IBN HALDUN UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF AIR TRANSPORT MANAGEMENT

MASTER THESIS

INDUSTRY 4.0 TECHNOLOGIES REVOLUTIONIZING THE CIVIL AVIATION SECTOR: PASSENGER PERSPECTIVE ON MODERN DIGITALIZATION (E-SERVICES / SELF-SERVICES) IMPLEMENTATION

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THESIS SUPERVISOR
PROF. ÜMİT HACIOĞLU

ISTANBUL, 2024

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by
YA NENEH AWE

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirement for the degree of Master of Science in Air Transport Management

THESIS SUPERVISOR
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ISTANBUL, 2024

APPROVAL PAGE

This is to certify that we have read this thesis and that, in our opinion, it is fully adequate, in scope and quality, as a thesis for the degree of Master in Air Transport Management.

Thesis Jury Members

Title – Name Surname	Opinion	Signature
_____	_____	_____
_____	_____	_____
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This is to confirm that this thesis complies with all the standards set by the School of Graduate Studies of Ibn Haldun University:

Date of Submission Seal/Signature

ACADEMIC HONESTY ATTESTATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all materials and results that are not original to this work.

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ÖZ

ENDÜSTRİ 4.0 TEKNOLOJİLERİ SİVİL HAVACILIK SEKTÖRÜNDE DEVRİM YAPTI: MODERN DİJİTALLEŞME (E-HİZMETLER / SELF-HİZMETLER) UYGULAMASINA YOLCU BAKIŞ AÇISI

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Ağustos 2024, 63 sayfa

Endüstri 4.0 teknolojileri, operasyonların iyileştirilmesi, güvenliğin iyileştirilmesi, zaman ve maliyet tasarrufu ile sonuçlanan sofistike ürün ve hizmetlerin üretimi yoluyla verimliliği ve etkinliği optimize etti ve hemen hemen tüm endüstrilerdeki operasyonları devrim niteliğinde değiştirdi ve havacılık sektörünü muazzam bir şekilde dönüştürdü. Bu teknolojiler, genellikle havayolları veya havalimanları tarafından uygulanan cihazlar veya yazılımların yardımıyla kendi kendine hizmet verilen e-hizmetlerin geliştirilmesinde temel olarak kullanılan yapay zeka AI, nesnelerin interneti IoT, büyük veri Analitiği, modern robotik, blok zinciri teknolojileri vb. içerir, ancak bunlarla sınırlı değildir. Bu çalışma, bilet rezervasyonlarından, kendi kendine hizmet check-in kiosklarından, e-kapıdan, dijital uçak içi hizmetlerden ve uçuştan sonra bagaj takibinden seyahat öncesi, sırasında ve sonrasında bu e-hizmetlerin uygulanmasıyla yolcu seyahat deneyimini araştırmayı amaçlamaktadır. Ayrıca, yolcuların seyahatte hangi modern teknolojilere aşina olduğunu veya kullandığını anlamak ve bu e-hizmetlerin kabulünü etkileyen faktörleri anlamak. Bu çalışmanın amaçlarına uyacak şekilde değiştirilmiş Genişletilmiş Teknoloji Kabul ve Kullanım Teorisi'ne (UTAUT2) dayalı bir araştırma modeli geliştirilmiştir. Çalışma hedeflerine bir anket aracılığıyla ulaşıldı, 253 hava yolcusundan kendi kendine uygulanan çevrimiçi anket elde edildi ve veriler SPSS 25 yazılımı kullanılarak analiz edildi. Sonuçlar, önerilen tüm değişkenler arasında

performans beklentisi, fiyat değeri, hedonik motivasyonlar, algılanan faydalar ve alışkanlığın davranışsal niyet üzerinde olumlu ve önemli bir etkiye sahip olduğunu gösterirken, sosyal etki, kolaylaştırıcı koşullar ve çaba beklentisi önerilen hipotezler desteklenmedi.

Anahtar Kelimeler: Akıllı Havalimanı Dijitalleşme, E-hizmetler/Kendi Kendine Hizmetler, Endüstri 4.0 Teknolojileri, Havacılık, Yolcu Deneyimi.

ABSTRACT

INDUSTRY 4.0 TECHNOLOGIES REVOLUTIONIZING THE CIVIL AVIATION SECTOR: PASSENGER PERSPECTIVE ON MODERN DIGITALIZATION (E-SERVICES / SELF-SERVICES) IMPLEMENTATION

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Industry 4.0 technologies have optimized efficiency and effectiveness through the manufacture of sophisticated products and services, which result in enhancement of operations, improvement in safety, time, and cost-saving, and have revolutionized operations in almost all industries and have tremendously transformed the aviation sector. These technologies include but are not limited to artificial intelligence AI, the Internet of Things IoT, big data Analytics, modern robotics, blockchain technologies, etc., which are used as a foundation in the development of e-services that are usually self-serviced through the help of devices or software implemented by airlines or at airports. This study aims to investigate the passenger travel experience with the implementation of e-services before, during, and after trips, from ticket bookings, self-service check-in kiosks, e-gate, digital in-flight services, and baggage tracking after flight. Also, to understand which modern technologies air travel passengers are familiar with or use and to understand factors that influence acceptance of these e-services. A research model was developed based on the extended Unified Theory of Acceptance and Use of Technology (UTAUT2) and modified to suit the objectives of this study. The study objectives were achieved through a survey, a self-administered online questionnaire from 253 air passengers was obtained, and data was analyzed using SPSS 25 software. The results indicate that out of all the proposed variables, “performance expectancy, price value, hedonic motivations, perceived benefits and

habit" were found to have a positive significant influence on behavioral intention, while "social influence, facilitating conditions, effort expectancy and perceived challenges" proposed hypotheses were not supported. The results of the study give insights into how different demographics perceive such implementations. This will provide policymakers ideas on how to better manage and enhance e-services.

Keywords: Aviation, Digitalization, E-services/Self-Services, Industry 4.0 Technologies, Passenger Experience, Smart Airport.

DEDICATION

This thesis is dedicated to my family, who have provided unwavering assistance and been my support system throughout my education journey.

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I would like to recognize the support of my supervisor, Prof. Ümit Hacıoğlu, and convey my sincere appreciation for his tireless efforts and understanding; thank you very much, Sir. Also, I would like to express my heartfelt gratitude to Prof. Ali Osman Kusakcı for his unwavering support throughout this Master's journey; it is truly valued. Finally, I express my sincere thankfulness to Ibn Haldun University for giving me the opportunity to embark on the journey.

Ya Neneh Awe

Istanbul, 2024

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LIST OF ABBREVIATIONS

3D	Three Dimension
AI	Artificial Intelligence
AR	Augmented Reality
C-TAM-TPB	Combined Theory of Planned Behaviour/Technology Acceptance Model
DIT	Diffusion Innovation Theory
E-Service	Electronic Service
Etc.	Etcetera
IATA	International Air Transport Association
ICT	Information Communication and Technology
ID	Identification
DIT	Diffusion Innovation Theory
IFE	In-Flight Entertainment
IoT	Internet of Things
IR4	Fourth Industrial Revolution / Industry 4.0
LCC	Low-Cost Carriers
MPCU	Model of PC Utilization
PEOU	Perceived Ease of Use
PU	Perceive Usefulness
SCT	Social Cognitive Theory
SPSS	Statistic Package for Social Sciences
SST	Self-Service Technology
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TSA	Transport System Administration
UTAUT	Unified Theory of Acceptance and Use of Technology
VR	Virtual Reality

CHAPTER I

INTRODUCTION

1.1. Background of the Study

Over the decades, the aviation industry has transformed tremendously through digitalization, which has impacted one of its key areas: passenger experience. By 2037, air passengers are projected to reach 8.2 billion; thus, there is a need for better operation and the introduction of sophisticated digital practices to leverage the situation (IATA, 2021). These changes can be facilitated by introducing industry 4.0 technologies, one of the most trending topics in academia and the business world (Chiarello et al., 2018). Air transportation has been the mode of transport that has brought the world together as one community. Connections that seemed impossible due to distance or other geographical obstacles are now covered within minutes or a few hours. The aviation sector has been one of the fastest-growing industries in the world because of its role in economic, cultural, educational, and social development. This sector has contributed enormously to the world economy trade, and predictions are that this number will continue to increase.

The introduction of digitalization has brought a paradigm shift in our everyday living; things that were manually and tediously handled are now clicks or products away. It has successfully transformed many industries, and the aviation sector has been among the places to utilize this development extensively. Digitalization has not only modified the mode of operations through efficiency and effectiveness but also brought about the need for improvement as the world evolves and engagements arise; the need for working smarter and ease of task and timesaving becomes the order of the day; thus, enhancement in digitalization is paramount as the determinant for the success of businesses is through digital competitiveness (Hacioglu and Sevgilioglu, 2019).

The incorporation of IoT, big data analytics, and cloud computing which are the base foundation of industry 4.0 technologies to now artificial intelligence, modern robotics

have leveraged all dimensions and brought about the possibility of interconnectivity and intelligent systems in all sectors (Tao et al., 2018; Wang et al., 2016; Gilchrist, 2016). With the tremendous outcome observations from these technologies, digitalization has been used intensely, its effect is observed, and this trend will continue to increase in the years to come. Through digital transformation, businesses in all industries have experienced increased digitalization trends, which significantly influence their respective businesses. Management and businesses are challenged to adjust their focus on operations because digitalization is the key to the pivotal modification of recent businesses and management processes. Its incorporation has enabled businesses to survive competitiveness and the chance to climb higher on the business ladder, which is an added advantage (Slavinski and Todorović, 2019).

1.2. Digitalization

The term digitalization is often defined using two key terms, namely digitization which refers to the transformation of products and services to digital form, whereas the other term is digital transformation, which refers to the improvement of business models, products, and services via innovation which requires continuous improvement and ability to adapt to modern digital innovations (Skog, 2019). Gartner, 2020 thus defines the term digitalization as businesses or enterprises' ability to increase effectiveness and efficiency by modifying operations using digital technologies.

Keeping up with technological evolution requires business managers to merge modern technologies to keep up with fast-evolving technological developments (Lumpkin and Dess, 1996). The outcomes of commercial exploitation of digitalization are efficiency improvements, generating returns, and reducing operational costs. Eitrem and Öberg (2018) conclude that businesses' or organizations' ability to achieve their aims and objectives, adaptability to new trends, and potential to have a favorable position over competitors is through digitalization.

The airline industry is a complex system often described as a "system of systems," of which these subsystems include technical, operational, organizational, and social components (Hansman, 2005). In the past years, we have witnessed most of the

activities in these subsystems have been digitalized or function in hybrid motion and all of these have an influence in the enhancement process of the airline industry.

1.3. Industry 4.0 Technologies

Information technology has been utilized in different aspects of the aviation world. When we talk about industry 4.0 technologies, we refer to the integration of intelligent modern technologies that have tremendous importance in this century. The concept of Industry 4.0 dates back to 2011 through an initiative by the German Government in collaboration with private companies and universities. The main idea of the program was to enhance productivity and efficiency through the development of advanced production systems (Kagermann et al., 2013). These technologies include artificial intelligence, the Internet of Things, big data, cyber security, cloud computing, modern robotics, blockchain technology, facial recognition, biometrics, etc. The implementation of these technologies has been widely studied in almost every aspect due to the significant role they play in revolutionizing all acts of operations in every industry, from aircraft design and maintenance, flight operations, air traffic, and safety and maintenance to passenger experience and connectivity (Valdez et al., 2018).

Digital transformation in the aviation industry impacted all divisions, from aircraft manufacturers now building more sophisticated, better operational aircraft that utilize modern engines, lesser fuel consumption, better improvement on safety, less carbon pollution, etc. Also, most advanced airports have implemented almost all the technologies mentioned above for security, efficiency in time, and cost management. The civil aviation industry has also gained its share of enhancement of operations through digitalization as it has moved from a primitive mode of operation to almost fully digitalized, saving time and cost and providing better outreach, etc. Airlines/airports use some of these technologies in forecasting processes, understanding how individuals perceive their brand through sentiment analysis, tailoring packages and adverts to specific passengers, etc. However, passengers are one of the essential components of the aviation chain. Most studies focus on how modern technologies impacted aircraft manufacturers, airports, or airlines, but little focus is on how they impact passengers. The influence these digital changes have on passengers should be researched more; thus, this study aims to investigate the

passenger travel experience with the implementation of electronic services that are usually self-serviced and referred to as e-services in this study. These e-services usage may commence pre-travel journeys, for example, booking and purchase of air tickets to digital self-navigation within the airport terminal, self-service check-in, e-gate self-boarding, in-flight Wi-Fi access, and self-entertainment via video streaming to baggage tracking after the flight.

1.3.1. Technology Advancement Distribution

Developing a product or service is one thing; its acceptance is another. There is no benefit in innovations that are not used, which is where the role of passengers comes in. Passengers are vital stakeholders in the airport and airline business, without whom the airlines will not survive, and passenger-only aircraft will cease to function. Commercial business stores, restaurants, currency exchange offices, and duty-free stores will also become extinct. Also, although little study has been conducted in this regard, studies in some parts of the world are limited or scarce, which serves as another motivation.

Most of these industry 4.0 technologies are widely used in advanced countries where technology is at its peak. People are very aware of them and incorporate them into their daily livelihood, whereas in other parts, they are limited; thus, this study was generalized to six continents.

My childhood passion for aviation and background in computer science fuelled my drive to learn how passengers perceive these e-services supported by industry 4.0 technologies already implemented by airlines and airports to develop and manage better products and services in the future.

