Digital Transformation in the Aviation Sector: Impact of Emerging Technologies on Consumer Experience

Submitted towards fulfilment of the requirements of the University of St Andrews, for the degree of Master of Letters (MLitt) in Marketing.

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Declaration

I hereby certify that this dissertation, which is 14830 words in length, has been written by me, that it is the record of work carried out by me and that it has not been submitted in any previous application for a higher degree. This dissertation was conducted by me at the University of St Andrews from May 2024 to August 2024 towards fulfilment of the requirements of the University of St Andrews for the degree of Master of Letters (MLitt) in Marketing under the supervision of Prof Ruth Woodfield.

Date, Signature of candidate

Abstract

The airline industry has experienced significant changes driven by digital transformation, affecting operational processes and the passenger experience. This dissertation, titled: "Digital Transformation in the Aviation Industry: Impact of Emerging Technologies on Consumer Experience" aims to explore the impact of digital innovations on frequent flyers. The study examines how emerging technologies such as biometric boarding, e-ticketing, baggage tracking systems, and in-flight entertainment affect passenger travel, especially Generation Z.

Using qualitative research methods, data were collected through semi-structured interviews with frequent travellers in their 20s and 30s. The findings reveal that while digital technologies are improving the convenience and efficiency of booking, check-in, and in-flight experiences, there are still significant concerns about data privacy and security. Participants in the study expressed the need for greater transparency and protection measures from airlines. In addition, the study highlighted the importance of user-friendly interfaces and the provision of immediate customer service to mitigate the stress and anxiety associated with digital technologies.

The dissertation concludes that digital transformation in aviation offers significant benefits. However, privacy, security, and usability issues need to be addressed to improve overall passenger satisfaction. Recommendations for future research include expanding the demographic scope and conducting further analysis of specific technologies to gain a more comprehensive understanding of their impact on the passenger experience.

Keywords: Digital transformation, aviation sector, consumer experience, biometric technology, e-tickets, baggage tracking, in-flight entertainment, privacy, data security, self-bag drop, mobile check-in, Gen Z,

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1. Introduction to Digital Transformation in the Aviation Sector

The aviation sector has undergone significant transformations since its origins in the early 20th century, evolving from a luxury experience for the elite to a widely accessible mode of transport. This evolution has been marked by continuous innovation, from the introduction of jet engines in the 1950s to the development of advanced air traffic control systems in the 1970s (Geels, 2006). In recent decades, the development of digital technologies has brought another revolutionary shift, fundamentally changing operational efficiency and the passenger experience (Horonjeff et al., 2010; Scribner, 2023). Digital transformation in aviation involves several advances, including online booking systems, electronic ticketing, mobile check-in, biometric security measures, and personalised in-flight entertainment systems, all designed to streamline processes and enhance customer satisfaction (Murugan, 2024).

The digital revolution in aviation began with computerised reservation systems (CRS) in the 1960s, pioneered by American Airlines' Sabre system. This innovation allowed airlines to manage bookings more efficiently and established subsequent technological advances. The 1990s saw the development of the Internet, which revolutionised the booking process, allowing passengers to book flights online, thus avoiding traditional travel agents and reducing costs for airlines (Copeland & McKenney, 1988). In recent years, integrating advanced digital technologies has further transformed the industry. Innovations such as self-check-in kiosks, mobile boarding passes, and automated baggage handling systems have become more common. Biometrics, including facial recognition and fingerprint scanning, are also increasingly being used to speed up security checks and boarding processes (IATA, 2022).

The pace of digital transformation has accelerated significantly in the 21st century, driven by fast technological advancements and the growing demands of tech-savvy consumers, especially those in Generation Z (Brynjolfsson and McAfee, 2011). This demographic group, growing up in a digitally connected world, expects seamless and integrated digital experiences in all aspects of life. Despite extensive research into the operational benefits of digital transformation, the subjective experience of passengers, especially frequent travellers, remains under-researched. This study aims to fill this gap by providing a qualitative analysis of individual perceptions and experiences with digital technologies in the aviation sector. The relevance of this research is to address the gaps in the current literature on passenger

preferences and experiences. Existing studies use quantitative approaches, focusing on large-scale surveys and statistical analyses to understand passenger behavior and preferences. These methods often overlook passengers' subjective experiences and their interactions with digital technologies at different stages of the journey. Furthermore, the emotional and psychological effects of these technologies, such as stress, anxiety, and privacy concerns, are not sufficiently addressed (Davis, 1989; Venkatesh et al., 2012). This dissertation aims to fill these gaps by adopting a qualitative approach that explores individual perceptions and experiences of frequent young travellers. It seeks to understand how digital innovations affect passenger satisfaction, preferences, and well-being. By focusing on frequent travellers, who are more likely to interact with these technologies, this study provides further insight into the usability, effectiveness, and areas for airline and airport improvement in the aviation sector.

Thus, the main aim of this study is to explore how airlines and airports can effectively use digital innovations to improve passengers' travel experience while addressing their concerns about usability, privacy, and emotional well-being. The study will explain passenger preferences and expectations for future digital innovations in aviation, as well as usability and user experience challenges faced by technologies such as self-check-in, e-ticketing, and biometrics. In addition, the study will examine how these advances affect passengers' stress, anxiety, and overall emotional well-being, as well as explore their main concerns around privacy and data security to determine how airlines can address these issues to build trust.

The structure of this essay starts with Chapter 2, which reviews the existing literature on digital transformation in aviation, focusing on operational efficiency and passenger experience, and identifies research gaps. After that, Chapter 3 presents the qualitative research methodology, including semi-structured interviews and data collection methods. Chapter 4 describes the results of these interviews, including passenger preferences, usability challenges, and the impact of digital technologies on emotional well-being. Furthermore, Chapter 5 analyses the findings of the research questions and existing literature, highlighting the similarities and differences. Chapter 6 provides practical recommendations for airlines to implement digital innovations that improve the passenger experience while addressing usability, privacy, and emotional well-being concerns. Finally, Chapter 7 concludes with a summary and suggests areas for future research to meet the evolving needs of passengers.

2. Literature Review

2.1 Digitalisation & Digital Transformation

2.1.1 Definition of Digital and Digitalisation

The term “digital” refers to technologies that use digital signals, indicating a shift from analog systems. According to Yoo et al. (2012), digital technology is altering information processing, storage, and communication, resulting in enhanced connection and interaction. Digital technologies such as computers, smartphones, and the internet, speed up modern communication and information exchange by transforming data into binary code, thus enabling fast and efficient data processing (Tilson, Lyytinen, & Sørensen, 2010). What is more, the meaning of digitalisation refers to the shift of analog information into digital form (digitisation) and involves the broader socio-economic implications of adopting digital technologies. According to (Brennen and Kreiss, 2016; Gartner, 2024) digitalisation refers to the restructuring of many aspects of social life around digital communication and media infrastructure. Organisations use the technologies to integrate and analyse data, which drives data-driven decision-making (Westermann et al., 2014). In various sectors, digital technologies have brought significant changes and improved the current processes. In manufacturing, it enabled the development of smart factories with interconnected and autonomous machines (Rüßmann et al., 2015). Additionally, in the healthcare sector digital tools enhance patient care through telemedicine and electronic health records (Agarwal et al., 2010).

On a societal dimension, digital technologies influence communication and information consumption. Social media platforms, for instance, have transformed global connectivity (Kaplan & Haenlein, 2010), while digital learning platforms have modified education by making it more accessible and flexible (Means et al. 2009). Henriette et al., (2015) highlight that digitalisation encompasses not only technology but also strategic, cultural, and organisational change. The authors suggest that digitalisation influences how businesses produce value, interact with customers, and compete in the market. Moreover, Skog et al. (2018), define digitalisation as the adoption and integration of digital technology to improve efficiency and enhance customer service.

2.1.2 Digital trend in the airline industry

The aviation sector has undergone substantial modifications since its inception in the twentieth century. Initially, the sector faced stringent rules and a focus on safety and logistics (Horonjeff et al., 2010). However, with the deregulation in the late 1970s, considerable changes began to occur in the industry (Scribner, 2023). This policy, notably in the United States, permitted increased competition and innovation, promoting the rise of low-cost airlines and increasing worldwide air travel availability (Hu et al., 2022; Endava, 2023). Critical technological innovations, such as the development of jet engines and air traffic control systems, have accelerated the evolution, increasing operating efficiency and safety (Endava, 2023; Graham, 2023).

In recent decades, digital transformation has emerged as a critical driving factor in the aviation industry. This change requires the integration of modern technologies such as Big Data, the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain (Kanani, 2023). These technologies are used to optimise operating procedures, strengthen safety protocols, and enhance passenger experiences (Murugan, 2024).

Between 1996 and 2016, worldwide aviation operations doubled due to technological advancements, with international departures increasing from 650 million to 1.45 billion. This trend is expected to continue, with global emerging markets contributing 70% of total airline traffic by 2034 (WEF, 2023). Most of this growth will be driven by demographic shifts involving Asia, Africa, and Latin America's emerging middle class.

2.1.3 Generation Z towards Digital Innovation

Generation Z consists of people born between the mid-1990s and early 2010s which is characterised by a strong attachment to technology and digital environments (Turner, 2015). Often referred to as "digital natives", this cohort has grown up immersed in a world where the Internet and mobile devices are ubiquitous, shaping their attitudes towards technology and its integration into everyday life (Prensky, 2001). The Technology Acceptance Model (TAM) proposed by Davis (1989) provides a theoretical framework for understanding Generation Z's adoption of digital innovations in aviation. According to the TAM, perceived ease of use and perceived usefulness significantly influence technology acceptance. For Generation Z, these

factors are particularly important as they are accustomed to intuitive interfaces and seamless digital experiences. Research suggests that Generation Z have high expectations for the efficiency and personalisation of technology solutions, perceiving them to be fundamental elements of an enhanced user experience (Shams et al., 2020). Their interaction with digital technologies in the aviation industry is likely to be characterised by a demand for advanced, user-friendly, and secure digital systems.

