Passenger intentions toward the use of self-service technologies in the air transport industry

Bachelor Thesis for Obtaining the Degree

Bachelor of Science

International Management

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Vienna, 20th of June 2023

Affidavit

I hereby affirm that this Bachelor Thesis represents my own written work and that I have used no sources and aids other than those indicated. All passages quoted from publications or paraphrased from these sources are properly cited and attributed. In particular, I did not use any text generators or other paraphrasing tools.

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Abstract

The global airline industry is part of the largest sectors in the world today, and an ever-growing passenger influx generates many new challenges in the airport environment. The industry's responsibility in striking a balance between ensuring seamless security measures and a streamlined operational structure at airports is fundamental to the increasing number of travellers opting for digital processing functions. Airports worldwide have been actively embracing state-of-the-art technologies to strengthen aviation security and enhance passenger flow following the impact of the recent global pandemic. Biometric security, in particular, has gained increasing relevance as it ensure both accuracy and convenience in authentication services. This research paper aims to provide empirical evidence that yields a comprehensive understanding of the user-perceived risks over biometric self-service technologies at the airport, namely data privacy concerns, and their influence on travellers' intentions to use such automated authentication processes.

Through an extensive literature review and data analysis, valuable insights are gained regarding the digitalisation of processing functions and the challenges faced by the industry during the implementation of biometric technology. Findings revealed the statistical significance of factors including perceived control and perceived risk, highlighting the effect that said aspects have on the acceptance of self-service technologies. The research approach posed in the study aims to guide airport management in designing the appropriate strategies for a successful integration of digital technologies.

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List of Abbreviations

SST – Self-service technology

IATA – International Air Transport Association

ICAO – International Civil Aviation Organisation

SITA – Société Internationale de Télécommunications Aéronautiques

1 Introduction

1.1 Context, previous research & motivation

Three years following the outbreak of COVID-19, the global airline industry is on a path to a sustained recovery as most regions are expected to meet or even exceed pre-pandemic levels of demand by the end of 2023 (IATA, 2022). As part of the growing passenger influx, the industry has a crucial responsibility to find a balance between satisfying present safety standards and implementing an efficient processing framework to provide a positive passenger experience at the airport. Though numerous government-imposed travel restrictions have left airlines with no choice but to revert to the manual verification of travel and health documents over the course of the pandemic, IATA (2022) has mentioned in its report that today's increasing traffic is leading several airlines to reintroduce previously suspended automated processes. The objective to minimise passenger touchpoints at airports in the frame of a safer and healthier travel experience has indeed become part of the industry's priorities, as new actions are sought through the Traveller Identification Programme (TRIP) Strategy for a facilitation of the safe resumption of air transport operations (ICAO, 2021).

Over the last decade, the digitalization of processing functions has been widely viewed as an innovative approach to reduce operating costs (Castillo-Manzano & López-Valpuesta, 2013). However, airport management has generally shown greater inclination toward enhancing the passenger experience, rather than considering profit and cost factors (Halpern et al., 2020). As an increasing number of travellers are opting for digital processing functions, newly developed technologies are being introduced to provide airports with seamless security measures and an optimised passenger flow (Wittmer, 2011). Biometric security in particular, has become increasingly relevant as it offers a balance between accuracy and convenience in authentication services: its ability to enhance safety and to reduce waiting times at airports has led to improve overall passenger satisfaction (Ayodeji et al., 2023). Extensive studies have shown the efficiency of this innovative means of authentication, but there remain barriers to its acceptance in an airport environment. Passengers' perceived ease of use and perceived usefulness have previously been

highlighted as elements capable of influencing the attitude toward the use of self-service technologies (Taufik & Hanafiah, 2019). Some studies have narrowed their focus on socio-demographic factors which underlined their role in the success of SSTs based on characteristics such as age, education, and the reason for travelling (Castillo-Manzano & López-Valpuesta, 2013). It was additionally found that both performance and effort expectancy have a significant impact on intentions to use SSTs (Morosan, 2016). However, there is limited research available on the perceived risks and control associated with the use of digital processing functions and their effects on adoption behaviour. This thesis therefore aims to close the knowledge gap that lies in understanding how perceived risks, generated by the characteristics of biometric self-service technologies, will influence passenger intentions to use automated authentication processes.

1.2 Research objectives, questions & structure

Biometrics are in essence a long-term cost-effective solution meant to offer passengers an expedited experience through digital identification (IATA, 2022). The industry's initiative to push for worldwide adoption of biometric self-service technologies is not without challenges however, and a number of factors have previously been revealed to influence travellers' intentions to use them.

In a world of rapid technological change, individuals may perceive risk in biometric services due to uncertainties associated with the use of the platform. The main objective of the thesis is to therefore gain an insight on the way perceived risk, as a construct in human behaviour, can leave an impact on travellers' acceptance of SSTs. In order to understand the circumstances affecting adoption behaviour, and to present a set of possible solutions for the industry to facilitate the integration of the technology, the following research questions are put forward:

1. *How do perceived risks regarding biometric self-service technologies influence the use of automated authentication processes at the airport?*
2. *Which relevant user-perceived risk might pose a challenge in the face of the integration of a digital identity verification system at airports?*

3. *In which manner could the aviation industry ensure a positive adoption behaviour of automated processing functions, within the scope of an improved handling of passenger flow?*

This thesis aims to contribute to existing literature through findings structured into five main chapters. The first part provides a comprehensive overview of the topic, encompassing prior research, the objectives of the thesis, and the research questions. The subsequent part consists of the literature review which will define key terms and explore relevant topics in support of this research. The review includes 2 main sections, primarily introducing the role of self-service technologies, and their integration within the airline industry thereafter. A third chapter features the methodology, wherein the research design and the chosen research approach is described in parallel with the process of data collection. The fourth part of the thesis demonstrates the conducted statistical analyses and the interpretation of the results. A fifth and final chapter provides a conclusion, the limitations, as well as an outlook for future research.

2 Literature Review

This review aims to put the SST innovation in context with the aviation industry. More precisely, the main objective is to understand how self-service technologies function at the airport; how they impact passenger flow management and traveller experience.

The first major part of the review outlines the way in which the technology works as well as a major component: biometrics. Meanwhile the second part details its integration into the industry and highlights the aspects influencing acceptance of SSTs.

2.1 Self-Service Technologies

Significant changes have been made in the way service providers engage with their customers, as the use of information and communication technologies are becoming increasingly relevant within the service industry (Gelderman et al., 2011). Self-service technologies are in essence definable as a software or a “hard technology”

that necessitates a customer's active participation in order to obtain a particular service (Behzod & Richard, 2017). Such automated systems enable customers to perform tasks without external assistance by providing a technological interface capable of fulfilling service requests that would otherwise require direct employee involvement (Chan & Petrikat, 2022). While SSTs give businesses the ability to reduce operating costs and improve both productivity and efficiency, the technology can furthermore benefit consumers by offering convenience, as well as the sense of privacy and flexibility (Wang et al., 2022). Such positives render SSTs the ideal form of service providing, and the recent pandemic has but increased motivations to integrate digital technologies into several industries, namely the banking, logistics, hospitality and retailing sectors (Lee & Yang 2013). Numerous industries have indeed seen a boost in contactless consumption as triggered by COVID-19 health concerns, but the success of digitalised services remain dependent on the customers' inclination to use them (Gelderman et al., 2011, as cited in Wang et al., 2022). This fundamentally means that companies must evaluate the response of customers toward self-based services before investing into this type of resource and must establish a service quality that meets customer expectations (Behzod & Richard, 2017).

2.1.1 Changing the traditional approach to service providing

The afore-mentioned characteristics of an SST are in fact part of an innovation that dates back to the late 1970s as seen in the widespread adoption of ATMs, gas stations, and parking ticketing, while the idea of an internet-based self-service kiosk has been integrated into the travelling, hospitality, food service industries in more recent developments (Chan & Petrikat, 2022). Aside from cost-cutting benefits, the purpose of SSTs revolves around the initiative to increase customer satisfaction and improve the customer experience by reducing customer waiting times. Distonont and Khongmalai (2018) define customer satisfaction as the level of contentment that consumers experience with a company's service offerings, product capabilities, and overall value proposition. Kokkinou and Cranage (2013) have identified four different factors that may contribute to longer waiting times, especially during periods of high customer demand: this includes the arrival rate of customers, the resources available to them, as well as the processing speed and failure rate of self-service kiosks – hence the importance for businesses to pay close attention to the design and performance

of the technological interface. However, the ability of SSTs to ameliorate waiting times does not necessarily mean all customers will elect to use them over face-to-face interactions. In certain industries such as aviation, customers may still prefer traditional services due to the value they place on interactions with staff personnel (Halpern et al., 2021). In some sectors, traditional services sometimes have a stronger influence on customer loyalty, satisfaction, and perceived quality compared to SSTs, which provides the evidence that some firms and businesses can still benefit from retaining and promoting the former means of service delivery (Sharma et al., 2021). However, Hassan et al. (2020) discovered in a study conducted in the service sector that the quality of SST accounted for 75% of customers' loyalty, affirming that the rapid advancements in the technology help tailor a service that gives consumers a greater sense of independence when they are able to do the process themselves. With both types of service providing available to consumers today, it is important to consider the challenges in the frame of adoption, before shifting entirely to self-based services.

Previous research has shown that the rejection of technologies can be driven by personal, behaviour and environment factors (Oyedele & Simpson 2007), while a more recent study reveals that technology trust plays a crucial role in the behavioural intention toward SSTs (Hassan et al., 2020). Customer readiness demonstrably affects participative behaviour and has been shown to be a major contributor to decision-making processes (Bitner et al., 2002) as part of an interrelated set of elements involving technology readiness, perceived ease of use and perceived usefulness (Nguyen, 2021). Evidence suggests that technological anxiety for instance, can lead to preferences in interpersonal services and social interaction, and an environment that is equipped solely with SSTs may be too challenging, especially for older individuals (Kucukusta et al., 2014).

Despite this, Behzod and Richard (2017) assert that customers in general have gotten more comfortable with using SSTs and that they are able to adapt to these modern services with the possessed technological knowledge. Furthermore, the technology's incorporation into the processing functions of different settings provides customers with a greater sense of control (Wei et al., 2016). Indeed, findings suggest that customers tend to appreciate services that offer greater autonomy across

multiple channels (Meuter et al., 2000). The provided convenience and flexibility are revealed to be what typically motivates customers to choose customised SSTs over traditional services (Cunningham et al., 2009).