1.4. Purpose of the Study

The advancement in technology, its high impact on the advancement of businesses, and the convenience it has brought to people are opportunities that should not be taken lightly. The aviation industry is one of the most digitalized sectors that continue to bring innovations, and for such development, end users must follow the trend to keep

up with new or enhanced experiences and modern ways of managing air travel. Thus, the significance of this study is that it aims to investigate user perception of the implementation of these technologies. Any innovation without implementation is null, so understanding how users feel about some of these services, their level of awareness, and the constraints in utilizing the products or services is crucial for better catering to passenger needs.

1.4.1. Objectives of the Study

User readiness to accept and use any innovation is a crucial pillar for its success. Therefore, the user perspective on such developments must be understood to improve the implementation of e-services and enhance voluntariness in using them, thus motivating this study.
The aim/objectives of this study are:

- To investigate the passenger travel experience with the implementation of these modern technologies, from ticket bookings, self-service kiosks, e-gates, etc., during airport experience, digital in-flight services, and baggage tracking after flight.
- To understand which modern technologies air passengers are familiar with.
- To understand factors that influence acceptance of these e-services.
- To understand how passengers perceive benefits or challenges in using such technologies introduced by airlines or implemented at airports.

1.4.2. Research Questions

- What is the level of familiarity and frequency of use of these e-services?
- How do passengers perceive the implementation of these e-services?
- What are the perceived benefits or inhibitors in utilizing the implemented technologies?

1.4.3. Significance and Justification of the Study

There is limited research based on our searches about air passengers' general perception of multiple technology implementations at airports or by airlines. The influence of the COVID-19 pandemic on the mode of operations in many industries has made digitalization key and the new normal. Therefore, understanding user perception in order to sensitize them and make the e-services easy to adopt and operate makes this study very important.

The era of globalization has favored mostly the younger generation, who, according to most studies, are more adaptive and curious about exploring new things. However, they are not the only age group that uses air travel; therefore, for better operation, all ages' perceptions need to be understood and considered in the development of new e-services to suit all passengers.

Moreover, studies on passengers were mainly associated with keywords like customer satisfaction, brand loyalty, service quality, brand awareness, etc. Finally, we live in an unpredictable world, and the COVID-19 pandemic is an example. The extensive implementation of modern technologies in most sectors was also fuelled by the COVID-19 pandemic, which caused transactions to be automated and self-serviced.

CHAPTER II

LITERATURE REVIEW

Business models have changed due to the advent of digitalization, and it is believed to assist in achieving sustainable development goals (SDG) (Di Vaio and Varriale, 2020). In any business, retaining customers is as valuable as gaining new customers. Also, there has been a lot of competition since the advent of low-cost carriers (LCC), characterized by low fares. These carriers rely heavily on technology for their operations as it is believed to be cheaper. Millions of people in this generation use air transportation, so it will be time-consuming and exhausting to commute specific data or operate certain travel procedures manually. Thus, information technology comes into play to remedy this problem. Computing customer data or tailoring adverts to their needs or the ability to attract new ones has recently been associated with many activities that are supported by modern technologies (Park et al.,2019).

> The airline industry has not just revolutionized the way we travel but has shrunk the world into few hours. Today, the airline industry carries a huge number of 3.6 billion passengers per year and accounts for delivering one-third of the world's trade. The growing numbers of passengers and the technological innovations have changed the face of the airline industry for good (Robosoft Technologies, 2017).

During its early development in aviation, digitalization implementation was mostly at airports or airline levels, where passengers manually completed the entire travel process. Times have changed, and things get extended to the passengers, from the ability to book or reserve their flight to the privilege of self-check-in to access to the internet in the aircraft and many other services. All these have been enhanced through the years with services like self-check-in, smart border control via facial recognition and other biometrics, smart boarding e-gates, baggage tracking, service customization, and more. These have been made possible through the emergence of industry 4.0 technologies (Molchanova et al., 2020).

Industry 4.0 technologies have significantly been incorporated in many sectors, resulting in the enhancement of available services/ products and the introduction of

new ones. Industry 4.0 technologies enable the operation of intelligent systems and interlinked processes, which further intensify productivity, efficiency, and general performance (wang et al., 2016). These technologies have made a significant impact on the passenger travel journey. Most studies on modern technologies are centered on how they impact airports or airlines and little on how services developed from these technologies impact consumers or passengers.

2.1. Some Industry 4.0 Technologies Used in the Development of Airport/Airlines E-Services

Some Industry 4.0 technologies noticeably used in the development of self-service software are blockchain technology, virtual and augmented reality, AI, Big Data Analytics, and cloud computing.

2.1.1. Blockchain Technology

This technology came into existence a couple of years ago, but it has been widely used due to its transparency and efficiency enhancement capabilities (Hacioglu, 2020). It is characterized by trust and decentralization, decentralization in the sense that its measurements are consistent or its outputs are believed to be dependable (reliable). Its ability to adapt to many different activities and functions(versatility)and its ability to protect the content of information (privacy). At the same time, trust is characterized by its openness and accountability, where parties involved in the transaction know what's going on(transparency). It is also characterized by its ability to ensure the accuracy of data stored or shared (data integrity) and, finally, its distinct ability to maintain the state of data stored in the system in its original state without being altered(immutability) (Ali et al., 2020).

Blockchain technology in the airline industry can assist in areas like identity management, payments, air traffic control, tracking, and customs clearance, as demonstrated in Figure 1 below.

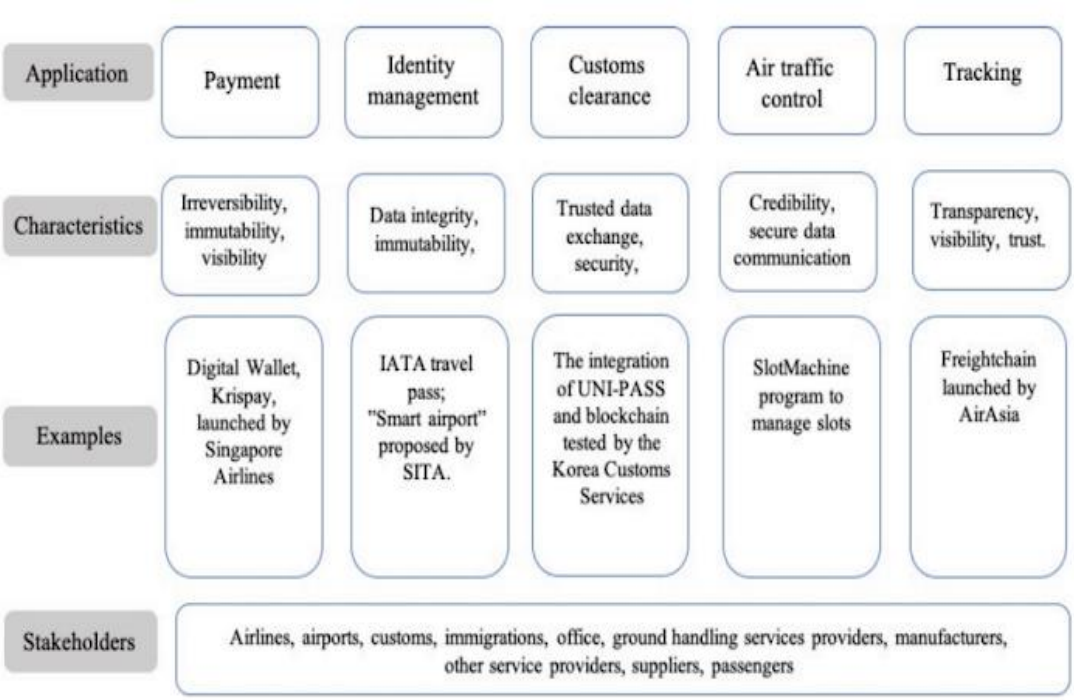

Figure 2.1. Blockchain Application in the Aviation Industry

Source: Li et al. , 2021

This technology could assist airlines retained customer data in a database and spare the need for physical identity proofs. Air France demonstrated their interest in the implementation of this technology to enhance workflows and business processes (Robosoft Technologies, 2017).

2.1.2. Virtual Reality / Augmented Reality

These technologies are the process of the combination of the real and virtual world on a single-screen display device (Billinghurst et al., 2015). Virtual reality is described as a user experience of computer-generated effects that enable them to see simple or complex three-dimensional images with lightning scattered from an object. This technology was primarily noticed in the entertainment industry. However, it plays its part in one of the most essential aspects of air transportation, which is safety. Air traffic controllers use this technology to monitor the airspaces and report the safety of flights, as used by the London City Airport. It is also used in passenger navigation systems through the huge airport complex of Gatwick, which was made possible through the incorporation of augmented reality (Safi et al., 2019).

The application has changed customer experience in multiple ways. For example, in in-flight entertainment services (IFEs), the use of smart glasses gives passengers an entertaining experience to enjoy three-dimensional (3D) images or videos. Furthermore, it is also seen in the safety processes, for example, as a medium for communicating with passengers on instructions like seat belt fastening, calling for assistance if there is an emergency, and the like (Morrison, 2018). Another example is Air New Zealand's use of this technology to retrieve customer information in order to recognize key-on-board passengers and share their information with crew members, which in turn helps in more accessible interactions and is believed to be achievable by data stored in the cloud, other computer vision algorithm and augmented reality (AR) modules (Bellamy, 2017).

2.1.3. Artificial Intelligence

Customer experience is an important concern in most businesses, and the airline sector is no different. These experiences can measure survival or losses as good experiences result in frequent flying, leading to customer retention. In contrast, bad experiences may result in customers switching carriers.

A traveler weighs not only fare when choosing an airline but also many other options like security, timing, baggage kilos, transits, and feedback from existing or old customers (Kumar and Zymbler, 2019). Often, these experiences are not expressed physically due to time constraints when passengers land or during flight, so most of the time, they resort to online platforms, which can be through airline complaint email, airline website comment section, or the most frequent, which is through social media platforms. Customers express their concerns through writing or via videos about their experience on their timelines or sharing on public pages. These sentiments, either good, negative, or neutral, can be analyzed through the use of Artificial Intelligence (AI), and this analysis helps airlines to understand the stands of these emotions. Airlines now make use of these technologies to sort customer feedback, and with such, they may improve on weak points and serve their customers better. Artificial intelligence is a subset of computer science that deals with the ability of training machines to mimic humans, in other words, to act intelligently (Nilsson, 1982).

Airlines use this technology to sort tweets into positive, negative, and neutral so as to enhance customer experiences.

2.1.4. Big Data

Big data is described as the accumulation and computing of enormous datasets that are too complex to be assessed by traditional means (Favaretto et al., 2020). With the use of mobile phones and billions of people's access to the internet on different platforms to interact, get entertained, or do business, airlines now have strategies that can study customers' online activities. This huge amount of data available to airlines helps them understand customer needs and tailor services to their preferences. An example could be through their purchase history. These data can be used in conducting predictive analytics, which enhances overall operations (Park et al., 2019).

2.1.5. Internet of Things (IoT)

This technology is based on the principle of linking devices using technologies like RFID sensors, which enhances the relationship between the environment and internet-connected devices (Rajeb et al., 2022). Tan and Masood (2021) describe it as technologies that communicate through sensors and other intelligent devices. IoT is used in maintenance to help detect faults and monitor aircraft. It can also be seen in baggage tracking, inflight entertainment through service personalization, automated check-ins, etc.

2.2. Smart Airports

The concept of smart airports came into existence with the development of IoT, which allows the remote control of devices. It has a significant role in this study as the measures of some of these e-services chosen are based on the characteristics of smart airports. Smart airports are characterized by leverage in the industry 4.0 technologies to be more innovative and promote passenger self-service interaction with smart devices (Bouyakoub et al., 2017; Rubio-Andrada et al., 2023). Stakeholders are challenged to keep up with the advancement in technology and the need to enhance

passenger experience and satisfaction (Alabsi and Gill, 2021). They further described the passenger travel journey as follows, depicted in the Figure below.

Table 2.1. Passenger Travel Journey in Smart Airports

STAGES	**CHECK-IN**		**SECURITY CONTROL**	**BORDER CONTROL**	**BOARDING**
Application	**Smart check-in**	**Smart baggage handling**	**Smart security**	**Smart border control**	**Smart boarding**
Goal	Smartly check-in of passenger's documents and baggage to issue a boarding pass and bag tags.		Self verification and screening by passenger and carry-on bags.	ID verification and crossing the restricted area by self-service.	Self-boarding to the aircraft.
Process (Activity)	Enter surname and booking reference JPNR via a specific technology in order to issue the boarding pass.	Scan passport to Print out and affix the baggage tag. then put them in the automated bag drop area.	confirm the match between passenger information in e-passport and the taken photo with stored information in government database.	Enter the e-gate: scan the e-document then the data are processing in order to verify the biometric identity; exit the e-gate.	Scan the boarding pass in boarding card scanning machine. Then the e-gate opens after the verification.
Information	Biographic/ biometric		Biometric	Biometric	Travel information (boarding pass)
Enabling technology	Intelligent kiosks KATE, biometric tech (smart path)	Automated system, RFID tech	Biometric tech	Biometric tech Automated system REID tech	REID tech Automated system
IoT , Cloud Servers					

Source: Alabsi and Gill, 2021

2.3. Usage of Industry 4.0 Technologies in Other Sides of the Industry

These technologies have been used extensively in all aspects of the industry, some of which are:

2.3.1. Smart Maintenance and Predictive Analysis

Maintaining the lives of aircraft is fundamental in the industry. The improvement in technology with the Internet of Things IoT and big data analytics offers efficiency in maintenance, increased reliability, and enhanced supervision of flight components through smart maintenance (Daily and Peterson, 2017). This state is catalyzed by the development of IoT sensors and the use of machine learning techniques in available data to predict future outcomes. Zonta et al., 2020 reported that these smart net results lead to real-time monitoring to avoid failures, cut operational costs, and reduce downtime.