Psychological research indicates that younger generations, such as Millennials and Gen Z, are more comfortable sharing personal information online than older generations like Baby Boomers and Gen X, who may exhibit higher levels of privacy anxiety. Studies by Anderson and Rainie (2018) from the Pew Research Center highlight that younger individuals prioritise convenience and social connectivity over privacy. In contrast, older adults tend to have greater concerns about data misuse and surveillance.

2.1.3 Definition of Digital Transformation

Over time, extensive research has further developed the term “digital transformation”. Digital transformation refers to shifts that occur when digital technologies are incorporated into all aspects of business and society, significantly affecting operations and providing value (Vial, 2019). It involves using digital tools to innovate and enhance processes, customer experiences, and organisational efficiencies (Bharadwaj et al., 2013). According to Fitzgerald et al. (2014), digital transformation requires changes in technology, culture, and leadership. Companies employ technology such as big data, cloud computing, and AI to improve decision-making, streamline operations, and foster innovation (Sebastian et al., 2017). Furthermore, digital transformation can generate new business models and revenue sources (Henriette, Feki, & Boughzala, 2015). Schallmo and Williams (2018) emphasize that digital transformation combines digital technologies and business areas to realise the transformation of management and business models. Apart from products, business models, services, and value chains are currently being digitalised (Porter & Heppelmann, 2015).

2.1.4 Technology Acceptance Model (TAM)

Davis (1989) developed the Technology Acceptance Model (TAM), which is a fundamental framework for understanding user acceptance of technology, emphasising perceived usefulness and ease of use as critical drivers. Venkatesh and Davis (2000) expanded the TAM by including social influence and cognitive processes to better explain technology adoption in various circumstances. In aviation, TAM has been used to examine how passengers perceive and accept new technologies such as biometric boarding and smartphone check-in, with results indicating that perceived usability and simplicity of use greatly enhance passenger satisfaction and adoption rates (Hu et al., 2022). What is more, psychological research indicates that perceptions of privacy and security significantly influence users' acceptance and use of technology. For instance, Westin's (1967) seminal work on privacy emphasized the importance of personal control over information, which remains relevant in the context of digital technologies in aviation. Users' confidence in data security is shaped by their understanding of how their information is stored, managed, and protected.

2.1.5 Unified Theory of Acceptance and Use of Technology (UTAUT)

Expanding upon Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT) incorporates performance expectancy, enabling conditions, and social impact. According to Venkatesh et al. (2012), these elements collaborate to affect users' intentions and usage patterns. UTAUT may be especially crucial in the aviation industry for comprehending how travellers adopt technological advances through the support of infrastructure and suitable resources, as well as peer pressure. Similar to aviation, research by Wang and Liao (2008) indicates that social impact and supportive environments are necessary for technology adoption in public transit systems.

2.2 Impact of Emerging Technologies on Consumer Experience

2.2.1 Impact of Digital Transformation on the Aviation Sector

The digital transformation of aviation has been a progressive development marked by significant milestones. The initial implementation of digital technologies by airlines in the early 1990s involved asynchronous applications with limited interactivity, primarily aimed at

establishing a presence on emerging digital platforms. These early systems were used by carriers to provide travellers with basic information such as in-flight services, destinations, flight frequencies, and schedules (Jarach, 2002).

Throughout the years, the airline industry has adopted various digital technologies to improve the travel experience. According to the Global Passenger Survey (IATA, 2022), travellers report high levels of satisfaction with several aspects of travel, including booking (84%), checking in (80%), and searching for travel options (81%). However, some areas still cause significant stress for travellers, such as transfers (68%), onboarding/immigration (64%), and baggage claim (69%). It is worth noting that baggage handling remains an issue faced by 2 in 5 travellers.

The adoption of e-ticketing and online check-in saved time and effort for passengers (IATA, 2018). Mobile apps provide real-time information about flight status, gate changes, and luggage tracking (SITA, 2019). Biometric boarding and digital passports are examples of digital identity technologies that assist in streamlining boarding processes (Patel, 2018). Furthermore, airlines use big data and analytics for predictive maintenance, improving aircraft reliability and reducing downtime (Daily & Peterson, 2017). The usage of advanced data analysis improves fuel management and route planning for planes, lowering costs and minimising environmental impact (Airbus, 2024). Airports use automated check-in kiosks, self-service bag drops, and smart security technologies to increase efficiency. AI in air traffic control increases operational efficiency and safety (Eurocontrol, 2024).

Based on literature review, the next section will cover key technologies that have been applied to improve travel experience and optimise the processeses. These include the development of baggage tracking systems, the adoption of e-tickets, biometrics, and IFE, and the implementation of self-check-in and self-bag drop systems. Additionally, the development of self-service baggage claim systems and biometrics will be evaluated.

2.3 Emerging technologies

2.3.1 Baggage Tracking Systems

The passenger experience has been significantly affected by the digital transformation of the airline industry, particularly since the introduction of baggage tracking systems. Baggage tracking technologies are crucial to providing real-time information on the location and status of baggage, increasing transparency, and reducing traveller anxiety (Valamarthy, 2023). These solutions offer many benefits, including operational efficiencies, cost savings, and improved customer satisfaction.

Quantitative studies indicate that the adoption of baggage tracking has led to significant operational improvements. For instance, for more than a decade, the global rate of mishandled baggage has decreased to 7.6 bags per 1000 passengers in 2022, up 74.7% in comparison to 2021, indicating significant improvements in reliability (SITA, 2023). This improvement is attributed to the integration of real-time tracking features that allow airlines and passengers to monitor the status of baggage throughout the journey. Moreover, the use of mobile applications to track baggage has become more common. SITA Baggage IT Insights report (2019) gathered data using a survey method including response from airlines and airports that indicates that 48% of worldwide passengers want more information about the status of their language via their smartphone while traveling. This demand reflects a trend towards mobile integration and real-time updates that significantly improve the travel experience, reducing uncertainty and risk regarding lost luggage.

Delta Airlines provides a compelling example of the effectiveness of baggage tracking systems at London Heathrow International Airport. According to Business Traveller (2018), their baggage can be tracked with a 99.9% success rate, highlighting the reliability of their system and resulting improvement in passenger satisfaction. This high success rate provides consistent baggage handling and reinforces customer confidence in the airline’s ability to effectively manage their belongings for their clients.

In addition to individual airline initiatives, major infrastructure projects such as Istanbul International Airport underscore the critical role of baggage tracking systems in enhancing passenger experience, especially in managing high volumes of traffic (SITA, 2024; Bilgen, 2024). The airport is expected to handle over 28,800 bags per hour, ensuring that passengers

receive timely updates on their luggage status and experience minimal delays and waiting time in baggage retrieval (Airport Technology, 2017). The trend of integrating advanced baggage tracking systems is currently becoming increasingly common in the construction of new airports not only in Europe but also in Asia. For example, at Daxing International Airport in Beijing, passengers can track their checked baggage in real time via the CSAir app, a public WeChat account, and the official website. It gives passengers real-time access to the status of their baggage, like tracking the location of a parcel (CSAir, 2019).

Furthermore, a case study by Zhang et al., (2008) used comparative analysis to compare advantages and disadvantages of barcode-based system and examined the implementation of RFID baggage tracking systems at Beijing Capital International Airport that have been working to convert the traditional barcode-based baggage system to RFID. One of the most important findings was the increased accuracy of baggage handling facilitated by RFID technology. The precision capabilities of the tracking system have led to a significant reduction in the number of lost or mishandled bags, directly contributing to higher levels of passenger satisfaction. This improvement addresses a major source of passenger complaints and increases overall confidence in airline services.

Additional findings from the International Air Transport Association highlight that baggage tracking is a crucial factor in ensuring a positive passenger experience. According to the IATA passenger survey (2023), 57% of travellers have used or want to use electronic baggage tags and 59% stated that real-time baggage tracking would significantly increase their confidence in traveling with checked baggage. Furthermore, 87% of respondents indicated that they would be more likely to check in their luggage if they could track it throughout their trip. What is more, IATA (2022) global passenger survey found the highest levels of satisfaction in areas such as booking, check-in, and arrival at the airport, but highlighted those transfers, border control, and baggage reclaim remain the main areas of stress for travellers.

The need for alternative options for checking in baggage was also highlighted in the IATA survey (2022). A significant percentage of passengers expressed interest in services such as having airlines transfer their bags from home to their destination (67%), checking in baggage at a location near them (73%), and sending baggage on a separate flight (46%). These findings underscore the potential for innovative baggage handling solutions to further enhance the

passenger experience by reducing the stress and inconvenience associated with traditional baggage processes.

2.3.2 E-Ticket

Digital transformation of the airline industry, particularly through the adoption of e-ticket technology, has revolutionised the consumer experience, introducing significant changes in the way services are delivered. Pine and Gilmore (2000) argue that airline customers viewed the purchase of tickets as an individual transaction rather than as part of a broader and complex consumer experience. This technological improvement provides essential travel information and integrates additional services perceived by consumers as valuable.

According to Brandenburger and Nalebuff (1996), for consumer e-ticket advancement the main benefits include reduced booking times and faster check-in procedures, increasing efficiency and convenience of travel. These advantages are important in an industry where time and streamlined processes are paramount. What is more, Zou et al. (2012) point out that customers can book tickets quickly and conveniently through digital channels, often at lower prices due to lower operating costs for airlines. However, digital transformation also brings challenges, such as privacy concerns and the digital divide affecting elderly customers who are less familiar with technology (Charness et al., 2009; Hill et al., 2015). Despite this, digital transformation encourages airlines to focus on building customer loyalty through membership programs and alliances that offer free registration and allow passengers to collect and use flight points (Driver, 1999).