Airline customers today are given the ability to purchase tickets and complete check-in processes through various online channels, while patients in healthcare settings are able to schedule appointments, fill out paperwork, validate and receive information via mobile devices (Lin & Hsieh, 2011). Similarly, banks offer a range of services through channels including the Internet, mobile devices, automated teller machines (ATMs), and so forth (Lin & Hsieh, 2011). An ever-increasing percentage of technologically aware customers means that the market for SSTs is exponentially growing; management teams must be able to determine their readiness to implement a plan for self-based services (Chan & Petrikat, 2022). In order to ensure long-term success and remain competitive, businesses notably in the tourism and hospitality industries are considering the added functionality of SSTs, as it has generally shown to increase service satisfaction.

The below figure displays that the businesses who had implemented SSTs experienced a 3.2% rise in customer satisfaction compared to those that did not. This implies that customers who are satisfied with the received services tend to remain loyal to the same company, which gives a competitive advantage to the business (Minkara, 2021).

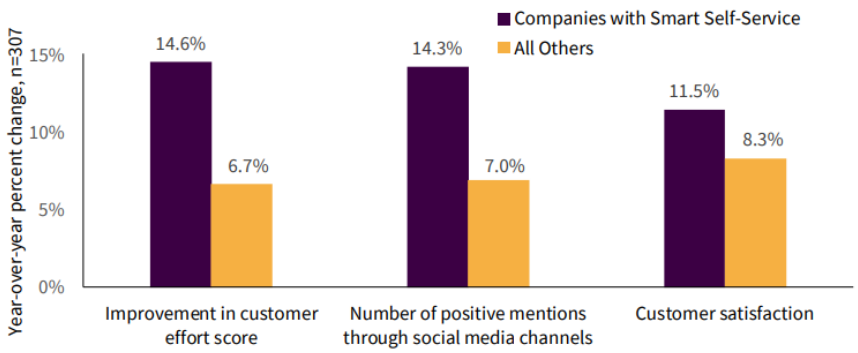

Figure 1: Smart Self-Service Users Enjoy Superior CX Performance Improvements (Minkara, 2021)

Notwithstanding the consumer preferences for digitalised and traditional services that can vary based on factors such as uncertainties, perceived usefulness and ease of use (Nguyen, 2021), a diverse literature affirms that the shift to SST is

inevitable in the sense that businesses must consider its implementation in order to ensure long-term success, and they must leverage customer participation and value co-creation as tools to innovate self-based services, in a way that all individuals perceive it as a secure, convenient and accessible form of service providing (Bolton et al., 2007).

2.1.2 Biometric security

The remarkable progress achieved in the development of biometrics has played a significant role in replacing outdated forms of identity verification in favour of more modern authentication processes. Khan and Efthymiou (2021) define biometric security as a modern technology that allows a contactless means of identity verification and enhances the ability to detect fraudulency or document discrepancies. The technology involves the verification of distinct individual characteristics ranging from fingerprints, retina scans, to other identifiable facial features (Haas, 2004).

Countless businesses across many industries have already integrated this technology to some degree, either within the functions of their products (Acquista, 2020) or their infrastructures (Keyser et al., 2021). Acquista (2020) interprets biometric security as a fairly common technology that enables a convenient form of identification, notably in the case of iPhone users, who have had the option to use a facial or fingerprint means of verification for several years now. Nanavati et al. (2002) describe facial scans as a one-to-one verification process that distinguishes an individual's identity by comparing it to a pre-existing biometric template stored in a database. While the concept of user authentication has remained constant over time, the reliance on a single password as the sole factor for authentication has indeed evolved (Benarous, et al. 2017). The range of applications for biometric security has continually broadened over the years, as a result of the increased effectiveness and affordability of the technology (Nanavati, 2002). Advancements of the technology have allowed a significant expansion in the use of biometrics in internet and mobile applications, which opened up the possibility to use it in various areas such as healthcare, banking, transportation, retailing, and hospitality among others (Jiang et al., 2016; Keyser et al., 2021). The emergence of biometrics and its application in the previously mentioned sectors have created a significant market demand for the

technology according to Jiang et al. (2016), driving further research and development in the field.

2.1.3 User perceptions on biometrics and privacy concerns

According to Morosan (2016), intentions toward the use of biometric verification systems are contingent upon the users' specific perceptions on the technology's reliability. Stotz et al. (2022) add that the acceptance of automated security checks, including the processes of pre-screening and digital scan of facial features or fingerprints, as described by Nanavati (2002), relies heavily on the perceived fairness and security of the system rather than individual characteristics such as trust in the security authorities. It was previously detailed that the identities of users are compared based on unique biological traits available in biometric templates that are stored in a database. The level of sensitivity of stored information can therefore lead to privacy concerns, which, in turn, may create a sense of bias among users, in some cases including those who are familiar with the technology (Morosan, 2016). Conversely, Nguyen and John (2017) argue that a lack of understanding regarding the technology and its effectiveness may as well influence individuals to favour traditional service deliveries.

Previous findings suggest that numerous privacy concerns have emerged, particularly regarding data security (Acquista, 2020). As per Farrell (2016), privacy concerns regarding the technology's use can be attributed to personal privacy beliefs or concerns about information privacy, which refers to the exchange of personal information. More precisely, privacy concern as a concept pertains to an individual's perception of whether a system incorporates the requisite organisational or technical safeguards in place to protect against privacy breaches (Glasman & Albarracín, 2006). The functioning of our economy relies on the collection and exchange of personal data, but this practice carries inherent risks (Citron & Solove, 2022). The authors define privacy laws as legislations ensuring the proper use of personal data by giving individuals more control over their information and establishing clear boundaries on data collection, usage and disclosure. The effectiveness of privacy laws, however, has been hindered by challenges in recognising and addressing identifiable privacy harms as per Citron and Solove (2022).

The loss of anonymity, regardless of whether an individual has a recorded biometric identifier, is irreversible and may lead many people to exercise caution in using biometric authentication (Mitra & Gofman, 2017). Biometrics go beyond capturing an individual's identity and can potentially reveal additional personal information, such as health status and age among others – although this is yet to be proven, the mere possibility of it has raised concerns regarding its use (Woodward, 1997). While the interest in biometrics continues to grow due to security advantages, the concern for misuse of personal data generates numerous questions as for the threat to user privacy (Boulgouris et al., 2009). The authors mention the significant research efforts that have been made over the years to develop techniques that aim to protect the unique templates through the combination of cryptography and biometrics, and the use of secure identifiers that can prevent them from being accessed. Mitra and Gofman (2017) underline the importance of enhancing the privacy of biometric traits, as without the sufficient assurance that they cannot be compromised or used without consent, many individuals will remain apprehensive about the use of this innovative form of identity verification.

Winter et al. (2021) note that individuals have the tendency to weigh their privacy concerns against the benefits associated with the use of biometric security. The pre-pandemic years for instance have highlighted the widespread acknowledgment that in the case of the aviation sector, wherein security is of paramount concern, both airports and passengers have been hesitant to embrace the adoption of biometric-based automated authentication (Kim et al., 2020). The author states that the perceived risks and benefits alike play a significant role in shaping intentions to use biometric security measures initially and repeatedly. According to Thieme (2003), individuals tend to perceive certain verification processes as less privacy invasive based on a handful of application contexts, in which users may feel more inclined to participate.

A more comprehensive analysis of the privacy risks associated with biometric systems can be conducted by considering the specific application and the biometric trait involved. Table 1 below provides a qualitative representation plotted by the International Biometric Group (IBG), of the privacy risks in relation to 10 different application features as interpreted by Boulgouris et al. (2009).

Lower ← Risk of Privacy Invasiveness → Greater		
Overt	↔	Covert
Optional	↔	Mandatory
Verification	↔	Identification
Fixed period	↔	Indefinite
Private sector	↔	Public sector
Individual, customer	↔	Employee, citizen
Enrollee	↔	Institution
Personal storage	↔	Database storage
Behavioral	↔	Physiological
Templates	↔	Images

Table 1: Applicative aspects concerning privacy (Boulgouris, 2009)

The analysis, originally constructed by Thieme (2003), implies that covert biometric applications, or surveillance systems without individual authorisation are regarded as posing a higher risk to privacy. In contrast, optional verifications are seen as being more privacy compliant. The privacy risk associated with biometric data is furthermore influenced by the duration for which the data is retained, in which case Boulgouris et al. (2009) propose that authorities should clearly state the duration for which the data is kept. The sector of application (private versus public) is an additionally important factor, as well as the different roles of individuals subject to the biometric verification process, and the association with fundamental rights – indicating that people with control over their personal data will perceive less risk. This interconnects with another critical aspect, being the storage method that is employed, as a centralised database is likely to be outside the user's control. Moreover, it is important to note the differences between behavioural and physiological traits, the latter being a far more accurate template (fingerprints, iris scan) compared to behavioural traits, rendering the user inessential and therefore less in control. Finally, biometric templates contain slightly less information than original samples, making their condensed form slightly more ineffective for identification purposes.

While the technological advancements have undoubtedly shaped the landscape of biometrics over the past few years, the fundamental principles underlying the afore-mentioned aspects remain significant in addressing privacy

concerns associated with biometrics and ensuring the widespread acceptance of biometric security (Labati et al., 2012).

2.1.4 Measures to mitigate biometric concerns: enhancing privacy protection

The introduction of SSTs has been a noticeable effort across various service industries, as a means to replace traditional services (Lee & Yang 2013). With that, biometric security has gained significant traction within the scope of a more accurate identity verification process, especially in the case of surveillance measures, border control sectors, airport environments and so forth (Khi, 2020). However, the need to address and resolve the privacy issues associated with the user's digital information when interacting with biometric self-service technologies is crucial to ensure the acceptance and adoption of said technologies, which requires a new set of solutions that will enhance digital security (Alabsi & Gill, 2021).