2.3.2. Digital Twin Technology

Digital Twin is one of the top ten modern emerging technologies (Zhou et al., 2019). It uses technologies like the IoT, XR, cloud computing, and AI. IoT creates digital duplicates of physical objects (Tao et al., 2019), enabling constant data transmission via IoT sensors. Further, digitally model objects through the XR visualization capabilities while easing the access of stored data in the virtual cloud. Finally, using its AI components for predictive analytics. The most notable areas of application of this technology are in product assembly, product manufacturing, structural optimization, design operation, and maintenance (Xiong and Wang, 2022) hence resulting in more excellent safety, optimizing and organizing productivity, enhanced research and development R&D, cost savings, effective cooperation and better management of products and services (Zonta et al., 2020).

2.3.3. Autonomous Systems / Robotics

As the name suggests, these are systems or products characterized by self-aware, open, and environmentally smart, developed to complete tasks with limited or no

intercession of humans (Wong et al., 2017; Guenat et al., 2022). Robotics in baggage handling or maintenance warehouses, driverless cars, drones, pilotless aircraft, etc. This technology has revolutionized operations as most tedious and hazardous tasks can be operated by them with reliable output, efficiency, and boost operation as they are mainly developed with AI algorithms.

2.3.4. Supply Chain Optimization

AI analytics is optimizing inventory management. On the other hand, blockchain technology has worked magic in the development of many technologies, one of which is the security and maintenance of records' originality. These incorporated technologies ensure effective cost utilization, traceability, and transparency in the supply chain process (Fatorachian and Kazemi, 2021).

2.3.5. Human-Machine Collaboration

Digitalization is paramount, but some operations still require human support. It’s a human-machine relationship that enhances general outputs on operations (Conversy et al.,2018). An example of this is augmented reality, which is catalyzed by AI. I 4.0 technologies play an efficient role in air traffic control, which is still heavily operated by humans. These I4.0 technologies provide collaboration and rapid state-of-the-art results (Zazzaro et al., 2015).

2.4. Brief Description of the E-Services Related to the Study Supported by Industry 4.0 Technologies

Modern technologies have almost entirely transformed the passenger air travel experience. This phenomenon was widely noticed during and after the covid 19 pandemic; the legislation for non-physical contact and the need for social distancing has challenged airlines and airports to adapt to the new normal, which is the automation of services and products and enhancing the available ones. Some of the e-services used in this study are as follows:

- *Airports or Airline's digital platforms:* passengers' usage of the airline's digital website or app to make reservations, complete online check-in, or use airport apps for navigation.

- *Service personalization and customization*: passengers' ability to tailor services based on their preference, for example, Seat selection, pre-ordering food or arrangement for special assistance.

- *Personal device usage*: Passengers' access to connect personal devices like phones or tablets to retrieve flight information and complete check-in procedures, monitor the status of flights, receive immediate notifications about gate modifications or delays, or access electronic boarding passes.

- *Self-check-in kiosk:* passengers' ability to check-in using self-check-in kiosks.

- *Smart baggage handle*: passengers' access to self-print and fix baggage tag then transfer to automated bag drop area.

- *Smart security and smart border control:* passengers' ability to self-verify documents using facial recognition or other biometric technology to match e-passport details.

- *Smart boarding*: Passengers can self-board aircraft by scanning the boarding pass and entrance via e-gate.

- *Inflight entertainment*: In-flight entertainment services are used to connect passengers to Wi-Fi or stream videos during flights.

- *Baggage tracking:* passenger ability to self-track luggage in case of delay/ missing.

2.4.1. Some Real-Life Cases of E-Services Introduced by Airlines and Implemented at Airports and Their Impacts

Delta Airlines: Boarding And Checking Bags With Facial Recognition" Case:

A biometric check-in provides a contactless, facial recognition solution for passengers by measuring dozens of facial features and matching them with photos stored in border control agency databases, such as passports, visas, and other travel documents. Thus, passengers can use their faces to access facilities around the airport. Thus, your face is your boarding pass.

According to (Delta Airlines, 2021), although primary U.S. carriers such as United and American Airlines are conducting biometric ID checks at certain and restricted airports, Delta desires to be the leader in providing full curb-to-gate security focused on facial recognition. Accordingly, to serve its customers well and satisfy their needs, Delta Airlines came up with facial recognition in order to enhance the airport experience through a partnership with the US Transportation Security Administration (TSA).

Firstly, passengers are registered with TSA using passports and other travel-related documents. With the operation of this application, TSA pre-checks the passengers to get the benefit of a dedicated bag drop lobby, passing through, checking hands-free, and boarding the aircraft. The use of this application is facilitated through the Delta app where passengers need to store their details to the system and they must save their digital information to their profile. An encryption technique ensures security, where the passengers scan their faces, and these details are forwarded to the US Customs and Border Protection facial biometric matching service. Once the details are verified, pre-check passengers will be allowed to proceed from the kiosks, which gives them the privilege of skipping lines and saving time. Finally, a last scan is done at the gate, and passengers can board the aircraft.

Additionally, airlines' ideal and steadily operational experiences in biometrics are also facilitated through biometric security kiosks commonly referred to as CLEAR. This initiative gives passengers the opportunity to verify their identity in a secure way via

a fingerprint reader, making paper or electronic boarding passes unnecessary as passenger details have already been captured. "*We want to give our customers more time to enjoy travel by unlocking simplified, seamless, and efficient experiences,* " Delta vice president of brand experience design Byron Merritt said.

Travelers now opt for the latest boarding option, which is the idea of facial recognition for many reasons. Facial recognition saves passengers time when checking their bags and boarding the aircraft. It facilitates the experience in the airports and meets high levels of customer satisfaction. It is also reported that 72 percent favored the biometric boarding experience through facial recognition over the traditional one. To sum up, facial recognition is the future of airport security.

Easy Jet Predictive Analytics:

EasyJet data experts use algorithms as prescriptive analytics examples, they gather the data about food consumption according to routes and day times so they can adjust the food load. Thanks to their algorithm supported by Industry 4.0 technologies, the airline saves a high amount of income, and by decreasing food waste, it benefits the environment as well. (Aviation Week Network, 2022).

2.5. Research Models Used Over the Years to Test for User Acceptance and Use of Technology

The user's intention to accept and use innovation is quite challenging; it is human nature to defy change. Accepting and using an innovation is a whole process, and the intention to use and adapt to a new thing will take time and process. Over the years, many scholars have been driven to study the nature of this phenomenon, and many results have emerged in different dimensions and have been seen to be affected by many factors. Some of this study constructs tests for behavioral, availability, ease, complexity of the products, user knowledge, motivation, trust, and social influence. Some are moderated by other factors such as gender and age. Some of the theories developed to test for user acceptance of technology include the technology acceptance Model (TAM), Theory of Reasoned Action (TRA), Theory of Planned Behaviour

(TPB), Diffusion Innovation Theory (DIT), Unified Theory of Acceptance and Use of Technology (UTAUT).

According to Tan (2009), TPB, TRA, and TAM focus more on user perceptions about how certain innovations impact them, while DIT focuses more on users' intentions in adopting new innovations. Among these, the most widely used theory is TAM.

2.5.1. Technology Acceptance Model (TAM)

This theory is one of the most widely used in technology acceptance studies, and it was developed by Davis in 1985. His conceptual model to test for acceptance of the use of systems or technology was centered on two main characteristics: perceived usefulness and perceived ease of use. According to him, user motivation to use a system emanates from the features and capabilities of the system, in other words, how comfortable users are with the system, and as a result of such inspiration, it results in the actual use of the system as depicted in the Figure below.

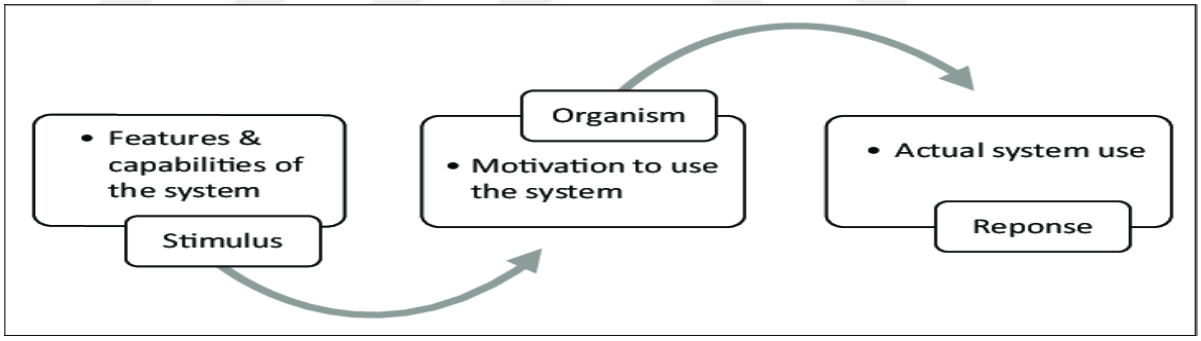

Figure 2.2. Enhanced Design of Davies' Conceptual Model

Source: G Lala, 2014

As demonstrated in Figure 3 below, he further elaborated on user motivation and gave a befitting definition that factors for motivation of system usage are perceived usefulness (PU), defined as the extent to which the user perceives an innovation to serve its purpose, perceives ease of use (PEOU) which is user ability to use innovation with limited exertion of energy and convenience whiles the verdict to take or discard the innovation is attitude (A) toward usage, these are concluded to be the main

constructs of TAM. User attitude to embrace or reject an innovation is associated with PU and PEOU, thus the birth of the theory as shown below.

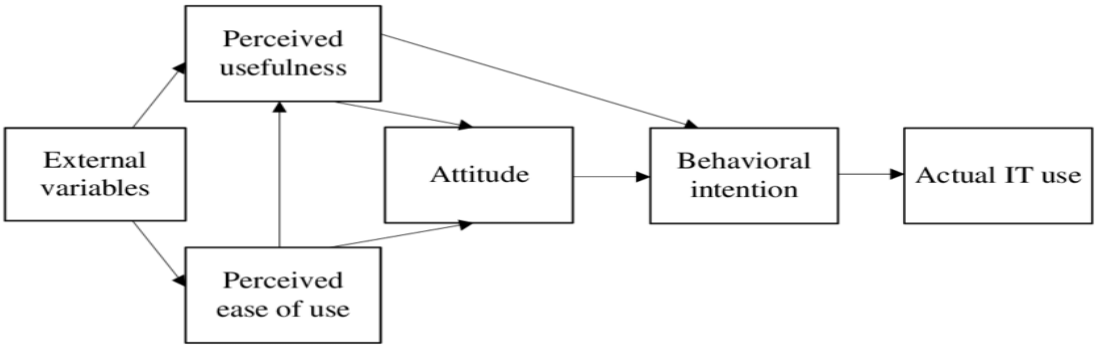

Figure 2.3. Technology Acceptance Model

Source: Davies , 1989

2.5.2. Unified Theory of Acceptance and Use of Technology (UTAUT)

Finding answers to people's intention to accept and use an innovation continued to be challenging. Scholars came up with a combination of two or three theories, but some still found it insufficient, thus the development of UTAUT by Venkatesh et al. (2003). They proposed the combination of eight previously used theories related to test for user acceptance. These models are the Technology Acceptance Model (TAM), the Motivational Model (MM), the Theory of Planned Behaviour (TPB), the Theory of Reasoned Action (TRA), a combined Theory of Planned Behaviour/Technology Acceptance Model (C-TAM-TPB), the Model of PC Utilization (MPCU), Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT). They further came up with constructs that embody the elements from the combined model. These constructs are:

- Performance expectancy: the degree to which the usage of an innovation is perceived to be beneficial.

- Effort expectancy: the degree of ease related to the use of an innovation.

- Social influence: The measure of the impact other people have concerning one's acceptance of the use of an innovation.

- Facilitating conditions: the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system.

Also, they proposed "Gender," "age,"" experience," and "voluntariness of use" are moderators of the constructs, as shown in the figure below.