The internet has fundamentally changed the paradigm of airline ticket distribution, presenting new alternatives to direct and indirect sales channels. As Zhou (2004) points out, airlines can sell tickets through their websites, call centres, and sales offices, as well as through traditional and online travel agencies such as Travelocity and Expedia. This change has affected consumer buying behavior, making the future of traditional and online travel agencies uncertain. Motivations for using online platforms include 24 24/7 accessibility, up-to-date information, global reach, and comparison options that attract technologically curious travellers away from traditional agents (Yoon, 2006).

Age demographics also have a crucial role in the adoption of e-ticketing in the aviation sector. Yoon (2006) from conjoint analysis indicates that younger travellers, especially those in their 20s and 30s, prefer to use online travel agencies because of the lower prices and comprehensive information available online. In contrast, older travellers aged over 50 and older prefer traditional travel agencies, valuing the human contact and professional service that they offer. This divergence underscores the need for airlines to meet a diverse customer base with different preferences and comfort levels with technology.

The convenience of using e-tickets is a major factor in their popularity. Bharadwaj et al. (2013) underscore that the ability to book and receive tickets online has streamlined the booking process, making it more efficient and user-friendly. This digital shift is particularly beneficial for frequent travellers, who can easily manage their travel plans through airline websites or mobile apps. Lau et al., (2011) conducted a convenience survey indicating that e-tickets facilitate faster check-in and streamline security processes, significantly improving the travel experience. Overall satisfaction with e-tickets, however, varies among passengers. While frequent travellers generally report greater satisfaction due to their familiarity with the digital system, occasional travellers or those less familiar with the technology may find the process confusing and stressful, especially in the event of flight changes or cancellations (Bharadwaj et al., 2013).

2.3.3 Self-Check-In

Transformation in the aviation sector has had a significant impact on the passenger experience in terms of check-in processes. Research reveals a distinct preference for online and self-service check-in methods over traditional counter-based systems. Heiets et al. (2022) conducted research based on primary data sources from the online questionnaire survey among passengers of different ages and travel purposes using the check-in phase, online check-in, self-service kiosks, and traditional counters on the passenger experience. The findings present that online and self-service check-in are mostly preferred due to their time-saving and convenience. These preferences present an acceptance and appreciation of digital check-in modes among passengers.

According to Heiets (2022), around 70% of respondents currently choose online check-in or self-service facilities over traditional counters. This shift is attributed to several factors, including the belief that digital check-in methods save time and simplify picking a seat on the plane. The International Air Transport Association (IATA) survey, which included responses from 8,000 travellers from 200 countries, confirms these findings. The survey presents that passengers tend to use mobile apps for check-in, especially younger travellers who are more likely to use mobile technology (IATA, 2023).

Despite the growing popularity of digital check-in methods, several challenges were discovered. Heiets (2022) identifies key issues such as the digital systems' inability to resolve issues quickly, which are often due to a lack of human intervention. What is more, more than 20% of respondents express concerns about cyber security, including the possibility of personal data leakage. Digital check-in methods are also perceived to be more error-prone compared to traditional counters. A small proportion of respondent's experience difficulties in using online or self-service check-in facilities, although airlines appear to guide these technologies.

Furthermore, the IATA (2022) survey also underscores that passengers increasingly prefer to handle certain processes outside of the airport. For example, 44% of respondents prefer to check in outside the airport, 33% prefer to handle immigration procedures outside the airport, and 32% choose to check their luggage outside the airport. These preferences underscore the desire for a more seamless and efficient travel experience, facilitated by digital transformation.

Heiets (2022) also notes that digital transformation goes beyond simple convenience. It increases passengers' autonomy and flexibility, allowing them to manage their travel plans and make changes without on-site visits to counters. However, the lack of immediate human support remains a significant disadvantage, especially in terms of quick problem resolution.

2.3.4 Self Bag Drop (Passanger Self Service)

Self-service baggage drop (SSBD) systems have significantly transformed the passenger experience at airports, reducing waiting times and improving general efficiency. Studies and actual implementations show the huge impact these systems have on passenger satisfaction and operational efficiency.

A research by Yang and Santonino III (2016) at Singapore's Changi Airport used Kano analysis to assess passenger satisfaction with SSBD systems. The study, which involved 157 randomly selected passengers, found higher levels of satisfaction with SSBD compared to traditional baggage check-in methods. The main reasons passengers preferred SSBD included reduced waiting times and ease of use, especially among those familiar with other self-service technologies.

Furthermore, an annual report by Stantec (2019) discusses the widespread implementation of SSBD systems at major airports and their advantages, such as shorter queues and faster processing times. For example, the implementation of SSBD at Vancouver International Airport has significantly reduced the average check-in time from minutes to seconds. Not only does this increase passenger satisfaction by minimising stress, but it also allows for more efficient use of airline staff, as fewer agents are needed to manage check-in counters, allowing them to focus on other critical tasks and passengers.

According to the IATA Global Passenger Survey (2019), a significant percentage of passengers prefer SSBD systems because of the ability to track baggage in real-time. The survey highlighted that 81% of passengers would be more likely to check in their baggage if they could track it in real-time, highlighting the importance of visibility in baggage handling. In addition, the survey also noted that major stress points for passengers include baggage reclaim, a challenge that SSBD systems help to alleviate by streamlining the process and reducing the likelihood of baggage mishandling.

2.3.5 IFE

The implementation of in-flight entertainment (IFE) systems has become a crucial element in enhancing passenger comfort in the aviation sector. Offering different types of entertainment and connectivity options, significantly impact passenger satisfaction and comfort during flights. Various studies have analysed the multifaceted impact of IFE systems on the passenger experience, revealing their great importance in modern air travel.

The deregulation of the aviation industry has led to continuous improvements in airline services, particularly in-flight services. Sarno et al. (2013) highlight that the new generation of IFE systems provides passengers with more onboard choices, such as video, audio, games, and

music, greatly enhancing the travel experience and reducing tiredness. The wide range of options contributes to a more engaging and enjoyable in-flight experience, which is essential to maintaining a high level of passenger satisfaction during the flight.

Furthermore, advances in IFE systems include connectivity features, enabling passengers to use personal electronic devices (PEDs) to access entertainment and online services. Wallace (2024) indicates that this integration increases passenger engagement and improves passenger loyalty levels and satisfaction by providing continuous connectivity and personalised content. The ability to stream favorite content, stay connected via social media, or browse the internet during flights is highly valued by passengers, especially younger demographics who are used to constant connectivity.

Additionally, operational efficiency and passenger comfort have also guided the evolution of IFE systems. Safran Passenger Innovations (2023) introduced the RAVE Ultra plus IFE system, which focuses on reducing system weight and energy consumption while improving display quality. These advancements will lead to operational cost savings for airlines and provide passengers with bright and responsive high-resolution displays in early 2025. Such technological improvements provide a more enjoyable and seamless entertainment experience on day and night flights.

Moreover, digital IFE systems that provide real-time information and connectivity options play a crucial role in reducing travel-related stress. According to Bansal (2024), passengers highly value access to flight information, connecting flight details, and destination guides through their IFE systems. The availability of real-time updates enhances passengers' sense of control and reduces anxiety, particularly during long and complex journeys. This ability to stay informed and connected throughout the flight significantly contributes to overall passenger satisfaction.

Qualitative analysis of postal questionnaires and interviews by Alamdari (1999) further confirms the importance of in-flight premium services, such as the latest movies and available Wi-Fi, in influencing travellers' ticket choices and contributing to customer satisfaction. These premium services are increasingly seen as differentiators that can influence passenger preference toward airlines offering better IFE options.

Real-world implementations of advanced IFE systems further highlight their positive impact on the passenger experience. For instance, Singapore Airlines‘ KrisWorld system and Emirates’ ICE (Information, Communication, Entertainment) system are known for their extensive content libraries and user-friendly interfaces. These airlines consistently receive high passenger satisfaction ratings due to their commitment to offering a high-quality IFE experience (Business Traveler 2024). Delta Airlines has also enhanced its IFE offering with the introduction of Bluetooth connectivity, allowing passengers to use wireless headphones, which meets passenger preferences and enhances the in-flight experience (Singapore Airlines 2024, Emirates 2024, Delta Air Lines, 2023).

2.3.6 Biometrics

The SITA (2018) report highlighted the increasing investment in biometric technologies by airports and airlines to deal with the projected doubled number of passengers to 7.8 billion by 2036. Technologies such as palm vein scanning, face and voice recognition, fingerprint scanning, and digital passports are increasingly being used to enhance security and speed up passenger processing (Jain & Kumar, 2010; Labati et al., 2016) However, the report also highlighted passengers' interest in using these technologies, with only 57% expressing a willingness to use biometric systems. This reluctance may impact the overall adoption and effectiveness of these technologies in improving the passenger experience. However, in addressing concerns about biometric technology, IATA (2023) noted that while 75% of passengers prefer to use biometrics over traditional travel documents, there are significant concerns about data breaches and the sharing of personal data. Findings also present an 85% score on positive satisfaction for those using biometrics.

Sinha et al. (2018) in their study highlighted that digital technologies, such as fingerprint and facial recognition, can significantly reduce passenger queuing times. In addition, these technologies streamline processes, making travel more convenient and efficient.

Furthermore, the experiment based in Helsinki airport, documented by Duman (2019), tested facial recognition technology with passengers in real-time, providing valuable insight into its practical application. Feedback was collected during face-to-face interviews, revealing that passengers were very positive about the check-in process using facial recognition. The app

scored 4.75 out of 5 for ease of use and 4.6 out of 5 for the overall experience. Passengers also felt safe using the technology, with the majority rating their feeling of safety at 4 out of 5. These results further suggest that facial recognition technology can significantly improve the passenger experience, making the check-in process more efficient and rewarding.

