acceptance and mitigating resistance to automation in high stakes environments. Also, this study highlights the critical necessity of a unified solution called as "one stop solution" to streamline the processes such as baggage and pets handling, digitization in immigration process, priority seating for senior citizens and children and overall user experience for passengers through ethical AI process.

Final thoughts

As an ultimate thought on this study, researcher aims and desires to advocate for development of an inclusive, sustainable, smarter, more digital aviation solutions that can cater to diverse passenger demographics and consistently deliver trustworthy information on all channels. It offers a visionary perspective in achieving seamless, anxiety free air travel experiences, thus setting a foundation for ongoing innovation and sustained industry wide improvements.

Research also highlights on the urgency of unified digitization, moving away from fragmented digital solutions, importance for greater integration and collaboration among stake holders, policy makers, regulatory bodies, airliners, technology providers, compliance authorities. Research advocates that the pain points, stress and anxieties experienced by passengers should be addressed by providing transparency and removing technical gaps. Hence proposed unified digital platform ensures consistency and reliability in information across multiple channels, reducing passenger's ambiguity and anxiety caused by inconsistent, untimely, irregular updates and operational miscommunication and few cases abrupt communication.

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SURVEY COVER LETTER

Sustainable Solutions for Smart Flying using AI

Hello to all Air travelers, Crew, Pilots and Ground Staffs involved in short and long-distance travel using domestic and international flights!

I am Sandhya Haridas, currently pursuing Doctorate in Business Administration (DBA) at the prestigious Swiss School of Business Management (SSBM) in Geneva. I am conducting a crucial research study on Smart Flying using Ethical/Explainable AI (XAI) that aims at providing sustainable solution, optimizing time, improving efficiency, more ease of travel and provide ultimate customer satisfaction.

Your input matters! I invite you to participate in this interesting and vital survey, articulated to gather valuable insights from all personas who travel often, not so often, either for work or leisure. You may be a solo traveler or travel with family, friends, or colleagues. I welcome your honest inputs. Your participation will directly contribute to shaping the future of the Airline Industry and impacting air travelers in the future. What's in it for you?

- ✓ Contribute to upcoming technology in Aviation Industry
- ✓ Gain valuable insights into emerging AI and ML trends and use-cases
- ✓ Sharing your experiences and paving path for upcoming technologies
- ✓ Complete a concise survey in less than 15 minutes
- ✓ Maintain complete anonymity and confidentiality.

 Who can participate?

This survey is open to all who travel via Airways to Domestic and International destinations. Thank you for your time and support! Your participation is greatly appreciated and will significantly contribute to this important research initiative. The responses will be used only for research purpose and kept strictly confidential. Your anonymity will be maintained throughout the study. Survey Link: https://docs.google.com/forms/d/e/1FAIpQLSfbi0LtEkj3_d5TagQNmuxR0gjI45SaCvzcA6M193oKF0cxgA/viewform