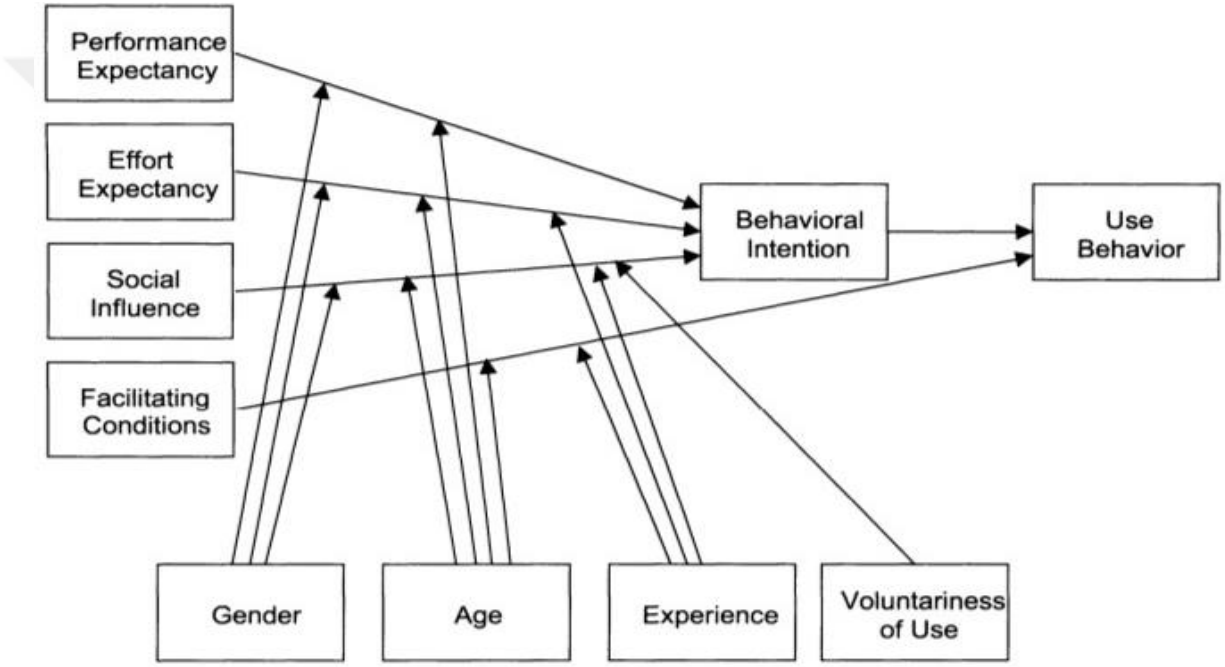

Figure 2.4. The Unified Theory of Acceptance and Use of Technology (UTAUT)

Source: Venkatesh et al., 2003

The main idea of UTAUT was to review the degree of user acceptance and understand the research gap. Next, through comparison and similarity among the eight models, the third point was to develop a unified theory based on the conceptual similarities of the eight models, and the final aim was to validate the UTAUT (Venkatesh et al., 2003).

However, this model was seen to be beneficial only to organizations, so for the model to be generally used for consumer technology acceptance, the model was extended, and in 2012 Venkatesh, Thong, and Xu developed the extended UTAUT, also known as UTAUT 2, in 2012. In the new model, hedonic motivation, price value, and habit were added constructs believed to be associated with consumer acceptance to achieve the aim of UTAUT 2. However, voluntariness was removed from the moderators as general consumer acceptance is voluntary.

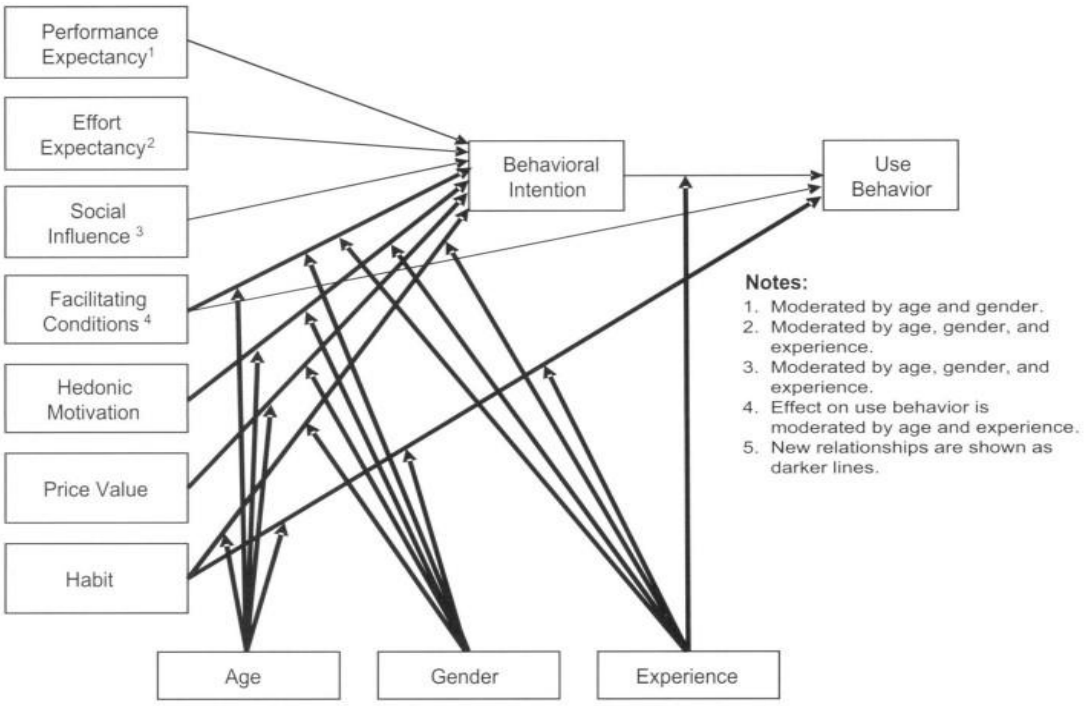

Figure 2.5. The Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)

Source: Venkatesh et al., 2012

2.5.3. Summary of Relationship Between UTAUT Constructs and the Constructs of the Other Theories it is Composed from

The table shows how the individual variables from the joined theories where UTAUT is developed from.

Table 2.2. Technology Acceptance Theories and Their Relationship to UTAUT

Models	Main Constructs/ Variables	Relation Of Variables To UTATU•S
TRA	Attitude toward behavior	Behavioral intention
	Subjective Norm	Social Influence
TAM	Perceive Usefulness	Performance expectancy
	Perceive Ease of Use	Effort Expectancy
MM	Extrinsic Motivation	Performance expectancy
	Intrinsic Motivation	Behavioral intention
TPB	Attitude toward Behaviour	Behavioral intention
	Subjective Norm	Social influence
	Perceived behavioral control	Facilitating conditions
C-TAM-TPB	Attitude toward	Behavioral Intention
	Subjective Norm	Social Influence
	Perceived Behavioral Control	Facilitating conditions
	Perceive Usefulness	Performance expectancy
MPCU	Job fit	Performance expectancy
	Complexity	Effort Expectancy
	Affect Toward Use	Behavioral intention
	Social Factors	Social Influence
	Facilitating Conditions	Facilitating conditions
	Relative Advantage	Performance expectancy
	Complexity	Effort Expectancy
	Trialability	
	Observability	
CIT	Outcome Expectations-Performance Outcome	Performance expectancy
	Anxiety	

Source: Awe and Ertemel, 2021

This study employs the UTAUT2 as agreed by some scholars that to test for acceptance of an innovation, a single theory may sometimes not be sufficient (Abdulhakeem et al., 2017; Venkatesh et al. (2003); thus, the selection of this theory as it encompasses eight more user acceptance theories.

2.6. Empirical Studies on Passenger Experience with Technology in Aviation

In 2017, Bogicevica and colleagues conducted a study to assess passenger confidence, enjoyment, and satisfaction with different airport technologies. The check-in kiosk, self-baggage, business center tour guide, and chargers/USB were the chosen technologies. A sample size of 353 participants from two separate studies, the first of which focused on commonly used technologies, and the target group was university graduates from a large university in the southern United States. In the second step, the developed measurements from the first step were enhanced to evaluate the proposed hypothesis in the second phase, where its target population was adult travelers in the US. Results revealed that the relationship between airport self-service technologies and travelers' confidence, benefits, and enjoyment was significantly positive.

Antwi et al. (2021) further studied the importance of consumer thoughts on acceptance of self-service innovations facilitated by technologies in travel. The target group was passengers leaving the Shanghai International Airport, and there were 547 participants in the study. The researchers aimed to examine the association between six independent variables and their relation to the satisfaction of travelers. They employed a structural equation model, and the outcome of the analysis revealed that all six proposed variables related to technology acceptance were found to have a significant positive relation to satisfaction level.

A study in Bangkok, Thailand, by Suwannakul (2021) dealt with user technology readiness and the perception of airline e-services. Data from 382 participants was obtained and analyzed. The findings reveal a huge difference between age, education, occupation, air travel frequency, income, and technology readiness. Further results revealed that technology readiness dimensions like optimism, anxiety, innovativeness, and insecurity have a major influence on passengers' perception of service quality.

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self-baggage, business center tour guide, and chargers/USB were the chosen technologies. A sample size of 353 participants from two separate studies, the first of which focused on commonly used technologies, and the target group was university graduates from a large university in the southern United States. In the second step, the developed measurements from the first step were enhanced to evaluate the proposed hypothesis in the second phase, where its target population was adult travelers in the US. Results revealed that the relationship between airport self-service technologies and travelers' confidence, benefits, and enjoyment was significantly positive.

Hanantyo and Mahmudi (2024) studied user perception with the incorporation of UTAUT2 and technology readiness and the addition of more variables to suit their study objectives. A survey method was used to collect data from passengers at 13 Indonesian airports. Participants were selected based on experience with SSTs and self-check-in kiosks in the research. Perceived trust, perceived enjoyment, and reduced wasting time were the added variables, and all of them were found, including performance expectancy, effort expectancy, habit, optimism, and innovativeness, to influence the use of SSTs. However, hedonic motivation was not a predictor of SST acceptance.

In 2019, Punel et al. studied the relationship between air passenger experience and service quality. More than forty thousand reviews and ratings were extracted from the Skytrax database. Sentiment analysis was employed, and the results suggest that passengers' geographical regions shape their perception of using airline services.

2.7. Proposed Research Model

The model below was designed from the extended unified theory of acceptance and use of technology UTAUT2 adjusted to suit the aims of this research. We use its constructs: Performance expectancy, Effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, Behavioral Intention, and actual Use. Age, Gender, and Experience moderate the independent variables. Also, perceived benefits and perceived barriers/challenges are added as new constructs, as shown in Figure 6.

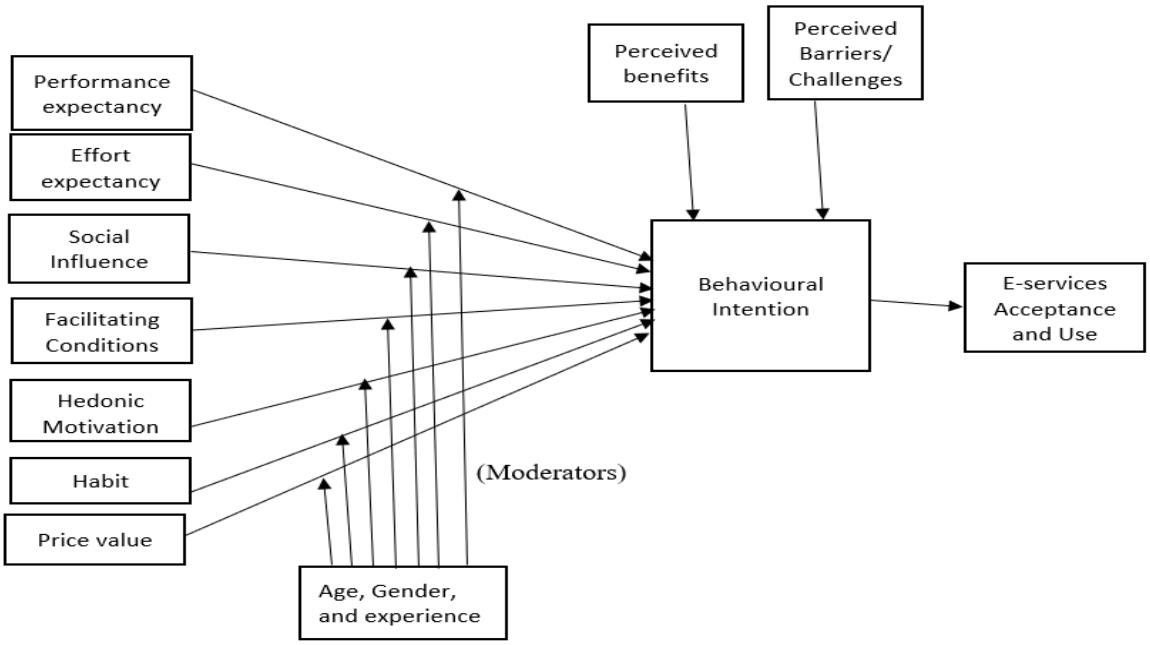

Figure 2.6. Proposed Research Model

2.7.1. Hypothesis Development

H1: Performance expectancy has a positive influence on passenger behavioral intention.

H2: Effort expectancy has a positive influence on passenger behavioral intention.

H3: Facilitating condition has positive influence on passenger behavioral intention.

H4: Social influence has a positive influence on passenger behavioral intention.

H5: Hedonic motivation has a positive influence on passenger behavioral intention.

H6: Habit has a positive influence on passenger behavioral intention.

H7: Price value has a positive influence on passenger behavioral intention.

H8: Perceived Benefits have a positive influence on passenger behavioral intention.

H9: Perceived challenges have a positive influence on passenger behavioral intention.

Age, Gender and experience of passengers will moderate the relationship between Performance expectancy, Effort expectancy, social influence, facilitating conditions, hedonic motivation, price value AND Behavioral Intention.

CHAPTER III

RESEARCH METHODOLOGY

3.1. Research Design

The research design is the conceptual guide through which research questions are answered, the determinants of the type of measurement, and the method of data analysis used to effectively address the research problem (Khandi and Khanam, 2019). In other words, "*the extensive means of gathering and computing data in empirical research* "(Bhattacherjee, 2012).

The data analysis approach in this study is a statistical method. It is used due to the nature of the study as it is quantitative and the number of respondents and questions to be answered. This method is believed to be less time-consuming, and the output is free from researchers' interference. Since the method is quantitative and wishes to get answers through hypothesis testing, the positivist approach is employed.