Zhu et al. (2020) highlighted the effectiveness of facial recognition technology compared to traditional manual verification methods. According to their study, the average time for manual identity verification was around 16 seconds, while biometric verification gates reduced this time to around 7 seconds. In some cases, the facial re-verification gates allowed passengers to verify their identity in 3 seconds. Findings claim that it improves operational efficiency and passenger satisfaction due to the non-invasive process.

What is more, the IATA One ID technology aims to streamline the passenger journey by enabling earlier information exchange and facilitating a contactless process at airports. The initiative enables passengers to obtain the necessary travel authorisations digitally and pass through airport checkpoints using biometric identification without the need to repeatedly present physical documents (IATA, 2024). By ensuring that passengers are ‘flight-ready’ before arriving at the airport, One ID improves the travel experience through digital identity technology, making the process smoother and more efficient.

The integration of biometric technologies in aviation, particularly through IATA's One ID, offers more significant passenger benefits. This decentralised digital identity framework allows passengers to control their identity information, sharing it directly with relevant parties only with the consent and to the minimum required extent. One ID also enhances privacy protection and provides the convenience of electronic data sharing, eliminating the need for manual data entry (IATA, 2023). These advancements align with existing literature, highlighting the potential of biometrics to improve efficiency, security, and passenger satisfaction in aviation.

Lastly, Heiets (2022) examined the reliability of various biometric systems, including facial recognition, fingerprint recognition, and others. The study found that the majority of passengers perceived these systems as reliable, with less than 10% reporting frequent problems. Fingerprint recognition in particular was noted for its accuracy and reliability, positively impacting the passenger experience by ensuring smooth and seamless verification processes.

3. Research Gap & Research Questions

3.1 Research Gap

Existing research is dominated by quantitative approaches, focusing on statistical analyses and large-scale surveys to understand passenger behavior and preferences. This prevalence highlights a gap in the literature, where the subjective experience of passengers, particularly in terms of the impact of digital transformation, remains unexplored. By adopting a qualitative approach, this study aims to fill this gap, providing a deeper understanding of individual perceptions and experiences that quantitative methods may miss. What is more, some of the studies above were not looking at frequent flyers, but this paper will focus on this unexplored group of passangers.

Despite extensive research into the operational benefits and efficiencies of digital transformation in the aviation sector, several additional critical gaps remain unexplored, most notably passenger preferences for future digital innovations, usability, and user experience issues, and the emotional and psychological impact of these technologies.

The aviation industry has experienced significant transformations since its inception in the 20th century, with digital transformation emerging as an essential factor (Horonjeff et al., 2010; Scribner, 2023). However, digitalisation has been shown to enhance operational procedures and passenger experiences (Murugan, 2024). However, current research frequently fails to consider passengers' preferences and expectations for future digital technology advancements. Existing literature fails to address the digital functions and services that passengers desire sufficiently. This gap demands qualitative research to capture passengers' opinions of desirable digital features and services, as well as understanding how they perceive the role of digital technology in improving their overall travel experience.

Furthermore, there is a noticeable gap in detailed qualitative data on the usability and user experience concerns passengers have while using digital technologies such as self-check-in, e-ticketing, self-bag drop, and biometrics. While the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) frameworks explain the factors that influence technology adoption (Davis, 1989; Venkatesh et al., 2012), additional study is needed into the specific usability challenges that passengers face, their perceptions of

ease of use, and potential areas for improvement. Conducting interviews in the form of qualitative research is essential for gathering input on these factors and addressing usability concerns with existing edigital solutions. Furthermore, the emotional and psychological impact of digital transformation on travellers is an unexplored area. Although digital technologies can improve the passenger experience (IATA, 2022), current studies do not fully examine how these technologies affect passengers' levels of stress, anxiety, and confidence while traveling. Furthermore, there is a lack of awareness of passenger privacy and data security concerns, particularly in the context of biometric technologies (Jain & Kumar, 2010; Labati et al., 2016). Investigating emotional and psychological components through qualitative research can provide insights into the impact of digital technology on passenger well-being, as well as identify areas for development to increase trust and minimise travel-related discomfort.

This dissertation aims to fill these gaps by exploring passenger satisfaction and perceptions of digital technologies at different stages of the travel journey. Analysing customer demands and preferences based on gender, age, destinations, and purpose of travel can suggest a direction for future studies for planning future growth and investment. The main motivation for this study is to explore passenger satisfaction and needs in a very rapidly evolving aviation sector.

3.2 Research Questions

- How can airlines effectively leverage digital innovations to enhance passengers' travel experiences while addressing their concerns about usability, privacy, and emotional well-being throughout their journey?

- What are the specific preferences and expectations of passengers regarding future digital innovations in the aviation industry?

- What are the usability and user experience challenges that passengers encounter with digital technologies such as self-check-in, e-ticketing, self-bag drop, and biometrics?

- How do digital technologies, such as biometric boarding and baggage tracking, impact passengers' levels of stress, anxiety, and overall emotional well-being during travel?

- What are passengers' primary concerns regarding privacy and data security when using digital technologies in aviation, and how can airlines address these concerns to build trust?

- In what ways do passengers believe digital technologies can improve their overall travel experience from booking to post-travel, and what specific digital features or services do they wish airlines would implement in the future?

4. Methodology

4.1 Research approach and strategy

The study focuses on the aviation sector and targets frequent travellers who have substantial experience with both business and leisure travel at different stages of their travel journey. In understanding the transformation of digitalisation and its impact on passengers, it is crucial to analyse their motivations, preferences, opinions, and challenges toward advancements in digital technologies. The study area is focused on both ground and in-flight experiences providing the study to capture the full view of interactions passengers have with digital technologies, from initial home check-in to flight activities. Combining applied digital technologies at different journey stages, this study aims to collect comprehensive data on the passenger experience, thus providing broad findings on how digital innovations are perceived and used. This approach is crucial in understanding the evolving environment of air travel and ensuring that future developments align with passenger needs and preferences. Considering, the research question to understand the 'why' and 'how' behind the impact of digital transformation on frequent travellers, a qualitative approach is the most appropriate (Bryman, et al., 2019)

The research methodology used in this study is grounded in ontology and epistemology, providing a framework to explore the impact of digital innovations on frequent air travellers. Ontologically, the study acknowledges the diverse and subjective realities shaped by travellers' interactions with digital technologies during their travels (Guba and Lincoln, 1994). This perspective is consistent with constructivist ontology, which emphasises the importance of understanding phenomena from the perspective of the participants (Gergen, 1999).

From an epistemological perspective, the study adopts an interpretive approach to explore travellers' subjective meanings, interpretations, and experiences of digital transformation in air travel (Creswell, 2013). What is more, qualitative method is grounded in interpretivism, which aims to understand the subjective experiences of participants through in-depth interviews (Denzin & Lincoln, 2006). Qualitative methods, such as in-depth interviews, were used to capture insight into how travellers perceive, adapt to, and use technological advances. Neverthless, the flexibility and depth of qualitative research can also introduce variability and interviewer bias, which may affect the consistency and objectivity of the data collected (Patton, 2002).

Furthermore, qualitative methods are better suited to an in-depth study of human perception and behaviour. In addition, the words and statements of participants provide a deeper understanding that is often more insightful than quantitative data (Silverman, 2013). However, this broad scope introduces challenges for researchers in terms of complexity in data integration and analysis, requiring significant resources and careful data management.

Qualitative research provides a way to capture changing attitudes in a target audience, such as customers of a product or service (Gill et al., 2008). The approach supports understanding complex phenomena from the perspective of those who experience them (Patton, 2002). As a qualitative method, interviews are often used to assess thoughts, opinions, and feelings, high representativeness, and convenient data collection (Gobo, 2004; Moser et al., 2018). On the other hand, the process of conducting and analyzing in-depth interviews requires significant resources, time and effort (Gobo, 2008).

The literature supports the use of semi-structured interviews by highlighting their adaptability and capacity to delve further into participants' feedback (Kvale, 2007). Rich and detailed data that quantitative approaches could miss can be captured by researchers using this strategy.

(Creswell & Porth, 2016). Additionally, standardized questionnaires could not adequately capture the range of passenger experiences in comparison to qualitative interviews that are supportive of exploring new findings such as the impact of digital, especially in the influence of digital transformation in aviation (Rubin & Rubin, 2011).

4.2 Data collection

4.2.1 Semi-structured interview

The use of semi-structured interviews is appropriate for comprehending the complex aspects of digital transformation within the aviation industry (Kallio et al., 2016). This method facilitates in-depth exploration of individual perceptions and experiences, providing rich data that quantitative approaches may overlook (Longhurst, 2003; Creswell, 2013).

Semi-structured interviews combine the advantages of structured and unstructured interviews. Structured interviews are based on a predetermined set of questions, ensuring consistency across interviews, while unstructured interviews offer a more spontaneous interaction without a set agenda (Zhang & Wildemuth, 2009). The semi-structured approach adopted in this study ensures that core themes are consistently addressed through a set of open-ended questions while providing participants with the freedom to express their own opinions and personal experiences. In addition, the method is effective for exploring the impact of digital transformation in the aviation sector, as it allows for the collection of rich qualitative data that may be overlooked by more quantitative rigid methods (Adams, 2015).

Compared to structured and unstructured interviews, semi-structured interviews offer a balanced methodological framework. Structured interviews, characterised by a rigid format, are unable to capture the depth and breadth of participants' experiences. Conversely, unstructured interviews that are flexible may lack focus and consistency (Longhurst, 2003). The semi-structured format used in this study uses a flexible questioning framework that ensures that all relevant themes are covered and allows the interviewer to analyse responses in greater depth and gain detailed insights (Galletta, 2013).