Some findings related to the encryption of biometric templates suggest the use of a new technique called PPS-BAS (Protective Privacy System for Biometric Authentication in Cloud Computing Platform), comprising the automated process that encrypts biometric data in a cloud computing environment (Prabhu et al., 2022). The authors highlight the effectiveness of this tool for securing identity verifications, as it adds an additional layer of protection to the templates that contain personal data, from data compromission and nonconsensual use, through secure and encrypted transmission methods. Others propose the approach for "soft" biometric systems by leveraging differential privacy: this concept aims to improve the privacy-preserving framework within a centralised storage of biometric data, all the while maintaining the system's functionality and performance (Sadhya & Singh, 2016; Sadhya & Singh, 2017). There is, however, extensive literature available on the application of blockchain for biometric data management. While blockchain is most commonly perceived as a tool used within the context of cryptocurrencies, its functions encompass a decentralised and automated means of recording and storing information in an immutable database that can be used in several different settings (Guo & Yu, 2022). Acquista (2022) interprets the blockchain database as a technology capable of removing the need of a third party during a transaction medium, which furthermore limits the chances of data leaks. Various findings reflect on the

technology's ability to facilitate user co-operation by means of the additional safety and transparency of blockchain's data storage (Ahmad et al., 2021; Garcia, 2018; Cao et al., 2022; Bandara et al., 2021). The authors show a mutuality in the advantages of a blockchain-based data management, which can improve privacy protection in the case of identification processes, through strong cryptographic security features and a decentralised peer-to-peer network.

2.2 Self-service technologies and the airline industry

Following the impact of the recent COVID-19 pandemic, an estimated 4 billion scheduled passengers were boarded in 2022 (Salas, 2022). One of the most dynamic sectors in the world is subject to a continuous growth as part of an increase in the level of accessibility in air travel (Eliasson, 2022). This increase in global passenger traffic, however, necessitates airports to adapt processing functions and optimise operations in order to meet modern safety standards while providing every aspect of a dependable means of transportation. Passenger experience at airports holds significant influence on customer satisfaction, and the latter can often be boosted through shorter waiting times (Lopez-Valpuesta & Casas-Albala, 2023). As it is, numerous airports internationally have begun implementing SSTs across their infrastructures, hoping to ensure a seamless passenger flow and a higher satisfaction rate by reducing these waiting times (Ayodeji et al., 2023). It is important to understand how self-based services are being implemented, and what purpose they serve at airports – this section of the review therefore details how modern airports currently operate, before putting focus on a much more in-depth contextualisation of the technology within the aviation industry.

2.2.1 Overview of airport structures and management

Air travel and airports significantly contribute to the thriving tourism industry, which is recognised as the largest sector worldwide (Hanlon, 2007). Various factors were instrumental in propelling growth in this industry: the influences of globalisation, demographics and liberalisation emerged as significant contributors (Cook & Billig, 2017). The evolution of the industry throughout the 1970s and 1980s, marked by the early stages of airline privatisation, deregulation, and overall maturation, led to a shift in perceptions regarding airport management (Graham,

2018). As airports transitioned from being perceived as public utilities, the move toward a more commercialised approach prompted a gradual expansion in resources and staffing to match the increasing significance of commercial functions within airports (Graham, 2018). As a result, airport managers began concentrating more efforts on ensuring an increased revenue stream through improved commercial operations (Gleave, 2016). As part of this initiative, airports are to this day actively pursuing developments in facility designs and seek to optimise operating methods for an efficient and safe processing system (Young & Wells, 2011). Vienna airport, as an example, implemented a structural reorganisation during the late 1980s by establishing customer divisions, including departments responsible for safety and security, technical service, maintenance, as well as finance, which allowed its management to align with business practices that comprise the key aspects of generating profits while providing cost-effective services (Graham, 2018).

Airports play an indispensable role in the process of globalisation: by stimulating the economic development of a region as a transportation medium, airports directly influence the competitiveness of the country (Forsyth & Niemeier, 2021). The performance of an airport comes down to a multitude of efficiency related factors within the structural and operational dimensions (Özsoy & Örkcü 2021). The authors note that this involves the development of a structurally effective airport layout, as well as the essentiality of a competent workforce, which impacts the efficacy of processing facilities. Meeting passenger needs by mitigating delays and providing comfort is a critical aspect in airport competitiveness, reflecting on the necessity of a well-designed set of service points. Milbredt et al. (2017) highlighted in this regard, the value that information holds and emphasize that airlines and airports alike must prioritise the timely delivery of real-time data to passengers. Another study reveals the importance of accommodation and lounge spaces at the airport, which can enhance passenger satisfaction and essentially differentiate an airport from others (Chatterjee et al., 2023). As per the authors, it is crucial to design such spaces according to travel class and the different cultures in order to satisfy passenger needs and preferences. Airport planning techniques are vital for the construction of airport capacity. Cheong (2018) underlines that a phased approach must be employed when designing the processing systems and overall layout of the airport: this will help prevent substantial future delays and allow airports to expand their capacity.

Development decisions regarding all of the above-mentioned aspects mostly derive from a combination of private investors and airport operators (Gleave, 2016). The author states that this composition emerges from a bidding process that determines airport ownership – with the inclusion of public sector involvement in some cases – and that operators typically oversee the day-to-day management of the airport, while private investors contribute financial resources to generate profitable returns from airport concessions. Kim and Shin (2001) define concession revenues to be principal determinants of airport performance within the context of profit maximisation and customer satisfaction. Airport management and shareholders, however, are not always fully in charge of internal services, which include ground services such as passenger or baggage handling. Gleave (2016) gives an overview of the differing airport services around the world and emphasises on the contrasting regulations dictated by countries and airports globally, that separate self-handling (by airlines or airports) from third-party independent ground handling companies. While it partially depends on the available ramp and terminal infrastructures, it is revealed that numerous airports internationally rely on the third-party ground handling market – mostly apart from the US wherein services are often handled by airlines – which suggests that delays can originate from factors that are not directly related to the airport's processing facilities responsible for handling passengers.

Ensuring safety within the aviation industry is just as crucial as maintaining a streamlined airport processing system that meets the demands of travellers and shareholders. Over the last decades, the industry has been facing an important challenge in finding the balance between the implementation of flawless security measures and an efficient and safe airport experience for passengers (Farrell, 2016).

2.2.2 The 2020 global pandemic: health and safety measures

Global air travel demand experienced a sharp decline of approximately 90% following the lockdown restrictions in 2020, which resulted in significant revenue losses for commercially operated airports and the overall industry (Colak, et al. 2023). IATA (2022) mentions that despite governments putting self-servicing to a halt to enable a more rigorous and manual verification process of travel and health documents in the early period of COVID-19, airlines were quick to offer new solutions to reintroduce automated processes and reduce customer touchpoints for travellers.

Over the last three years, the industry's focus on creating a safer and healthier travel experience by minimising passenger touchpoints at airports has emerged as a key priority (ibid). This objective is being pursued through the implementation of new propositions, including the TRIP strategy (Traveller Identification Programme), which are aimed toward ensuring a safe and sustained resumption of air transport operations (ICAO, 2021). Another initiative seeks to develop a fully biometric experience that offers passengers a safe and efficient travel process, involving the use of a facial or fingerprint travel token, allowing a direct and decentralised transmission of personal data (IATA, 2022). According to Lopez-Valpuesta and Casas-Albala (2023), airports and governments must indeed prioritise their efforts on these long-term changes and innovations alongside the rapid and short-term actions that help cope with health concerns, due to the downturn in passenger satisfaction that occurred in 2021 as part of an extended period of uncertainty, which shows the importance of developing long-term resilience. This means that the operational dimensions of airports must be adapted, and the technological infrastructures enhanced in order to improve the safety and experience of passengers (Colak, et al. 2023). Such changes would allow airports, being in a highly regulated environment and a financially fragile sector, to better sustain operations in the case of pandemics as well as other disruptions and would help to develop trends that can reduce safety risks (Kurzweil, 2022). In terms of technological advancements, findings show the integration of digital services within the airport environment to be an advantage with the digital maturity gained by individuals and organisations over the course of the pandemic, bringing positive implications that contribute to an improved quality of life (Eliasson, 2022). Halpern et al. (2021) state that digital technologies are in fact a pertinent solution for addressing health measures, both in present and future contexts.

2.2.3 Integration of self-service technologies at airports

As revealed in a yearly report by SITA (2019), investments in digital technology within the aviation industry, including state of the art security measures, were part of a substantial increase as compared to previous years, reaching 11,8 billion US dollars in 2019. The aviation industry and airports internationally have witnessed the unfolding of digital transformation processes in various segments and application areas. Such initiatives have encompassed the adoption of automated processing

functions, the digitisation of information, as well as the use of artificial intelligence, which can be found in airports when it comes to self-service kiosks and automated screening (Thums et al., 2023). In spite of pandemic related setbacks, having significantly impacted investment plans at airports globally, the potential of contactless features that biometric-based authentication provides is one very much sought after solution, especially noting the responsibility that the industry must hold for appropriate health and safety measures (Halpern, et al. 2021). Self-service technologies on the other hand have been identified as tools that offer numerous advantages, especially in busy and demanding airport settings, as they effectively decentralise processing functions (Taufik & Hanafiah, 2019). The previously mentioned shift of airports toward commercialisation (Graham, 2018), which led to a progressive growth in resources is important to note, as it accounts for the advancements made in processing functions and overall operational procedures (Young & Wells, 2011). Figure 2 illustrates a comprehensive analysis of the digital maturity that the industry has undergone, by considering the integration of SSTs and the application of biometric data security, as interpreted from Rajapaksha and Jayasuriya (2020).