3.2. Data Collection Process

The primary data collection method was used to satisfy the objectives of this research. One of the aims is to investigate air passengers' perspective of modern e-services implemented by airlines or at airports. For that reason, data needs to be collected directly from air travelers, consequently making secondary data not entirely feasible.

This study used the positivist data approach method which Bhattacherjee in 2012 defined as the procedure of testing a hypothesis or suggested theory by the use of numerical data whereas the other method known as the interpretive method is used when a theory is wished to be attained from the analysis of particular data. Thus, the most befitting approach for this study is the positivist method since we are testing proposed hypotheses.

3.3. Population and Sample

The population is a broad spectrum or a wide unit from which a researcher wishes to draw answers, also known as the researcher's target (Sekaran, 2003). However, not all targets can participate and are often required to be narrowed to a subclass, which is often determined by the research objectives. This study's focus group is air travelers who traveled at least once in the last four years because most of the modern e-services became more popular during and after the COVID-19 pandemic. The method of participant selection was random regardless of residence or continent.

Research sampling techniques are either probability or non-probability sampling. The possibility of each member being chosen or having an equal chance of selection is the idea of probability sampling (Bhattacherjee, 2012), whereas, in non-probability, the chance of selection is unequal and often generalized. The fact that air travelers were targeted regardless of residence, but the idea that not all are formally educated and have the ability to use online questionnaires and understand the questions correctly, so a purposive sampling technique was used, which is a method of non-probability sampling based on the researcher's judgment on who is fit to participate.

Further, a cross-sectional survey method was used to collect data through a self-administered online questionnaire. Studies with large target groups or populations are best believed to use survey methods as many questions can be answered, and statistical techniques can be used to analyze the huge data efficiently within a short span, with less expensive and effective computations (Fitzgerald and Howcroft, 1998).

3.3.1. Sample Size Determination

A sample size of 450 air travelers was targeted for the study; however, two hundred and fifty-three (253) valid responses were received, which is equivalent to 56. 2% response rate, which is an acceptable number in research, as stated by Roscoe (1975) cited by Tan (2009). He expressed that the benchmark for studies that aim to understand the link between variables (the independent variables and the dependent variable), the determinant of the sample or responses can be done through simple mathematical computation by multiplying the total study variables by 10. In our study,

we have 11 variables that are hypothesized to influence the dependent variable. Therefore, giving a total of 110 so, our 253 responses are quite sufficient.

3.4. Data Collection Instruments

The efficient service of web was used for effective communication and dissemination of survey questions to participants. An online self-administered questionnaire was developed and sent via email, WhatsApp, and other social media platforms.

The questions were closed-ended, and we included all possible responses related to each question, especially in the demography section.

The questions were in sections; the first part was related to demography, air travel experience, and familiarity with e-services. The questions in this section were age, gender, education level, employment status, residence (continent), countries usually travel to (continent), travel frequency in the past four years, flight classes, purpose of travel, airlines/airports, and e-services known or familiar with. In this study, age, gender, and experience are believed to moderate the independent variables; thus, some of these questions were included. The residence and travel destination were intentionally defined and generalized to "continent" to better understand the difference in responses based on places people live and travel to because technological advancement differs in terms of geography. The second and third sections consisted of a total of 31 questions based on passenger perception of e-services used adapted from the UTAUT2 (performance expectancy, effort expectancy, facilitating condition, social influence, hedonic motivation, habit, price value, behavioral intention). Also added perceived benefits and perceived challenges. Finally, the last part tested the use level of these e-services as one of the research's aims is to understand the level of familiarity and use of the chosen e-services, and there were 11 questions in this section.

All items in these sections were tested using a 5-point Likert measurement scale with descriptions: 1 - I Strongly Disagree, 2 - I Disagree, 3- I Neither Agree nor Disagree, 4 - I Agree, 5 - I strongly Agree.

3.5. Operationalization of the Study Variables

Table 3.1. Operationalization of the Study Variables

Variables	**QUESTIONS**	**Number of items**
Independent Variables		
Performance Expectancy	The use of e-services helps accomplish things quickly before and during travel. The use of e-services can improve my travel experience. The use of e-services can improve the efficiency of my mobility during travel. The use of e-services is very beneficial to me.	4
Effort Expectancy	I believe that it is easy to operate airlines or airport e-services. I believe that the operations on the interface of airlines or airports e-services should be clear and simple. I feel that the use of airlines or airport e-services is to my satisfaction.	3
Facilitating conditions	I have the resources necessary to use airlines or airport e-services. I have the knowledge necessary to use airlines or airport e-services. Airlines or airport e-services are compatible with other technologies I use. I feel that I am capable of using airlines or airport e-services.	4
Social influence	People who influence my behavior think that I should use airlines' or airports' e-services. I feel that the use of airlines or airport e-services signifies being able to keep up with modern technology trends. People I know use airlines or airport e-services, so I also feel that I should use them.	3
Hedonic motivation	Using airlines or airport e-services is very interesting. Using airlines or airport e-services is enjoyable.	2

Table 3.1. (cont.)

Variables	QUESTIONS	Number of items
Habit	I have already been accustomed to using e-services from other sectors. I think that the use of airlines or airport e-services in the future is a natural occurrence. I think that the use of airlines or airport e-services will become a habit.	3
Price Value	Airlines or airports e-services are reasonably priced. Airlines or airports' e-services are of good value for money.	2
Perceived benefits	Passengers using e-services will perceive higher service quality. Passengers using e-services will enjoy a substantial reduction in time spent through all processes (booking, check-in, boarding). Using e-services allows me the opportunity to do new activities which enhance my travel experience. Using e-services will facilitate new ways of managing and organizing travel.	4
Perceived challenges	I lack awareness of the benefits of airlines or airports' e-services. E-service adoption is low with the airlines or airports that I use. I don't think there is much difference with traditional services. Using airlines or airport e-services is expensive. I have Concerns about security (online payment/information requested). I have Insufficient technological knowledge to use airlines or airport e-services.	6
Dependent variable		
Behavioral Intention	I intend to use airlines or airport e-services. I am willing to use airlines or airport e-services. I will use airlines or airport e-services in the near future. I will continue using airlines or airport e-services.	4

Table 3.1. (cont.)

Variables	QUESTIONS	Number of items
e-services Use level		
e-services used	I use airlines' digital platforms, e.g., apps or websites, for booking flights or online check-in or checking flight promos. I use airport apps for navigation within the terminal/to locate amenities such as restrooms, restaurants, and parking areas. I use personalized and customized services for seat selection/ meal pre-orders, or requests for special assistance. I use my personal device to connect with the airport or airline for flight status/ receive notifications about gate changes, or acquire electronic boarding passes through my phone/iPad/tablet. I do check-in myself using self-check-in kiosks. I use a smart baggage handle to print and fix the baggage tag myself. I use smart security verification through facial recognition or other biometrics by myself. I use smart border control to cross restricted areas by myself via e-gate document scan and biometric verification. I use smart boarding to self-board the aircraft by scanning the boarding pass and entering via e-gate. I use in-flight entertainment services by connecting to Wi-Fi or streaming videos during flight. I self-track my luggage in case of delay/ missing	11

The questionnaire in this research is adopted from the studies of Venkatesh (2013), Awe and Ertemel (2021), Nordhoff et al. (2020), and Chu et al. (2022).

3.6. Validity and Reliability of Scales

The reliability and validity of measurement to test for any theory or concept is one of the key factors in research analysis. These terms are best described as follows:

3.6.1. Validity

This is referred to as the accuracy of the measurement of research, the degree by which hypotheses are measured (Sekaran, 2003).

In order to obtain valid research and to be in line with research ethics, the study scales were adapted from the theory that the study's research model is based on and from similar studies related to user acceptance of technology. Spearman correlation analysis was conducted to test for association between the variables, and there was a positive correlation between them. Further, the scales were reviewed in-depth to ensure they align with the research aims, objectives, and questions of this research. Also, the questionnaire was thoroughly reviewed and pretested by friends and colleagues with air travel experience before finally being sent to participants. The researcher made sure to write the questions in simpler English terms and further went on to give definitions or explanations of terms that the researcher presumed may not be familiar to some participants for easy understanding and to ensure correct answering of the questions.

3.6.2. Reliability

Reliability of scales is the idea of how well research objectives are measured and the consistency of the measurement for a time period without prejudice (Sekaran, 2003). The Cronbach alpha coefficient is mostly used to test for reliability, and the alpha value must be 0.7 – above to be accepted.

The reliability analysis in this study, as indicated by Cronbach's alpha shown in Table 5, demonstrates a coefficient of 0.773, suggesting an acceptable internal consistency. If items were deleted, Cronbach's alpha values generally remain close to the overall alpha, indicating no significant increase in reliability if any single item is removed.

Table 3.2. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.773	.887	11

Table 3.3. The Cronbach's Alpha Values if Items were Deleted

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Behavioral intention	144.04	640.379	.736	.730
Performance expectancy	144.85	628.623	.725	.727
Effort expectancy	149.52	674.592	.733	.741
Facilitating condition	145.69	621.700	.727	.725
Social influence	150.93	698.071	.495	.756
Hedonic motivation	153.16	696.118	.745	.749
Habit	149.51	662.290	.776	.736
Price Value	154.43	729.556	.431	.765
Performance expectancy	145.16	640.859	.732	.731
Effort expectancy	145.09	810.277	-.207	.834
e-services Used	126.74	410.835	.535	.822

3.7. Data Analysis Method

Due to the nature of the study, which is quantitative and is impossible to compute manually, a statistical software Package for Social Sciences (SPSS) 25 was used to compute the data. Participants' demographic questions were computed through descriptive analysis, and the mean, standard deviation, frequencies, and proportions were obtained. Also, the relationship and association between the independent variables (performance expectancy, effort expectancy, facilitating condition, social influence, hedonic motivation, habit, price value, perceived benefits, perceived challenges) and the dependent variable (Behavioral intention) were tested through correlation. An ideal way to test for association between two variables can be through regression analysis (Sekaran, 2003); thus, it was also used. Finally, the level of e-services used was also described.

3.8. Ethical Consideration

The roadmap for an ethically acceptable study is through researchers' ability to uphold moral behaviour throughout the study, especially with regards to data collection and computation to ensure participants rights are not compromised or violated (Saunders et al. 2009). The following points were put forward during and after research to ensure an ethical study.

- The study aim was stated clearly through a detailed description and what is expected, this was on the first page of the questionnaire.
- Participation in the study was voluntary; participants voluntarily filled in the forms.
- Confidentiality of the responses were assured and promised to be used only for the purpose of this study.
- The estimated time to complete the survey was clearly stated.
- Hypotheses were determined before data collection and analysis to avoid manipulation of results.
- To avoid bias and researcher interference with results, the data was analyzed through statistical software.
- The limitation of the study is provided at the end of the research to show the weak points and for future studies to be considered.

CHAPTER IV

DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1. Statistical Analysis Introduction

The Statistical Package for Social Sciences (SPSS) 25 was used to analyze the data. Descriptive statistics (mean, standard deviation, frequency, and proportions) were computed to describe the participants' demographics and other variables. The items in each scale were added, and the behavioral intention, performance expectancy, effort expectancy, facilitating condition, social influence, hedonic motivation, habit, price value, perceived benefits, and perceived challenges were computed. Spearman's correlation was conducted between behavioral intention, performance expectancy, effort expectancy, facilitating condition, social influence, hedonic motivation, habit, price value, perceived benefits, and perceived challenges. Linear regression analysis was conducted to examine the association between dependent and independent variables; Coefficients and their 95% CIs were calculated.

4.2. Socio-Demographic Characteristics Results

The demographic and travel-related variables indicate several pertinent outcomes. Age distribution shows a substantial portion of participants falling within the 25-35 age range (62.1%), suggesting a predominant presence of young to mid-adult individuals in the sample. Regarding gender, there is a relatively balanced representation between females 142 (56.1%) and males 111 (43.9%). Educational status highlights a significant proportion of participants holding master's degrees (36%), indicating a relatively high level of education within the sample. Employment status reveals a diverse mix, with private sector employees being the largest group (34.8%), followed by students (23.3%). Residence showcases a varied distribution, with Africa (38.3%) and Europe (23.7%) being the primary continents represented. Africa is the most

frequently visited continent, with 55 (21.7%) respondents. This is followed by Europe with 32 (12.6%) respondents and Asia with 31 (12.3%) respondents.

Table 4.1. Socio-Demographic and Other Characteristics

Variable	Characteristics	Frequency	Percentage
Age	under 25	34	13.4
	25 – 35	157	62.1
	36 – 45	40	15.8
	46 – 55	15	5.9
	Over 55	7	2.8
Gender	Female	142	56.1
	Male	111	43.9
Educational status	High School or Less	18	7.1
	Diploma /College	43	17
	Undergraduate	77	30.4
	Masters	91	36
	Other post-graduate studies	24	9.5
Employment status	Entrepreneur	18	7.1
	Private sector employee	88	34.8
	Public sector employee	57	22.5
	Self-employed	16	6.3
	Student	59	23.3
	Unemployed	15	5.9
Residence (continent)	Africa	97	38.3
	America	54	21.3
	Asia	29	11.5
	Australia	6	2.4
	Europe	60	23.7
	South America	7	2.8
Travel frequency in the last four years	Once	32	12.6
	2 to 4 times	107	42.3
	5 to 7 times	53	20.9
	8 to 10 times	22	8.7
	More than 10 times	39	15.4
Flight Class	Business	33	13
	Economy	207	81.8
	First Class	10	4
	Private	3	1.2
Purpose of trip *	Visiting family/friends	127	50.2
	Business	84	33.2
	Educational	66	26.1
	Leisure tourism	58	22.9
	Religious	9	3.6
	Health	7	2.8
	Other	11	4.3

*Categories can overlap as individuals might travel for multiple purposes

Various combinations of travel destinations are also reported, with notable mentions including Africa and Europe (25 respondents, 9.9%), Africa and America (15 respondents, 5.9%), and Africa, Asia, and Europe (13 respondents, 5.1%).