As this study aims to understand the passenger experience and the impact of digital technologies, the semi-structured interview method is particularly appropriate. In particular, this study aims to explore how digital advances affect various aspects of passenger travel,

including convenience, efficiency, and overall satisfaction. Due to individual differences in travel behavior and perceptions, participants will provide diverse and unique insights. Capturing these varied responses requires a flexible approach to data collection, allowing the researcher to delve into personal experiences. This method ensures that all topics are addressed allowing interviewees to express their thoughts and experiences comprehensively.

I conducted four one-on-one interviews online using the Microsoft Teams platform. The choice of the Teams platform was based on accessibility and convenience for participants who were often traveling and had busy schedules. Despite their busy travel schedules, conducting the interviews online allowed for greater flexibility and participation without the need to be present on-site. The use of technology in Teams enabled me to observe participants and capture non-verbal cues such as body language, which enriched the data collection process. Additionally, high-quality audio recordings were made possible through Teams, enabling accurate transcription and the ability to review and take detailed notes. This approach ensured that the interviews were conducted effectively, gaining valuable insights into how digital technologies impact passengers' travel experiences.

4.2.2 Participant selection

Participants in this study are frequent travellers, aged between 20 and 30, who regularly travel for business and leisure purposes. Participants were recruited through convenience sampling, including colleagues and ex-colleagues who meet the criteria of frequent travellers. This approach to recruitment ensured a diverse and representative sample. Participants received by email a detailed information sheet about the study. In the end, four participants were chosen based on their travel experience. This diverse group provided a wide range of insights into the impact of digital technologies on passengers' travel experiences.

4.2.3 Participant characteristics

Participants in this study provided diverse perspectives on digital transformation in the aviation sector, representing varied demographic backgrounds and travel experiences. Participant 1, a 21-year-old male from Great Britain with a bachelor's degree, engages in leisure travel primarily within Europe and the Middle East, with Barcelona as his central hub. Participant 2,

a 23-year-old male from Poland with a bachelor's degree, travels for leisure mainly across Europe, using Warsaw as his primary hub. Participant 3, a 30-year-old female from Kazakhstan, undertakes leisure and business travel, frequently journeying between New York and Asia, particularly Japan, with New York serving as her travel hub. Participant 4, a 22-year-old male from Pakistan and an undergraduate student, travels for business and leisure across the UK, USA, and Pakistan, with Doha as his hub. These participants' experiences provide a comprehensive overview of the impacts of emerging digital technologies on consumer experiences within the aviation industry.

4.3 Semi-structured interview guide

During the semi-structured interviews, I focused on exploring the impact of digital transformation on the travel experience of frequent travellers in the aviation sector. The set of nine questions was divided into three main sections: general information about the participants, specific questions about digital use and experience, and summary questions about overall insights and suggestions. In addition, further questions were asked during the interviews based on the different responses of the participants to gain deeper insights and understanding.

The first section introduced the participants to the study and collected personal data. Firstly, I introduced the purpose of this study and acknowledged the participants. Afterward, I explained the importance of understanding digital transformation in aviation to introduce the topic and allow the participants to have an understanding of the interview. I avoided detailing the theoretical background and examples to minimise misunderstanding. Participants were asked to provide their age, gender, country of origin, level of education, the purpose of travel (business, leisure, or both), and the areas or countries they usually travel to.

The second section explored participants' experiences with digital technologies during their travel journey. In exploring the relevance of digital transformation, I asked participants to discuss different aspects of their travel experiences. Participants were asked what they thought about the use of biometric technologies, such as facial recognition and fingerprint scanning during check-in and boarding, and where they had experienced these technologies. In addition, they discussed their privacy and security concerns about their biometric data and how airlines could address these concerns. The section also covered advanced real-time baggage tracking

systems, asking participants whether they had experienced use of it. Additionally, participants discussed the features of in-flight entertainment systems they found most valuable, how can be improved, and any specific content or features they wanted. The impact of self-service technologies, such as check-in and self-baggage kiosks and e-ticketing was also examined, along with any challenges they faced and suggestions for improvement. Finally, participants' comfort with adapting to new digital technologies introduced by airlines was discussed, including any experiences while adapting to new digital services and suggestions for resources that airlines should provide.

In the third part, I wanted to understand the overall impact of digital transformation on travellers experience and collect their suggestions for future improvements. This section explored how digital technologies, such as biometric boarding or baggage tracking, affected their stress levels and emotional well-being while traveling. Participants shared experiences in which digital technologies either increased or decreased their stress or anxiety related to travel. This section also explored how digital technologies affected their confidence in the efficiency and reliability of airline service and concerns about the security of their personal information when using digital technologies. Finally, participants were asked to provide their impressions of the impact of digital transformation on their travel experience and to suggest specific improvements or changes that could improve the emotional and psychological aspects of the use of digital technologies in aviation.

Appendix 1 contains a copy of the original question list used in the semi-structured interviews. As previously mentioned, because of the nature of a semi-structured interview, additional questions that were not on the list were asked on an individual basis.

4.4 Data analysis

At the end of each interview conducted via Microsoft Teams platform, all the responses were collected and sorted in folder. Data was accurately transcribed by oTranscribe transcription software in written and audio form. In addition, notes were also taken during the interviews, which were also included in the transcription of the data. The procedure allowed me to review all the data collected and to gain a deeper understanding of the participants' statements

and reflections. After completing the transcription, I analysed the participants' statements and found similarities and differences, which will be discussed in later sections.

4.5 Ethical considerations

Ethical considerations included informed consent, confidentiality, and the welfare of participants were covered to protect well-being of all partiicpants. All participants received a participant information sheet detailing the purpose of the study, procedures, potential risks, and benefits. Participants had to give informed consent before taking part in the interviews, ensuring that they were fully aware of their rights, including the ability to withdraw from the study at any time without any consequences. To protect the privacy of the participants throughout the research process, all data collected during the interviews was pseudonymised. Data were securely stored in a OneDrive folder with access restricted to the researcher and supervisor. These measures comply with the University of St Andrews' data protection policy and ethical guidelines. The study was designed to minimize any potential distress or discomfort to participants. The online interview format was chosen for convenience and to reduce any stress associated with face-to-face interviews. Participants were informed that they could skip any questions they did not wish to answer and could withdraw from the study at any point.

5. Findings

5.1 Biometric technologies

The use of biometric technologies, such as facial recognition and fingerprint scanning, is becoming more common at major airports, with different experiences and concerns reported by participants. Most respondents stated that biometric technologies greatly enhance the convenience and efficiency of airport processes. Participant 1 was positive about the implementation at Edinburgh Airport, describing the process as "easy and simple" and "fantastic; it was revolutionary and shortened the immigration queue, speeding up the process". Similar comments were made by Participant 2, who highlighted the speed of the check-in and boarding process, stating: "It made the check-in and boarding process faster and faster". Additionally, Participant 4 highlighted the time-saving aspect, saying: "It's an excellent

initiative because it helps speed up the process because I don't have to queue for a long time to board".

These positive experiences are consistent with the Technology Acceptance Model (TAM), which suggests that perceived usability and ease of use are critical factors in determining user acceptance of new technologies. The participants' feedback is consistent with findings in the literature that efficiency and convenience are important factors influencing the adoption of biometric technologies in aviation (Davis, 1989; Venkatesh & Davis, 2000).

Although recognising the benefits, participants expressed varying levels of concern about data privacy. Participant 1 acknowledged the potential risks, stating: "I'm a bit worried about my data being stolen by hackers. However, I trust the current systems and privacy policies in the airline industry, especially after the 9/11 attacks'. What is more, Participant 2 indicated a high level of confidence in the security of digital systems, noting: "I don't have any concerns because digitisation is the future. Nowadays, storing data in the cloud is more secure. In contrast, Participant 3 had a less favorable view of facial recognition technology, finding it inefficient and time-consuming. She said: “Personally, it doesn't save me time. Every time I go to the face scanner, it doesn't recognise my face and I have to go in person. It's a waste of time.” Her main concerns were data privacy and the lack of choice in using these technologies. She stated: “My only concern is whether any country has access to this. They are taking away my freedom of choice of options; I don't like it.”

The results indicate a general trend toward acceptance of biometric technologies due to their convenience and efficiency. The positive experiences indicated by participants 1, 2, and 4 suggest that when biometric technologies work seamlessly, they are highly valued due to time savings. On the other hand, the concerns reported by Participant 3 highlight the importance of addressing issues related to the accuracy of biometric systems and the need for user autonomy in opting out of such technologies.

5.2 Baggage Tracking System

The implementation of advanced baggage tracking systems received mixed reviews from participants, with experiences ranging from very positive to indifferent. For instance,

Participant 1 reported a highly positive experience with these systems at Barcelona El Prat and Dubai International Airport. He emphasized the importance of real-time tracking, stating, “It's so relaxing to see the current status of the baggage that is traveling with me.” Using the airline app for this purpose, he rated it "10 out of 10" for its effectiveness and performance, indicating a high level of satisfaction and trust in the system. What is more, similar findings were observed by Participant 2 who recognised their potential value, particularly while traveling with expensive items. He mentioned that receiving notifications about baggage delays on his mobile phone was somewhat useful, indicating an appreciation for the information even in limited use.

In contrast, some participants were more indifferent towards baggage tracking systems, due to their travel habits and necessity. For example, Participant 3 usually carries expensive items with her and does not rely on checked baggage. She stated, “It's not important to me. If I have important things, I take them with me”. Although she used United's tracking app but did not find it particularly useful and does not usually track her baggage. It highlights a segment of travelers who may not see significant value in such systems due to their preference for carrying essential items personally. Similarly, Participant 4 had never experienced advanced baggage tracking systems but believes that this advancement would be psychologically beneficial, even if it would not drastically change his overall travel experience. He stated, “It would be good to know where my luggage is, but it would not change my travel experience.” His lack of use of mobile apps for tracking luggage points to a gap between the availability of technology and its adoption by travelers.