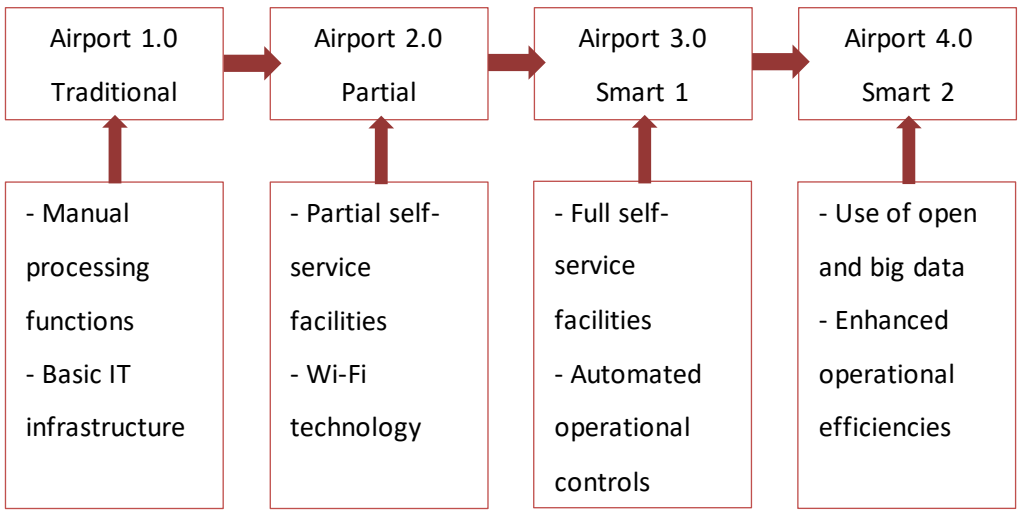

Figure 2: Digital Maturity and Technology Adaptation in Airports (Rajapaksha & Jayasuriya, 2020)

The above categorisation represents Airport 1.0 as traditionally operating airports, which rely on manual processing systems as well as a simple IT infrastructure,

while Airport 2.0 offers partial self-service processes, including a digitalised but simplified check-in service as part of an effort to reduce costs and improve passenger flow. The next level (Airport 3.0) features today's smart airports, comprising full self-service capabilities across all passenger processing facilities which essentially leads to a capacity raise within the airport environment. Finally, Airport 4.0 provides the optimal passenger experience and generates ancillary revenues by integrating artificial intelligence (AI), IP-based security, as well as data analytics on passenger behavioural intentions. As described by Alabsi and Gill (2021), "smart" airports function on enhanced operational efficiencies and service qualities that are reliant on several information technologies, such as biometrics, integrated within passenger processing functions that involve identification and authentication.

While the aviation industry has so far witnessed substantial advantages through digital transformations, the introduction of biometric SSTs within operational aspects is not without challenges. Literatures analysed in previous subsections reveal the importance of implementing the appropriate solutions to alleviate privacy concerns and ensure the successful adoption of the technologies within the airport environment. Airport management must therefore put focus on the assessment of passenger behaviour and intentions and carry out suitable strategies for biometric procedures and SSTs to enhance user acceptance levels (Kim et al., 2020).

2.2.4 Passenger intentions to use biometric SST

Eliasson (2022) found that the effects of the pandemic will not be reducing the level of traffic volumes globally, indicating that there is an obviously strong possibility for the continuous and rapid development of biometric self-service technologies and digital services at airports, which will cause lasting effects on the way we travel. The technologies' cost-effectiveness and reliability offer significant potential for widespread application within the industry (Farrell, 2016). Recent years have shown the increased adoption of SSTs has been a result of the continuous digital maturity experienced by the air transport sector, with operators encouraging a greater number of passengers to utilise these services due to the added benefits to passengers as well as airlines (Gures et al., 2018). Castillo-Manzano and López-Valpuesta (2013) mention the active interest of airlines to invest in SSTs, not only to enhance consumer service quality and reduce personnel costs, but also to project a

positive image of their commitment to service innovations. The COVID-19 pandemic has furthermore reflected the need to provide a touchless and expedited processing system that can help alleviate long queues and congestion at airports – achievable with the integration of biometric self-based services (Khan & Efthymiou, 2021). Such measures can reduce waiting-times and thus increase service quality as well as passenger satisfaction (Ayodeji et al., 2023). Lee et al. (2014) quantitively demonstrate the improvements in processing time and the increased number of passengers processed within a given timeframe when a major international airport uses SSTs. Some findings have, however, also highlighted the importance of monitoring the performance of SSTs, as service failures can cause delays and directly impact satisfaction (Taufik & Hanafiah, 2019). Previous literature investigates expectancy and customer responses toward failures of the technology and suggests that factors including perceived control and SST interactivity significantly influence customer recovery efforts (Zhu et al., 2013). The authors imply that it is important to design an appropriate and easy-to-use interface in order to ensure the acceptance of SSTs.

Halpern et al. (2021) argue that passengers show a strong inclination to use of technologies that offer more control through a more personalised and automated set of service options. Despite this, the authors highlight the presence of a minor but notable population of travellers who remain hesitant to incorporate digital technologies into their travel journey. Taufik and Hanafiah (2019) examine and reveal the likely impacts of generational differences that separate individual service preferences and the acceptance of SSTs. Studies have shown the challenges of implementing digital services into service industries, which can indeed be the nature of demographic factors (Castillo-Manzano & López-Valpuesta, 2013), with customer readiness and knowledge being major contributors (Nguyen, 2021). Stotz et al. (2022) conclude that individual perceptions on the technologies' effectiveness and fairness are significant determinants of user acceptance. Need for interaction as well as perceived crowdedness are other common factors influencing intentions to use SSTs at the airport (Gelderman et al., 2011). Although in the case of the aviation industry, travellers were not found to be influenced by the perceived ease of use and usefulness of SSTs (Lu et al., 2009) as much as within the hospitality sector (Oh et al., 2013). There is however less acceptance toward automated screening technologies when there is

a perception of risk in their use (Negri et al., 2019), or concerns about privacy with regard to the collection of biometric and behavioural data (Ioannou et al., 2020). The SITA director in this regard enforces a transparent approach to data management which aligns with ethical principles and privacy regulations ("How Biometrics Can Help Airlines Take Off Again", 2021).

While some passengers are still opting for traditional services at the airport due to the value held on interactions with staff personnel (Halpern, 2021), it is crucial for airports globally to consider the integration of digital technologies that can provide an enhanced level of security and a streamlined passenger flow. Extensive research made on this topic affirms the necessity of remaining competitive as a business, most notably within the air transport sector. In order to mitigate the challenges of a sustained adoption of biometrics and self-based services, airports must put focus on ensuring user certainty in the technologies by providing the sufficient assurance related to their advantages and efficiency, which will highlight the beneficial aspects over the non-beneficial aspects (Kim et al., 2020). Lastly, airport management and shareholders must prioritise the designing of a biometric self-service system that will not only improve user privacy but also generate an overall positive experience (Winter et al., 2021).

2.3 Hypotheses

Literatures show a mutuality pertaining to the operational efficiency of digital services within the context of the aviation industry. A thorough review of biometric SST, its advantages and drawbacks, helps formulate the following hypotheses, which will be tested as part of the investigation of this thesis:

H1: Concerns about personal data security have a significant negative effect on intentions to use SSTs.

H2: Prior knowledge of biometric security influences passenger intentions to use SSTs.

H3: Perceived control (PC) influences passenger intentions to use SSTs.

H4: Perceived risk (PR) influences passenger intentions to use SSTs.

H5: The effect of (a) data privacy concerns; (b) prior knowledge; (c) PC; and (d) perceived risk (PR) on the intention to use SST is lower for frequent fliers.

The following conceptual research framework is proposed to visually illustrate the hypothesised relationships derived from the previous literature, as seen in figure 3:

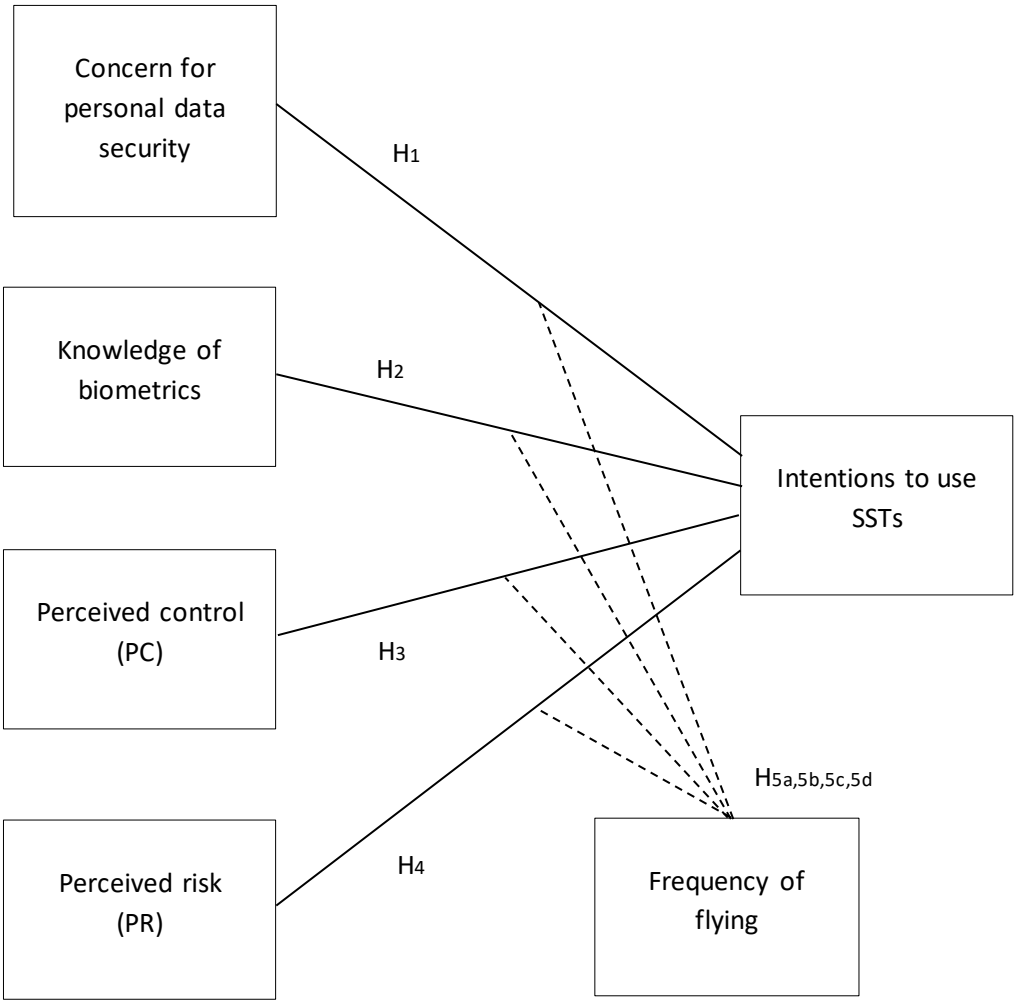

Figure 3: Research Model depicting the relationship between the variables

3 Methodology

3.1 Research Design

The aim of this research design is to describe the theoretical and practical research methods which will be used to collect and analyse data for the thesis. It essentially serves as a blueprint that outlines the employed research approach and identifies the methods for sampling as well as the interpretation and evaluation of data. Moreover, the design addresses ethical considerations pertaining to involved participants. Ultimately, it aims to structure the research process in a clear and systematised manner, in order to achieve an accurate and reliable set of results through efficient data collection and analysis. There are three distinct research approaches available for use, including the quantitative method which utilises numerical data and statistical analysis to test relationships among measurable variables; qualitative research, which focuses on the qualities of individual meanings through the characteristics of language and expression; while the mixed methods approach involves the combination of both quantitative and qualitative data to gain a comprehensive understanding and a more complete perspective of the research problem (Creswell, 2014). The research for this thesis is conducted through the quantitative approach, which helps provide a rigorous and objective examination on the way risk perceptions influence travellers' use of self-service technologies at airports as part of a set of findings that can be generalised to larger populations. The investigation led to understand the perceived risks arising from the features of such technologies involves a postpositivist worldview, which is a philosophy centred on identifying and examining causes and effects by using data and evidence to advance the understanding of a given research problem (Creswell, 2014). The quantitative approach is however backed by a non-experimental design, with which a survey is used to better understand the factors that influence passengers' adoption behaviour.