The majority of respondents, 207 (81.8%), prefer flying Economy class. Economy and Business combined is the next most common choice, selected by 23 respondents (9.1%). Business class alone 13% while Economy, Business, and First class together are chosen by 6 respondents (2.4%). Smaller groups opt for Business and First class (2 respondents, 0.8%), Economy and First class (2 respondents, 0.8%), and Private flights alone (3 respondents, 1.2%)

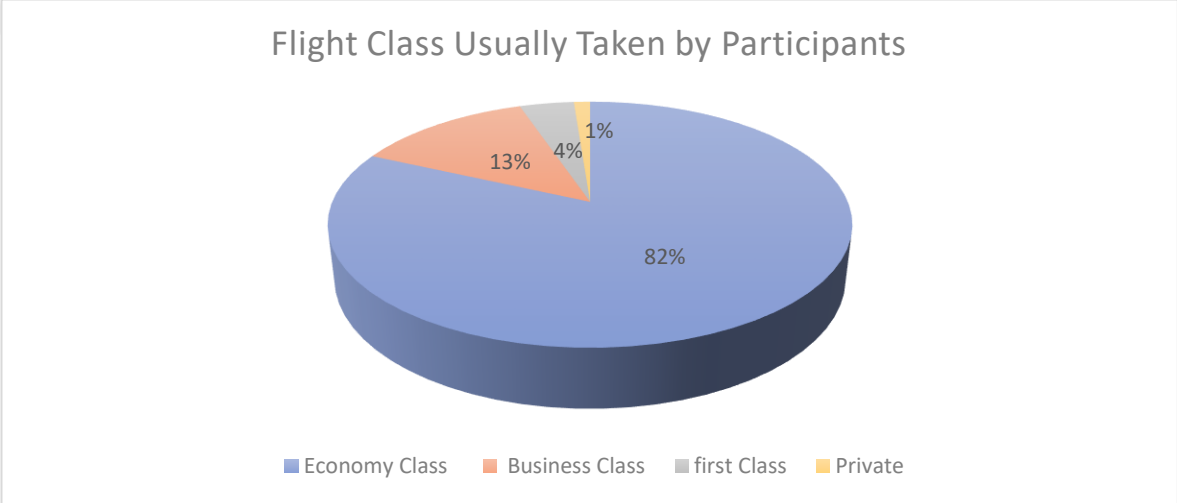

Figure 4.1. Flight Classes Usually Taken by Participants

Travel frequency over the last 4 years indicates a range of experiences, with the most common frequency being 2 to 4 times (42.3%). Lastly, flight class preferences show that the majority of people travel in economy class (81.8%), with a notable representation in first class (13%) (see Figure below).

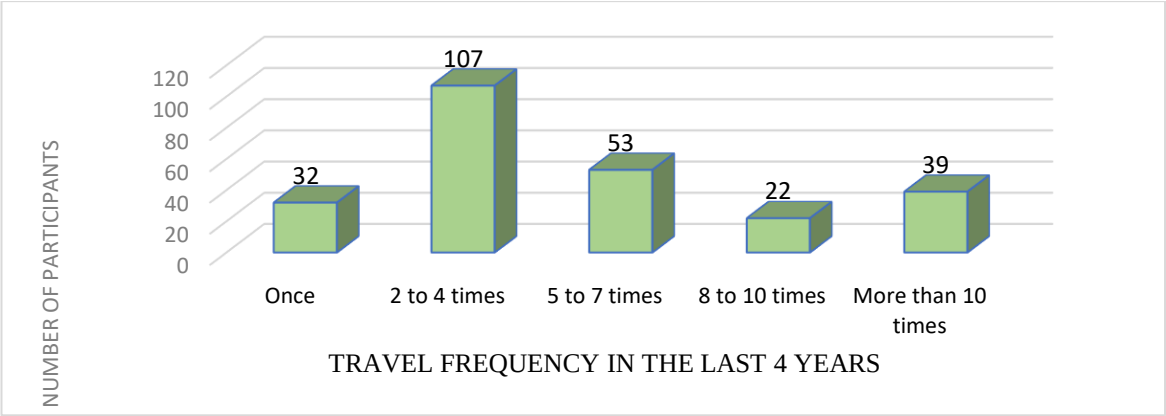

Figure 4.2. Travel Frequency in the Last 4 Years

Regarding the purpose of travel, the most common purpose is educational travel (44 respondents, 17.4%), followed by Visiting family/friends (39 respondents, 15.4%), and Leisure tourism and Visiting family/friends (24 respondents, 9.5%). Business/Work alone accounts for 22 respondents (8.7%), while Business/Work combined with Leisure tourism and Visiting family/friends is chosen by 13 respondents (5.1%). Other combinations include Business/Work and Visiting family/friends (11 respondents, 4.3%), Business/Work and Leisure tourism (9 respondents, 3.6%), and Educational combined with Visiting family/friends (17 respondents, 6.7%). Smaller groups reported mixed purposes such as Business/Work, education, visiting family/friends (8 respondents, 3.2%), and Health (1 respondent, 0.4%), respectively, as demonstrated in the Figure below.

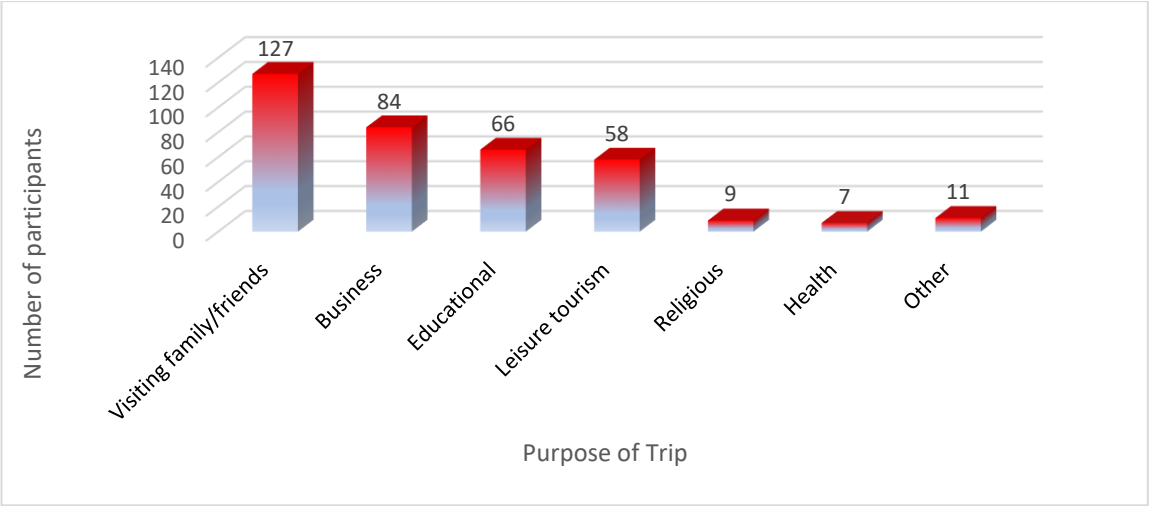

Figure 4.3. Purpose of Trip

Regarding familiarity with various e-services provided by airlines, airlines' digital platforms, exemplified by websites or apps facilitating activities such as making reservations, completing online check-in, and navigation, were notably familiar to about 90% of participants. This is followed by inflight entertainment, then service personalization and customization like seat selection and after-self-check-in kiosks. Conversely, other e-services such as personal device usage and baggage tracking exhibited much lower levels of familiarity. Smart security verification, smart baggage handling, and smart boarding were the least recognized among participants.

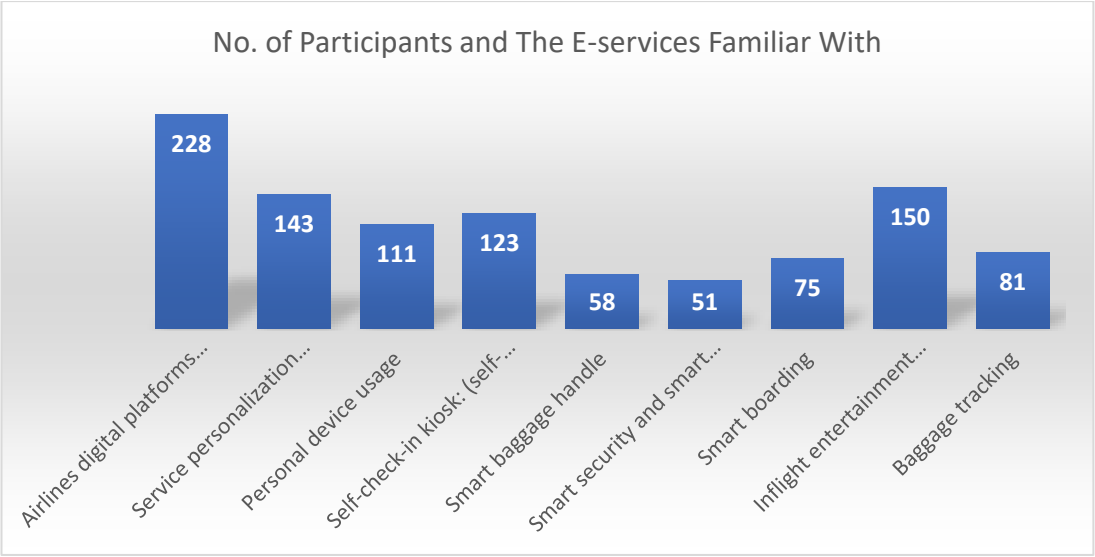

Figure 4.4. Familiarity with Various E-Services

4.3. Summary of the Descriptive Statistics of Behavioral Intention and Other Independent Variables

The mean behavioral intention score is 17.06 with a standard deviation of 1.98. The median score is 17, with the 25th and 75th percentiles at 16 and 20, respectively.

Table 4.2. Descriptive Statistics of Behavioral Intention and Other Variables

Variables	Mean	Standard Deviation	Median	25^{th} And 75^{th} Percentiles		Minimum	Maximum
Behavioral intention	16.87	3.337	17	16	20	4	20
Performance expectancy	16.07	3.68	16	14	19.5	4	20
Effort expectancy	11.39	2.496	12	10	13	3	15
Facilitating condition	15.23	3.845	16	13	18	4	20
Social influence	9.98	2.694	10	8	12	3	15
Hedonic motivation	7.75	1.932	8	7	9.5	2	10
Habit	11.4	2.666	12	10	13.5	3	15
Price Value	6.48	1.844	6	5	8	2	10
Perceived benefits	15.75	3.34	16	14	18	4	20
Perceived challenges	15.82	5.343	15	12	19	6	30
E-services used	34.17	11.125	35	26	42	11	55

4.3.1. ANOVA Matrix

Individuals under 25 exhibited significantly lower scores in behavioral intention compared to 25-35 (Mean Difference = -1.79, t = -2.88, p = 0.035) through a Tukey post-hoc test following an ANOVA analysis (see table).

Table 4.3. Difference Between Behavioral Intentions in Age Categories

Cases	Sum of Squares	Df	Mean Square	F	p	η^2p
Age	130.927	4	32.732	3.035	0.018	0.047
Residuals	2675.025	248	10.786			

η^2p: Partial eta squared, an effect size

The Tukey post-hoc analysis was conducted to assess mean differences between various age groups concerning behavioral intention. This finding suggests that Under 25 participants may have demonstrated less inclination towards the observed behaviour compared to those slightly older. However, no other significant differences were found across age groups concerning behavioral intention (p-value > .05) (see table).

Table 4.4. The Tukey Post-Hoc Analysis to Assess Mean Differences Between Various Age Groups Concerning Behavioral Intention

Age		Mean Difference	SE	T	p-value (Tukey)
(25- -	35)	0.09	0.58	0.15	1.000
	35)	0.87	0.89	0.98	0.863
	35)	1.45	1.27	1.15	0.782
	35)	***-1.79***	***0.62***	***-2.88***	***0.035***
(36 -	45)	0.78	0.99	0.79	0.934
	45)	1.36	1.35	1.01	0.849
	45)	-1.88	0.77	-2.45	0.105
(46 -	55)	0.58	1.50	0.39	0.995
	55)	-2.66	1.02	-2.62	0.071
Over 55	under 25	-3.24	1.36	-2.38	0.124

4.3.2. ANOVA Matrix of Travel Continent and Behavioral Intention

The analysis revealed a significant effect of the travel destination on behavioral intention, $F(5, 247) = 2.708$, $p = 0.021$, $\eta^2p = 0.052$. The ANOVA indicated that travel destinations accounted for a statistically significant proportion of the variance in behavioral intention.

Table 4.5. ANOVA Analysis of Behavioral Intention by Travel Continent

Cases	Sum of Squares	Df	Mean Square	F	P	η^2p
Travel to (continent)	145.82	5	29.164	2.708	0.021	0.052
Residuals	2660.132	247	10.77			

Significant differences were found between participants who traveled to Africa and America (mean difference =-1.85, p = 0.013), indicating a notable variation in behavioral intention. This suggests that individuals who traveled to Africa had significantly different behavioral intentions compared to those who traveled to America. However, no other significant differences were observed among the remaining continent comparisons (p-value > .05).