5.3 In-Flight Entertrainment Systems (IFE)

The evolution of in-flight entertainment (IFE) systems has led to a range of responses from participants, illustrating different preferences and expectations of these services.

Participant 1 valued the availability of screens and the ability to watch TV and films and emphasised the importance of IFE systems, particularly on long-haul flights. He noted: “The most valuable features are the screen and the ability to watch TV and movies”. However, he suggested improvements such as faster Wi-Fi and larger screens in economy class, indicating a desire for a better viewing experience. Similar to participant 1, participant 2 also found the IFE map showing the current location and duration of the flight useful. He mentioned: “The most valuable feature, which I always find useful even on short flights, is the IFE map showing

the current location of the aircraft and the duration of the flight." Although he rarely uses the IFE system to view videos due to having his own devices. Participant 2 suggested that airlines could offer unlimited free Wi-Fi instead of IFE screens, reflecting a preference for connectivity over traditional entertainment options.

What is more, Participant 3 values the IFE systems, focusing on the geographic map and movie catalog. She finds the map function convenient as it helps her prepare for landing. However, she expressed dissatisfaction with the quality of the headphones provided and the selection of films, highlighting problems with the visibility of adult content. "The problem is that all the films show adult content; if there's an intimate scene, I feel shy that the people around me can see it" - suggesting the need for more privacy and more carefully selected. Participant 4 similar to Participant 3, values the travel route information and entertainment options provided by IFE systems. He enjoys the movies and TV shows available during flights and occasionally uses in-flight Wi-Fi. Participants also suggested that airlines should partner with streaming services like Netflix and Amazon Prime to offer a broader selection of entertainment. "Airlines should partner with Netflix and Amazon Prime rather than just having specific movies," he proposed, reflecting a desire for a more diverse and personalized entertainment experience.

5.4 E-tickets and mobile check-in

The use of e-tickets and mobile check-in processes was broadly supported by participants, who highlighted their efficiency and convenience. The feedback revealed several common themes, including the improvement in travel experience, the need for additional infrastructure, and the occasional technical issues encountered. Participant 1 found adaptation to new technologies relatively easy, noting: "The process was very efficient and useful as I did not have to go through a traditional check-in". Similarly, Participant 2 valued the convenience and speed of the process, despite having encountered issues with British Airways' online check-in system. What is more, Participant 4 highlighted the ease of use and time savings, particularly for domestic flights, stating, "I use it quite often on domestic flights with EasyJet." However, most of the participants suggested that airlines could improve the adaptation process by providing more technical advisors to assist passengers, especially during security screening.

While the convenience of e-tickets and mobile check-in is evident, participants also pointed to the reliance on their mobile devices and the associated need for appropriate infrastructure. Participant 1 mentioned the need for more charging points near the gates to address low battery situations during long queues. Participant 3, who frequently uses e-tickets, shared similar concerns about battery life, suggesting that additional charging stations near check-in locations would address this issue. She stated: 'I use e-tickets 90% of the time; I don't need to print them because I have them on my phone or virtual wallet.'

Despite the positive feedback, technical problems with e-ticketing and mobile check-in werev also reported. Participant 2 recounted a specific incident with British Airways in which the online check-in system failed, requiring a visit to the airport that highlighted the lack of immediate support. The incident emphasises the importance of reliable digital systems and the need for effective customer service mechanisms when issues occur.

5.5 Adaptation to Digital Technologies

The adaptation to new digital technologies introduced by airlines varied among participants, highlighting different levels of comfort and the need for support. Many participants found the adaptation to new digital technologies relatively smooth, primarily due to their familiarity with digital tools.

Participant 1 mentioned, "I was born in the 21st century and for me, it is easy to adapt to different technologies." This ease of adaptation was mentioned also by Participant 2, who stated, "It is easy for me because I am young and I use it often." Both participants highlighted the benefits of frequent use and familiarity with digital technologies in facilitating their adaptation. However, they also suggested improvements. Participant 1 recommended that airlines should provide more technical advisors to assist passengers, especially during security screening, stating, "Security staff should be more open and helpful to new passengers." Participant 2 emphasised the importance of clearly advertising tutorials provided by airlines, citing British Airways as a positive example for its guided app tutorial.

In contrast to positive experiences, participant 3 reported discomfort with adapting to new digital technologies, indicating a preference for traditional, human-centered processes. She

explained: "I don't feel comfortable at all because since I had to scan my paper and my face, I didn't have a free option to choose". Her main concerns were privacy and the impersonal aspect of digital processes. She suggested that airlines should provide more choices and instructions, such as notifying passengers about the check-in process in advance and specifying which technologies will be used.

Similarly, participant 4, while feeling comfortable with digital technologies, admitted to initial confusion during his first experience of digital check-in at London Gatwick Airport. Nonetheless, he said the technological enhancements greatly improved his travel experience, stating: "I feel quite comfortable because it improves my travel experience. I save a lot more time with online check-in, biometric and facial recognition, and faster baggage handling". He recommended that airlines should offer a choice between tutorials for first-time users and a seamless process for experienced travellers, suggesting: "There should be an option for both people: those using such technologies for the first time and those who have already used them".

Participants' responses highlight the general trend of a smooth adaptation to digital technologies among younger and more digitally familiar travellers, who value the efficiency and time savings that these technologies provide. However, they also emphasise the challenges faced by those less familiar with digital processes, highlighting the need for additional support and communication.

5.6 Emotional and Psychological Impact of Digital Transformation

The emotional and psychological impact of digital transformation in the airline sector varied significantly among participants, reflecting a range of reactions and concerns. For many participants, digital technologies such as biometric boarding and baggage tracking had a positive impact on their travel experience, reducing stress and improving overall well-being.

Participant 1 highlighted that these technologies make him feel less stressed when travelling, stating: "To be honest, it reduces my stress levels. I feel a lot less stressed: His confidence in the efficiency and reliability of digital technology is high, as he rarely encounters problems. This is consistent with the experience of Participant 2, who noted: "If the technology works, it reduces stress. If it doesn't work, it increases stress". Similarly, participant 4 reported a positive

impact of digital technologies on his stress levels and travel experience. He noted that doing tasks in advance reduces last-minute stress and streamlines the travel process: "Doing everything in advance instead of waiting until the last minute has had a positive impact on my travel experience". His high level of confidence in the reliability of digital technology follows from its use in other areas, such as mobile phones.

Despite the overall positive impact on stress levels for some individuals, privacy concerns were a significant source of stress. Furthermore, Participant 3 experienced an increase in stress levels due to digital technologies, particularly those related to biometric data. She expressed serious privacy concerns and discomfort with the lack of choice in using these technologies. “It has hurt stress levels. Digital technology adds to my stress. Primarily privacy issues; the whole experience is robotic.” - She explained. Her confidence in the effectiveness of digital technologies is mitigated by concerns about data security and the potential misuse of biometric data by various countries. She suggested that digital services should be optional to increase trust and give passengers more control. She mentioned: "The use of them should be optional. I would like to be able to choose between human and technological services.” Participant 1, despite a positive experience, shared similar concerns about data security, particularly the risk of identity theft, suggesting that airlines should offer compensation in the event of a data breach: "I don't want my identity to be stolen. Airlines should offer compensation if there is a data breach and my data is taken." Participant 4 did not express significant privacy concerns but emphasised the importance of strict data security rules to maintain trust. He suggested that airlines should implement policies to ensure that customer data is not shared with third parties and is destroyed after a certain period.

5.7 Role of Digital Technologies in Overall Travel Experience

The integration of digital technologies in the airline sector had a significant impact on the overall travel experience. Participants highlighted various benefits and areas for improvement, with their feedback regarding efficiency, real-time interactions, and the need for flexibility and personalisation.

Digital technologies have made the travel journey process more efficient and enjoyable. Participant 1 highlighted how these technologies improve the whole journey, from booking to

travel: "They make it so much better, more efficient, faster, better. I think it's really great". He particularly appreciates the availability of Wi-Fi during flights, suggesting that it improves the travel experience. Similarly, Participant 2 highlighted how digital technologies streamline and speed up various aspects of the travel process: "Digital technologies can make the process more transparent and faster." He believes that in the future, airlines will use technology to increase efficiency and profitability: "This is the future of airlines, to make more money".

The importance of real-time digital interactions was a repeated theme among participants. Participant 1 noted that real-time interactions throughout the journey are "really important" for a positive experience. Participant 2 similarly to Participant 1, stated the importance of real-time support, such as live chat, for immediate staff assistance: "It's always good to have real-time interactions and support, such as live chat, for immediate help". These interactions are crucial in improving travel experience by providing timely assistance and information. Furthermore, Participant 3 also highlighted the value of real-time digital interactions, especially when direct contact with airline representatives is difficult: "Yes, it's very important. It is very difficult to talk to a representative on the phone". This highlights the role of digital technologies in facilitating communication and support during travel.

While generally satisfied with current digital technologies, some participants highlighted the need for more flexibility and personalized options in the travel process. Participant 3 in compare to others, is generally satisfied with the current digital technologies. However, she emphasised the need for more flexibility and personalized options in the travel process. She mentioned: ”I am happy with the current technologies”, but stressed the importance of being able to edit personal information such as passport numbers or names.

5.8 Desired Digital Features and Services

Participants expressed varied ideas for additional digital features and services to improve their travel experience. Participant 1 highlighted the need for instructions when purchasing tickets and suggested improving customer service at airports to help those unfamiliar with technology: "Better and clearer guidelines when purchasing a ticket". He noted that the availability of support staff would be beneficial, especially when using new technology. It was also noted by Participant 3, who praised customer service in other industries, such as Apple, and suggested

similar improvements for the aviation sector: "For example, the customer service at Apple is amazing, and I am always satisfied. Customer service at airports could be much better". She emphasised the need for more staff assistance with new technology and provided better guidance, making the adaptation process smoother for all travelers.