3.2 Research instrument

The quantitative research instrument in question is an online survey, which allows the collection of numeric data. This approach was chosen to conduct the research for this thesis as it can be conveniently accessed on various electronic internet devices, enabling the opportunity to reach a larger audience. Participants

benefit from the anonymity it offers, encouraging them to provide honest responses. They are furthermore equipped with the freedom to complete the survey at their own convenience, wherever and whenever they choose. To maintain participant engagement, the survey questions have been designed to be concise and ensures individuals remain interested and motivated to complete it.

The online survey was distributed through online messaging services and social networks and was available to fill out for the duration of a three weeks. The creation of the survey was made possible by Google Forms, which facilitated the customisation of the questions according to the topic's requirements and provided participants with easy access through a short URL link. The collected data was then imported to the Jamovi statistical software for analysis and the examination of potential correlations between variables of interest.

3.3 Data collection

3.3.1 Questions

Participants of the survey are presented with an initial introductory text that states the purpose and aims of the online questionnaire, followed by a short and clear explanation of the researched topic involving self-service kiosks and a key component, that is biometric security. Finally, participants are given a written guarantee that the provided responses are anonymous and remain confidential until the bachelor thesis is complete, at which point the data from the survey is erased.

The online survey encompasses 18 questions in total, with 17 single choice questions and only 1 multiple choice question. The first four questions were used to identify the sample characteristics based on demographic factors including gender, age, education level, occupation, with simple questions such as *"What is the highest level of education you have completed?"*.

Participants were then asked to answer four following questions which helped class them according to some aspects pertaining to the frequency of flying as well as past experiences with self-service kiosks at the airport, i.e., *"Have you previously used self-service kiosks at the airport for check-in or bag drops?"*.

Finally, participants had to assess and rate their level of agreement to specific statements for the ten subsequent questions, which were formulated on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5), and were developed based on the research conducted by Belanche et al. (2022); Taufik & Hanafiah (2019); Islam (2023), i.e., *"I think self-service kiosks have mechanisms to ensure the safe transmission of my personal data"*. Despite the fact that they cannot be skipped, the questions were made to be clear and concise and were constructed in a way that participants would easily comprehend them and answer without difficulty. To further ensure the clarity and reliability of the survey, several pre-tests were conducted before the official distribution, which was done to understand the way individuals interpret the various questions and to determine whether any additional clarification was needed.

Upon completion, the participants received a confirmation for successfully filling out the online survey. The Appendix of this thesis contains the complete set of survey questions for reference.

3.3.2 Measures

This research paper examines 3 measures, including concern for personal data security, perceived risk, and usage intention. The first measure is in relation to the first hypothesis, which incorporates the construct of concern for personal data security with the two following survey questions: *"I am generally concerned about the security of my personal information"*; *"I am concerned about the consequences of sharing my information with an automatic identity verification machine".* The second measure relates to the fourth hypothesis, which includes: *I believe my personal data would be well-protected by the security authorities"*; *"I think self-service kiosks have mechanisms to ensure the safe transmission of my personal data"*; *"I feel confident in using self-service kiosks at the airport because I believe my personal data is secure and well-protected."*. The third and final measure comprises the usage intention construct to assist with hypotheses one to five, using the last two questions of the survey: *"I would recommend the use of self-service kiosks to friends"*; "*I intend to use self-service kiosks in the future"*.

4 Data Analysis and Results

4.1 Sample Characteristics

A total of 108 responses were received for the online survey, comprising 81 male respondents and 26 female respondents, with only 1 respondent who preferred not to disclose this information. The below pie chart depicts the gender distribution of the survey participants, showing the demographic characteristics of the sample as unequally distributed. The exact percentages are 75%; 24.1%; and 0.9%.

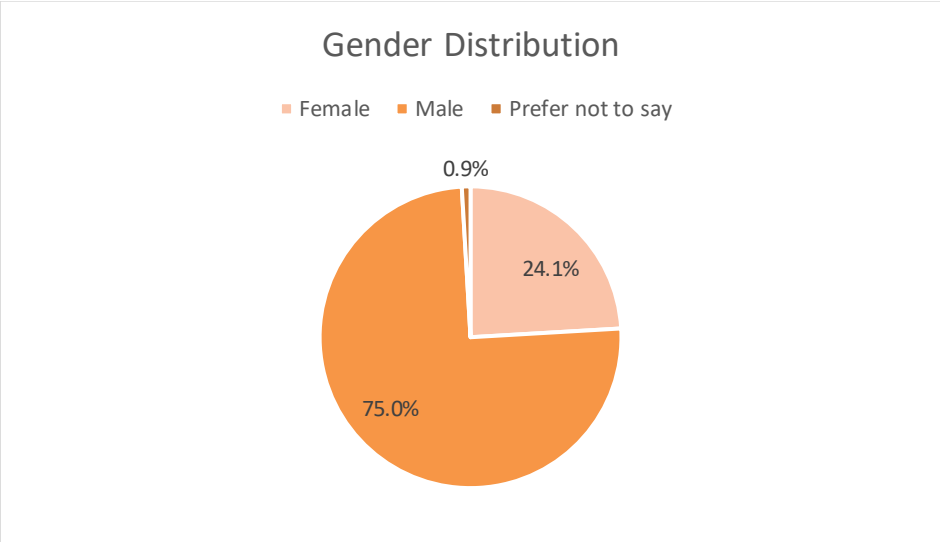

Figure 4: Gender distribution of survey participants

The age profile is illustrated in the table below, showing once again an unequally distributed set of results. No particular age group was targeted for questioning; however, the indicated age range of participants spans from 18 to over over 56 years old. The decision not to focus on a specific age group was made due to the variation in experiences, allowing for a broader perspective on the investigated factors. In terms of participant age distribution, the majority of responses were from individuals aged 18 to 25 years old accounting for 77 respondents. Figure 5 further indicates that the largest group of participants falls within the 18 to 35 age range with 85 responses, while there were only 23 respondents aged 36 and above.

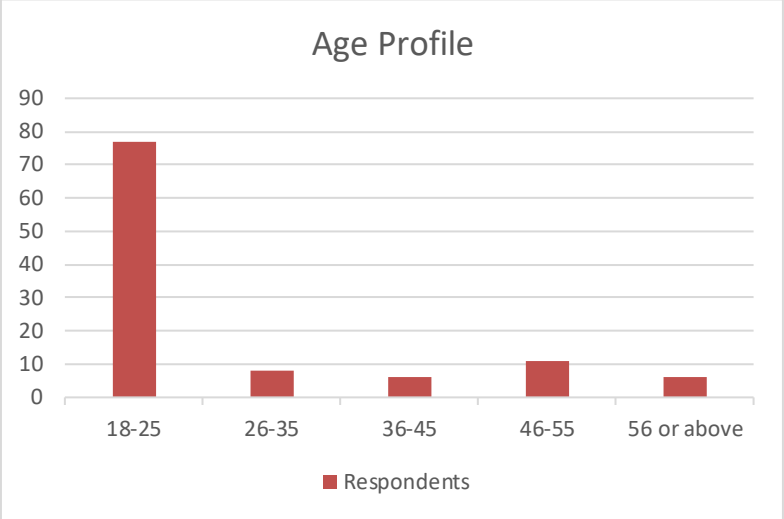

Figure 5: Age distribution of survey participants

Table 2 presents the distribution of education levels among the participants. It shows that 22 individuals, or 20.4%, have reported having obtained a Bachelor's degree, while 23 participants indicated possessing a Master's degree or a higher qualification, accounting for 21.3%. The majority of participants, comprising 63 individuals, reported having completed a secondary education or lower. The chart highlights an adequate diversity of education attainment within the surveyed population.

Frequencies of Education

Education	Counts	% of Total	Cumulative %
Bachelor's degree	22	20.4 %	20.4 %
Master's degree or higher	23	21.3 %	41.7 %
Secondary school or lower	63	58.3 %	100.0 %

Table 2: Education levels of survey participants

Finally, figure 6 indicates the job distribution among the participants. Respondents were given the option to select one of the four options including Employed (1), Self-employed (2), Student (3), Unemployed (4). Most responses came from individuals who are currently students, with 64 cases (59.3%). Following that, 31 individuals reported being employed, with 10 self-employed participants, accounting

for 28.7% and 9.3% respectively. Only 3 respondents indicated being currently unemployed.