Table 4.6. Post-Hoc Analysis of Behavioral Intention and Continent Traveled to

Travel to (Continent)		**Mean Difference**	**SE**	**T**	**p-value (Tukey)**
Africa	America	-1.85	0.56	-3.31	0.013
	Asia	-0.19	0.70	-0.27	1.000
	Australia	-2.35	1.38	-1.70	0.534
	Europe	-0.95	0.54	-1.75	0.498
	South America	-0.85	1.28	-0.66	0.986
America	Asia	1.66	0.76	2.19	0.246
	Australia	-0.50	1.41	-0.35	0.999
	Europe	0.90	0.62	1.46	0.689
	South America	1.00	1.32	0.76	0.974
Asia	Australia	-2.16	1.47	-1.46	0.687
	Europe	-0.76	0.74	-1.02	0.912
	South America	-0.66	1.38	-0.47	0.997
Australia	Europe	1.40	1.41	1.00	0.919
	South America	1.50	1.83	0.82	0.963
Europe	South America	0.10	1.31	0.08	1.000

4.4. Correlation Analysis

In the Spearman correlation analysis, behavioral intention shows significant positive correlations with performance expectancy (r=.64), effort expectancy (r=.56), facilitating condition (r=.56), social influence (r=.26), hedonic motivation (r=.66), habit (r=.62), price value (r=.31), and perceived benefits (r=.66), while it is negatively correlated with perceived challenges (r= −.35). Performance expectancy, effort expectancy, and facilitating condition are strongly interrelated, with correlations ranging from r=.68 to r=.70. Additionally, hedonic motivation, habit, and perceived benefits are consistently and significantly correlated with most other variables,

indicating their central role in shaping behavioral intention. Social influence, while positively correlated with other factors such as hedonic motivation (r=.36) and habit (r=.35), shows no significant correlation with perceived challenges (r=.09). All reported correlations are significant at p<.01.

Table 4.7. The Relationship Between Behavioral Intention and Other Independent Variables

Variables	1	2	3	4	5	6	7	8	9	10
1) Behavioral intention	1									
2) Performance expectancy	.64**	1								
Effort expectancy	.56**	.70**	1							
3) Facilitating condition	.56**	.68**	.70**	1						
4) Social influence	.26**	.21**	.26**	.27**	1					
5) Hedonic motivation	.66**	.60**	.59**	.59**	.36**	1				
6) Habit	.62**	.62**	.66**	.75**	.35**	.65**	1			
7) Price value	.31**	.33**	.35**	.43**	.29**	.46**	.41**	1		
8) Perceived benefits	.66**	.63**	.59**	.57**	.40**	.63**	.63**	.49**	1	
9) Perceived challenges	-.35**	-.29**	-.27**	-.34**	0.09	-.27**	-.33**	-.21**	-.26**	1

Note: ** Spearman Correlation is significant at 0.01 (2-tailed).

4.5. Predictors of Behavioral Intention

The linear regression analysis conducted to predict behavioral intention revealed several significant predictors. The overall regression model predicting behavioral intention was statistically significant, F (14, 238) = 49.629, p < .001. Among the predictor variables, performance expectancy (B = 0.17, p = .002), hedonic motivation (B = 0.59, p < .001), habit (B = 0.19, p = .017), price value (B = -0.16, p = .022), perceived benefits (B = 0.32, p < .001), and being under 25 years of age (B = 0.88, p = .011) were significant predictors of behavioral intention. Other variables, including effort expectancy, facilitating condition, social influence, perceived challenges, age groups (36-45, 46-55, over 55), and gender (male), did not show significant association.

Table 4.8. Model Summary of Linear Regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.859[a]	.738	.726	1.746	.738	61.778	11	241	.000

a. Predictors: (Constant), GENDER, PerformancexpeTot, AGE, perceivedchallengesTot, pricevalueTot, socialinfluenceTot, hedonicmotivationTot, facilitatingconditionTot, perceivedbenefitsTot, effortexpectancyTot, habitTot

Table 4.9. ANOVA Summary

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2071.359	11	188.305	61.778	.000[b]
	Residual	734.594	241	3.048		
	Total	2805.953	252			

a. Dependent Variable: behavioralintentionTot

b. Predictors: (Constant), GENDER, PerformancexpeTot, AGE, perceivedchallengesTot, pricevalueTot, socialinfluenceTot, hedonicmotivationTot, facilitatingconditionTot, perceivedbenefitsTot, effortexpectancyTot, habitTot

Table 4.10. Co-efficiets

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.962	.799		4.956	.000
	PerformancexpeTot	.175	.056	.193	3.119	.002
	effortexpectancyTot	-.018	.082	-.013	-.220	.826
	facilitatingconditionTot	.024	.052	.027	.459	.646
	socialinfluenceTot	-.023	.051	-.018	-.440	.660
	hedonicmotivationTot	.597	.095	.346	6.286	.000
	habitTot	.188	.078	.150	2.402	.017
	pricevalueTot	-.177	.070	-.098	-2.513	.013
	perceivedbenefitsTot	.315	.057	.315	5.558	.000
	perceivedchallengesTot	-.018	.022	-.029	-.804	.422
	AGE	.191	.080	.081	2.396	.017
	GENDER	-.348	.231	-.052	-1.509	.133
a. Dependent Variable: behavioralintentionTot						

Table 4.11. Predictors of Behavioral Intention

Variables	**Unstandardized coefficient (B)**	**Standard error**	**Standardized coefficient (β)**	**T**	**P-value**	**95% CI**	
Constant	3.92	0.75		5.19	< .001	2.43	5.40
Performance expectancy	0.17	0.06	0.19	3.08	0.002	0.06	0.28
Effort expectancy	-0.01	0.08	-0.01	-0.12	0.906	-0.17	0.15
Facilitating condition	0.01	0.05	0.02	0.25	0.805	-0.09	0.12
Social influence	-0.02	0.05	-0.02	-0.41	0.681	-0.12	0.08
Hedonic motivation	0.59	0.10	0.34	6.24	< .001	0.41	0.78
Habit	0.19	0.08	0.15	2.40	0.017	0.03	0.34

Table 4.11. (cont.)

Price Value	**-0.16**	**0.07**	**-0.09**	**-2.31**	**0.022**	**-0.30**	**-0.02**
Perceived benefits	0.32	0.06	0.32	5.65	< .001	0.21	0.43
Perceived challenges	-0.02	0.02	-0.03	-0.93	0.356	-0.07	0.02
Age (36 - 45)	-0.41	0.31		-1.30	0.197	-1.02	0.21
Age (46 - 55)	-0.37	0.48		-0.77	0.445	-1.32	0.58
Age (Over 55)	0.73	0.69		1.06	0.289	-0.63	2.09
Age (under 25)	0.88	0.34		2.58	0.011	0.21	1.55
Gender (Male)	-0.25	0.24		-1.07	0.284	-0.71	0.21

From the regression and Anova tables, we can see that the overall model is significant, the independent variables significantly influence the behavioral intention and the results of the hypothesis test are as follows:

Table 4.12. Results of Hypotheses

Hypothesis	**Relationship**	**(sig.)**	**Hypothesis supported**
H1	Performance expectancy with Behavioral intention	.002	**YES**
H2	Effort expectancy with Behavioral intentions	.826	**NO**
H3	Facilitating condition with Behavioral intentions	.646	**NO**
H4	Social influence with Behavioral intention	.660	**NO**
H5	Hedonic Motivation with Behavioral intention	.000	**YES**
H6	Habit with Behavioral intention	.017	**YES**
H7	Price Value with Behavioral Intention	.013	**YES**
H8	Perceived benefits with Behavioral intention	.000	**YES**
H9	Perceived Challenges with Behavioral Intention	.422	**NO**

4.5.1. E-Services Used and Level of Adoption

The table above shows the descriptive result of the items under E-services used; all items were measured using a 5-point Likert scale of 1 -5(strongly disagree to strongly Agree).

Table 4.13. E-Services Used and Level of Adoption

Descriptive Statistics			
E-Services Used	N	Mean	Std. Deviation
E-U1. I use airlines' digital platforms, e.g., apps or websites, to book flights or online check-in or check flight promos.	253	4.09	1.237
E-U2. I use airport apps for navigation within the terminal/to locate amenities such as restrooms, restaurants, and parking areas.	253	2.90	1.448
E-U3. I use personalized and customized services for seat selection/ meal pre-orders or requests for special assistance.	253	3.29	1.403
E-U4. I use my personal device to connect with the airport or airline for flight status/ receive notification about gate change or acquire electronic boarding pass through my phone/iPad/tablet.	253	3.32	1.455
E-U5. I do check-in myself using self-check-in kiosks.	253	3.24	1.434
E-U6. I use smart baggage handle to print and fix the baggage tag myself.	253	2.73	1.428
E-U7. I use smart security verification through facial recognition or other biometrics by myself.	253	2.67	1.411
E-U8. I use smart border control to cross restricted areas by myself via e-gate document scan and biometric verification.	253	2.57	1.420
E-U9. I use smart boarding to self-board the aircraft by scanning the boarding pass and entering via e-gate.	253	2.68	1.474
E-U10. I use in-flight entertainment services by connecting to Wi-Fi or streaming videos during flight.	253	3.71	1.400
E-U11. I self-track my luggage in case of delay/ missing	253	2.96	1.444
Valid N (listwise)	253		

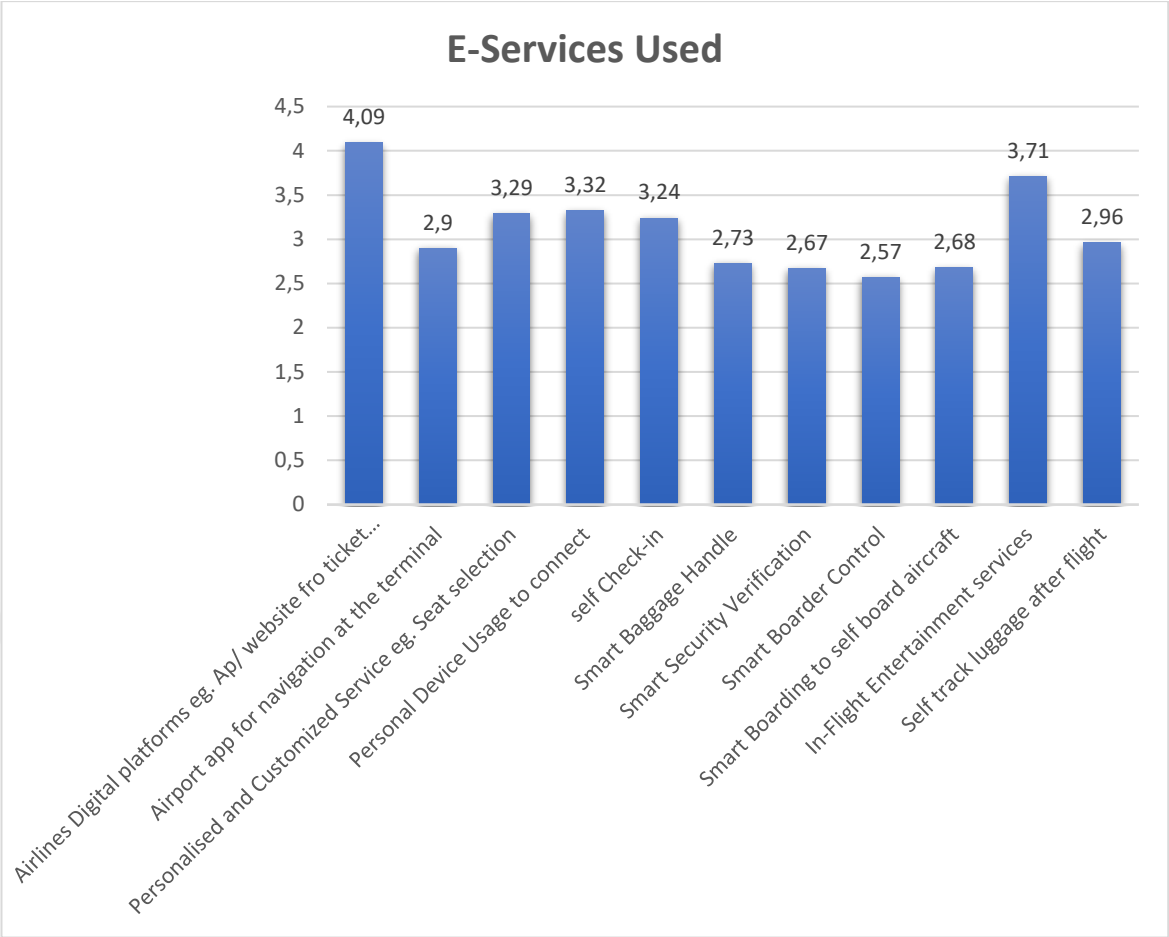

Figure 4.5. E-Services Used

The results showed that the e-service most familiar with and used is the "airline digital platforms," with a mean value of 4.09 out of a 5-point scale. Next is the "In-Flight entertainment (Wi-Fi or video streaming)," with a mean value of 3.71, followed by "Personal device usage to (receive notification or acquire electronic boarding pass)." Next is "service personalization and customization (mean value of 3.29), e.g., Seat selection or request for special assistance;" after is the "self-check-in kiosk" with a mean value of 3.24. After, "I self-track my luggage after a flight in case of delay," "I use airport apps to self-navigate," and" I use smart baggage handle to print and fix the baggage tag myself" were mostly used with mean values (2.96, 2.90 and 2.73) respectively. However, "I use smart security verification through facial recognition or other biometrics by myself," "I use smart border control to cross restricted areas by myself via e-gate document scan and biometric verification," and "I use smart

boarding to self-board the aircraft by scanning boarding pass and enter via e-gate" were the least used services.