Participants also suggested integrating digital services from other industries into aviation to enhance convenience and customer satisfaction. For example, Participant 2 proposed the comfort of ordering food or drinks via an app or in-flight entertainment system on short flights: "Maybe a feature for short flights that allows ordering food or drinks from my app or IFE". This idea emphasised the potential for cross-industry innovation to improve the travel experience. Participant also highlighted the need for the performance improvement of current mobile apps: "Mobile apps and their software should be much faster, and airlines should add more features".

Furthermore, participants also identified the need for flexibility and personalised options in the check-in process. Participant 3 found the idea of checking in luggage the day before the trip convenient, especially for those who want to explore the city without carrying luggage: "It sounds really convenient. Sometimes I want to spend time in the city before going to the airport, but carrying luggage is a problem."

Participant 1 also considered the idea of sending luggage via a machine the day before the trip attractive: "It's an amazing idea. I would use this option if it were available. Similarly, participant 2 supported the idea of registering luggage the day before travel, noting: "This is a very good idea for customer service and I would like to register". However, participant 4, unlike the others, was not interested in this option, stating: "I would not like to have such options and use them because I always pack until the last minute". This highlights the need for airlines to offer flexible options that cater to different traveller preferences.

6.Discussion

This study aims to fill gaps in the existing literature by exploring the subjective experiences of frequent flyers with digital transformation in the airline industry, focusing on passenger preferences, usability, and emotional well-being. The results indicate that digital technologies

such as biometric systems, baggage tracking, and in-flight entertainment systems increase efficiency and convenience, but also cause significant privacy and usability concerns. This analysis supports that technological advances with human-centered support can significantly improve passenger satisfaction. The findings suggest that future digital innovations should prioritise privacy, usability, and more personalised services to meet passenger needs and improve the travel experience.

To illustrate this in further detail, the research questions are answered below, providing a comprehensive analysis of how airlines can effectively leverage digital innovations to enhance passengers' travel experiences while addressing their concerns about usability, privacy, and emotional well-being throughout their journey:

- **How can airlines effectively leverage digital innovations to enhance passengers' travel experiences while addressing their concerns about usability, privacy, and emotional well-being throughout their journey?**

The results of this study confirm the positive impact of digital innovation in aviation, according to the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Davis (1989) emphasised the importance of perceived usability which is supported by the results showing that technologies such as biometric boarding and baggage tracking significantly reduce passenger stress and increase travel efficiency. Participants 1 and 2 described biometric boarding as easy and straightforward, valuing the reduction in waiting time in the immigration queue, which is consistent with findings. Venkatesh and Davis' (2000) extension of the TAM model to include social impact and cognitive processes is consistent with participants' concerns about data security and the need for customer service support during digital processes at airports, as highlighted by participant 3's concerns about privacy and lack of choice.

This study reinforces the TAM model, indicating that participants reported reduced stress and improved travel efficiency with the use of biometric boarding, baggage tracking systems, and mobile check-in. Participants 1, 2, and 4 emphasized the speed and efficiency of the check-in and boarding process facilitated by biometric technologies. This is consistent with Hu et al.

(2022), who found that perceived usability and simplicity significantly increase passenger satisfaction and technology adoption rates. However, the findings from this paper extend the understanding of TAM by highlighting the dual role of these technologies in improving both operational efficiency and emotional well-being. Previous research has focused primarily on operational benefits, but this study highlights the emotional well-being provided by real-time baggage tracking and enhanced boarding processes as equally important, as evidenced by Participants 1 and 2's positive feedback on baggage tracking advancments.

Privacy and data security appeared as significant concerns among participants, particularly in the case of biometric technologies. Participant 3's dissatisfaction with biometric systems and concerns about data privacy illustrates the need for robust data protection measures, as evidenced by studies by Jain and Kumar (2010) and Labati et al. (2016). Participant 1 was concerned about data theft, but trusted current systems and privacy policies. On the other hand, Participant 2 expressed high confidence in the security of digital systems, perceiving digitalisation as the future. These different views suggest that airlines need to transparently communicate their data security policies and provide robust protections to build trust. Addressing privacy concerns is not only a technical issue but also a psychological one, requiring passengers to feel confident about the security of their data (Westin, 1967; Anderson and Rainie, 2018). This finding reflects the data from IATA (2023) report, which emphasises the need for transparency and robust data security practices to build passenger confidence.

- **What are the specific preferences and expectations of passengers regarding future digital innovations in the aviation industry?**

The study identified several key passenger preferences and expectations for future digital innovations in aviation. Firstly, passengers prefer real-time information systems, particularly for baggage tracking, which reduces anxiety and increases trust in airlines. This is consistent with Hu et al.'s (2022) findings on the importance of usability and simplicity. Participants 1 and 2 found real-time baggage tracking to be highly effective, emphasising the importance of these systems in improving their travel experience.

Participants also prefer streamlined processes, such as biometric boarding and mobile check-in, which increase convenience and reduce waiting times. This supports the thesis of Venkatesh et al. (2012), who noted that efficiency is crucial to technology acceptance. Participants 1 and 4 were positive about the speed and convenience of biometric boarding, while participant 3 expressed dissatisfaction with the inefficiency and lack of choice, highlighting the need to improve both accuracy and user autonomy.

However, privacy and data security have emerged as significant concerns, particularly with biometric systems, confirming the concerns expressed by Jain and Kumar (2010) and Labati et al. (2016). Passengers are demanding greater transparency and robust security measures to protect their personal data. Participant 3's dissatisfaction with biometric systems and concerns about data privacy indicates a critical need for protection of personal data. In addition, Participants 1 and 2 also expressed concerns about data security, with participant 2 showing more confidence in the current systems.

In addition, there is a high demand for personalised and flexible travel options. Participant 1 appreciated the availability of screens for watching TV and movies, especially on long-haul flights. In contrast, Participant 2 preferred having unlimited free Wi-Fi over traditional in-flight entertainment. However, Participant 3 was dissatisfied with the limited selection of movies and privacy aspects, indicating a need for more personalised and private entertainment options, as discussed by Pine and Gilmore (2000). Additionally, all participants highlighted the need for better user interfaces and intuitive design of digital platforms, aligning with Bharadwaj et al. (2013) on the importance of user-friendly interfaces.

Furthermore, participants also highlighted the need for alternative baggage check-in options, which is consistent with the IATA (2022) survey. Passengers want new solutions and more convenient baggage handling options, such as the transfer of baggage from home to destination by airlines services. Participant 1, 2 and 3 suggested that such services would be highly convenient, especially for those who do not want to carry on a luggage while heading to the airport.

- **How do digital technologies, such as biometric boarding and baggage tracking, impact passengers' levels of stress, anxiety, and overall emotional well-being during travel?**

The study found that digital technologies, such as biometric boarding control and baggage tracking, have a significant impact on passengers' stress, anxiety, and overall emotional well-being while travelling. These advancements can alleviate or increase stress and anxiety, depending on their reliability. Similar to the findings of SITA (2018), Participants 1 and 2 appreciated the efficiency of biometric boarding, noting how it reduced their stress by streamlining processes and reducing waiting times, which is consistent with Davis (1989) emphasis on ease of use reducing user anxiety.

In addition, real-time baggage tracking significantly reduced anxiety associated with lost baggage, supporting findings from the IATA Global Passenger Survey (2019), which found increased passenger safety and reduced stress with real-time tracking. Participants 1 and 2 found real-time tracking highly effective, as it provided them with live updates on their baggage status. However, Participant 3, who prefers to carry valuable items personally, did not find the system beneficial, illustrating that the perceived value of this technology can vary based on individual travel habits and preferences.

Furthermore, the emotional well-being of these technologies depends on passengers confidence in their reliability and safety. Participants who trusted privacy systems reported lower stress levels. Participant 2 expressed a high level of confidence in the security of digital systems, which led to a more relaxed travel experience. At the same time, sceptics such as participant 3 felt increased anxiety negatively impacting their travel experience due to concerns about data privacy and lack of choice in using these technologies. This extends previous findings, highlighting the need for robust data protection and reliable technology to reduce stress and anxiety.

Lastly, findings in this paper highlight the crucial need for immediate human support during digital processes. Participants expressed frustration at the lack of immediate support when digital systems failed, highlighting the importance of customer service support available on-site. Participant 3 mentioned in particular the stress caused by biometric systems not recognising her face, compounding the lack of immediate assistance. Similar findigns were

discovered by Heiets et al. (2022), who identified the failure of digital systems to resolve issues quickly as a significant drawback. Providing adequate customer service can reduce the anxiety associated with digital technology, thus increasing overall passenger satisfaction.

- **What are passengers' primary concerns regarding privacy and data security when using digital technologies in aviation, and how can airlines address these concerns to build trust?**

The study identified significant passenger concerns about privacy and data security while using digital technologies in aviation. In particular focusing on the potential inappropriate use of biometric data and the risk of data breaches. These concerns are consistent with the literature review, highlighting privacy and security issues associated with biometric technologies (Jain & Kumar, 2010; Labati et al., 2016). Participants 1, 2 and 3 expressed varying degrees of concern about data security, highlighting the need for airlines to provide accessible information about their data security practices to mitigate these concerns. This aligns with Venkatesh et al.'s (2012) view on the importance of transparency in technology adoption. It is also consistent with the IATA (2023) report, which underlines the importance of transparency in building passenger trust

Furthermore, the findings suggest that the emotional impact of data security concerns on passengers' overall travel experience is more significant than previously understood. While previous studies (Charness et al., 2009; Hill et al., 2015; Hu et al., 2022) focused primarily on operational and efficiency benefits, this study points to significant psychological aspects associated with these concerns. For example, Participant 3 reported increased anxiety due to privacy concerns and the perceived lack of control over her data, indicating that airlines should not only focus on technical measures but also consider the emotional well-being of passengers when addressing data security issues.