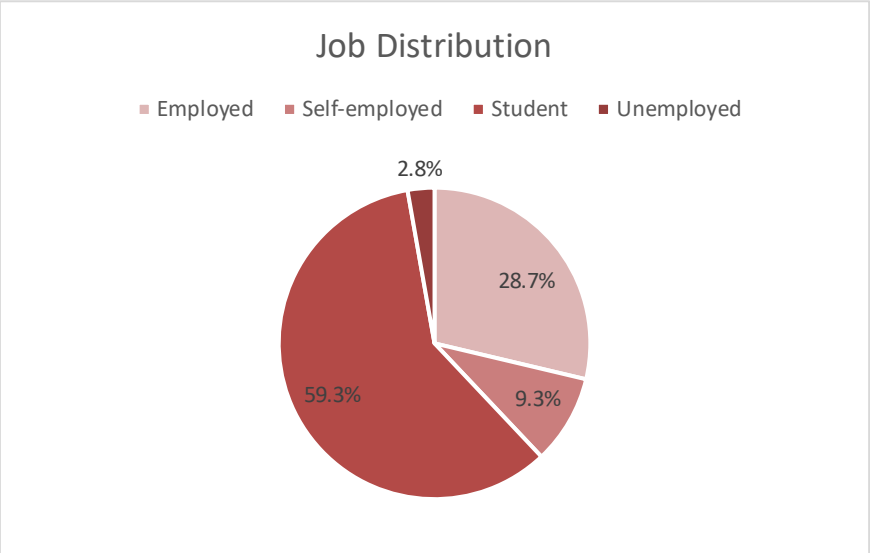

Figure 6: Current occupation of survey participants

4.2 Hypothesis Testing

A primary test involves the Shapiro-Wilk test to assess the normality of the independent variables. Table 3 reports the p-values as <.001 which suggests the evidence to reject the null hypothesis of normality. Furthermore, the standard deviation values ranging from 0.830 to 1.167 show a high degree of variability and spread of the data.

				Shapiro-Wilk	
	N	Mean	SD	W	p
PE2_RC	108	3.82	0.830	0.838	< .001
PC_RC	108	3.73	0.892	0.868	< .001
PDS1_RC	108	3.46	1.089	0.883	< .001
PDS2_RC	108	3.01	1.156	0.906	< .001
PR1_RC	108	3.31	1.001	0.889	< .001
PR2_RC	108	3.61	0.884	0.870	< .001
PR3_RC	108	3.93	0.893	0.827	< .001
NI_RC	108	3.32	1.167	0.907	< .001
UI1_RC	108	3.53	0.961	0.892	< .001
UI2_RC	108	3.83	0.952	0.852	< .001

Table 3: Shapiro-Wilk Test

A second test involves the use of Cronbach's Alpha to measure the reliability of the constructs and assess the internal consistency of the relevant variables. All survey responses from the three constructs were collected using a 5-point Likert scale, with options ranging from strongly disagree (1) to strongly agree (5). The first construct indicates a high level of reliability, with a coefficient of 0.753. While the second construct shows a lower, yet still acceptable level of reliability with a value of 0.693, the third and last constructs demonstrates a strong consistency, as indicated by a coefficient of 0.837.The questions are therefore reasonably correlated within the constructs, which are consequently accepted as reliable.

Measures	Cronbach's Alpha	N
Concern for Personal Data Security		
PDS1: I am generally concerned about the security of my personal information	0.753	2
PDS2: I am concerned about the consequences of sharing my information with an automatic identity verification machine		
Perceived Risk		
PR1: I believe my personal data would be well-protected by the security authorities	0.693	3
PR2: I think self-service kiosks have mechanisms to ensure the safe transmission of my personal data		
PR3: I feel confident in using self-service kiosks at the airport because I believe my personal data is secure and well-protected		
Usage Intention		
UI1: I would recommend the use of self-service kiosks to friends	0.837	2
UI2: I intend to use self-service kiosks in the future		

Table 4: Cronbach's Alpha

The following section of this subchapter presents the testing of the five hypotheses, which was completed by measuring the independent variable in relation to the same dependent variable, being the intentions to use SSTs. In order to assess the statistical meaning of the survey responses, all 5-point Likert scale variables were converted into an interval measurement. Table 5 below displays this conversion:

5-point Likert scale	Respective numeric values
Strongly agree	5
Agree	4
Neutral	3
Disagree	2
Strongly disagree	1

Table 5: IV measurement

The testing of the hypotheses provide an insight into the causal relationships influencing the acceptance of SSTs in an airport environment, which contributes to a more comprehensive understanding of the factors affecting behavioural intentions. Before conducting the statistical tests, the independent variables were additionally recoded into composite variables by calculating the mean of each construct, due to the plurality of questions.

4.2.1 Personal data security concerns

The primary hypothesis 'H1: Concerns about personal data security have a significant negative effect on intentions to use SSTs' was tested through the linear regression analysis, which helps assess the impacts of data privacy concerns on intentions to use SSTs.

The results obtained reveal an estimated coefficient of -0.25 with a standard error of 0.09 and a p-value of 0.005. The test therefore provides strong evidence in support of the alternative hypothesis. A sum of squares of 6.86 and a 1 degree of freedom furthermore results in a mean square of 6.86 for the independent variable, while an F-value of 8.07 confirms the statistical significance of the p-value. The residuals analysis reveals that the model has been constructed with an adequate sample size, as indicated by a sum of squares of 90.14 and 106 degrees of freedom. The mean square for residuals equals 0.85, which measures the level of variance and prediction errors. A p-value of 0.005 demonstrates the relevance of the observed negative relationship between the two variables, and the coefficient of -0.25 implies that as the level of concern for personal data security increases for an individual, the intentions to use SST tend to decrease by said amount. The relatively low variability around the estimated coefficient (-0.25) suggested by the standard error of 0.09 indicates a precise estimated effect of the independent variable on the dependent one. This finding presents that an increased awareness and apprehension about data privacy concerns is a significant influencing factor to SST acceptance, and therefore the null hypothesis can be rejected in favour of the alternative hypothesis. In consequence, considerations must be taken for strategies that will be able to assist in addressing concerns regarding data security, as they may be necessary to encourage greater acceptance and usage of SST.

Below is figure 7 illustrating the linear regression analysis conducted for H1, wherein the X-axis corresponds to the independent variable 'personal data security concerns', while the Y-axis represents the dependent variable 'intentions to use SST'. The figure displays the negative relationship between personal data security concerns and SST usage intentions.

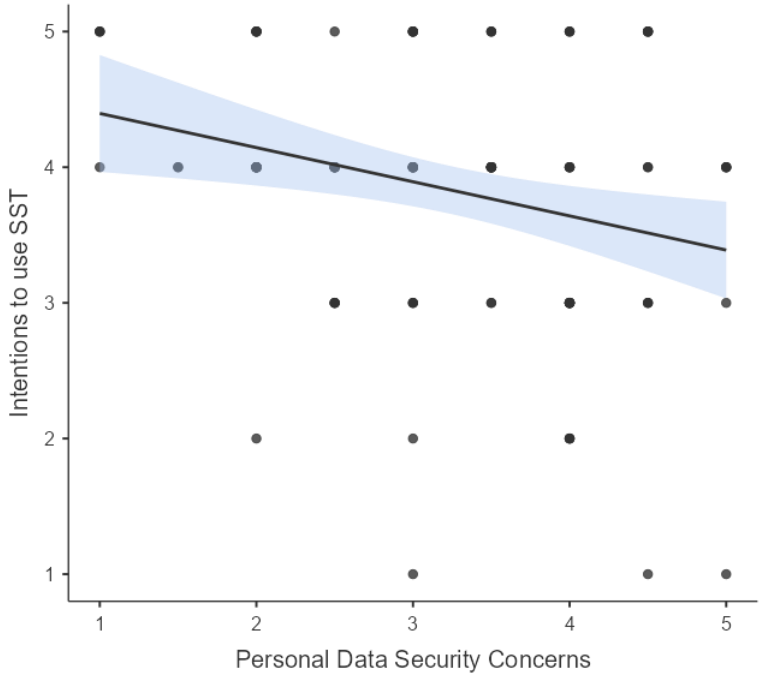

Figure 7: Hypothesis testing, H1 Regression Analysis

4.2.2 Knowledge of Biometrics

The secondary hypothesis 'H2: Prior knowledge of biometric security influences passenger intentions to use SSTs' was tested with the Kruskal-Wallis or one-way ANOVA analysis, which is a nonparametric alternative suitable for the non-normally distributed dataset. In order to conduct this statistical test, the data from the independent variable was converted into numeric values. As such, the four response options ranging from "I've never heard of it before" (1) to "I have a good understanding of it" (4) were converted, which is properly shown in table 6 below.

Level of Understanding	Respective numeric values
I have a good understanding of it	4
I somewhat understand what it is	3
I've heard of it, but I don't know what it is	2
I've never heard of it before	1

Table 6: Measurement scale for the Level of Understanding

A Kruskal-Wallis analysis revealed a test statistic of 5.31 with 3 degrees of freedom, resulting in a p-value of 0.15. This indicates that there is no significant evidence to reject the null hypothesis and that the alternative hypothesis must be rejected and the null hypothesis accepted. The epsilon squared value suggests that the level of understanding explains approximately 4.96% of the variance in usage intentions. It can be said that prior knowledge of biometrics has no significant influence on passenger intentions to use SST. Table 7 displays the results for H2:

Kruskal-Wallis				
	χ^2	df	p	ε^2
UI2_RC	5.31	3	0.15	0.0496

Table 7: Hypothesis testing, Kruskal-Wallis H2

4.2.3 Perceived Control

This section investigates the relationship between the perception of control and the intentions to use SSTs in an airport environment by testing the third hypothesis, 'H3: Perceived control (PC) influences passenger intentions to use SSTs'. The linear regression analysis was used to test the significance of perceived control on usage intentions.

The results demonstrate an estimated coefficient of 0.51, a p-value of less than 0.001 and a standard error of 0.09. These findings provide strong support for the alternative hypothesis; thus, the null hypothesis can be rejected. The sum of squares for the independent variable is 21.9, indicating the amount of variance explained by PC, with a degree of freedom of 1 and a mean square equal to 21.86 to be precise. It

can be said that for every unit increase in perceived control, the usage intentions increase by 0.51. Furthermore, a low standard error of 0.09 suggests that the estimated effect of PC is likely to be precise. The F-value of 30.9 associated with the independent variable is statistically significant at a p-value of less than 0.001, which highlights the significantly positive relationship between PC and the willingness to use SSTs. The residuals sum of squares is 75.1 with 106 degrees of freedom, leading to a mean square of 0.71, which represents a comparatively low level of unexplained variance. Overall, the results imply that perceived control plays a significant role in influencing passenger intentions to use SSTs, and that H3 suggests interventions aimed at enhancing passengers' perception of control as they contribute to the widespread adoption of SSTs.