4.5.2. Descriptive Results of Perceived Challenges

The figures below depict the different challenge that limits or non-use of the use of the e-services.

Table 4.14. Descriptive Statistics (Challenges)

Perceived Challenges	N	Mean	Std. Deviation
I lack awareness of the benefits of airlines or airports' e-services.	253	2.40	1.248
E-service adoption is low with the airlines or airports that I use.	253	2.90	1.220
I don't think there is much difference with traditional services.	253	2.23	1.102
Using airlines or airport e-services is expensive.	253	2.88	1.132
I have Concerns about security (online payment/information requested).	253	3.05	1.246
I have Insufficient technological knowledge to use airlines or airport e-services.	253	2.37	1.344
Valid N (listwise)	253		

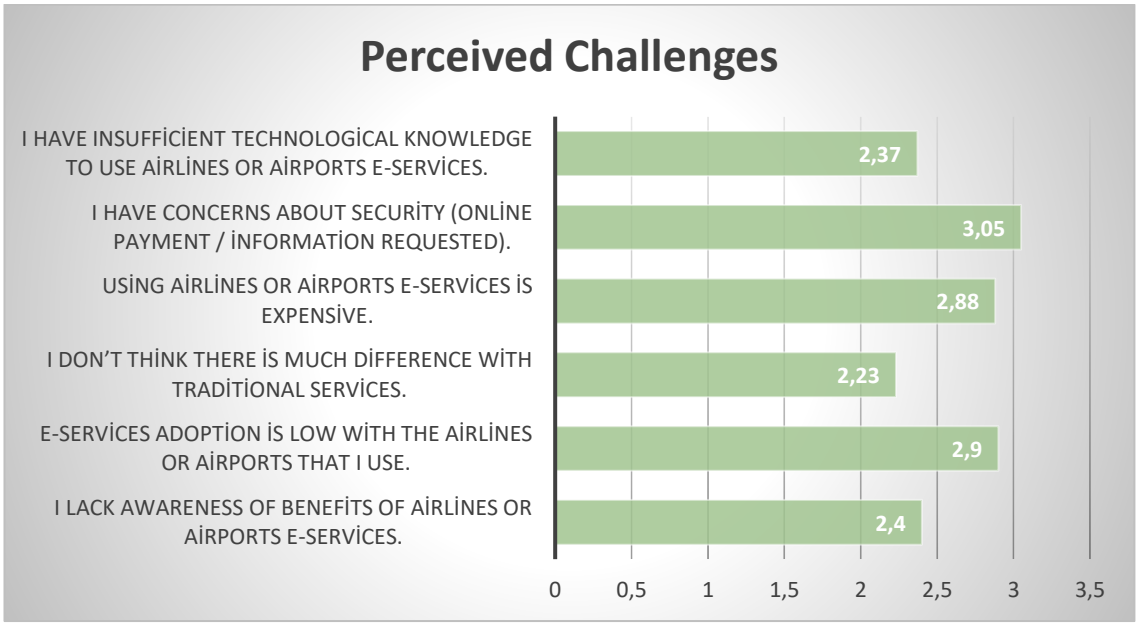

Figure 4.6. Descriptive Statistics (Challenges)

Items in this category were also measured on a scale of 5, and the result revealed that "I have concerns about security (online payment/information requested)" was the highest perceived challenge with a mean value of 3.05. "E-services adoption is low with the airlines or airports that I use." It is the second most perceived challenge, with a mean value 2.90. Next, "Using airlines or airports e-services is expensive," "I lack awareness of benefits of airlines or airports e-services," "I have Insufficient technological knowledge to use airlines or airports e-services," and "I don't think there is much difference with traditional services" respectively.

4.6. Discussion

Due to the fact that little study has been conducted regarding passenger perception of self-service technologies implemented by airlines or airports from pre-travel to after-flight, the available studies were mostly focused on one or two specific self-service technologies. Thus, this study aimed to understand multiple travel e-services passengers are aware of and which among them they utilize. Further, it investigated their outlook on the said technologies and the reasons for their use or non-use. This study proposed ten e-services/self-services used in today's aviation industry, from pre-flight to during and post-flight. Additionally, the few studies available were mostly focused on specific airports; thus, one of the motivations for the study was to understand passenger perception in different geographical regions and with different travel experiences using different airlines/airports.

The demographic profile results showed more than half the total participants, accounting for 62.2%, were between the age bracket of 20 -35, giving the millennial and Gen Z spirit who are described to be energetic and ready to take on adventures with readiness to explore new technological trends. The difference in gender of participants was not very significant. However, a great number of participants have achieved higher education, and interestingly, a good number got master's and other postgraduate studies. Further, out of 6 continents, most participants reside in Africa, followed by Europe, then North America and a few from South America and Australia. Participants' residence was taken based on the continent because the advancement of technology is not linearly distributed, and our study result confirmed It. The results showed that people from mature technology-developed areas were more familiar with

most of the e-services, and participants from less mature technology were less familiar with most of the e-services. This may be due to the unavailability of some of these infrastructures in these countries and regions. Participants' travel destinations revealed Africa is the most frequently visited continent; this is followed by Europe and then Asia. Multiple travel destinations were also reported. The number of times participants traveled in the last four years was reported; 42.3% reported 2- 4 times, 20.9% answered 5-7 times, and the rest were "once," 7-10 times", and more than 10 times. The time frame was set to be "in the last four (4) years" because most of the e-services were put to use more during and after the COVID-19 pandemic.

Furthermore, the majority of the respondents fly economy more and a decent fraction use business. However, only 6 respondents have flown in first class. This may be due to how expensive it is, and a good number of the participants in this study were students. The purpose of travel may overlap as many people travel for different reasons, but from the study, a great number were seen to travel for the purpose of "visiting family/ friends" and then for the purpose of business/work, education, leisure tourism, religion, and health, respectively.

Regarding familiarity with various e-services provided by airlines, "airlines digital platforms" exemplified by websites or apps facilitating activities such as making reservations, completing online check-in, and navigation, were notably familiar to 88.9% of participants then, "inflight entertainment" after "service personalization and customization" for seat selection after "self-check-in kiosks," then "personal device usage" then "smart baggage handle." Conversely, other e-services like "smart boarding," "Smart security verification," and "exhibited much lower levels of familiarity.

Moreover, the Spearman correlation analysis showed that behavioral intention and the independent variables (performance expectancy, effort expectancy, facilitating condition, social influence, hedonic motivation, habit, price value, perceived benefits and perceived challenges) indicated a significant correlation. Further, from the proposed hypothesis, performance expectancy, hedonic motivation, habit, price value and perceived benefits were supported through regression analysis. This indicates that participants perceive usefulness in using the technologies as most of them are literate,

so they find these innovations interesting and enjoyable. Most participants positively answered that they would continue to explore the currently used technologies, and they believe that adaptation to newer technologies in the future will be a natural occurrence. Finally, they also believed the ones currently used are good value for money and priced within means. This is an indication that people are time and effort-conscious and would pay for convenience as they perceived gains in utilizing them. However, effort expectancy, facilitating conditions, social influence and perceived challenges were rejected. These results are in contrast with some of the studies. This may be due to the population size, and the main factor could be related to the demographic, where most participants' geographical location is in Africa, where most of these technologies have yet to be implemented and the available ones are in the premature stage. Regarding facilitating conditions, this can be linked to the perceived challenges where participants agreed most to "security concerns";" "e-services adoption is low with the airlines/airports I use," which in turn connects to the fact that most participants in areas where these e-services are yet to be implemented as Punel et al. (2019) study revealed that geographical location or travel destination shapes user perspective on acceptance or use of technological innovation. Moreover, social influence was not found to have a positive relation with behavioral intention as most participants have higher education and believe in making choices that fit them most, so they'll use an innovation based on their judgments and not peer influence.

4.7. Implications

The results of the study have given an understanding of what it is like to accept this innovation in a broader perspective as it gives insights on different passengers, different age groups, different geographical locations, and different technology maturity in terms of how they perceived such implementations.

This study will give decision-makers ideas on how to improve the already introduced self-service technologies to leverage the gap so the different demographic profiles can benefit as the world continues to grow and air travel is projected to continue growing thus, the need for most operations to be automated, so understanding perception for better improvement and inclusion is crucial. Also, these results will add to the body of knowledge and future studies, especially in areas where this type of study is limited

with regard to passenger acceptance and usage of self-service technologies at multiple airports and in different countries.

The generalizability of regions and focus on multiple self-services from pre-travel to after-flight will give decision-makers an idea of the different technologies passengers are ready to take on if available, and this will provide solutions on the areas that need improvement for the benefits of airports/ airlines, passengers and the aviation industry at large.

4.8. Limitations of the Study

As with any other research, there are bound to be constraints, and this study is no different. Some of the limitations of the study are below:

- The number of participants was fair enough, but a larger number would have given better results as air transportation is a worldwide thing.

- Secondly, the sampling method was a purposive non-probability technique. This method has its limitations, as it is based on research knowledge on who is literate enough to understand the questions, which were self-administered. However, not all travelers can read and understand the questions.

- There were very few participants from Australia and South America, thus making the results in these regions less generalizable.

- Finally, these e-services implementation cannot be successful if passengers are not aware of them and their benefits because they are yet to be implemented by many airports and airlines in some regions.

4.9. Recommendations

A great observation was made from the analysis and due to the nature of the results, these recommendations are suggested for better implementation or usage of e-services

to benefit all parties (airports, airlines and passengers) and to prepare for future changes:

- Future studies should consider a larger sample as air transportation is global.

- Future studies should also employ a mixed method approach as some passengers cannot read and some do not understand the English language to comprehend the questionnaire; therefore, they should put this into consideration by having the questionnaire in multiple languages and adding qualitative study through interviews for those that cannot read.

- Airlines and airports should study better the passenger usage of these services and conduct more research to understand how passengers perceive these e-services as different people from different works of life with different literacy and technology knowledge use air transportation so these services should have a threshold where almost all passengers should feel comfortable in using them.

- Airlines, airports, and other stakeholders in aviation should provide sensitization campaigns, using the power of social media or their websites/apps or display screens at airports to give demos on how these e-services / self-services are used and the benefits of using them.

- Finally, some of these e-services that require extra payments should be made reasonable for passengers to take advantage of their benefits.

CHAPTER V

CONCLUSION

The needs of humans continue to grow, and for the fact, not everything one needs or wants is within one's immediate geographical space, so travelling continues to be a significant element in people's lives for different purposes. Also, with the changing needs, the high sensitivity of people with time, the desire to be self-sufficient, and the need for privacy, many things have been digitalized and programmed to be self-operated, which are believed to save time/ costs/ and offer privacy which is also the concept behind airlines or airport e-services/ self-service technologies.

The advent of technology has greatly impacted the way operations are carried out now, the output showcased and the convenience and sense of ease it has brought into the lives of people all over the world. Its incorporation into the aviation industry has tremendously brought about differences over the years with its continued upgrades and the introduction of new innovations, which benefit not only aircraft manufacturers, maintainers, airports, or airlines but passengers as well; thus, the motivation for the study.

This study pursued answers to how air passengers perceive the implementation of some e-services by airlines or at airports, the level of familiarity and use of these e-services, and the setbacks of using these services. To achieve the objectives of the study, the research methodology used a cross-sectional survey. Air passengers are the main target and data was directly collected from them through an online self-serviced questionnaire sent via email, WhatsApp and other social media platforms. The data was analyzed using SPPS 25 software, a statistical tool that fits well for the study as it is quantitative in nature. The answers to the research questions were obtained through descriptive analysis, correlation, ANOVA, and regression analysis to test for the association and relationship between the independent variables and the dependent variable.

To conclude, Economy class is the preferred choice for the majority of respondents. Performance expectancy, effort expectancy, facilitating condition, hedonic motivation, habit, and perceived benefits exhibit strong positive correlations with behavioral intention, highlighting their critical role in shaping user behavior. Further, Performance expectancy, hedonic motivation, habit, price value, perceived benefits, and being under 25 years of age were identified as significant predictors of behavioral intention.

The result indicated most of the selected e-services in the study are not highly utilized and can be tailored to the perceived challenges. Most participants' reports showed that the most notable points where participants agreed most were ("I have security concerns," " e- services adoption is low with the airlines or airports I use," "using airlines airports e-services is expensive" and "I lack awareness of the perceived benefits of e-services) this may be as a result most participants reside in Africa where most of these technologies are yet to be implemented. The study results indicated that travel destinations accounted for a statistically significant proportion of the variance in behavioral intention; this is in line with the study of Punel, Hasan, and Ermagun (2019) that geographical residence shapes user perspective account for the choice of airline services use thus making experience significant moderator of the independent variables. However, in other questions in the perceived challenges variable, the majority of the responses were more disagreed ("I don't think there is much difference with traditional services "I have Insufficient technological knowledge to use airlines or airports e-services"). The responses to these answers, if predicted, are highly supported by the demographic results where most participants have higher education, between the ages 20 to 40, so we conclude most of them are technologically aware and would use it if the opportunity is made easy.

The study results partially resonate with previous studies (Antwi et al. (2021); Hanantyo and Mahmudi (2024), Punel et al., 2019; Bogicevica et al. (2017); Swannakul, 2021). With the results obtained, there is optimism in introducing and managing better e-services and passengers' acceptance and use of e-services and other technological innovations in the future.

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