The participants of the study also found regular updates on security improvements positively which reinforced their confidence in the airline to protect their information. Participants 1 and 2 valued regular communications about data security measures as helping to build their confidence in the airline's ability to protect their information. This suggests that airlines should

proactively communicate their data security efforts to build and maintain passenger confidence, which is essential to enhance passenger trust in airline data protection practices

- **In what ways do passengers believe digital technologies can improve their overall travel experience from booking to post-travel, and what specific digital features or services do they wish airlines would implement in the future?**

The research reveals that passengers believe digital technologies can significantly improve their overall travel experience, from booking to travel, by improving convenience, efficiency, and personalisation. These responses are consistent with the literature review, providing findings of passenger expectations of future digital innovations in the airline industry. Participants emphasised the importance of streamlined booking and check-in processes, highlighting the positive impact of e-tickets and mobile check-in systems on the travel experience. Similar findings were described by Brandenburger and Nalebuff (1996), who identified reduced booking times and faster check-in procedures as the main benefits of e-tickets. Also, participants have suggested that airlines should further develop user-friendly interfaces and intuitive designs for booking platforms.

Participants 1 and 2 particularly appreciated the convenience of e-tickets and mobile check-in, noting that these technologies made their journey easier by reducing the time spent on traditional check-in procedures. Participant 4 mentioned the ease of use and time savings associated with mobile check-in, especially for domestic flights, which supports the findings of Brandenburger and Nalebuff (1996). In terms of desired digital features, participants expressed a strong preference for user-friendly interfaces and intuitive designs for booking platforms. Participant 2 emphasised the need for clear instructions and easy navigation, which is in line with Bharadwaj et al.'s (2013) research on the importance of user-friendly interfaces in digital adoption. This suggests that while current systems are beneficial, there is potential to improve their design and usability.

6.1 Limitations

Despite the valuable insights, it is crucial to consider the limiations of this study. Addressing these limiations in the future research can increase understanding of the impact of digital transformation in the aviation sector.

6.1.1 Sample size and demographics

The generalisation of the results is limited by the small sample size of only four participants. This sample consisted of individuals between 20 and 30 years old, most of whom had a university education and travelled for leisure purpose. This narrow demographic focus may not fully reflect the diversity of experiences and perspectives of all frequent travellers at different airports. Additionally, the sample included one woman and three men, each bringing distinct perspectives that could influence their views on digital innovations in aviation. However, the limited number of participants constrains the ability to draw comprehensive conclusions about gender-specific preferences and concerns.

Participants were from different countries, which introduced a variety of cultural contexts that may have influenced their expectations and experiences with digital technologies. Despite this diversity, the small sample size means that the results may not capture the full range of cultural influences on perceptions and use of technology in aviation. In addition, the study included participants with varying travel experience, with some having travelled more frequently and others less often. This difference in travel frequency may affected their familiarity and comfort with digital technologies, influencing their perceptions and opinions.

6.1.2 Broad technological range

Methodological choices were limited by the decision to focus on a wide range of emerging technologies. The study included biometric systems, baggage tracking, in-flight entertainment systems, e-ticketing, and check-in processes. While this broad approach provided an overview of the various technological impacts, it did not allow for an in-depth examination of each technology. For example, the study of biometric technologies included only general observations and did not explore the details of different biometric systems (e.g., facial

recognition versus fingerprint scanning) and their specific impact on user experience and privacy concerns. Similarly, while the study addressed the benefits of advanced baggage tracking systems, it did not delve into the technical aspects or compare different tracking technologies in detail.

6.1.3 Influence of Individual Personalties

The individual personalities of the participants significantly limited the study's results, especially given the small sample size. Each participant's unique personality traits, preferences, and experiences influenced their responses and perceptions of digital technologies in aviation. The variability of subjective experiences presents a challenge in generalising the results to the wider population, limiting the reliability of findings. The influence of individual personalities can lead to highly subjective and varied feedback. In addition, personal attitudes towards technology can result in different opinions, making it difficult to conclude the benefits and drawbacks of digital innovation.

For example, one participant's enthusiasm for new technologies led to positive views of biometric and real-time baggage tracking systems, highlighting their efficiency and convenience. Conversely, another participant's strong concerns about privacy and data security led to negative perceptions of the same technologies, focusing on potential risks and drawbacks. This discrepancy illustrates how personal attitudes towards technology can lead to highly subjective and differing opinions, complicating the interpretation of data.

The level of technological proficiency of the participants also influenced their responses. Those who felt more comfortable with digital tools were likely to report a positive experience, highlighting the ease of use and time savings from digital check-in and biometric boarding. In contrast, participants who were less familiar with such technologies may have experienced frustration or anxiety, affecting their overall satisfaction with the trip and leading to less favourable opinions.

6.2 Recommendations for future research

Based on the insights and limitations identified in this study, several recommendations are proposed for future research to better understand digital transformation in the airline industry and its impact on the passenger experience.

Future research should aim to include a more diverse sample to provide a more comprehensive understanding of the impact of digital technologies on different demographic groups of travelers. Expanding the demographic scope to include participants from diverse age groups, gender, educational backgrounds, and travel frequencies will provide a more comprehensive understanding of how different demographic groups interact with and perceive digital technologies. In addition, future research should also focus on specific technologies to provide a more detailed understanding of their impact on the passenger experience. While this study covered biometric systems, baggage tracking, in-flight entertainment, e-ticketing, and check-in processes, it was not possible to explore in-depth each particulat digital technology. Focusing on specific technologies, such as an in-depth analysis of biometric boarding processes or specific features of in-flight entertainment systems, can provide more detailed insight into the impact on user experience, privacy issues, and operational efficiency.

In addition, a larger qualitative study is recommended to capture a wide range of experiences and perspectives. The small sample size in this study limited the ability to draw comprehensive conclusions about the general passenger population. A larger-scale qualitative study would identify more nuanced trends and provide a more robust understanding of passenger attitudes and behaviors toward digital technologies in aviation.

Another issue is exploring the potential national and cultural differences in the adoption and perception of digital technologies. The limited sample size of the current study makes it impossible to identify such differences. Future research should include participants from different countries to explore how cultural context influences passenger experiences and attitudes toward digital transformation in the airline industry. Understanding these cultural differences is crucial for airlines operating in a global market, as it allows them to tailor digital services to meet diverse passenger expectations and enhance satisfaction in different regions.

Furthermore, focusing on specific demographic groups within the same country or gender can provide more targeted insights. For example, examining the experiences of frequent business

travellers versus leisure travellers, or comparing digital perceptions of different age groups within the same country, can reveal differences in user needs and expectations. This approach could help airlines develop more personalised and effective digital strategies that satisfy the consumer needs and concerns of different passenger segments.

Lastly, longitudinal studies can provide valuable insights into how passengers' perceptions and interactions with digital technologies evolve, especially in the emerging aviation market. By tracking the same group of participants across multiple journeys, researchers can identify changes in attitudes and behaviour, as well as the long-term impact of digital innovations on the passenger experience. Longitudinal data can reveal trends and patterns that may not be apparent in cross-sectional studies, offering a deeper understanding of how continued exposure to digital technologies affects passenger satisfaction and loyalty.

7. Conclusion

The digital transformation in the aviation sector highlights the significant impact of new digital technologies that influence passenger experience during their travel journey. The findings highlight the need for a forward-thinking approach that considers technological advances and anticipates future trends and passenger needs.

Looking ahead, the future of digital transformation in aviation promises the integration of even more advanced technologies. The emergence of artificial intelligence (AI) and machine learning (ML) can revolutionise and optimise airline operations. AI-based chatbots and virtual assistants could provide real-time customer service, while ML algorithms could analyse vast amounts of data to predict and mitigate operational disruptions, thus increasing efficiency. The potential of blockchain technology in providing secure and transparent transactions is also promising. Blockchain advancements can enhance the security of digital identities and streamline processes of ticketing and baggage handling while reducing fraud and errors.

Airlines should be committed to continuously investing in research and development to stay ahead of technological trends. Collaborations with technology startups and innovation centers can foster the development of advanced solutions tailored to the airline industry. By using big data, airlines can offer even more highly personalised travel experiences. Customs services

based on individual passenger preferences and behaviors can increase passenger satisfaction and loyalty. For example, personalised in-flight entertainment, tailored communications, and customised offers can significantly improve the passenger experience.

With increasing reliance on digital technologies, the risk of cybersecurity threats is rising. Airlines must prioritise cyber security by implementing advanced encryption techniques, conducting regular security audits, and fostering security awareness among staff. Furthermore, digital transformation should also be in line with sustainability goals. Implementing technologies that reduce the carbon footprint, such as optimised flight routes, and eco-friendly packaging, can contribute to environmental protection. In addition, digital solutions that minimise paper consumption, such as e-tickets and digital boarding passes, support sustainability initiatives.

Furthermore, it is essential to ensure digital innovations are accessible to all passengers, including those with disabilities or limited technological understanding. Airlines should design user-friendly interfaces and provide alternative options to meet the diverse needs of passengers. Offering training and support on how to use digital services can help reduce the digital gap. Integrating Internet of Things (IoT) devices can create a more connected and seamless travel experience. Smart airports, equipped with IoT sensors, can provide real-time information and improve passenger flow management and travel experience.

The future of aviation should be a strategic combination of innovation, personalisation, and safety. By adopting advanced technologies while maintaining a passenger-centric approach, airlines can successfully adapt to digital transformation. Prioritising continuous improvement, robust cybersecurity, sustainability, integration, and seamless operations will ensure that airlines not only meet but exceed, the evolving expectations of their passengers.

By focusing on these strategies, the airline industry can successfully combine new technologies with excellent customer service, creating a more efficient, enjoyable, and safe travel experience for the future. This approach to digital transformation will not only improve the consumer experience but will also give airlines a competitive edge in an increasingly digital world, ensuring long-term success in the competitive landscape.

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