Figure 8 presents the linear regression analysis results for H3, showcasing the relationship between the independent variable 'perceived control' on the X-Axis and the dependent variable 'intentions to use SST' on the Y-Axis. The figure illustrates a positive relationship between the two variables.

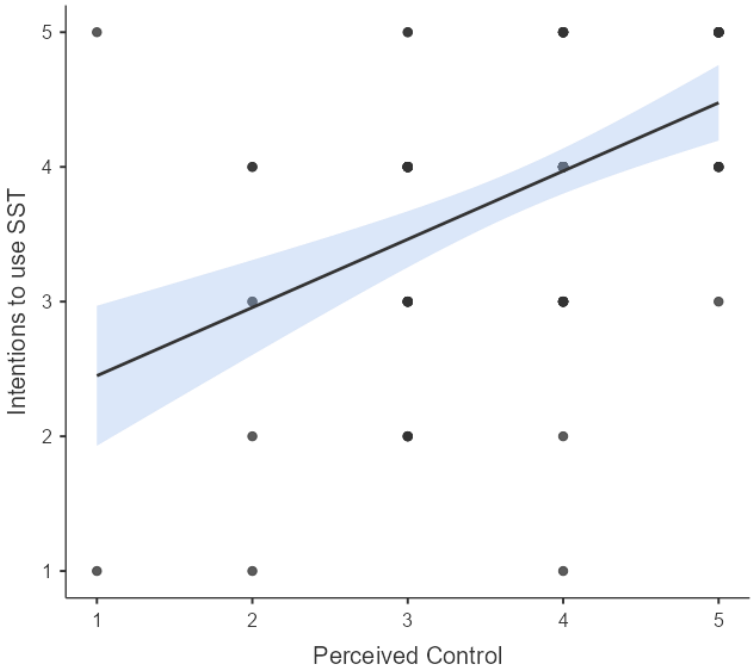

Figure 8: Hypothesis testing, H3 regression analysis

4.2.4 Perceived Risk

The next statistical test involves the use of the linear regression analysis for the fourth hypothesis 'H4: Perceived risk (PR) influences passenger intentions to use SSTs', which helped assess the significant of perceived risk on behavioural intentions.

It is important to note that, while all independent variables with 5-point Likert scale response options were converted to numeric values, from 'Strongly disagree' (1) to 'Strongly agree' (5) as previously shown in table 6 of this thesis, the PR construct required a different recoding, instead becoming 'Strongly disagree' (5) down to 'Strongly agree' (1). This was mandatory due to the nature of the survey questions within this construct, which were formulated as affirmation sentences (i.e., *"I feel confident in using self-service kiosks at the airport because I believe my personal data is secure and well-protected")*. The reason for the way the relevant questions were developed in this manner was the improved conciseness found during pre-testing. Table 8 illustrates the modification made to the independent variables of this particular construct for the purpose of conducting accurate hypothesis testing.

5-point Likert scale	**Alternative numeric values**
Strongly agree	1
Agree	2
Neutral	3
Disagree	4
Strongly disagree	5

Table 8: IV measurement for the PR construct

The results reveal important insights regarding the influence of perceived risks on intentions to use SSTs. A linear regression analysis shows an estimated coefficient of -0.77 with a standard error of 0.1 and a p-value below 0.001. This provides strong evidence for the alternative hypothesis, indicating a highly significant relationship between PR and behavioural intentions, and supports the rejection of the null hypothesis. The analysis further reveals a sum of squares of 34.1 and 1 degree of freedom, resulting in a mean square of 34.1. The corresponding F-value of 57.5 confirms the statistical significance of the relationship, reinforcing the evidence

provided by the p-value. The residuals analysis indicates a sum of squares of 62.9 and 106 degrees of freedom, while the mean square for residuals is 0.59, reflecting the low level of unexplained variance. Additionally, the negative coefficient of -0.77 suggested by the standard error of 0.1 assumes a precise estimated effect of PR on intentions to use SST. Moreover, it shows that an increase of one unit in PR will lead to a decrease of 0.77 in usage intentions. The empirical evidence highlights the significance of the influence of PR on passenger intentions to use SSTs and underlines the negative relationship between the two variables. Initiatives must be considered to mitigate the concerns associated with SSTs at the airport, as passengers who perceived risks are less likely to express intentions to use them.

The below figure 9 illustrates the analysis conducted for H4, examining the association between the independent variable 'perceived risk' on the X-Axis and the dependent variable 'intentions to use SST' on the Y-Axis. The figure reveals a negative relationship between these variables, demonstrating that as PR increases, intentions to use SSTs tend to decrease.

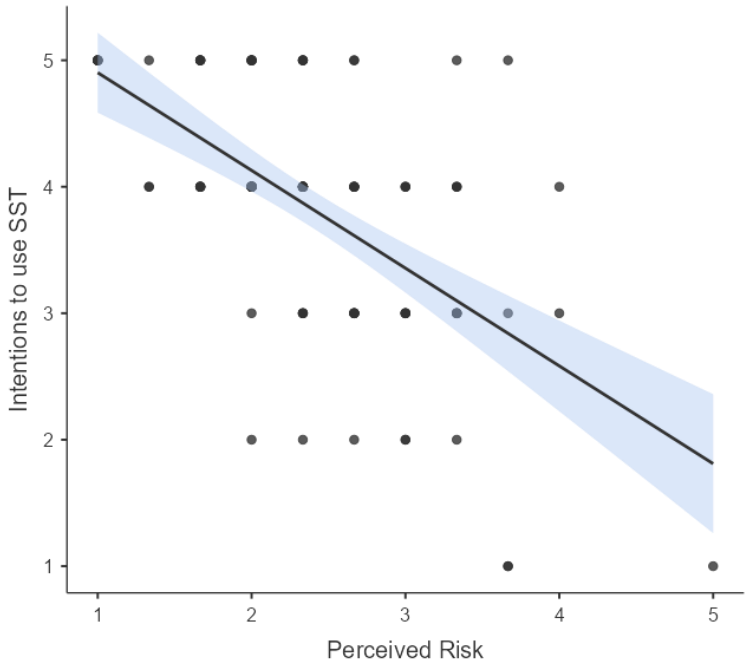

Figure 9: Hypothesis testing, H4 regression analysis

4.2.5 Moderation Analysis

The final hypothesis 'H5: The effect of (a) data privacy concerns; (b) prior knowledge; (c) perceived control; and (d) perceived risk on the intention to use SST is lower for frequent fliers' is aimed to examine the moderating effect of frequent flier status on the relationship between previously tested factors, including data privacy concerns, knowledge of biometrics, PC, PR, and the intention to use SST. This section involves conducting a moderation regression analysis as followed by the multiple regression statistical tests from previous subchapters. As per Jaccard and Turrisi (2003), the motive behind the inclusion of interaction terms can be driven by prior theory or empirical evidence which suggest the possibility of interactions between variables (p. 615). This helps understand whether the relationship between the independent variables (a,b,c,d) and the dependent variable (intentions) is changed in strength or direction by the moderating variable which comprises the passenger group that travels more often (frequently, at least once a week; regularly, at least once a month).

The moderation regression analysis for 'H5a: The effect of data privacy concerns on the intention to use SST is lower for frequent fliers' reveals a coefficient estimate of -0.52, a standard error of 0.31 and a corresponding Z-value of -1.67. The coefficient is not statistically significant at the conventional level (p=0.094), which suggests that there is no significant interaction between the two variables. More precisely, the effect of data privacy concerns on the intention to use SST does not differ significantly for frequent fliers compared to non-frequent fliers, thus the alternative hypothesis is rejected while the null hypothesis is supported. Table 9 displays the findings from the moderation analysis:

Moderation Estimates

	Estimate	SE	Z	p
PDS	-0.191	0.160	-1.20	0.231
FF_RC	-0.564	0.396	-1.42	0.155
PDS ✻ FF_RC	-0.518	0.309	-1.67	0.094

Table 9: Hypothesis testing, H5a moderation regression

A secondary test, conducted for 'H5b: The effect of prior knowledge on the intention to use SST is lower for frequent fliers', puts focus on the interaction between the knowledge of biometrics and the frequent flier status in predicting the intention to use SST. The results obtained show indicate an estimated coefficient of 0.58 with a standard error of 0.41 and a p-value of 0.155. This implies that there is no sufficient evidence to support the alternative hypothesis, therefore the null hypothesis is accepted, suggesting that having prior knowledge on biometric security does not significantly influence frequent fliers' intentions to use SST.

The following test for 'H5c: The effect of perceived control on the intention to use SST Is lower for frequent fliers' reveals a significant estimate of 1.17, a standard error of 0.31 and a corresponding Z-value of 3.82. The results of the moderation analysis indicate a statistically significant interaction effect, with a p-value below 0.001, implying that the relationship between perceived control and usage intentions differ based on the travelling regularity of the passenger. The null hypothesis is rejected, and it can be said that the influence of PC on intentions to use SSTs is lower in the case of frequent fliers.

The final statistical test conducted for 'H5d: The effect of perceived risk on the intention to use SST is lower for frequent fliers' explores how the relationship between PR and behavioural intentions is influenced by the frequent flier status. The analysis displays an estimated coefficient of -1.07 and a standard error of 0.4. Notably, the results reveal that the interaction between the PR and frequent flier variables is significant as indicated by a p-value of 0.007. This suggests that the impact of PR toward the intention to use SSTs is significantly reduced for frequent fliers. More precisely, frequent fliers are less influenced by perceived risks when forming their intentions. Table 10 demonstrates the moderation analysis for H5d.

Moderation Estimates

	Estimate	SE	Z	p
PR	-0.415	0.203	-2.047	0.041
FF_RC	-0.297	0.336	-0.885	0.376
PR ✻ FF_RC	-1.065	0.395	-2.697	0.007

Table 10: Hypothesis testing, H5d moderation regression

4.3 Evaluation & Interpretation

This subchapter puts focus on the evaluation and understanding of the empirical research conducted throughout this thesis, and its findings. In parallel with the interpretation of results, answers are provided for the research questions based on the reviewed literature and statistical analyses: "How do perceived risks regarding biometric self-service technologies influence the use of automated authentication processes at the airport", "Which relevant user-perceived risk might pose a challenge in the face of the integration of a digital identity verification system at airports?" and "In which manner could the aviation industry ensure a positive adoption behaviour of automated processing functions, within the scope of an improved handling of passenger flow?". Table 11 below provides a summary of the tested hypotheses, presenting the hypotheses and their associated p-values.

Hypothesis	Estimate	P-value	Result
H1: Concerns about personal data security have a significant negative effect on intentions to use SSTs	-0.25	0.005	Significant
H2: Prior knowledge of biometric security influences passenger intentions to use SSTs	N/A	0.15	Not significant
H3: Perceived control (PC) influences passenger intentions to use SSTs	0.51	<0.001	Significant
H4: Perceived risk (PR) influences passenger intentions to use SSTs	-0.77	<0.001	Significant
H5a: The effect of data privacy concerns on the intention to use SST is lower for frequent fliers	-0.52	0.094	Not significant
H5b: The effect of prior knowledge of biometrics on the intention to use SST is lower for frequent fliers	0.58	0.155	Not significant
H5c: The effect of perceived control on the intention to use SST is lower for frequent fliers	1.17	<0.001	Significant
H5d: The effect of perceived risk on the intention to use SST is lower for frequent fliers	-1.07	0.007	Significant

Table 11: Path Analysis

The primary objective of this research was to investigate the factors influencing passenger intentions to use biometric-based SSTs in an airport environment. The hypotheses were developed based on the identified variables of concern, and while the research paper's findings aligned with the results of previously published studies, the thesis was able to fill some gaps within the context of behavioural intentions in a rapidly growing industry. The testing process was therefore mostly focused on better understanding the challenges facing the adoption of SSTs at airports.

The path analysis in the table above confirms that concerns about the security and integrity of personal data have a significant negative effect on intentions to use SSTs. This claim is in line with the studies of Winter et al. (2021), who conducted tests related to passengers' acceptance of modern screening and digital services, including in part the implications of privacy concerns. The results of this hypothesis suggest that passengers who perceive a higher risk to their personal data are less likely to embrace biometric SSTs, emphasising the need for robust data protection measures in the design and implementation of these technologies. A second hypothesis proposed that prior knowledge of biometric security and its functions influences passengers' intentions to use SSTs, albeit it was not supported. While no other studies have yet been published regarding this factor, it may be beneficial to gain a more comprehensive insight on the relationship between said familiarity and the intentions to use SSTs. The findings of the third hypothesis indicate that passengers who perceive a higher level of control when engaging in the use of SSTs are more likely to express intentions to use them. Previous studies investigated customer responses toward self-based services and suggested that perceived control can significantly influence user intentions (Zhu et al., 2013). However, there is little research available pertaining to users' perception of control when it comes to an airport setting. The results of this hypothesis highlight the importance of providing passengers with a particular sense of autonomy and empowerment in the adoption process. Similarly, the fourth hypothesis which proposed that perceived risks have an effect on passenger intentions to use SSTs, was supported. This includes the trust in security authorities, SST mechanisms (system failures) and overall sense of privacy when submitting personal data to an automated verification system. It is crucial for airport operators to address and mitigate these perceived risks through effective risk communication

and transparency. Regarding the fifth set of hypotheses (H5a, H5b, H5c and H5d), which examines the moderating effect of frequent fliers on the relationships between the previously tested variables and intentions to use SSTs, the results were mixed. The purpose of these hypotheses were to understand the effects of the previous factors on passengers with more unique travel behaviours and motivations, especially in the case of individuals who might prioritise efficiency and time-saving measures at airports as they traverse through various checkpoints. The statistical tests in fact revealed that the impact of perceived control and perceived risk on intentions to use SSTs is different for frequent fliers compared to non-frequent fliers. Further investigation could shed light on the specific factors contributing to this moderation effect, perhaps in the context of being more willing as an individual to compromise some aspects of privacy as a means to minimise the time spent during the airport process.

This research paper provides support for the idea that perceived risks, specifically data privacy concerns, have a significant negative effect on passenger intentions to use SSTs. These factors act as a barrier to the adoption of digital services at airports, with passengers exercising caution due to the irreversible nature of losing anonymity when considering the use of biometric authentication. The results indicate that concerns for the security of personal data are a prominent perceived risk and passengers are wary of the potential risks associated with misuse and information compromission. Screening processes and digital scans are becoming increasingly prevalent in the industry, and airport authorities must ensure that SSTs are perceived as reliable. In order to facilitate the adoption of these technologies, it is essential to implement strong privacy protection measures along with a transparent approach to data management. To promote sustained adoption and ensure an optimised passenger flow, airports must focus on instilling user confidence in these technologies by providing assurance of their advantages and efficiency. Ultimately, the design of SSTs should prioritise convenience, flexibility, and a sense of control while assuring users of sufficient privacy protection.

5 Final Conclusion

The purpose of this thesis was to investigate passengers' intentions to use self-service technologies in an airport environment. An extensive literature review and data analysis allowed this research paper to provide valuable insights on the digitalisation of processing functions and the challenges that airports worldwide are facing within the frame of the implementation of biometric technology. Following the recent global pandemic, an ever-growing passenger influx means that airports must adapt their operational dimensions in order to contribute to a safer and more efficient travel experience. The proposed research questions were formulated to guide airport management in designing strategies and measures that can promote the successful integration of digital technologies and benefit both passengers and the aviation industry as a whole.

While an increasing number of travellers are considering the use of digital services and automated screenings over traditional services, the empirical study conducted in this research paper has revealed significant relationships between factors such as perceived control, perceived risk and passengers' intentions. A conceptual model and corresponding hypotheses were developed following the literature review, which were formulated according to previous research and the present knowledge gap. The relevance of data privacy concerns and their association with newly introduced technologies, namely biometrics, suggested that the application of digital authentication services are in fact challenged by certain factors related to the acceptance of these technologies. To put this into context with the aviation industry, an online survey was created, which helped understand the influence of passengers' perception of control when using self-service technologies, and the perceived risks that may influence them not to use said technologies, either because they are concerned about the integrity of their personal data, or due to their familiarity with biometrics, which may cause an instinctive reluctance in its use.

Overall, the results obtained from multiple regression suggest that perceived risks do indeed have a significant effect on passengers' intentions to use SSTs, and despite the improved safety and reduced waiting times that digital services can offer, the concern for personal data security remains an important factor that, based on the

conducted research, is still capable of shaping intentions to go through automated verification checks. However, the statistical test does not confirm H2, which refers to the relationship between prior knowledge of biometrics and behavioural intentions. Finally, H5a to H5d were not all proven to be statistically significant either. This set of hypotheses were developed and tested as a means to understand whether different, more unique travel behaviours and motivations, might shape intentions differently. The focus was put on individuals who fly more frequently and might prioritise efficiency and timesaving at airports. The moderation regression analyses revealed a statistical significance solely in the case of H5c and H5d, pertaining to perceived control and perceived risk, respectively. Overall, this thesis provided insightful knowledge on the perceived risks and control generated by the characteristics of biometric self-service technologies, with the purpose of understanding the influence of said characteristics on passengers' intentions to use digital processing functions.

5.1 Limitations and Future Research

This thesis is subject to a number of limitations, with some that need to be addressed in future studies. The first limitation arises from the geographical scope of the survey, as it mostly reached individuals from the central European region. It is important to consider that there may be different outlooks on the researched topic in other areas of the world, and the results of the primary research may not be applicable globally and thus cannot be generalised to every airport despite the efforts that were made to conduct this investigation with a broad perspective. Another major limitation concerns the time available to complete the thesis within the graduation timeframe. This made it practically impossible to reach and get a significantly wider range of individuals to complete the survey, which comes down to the third limitation of this thesis. With a relatively small sample size of 108 respondents, there was no added possibility to enhance the findings of this study. An increased number of responses would've facilitated the identification of potential outliers, enhanced the precision of the mean, and would've overall improved the quality of the research experiment.

It is important to acknowledge that the reliability and generalisability of the findings may be limited due to the nature of the survey questions and sample size, and it is recommended that some aspects be considered and addressed in future studies. First,

the primary emphasis of the thesis was to explore perceived risks associated with SSTs at the airport, rather than to conduct a more extensive investigation of other influencing factors, namely the perception of control. Said construct was limited to a single question in the survey, therefore rendering its testing less reliable. The study put focus on specific areas including biometric security technology and data privacy concerns to answer the research questions but did not help to gain a deeper insight into other specific areas. Furthermore, the results for hypotheses 5a to 5d are not as reliable due to the low number of frequent travellers in the gathered sample population. In order to conduct a more specific analysis, future research must consider using a more complete set of survey questions or a more suitable research instrument. This will help better understand the influence of relevant factors on behavioural intentions in the case of airport SSTs.

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Appendices

Appendices 1: Questionnaire for online survey

1. What is your gender?
   - Female
   - Male
   - Prefer not to say

2. Which age group do you belong to?
   - 18-25
   - 26-35
   - 36-45
   - 46-55
   - Above 56

3. What is the highest level of education you have completed?
   - Secondary school or lower
   - Bachelor's degree
   - Master's degree or higher

4. What is your current occupation?
   - Student
   - Employed
   - Unemployed

5. How often do you fly?
   - Frequently (atleast once a week)
   - Regularly (atleast once a month)
   - Occasionally (a few times a year)
   - Rarely (once a year or less)

6. Which reasons do you typically fly for?
   - Personal reasons
   - Business
   - Other

7. How would you best describe your understanding of biometric security?
   - I've never heard of it before
   - I've heard of it, but I don't know what it is

- I somewhat understand what it is
- I have a good understanding of it

8. Have you previously used self-service kiosks at the airport for check-in or bag drops?
   - Yes
   - No
   - Unsure

9. My previous interactions with self-service kiosks were mostly positive:
   - Strongly agree
   - Agree
   - Neutral
   - Disagree
   - Strongly disagree

10. When I use self-service kiosks to check in, I feel that I have control over the things I do:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

11. I am generally concerned about the security of my personal information:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

12. I am concerned about the consequences of sharing my information with an automatic identity verification machine:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

13. I believe my personal data would be well-protected by the security authorities:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

14. I think self-service kiosks have mechanisms to ensure the safe transmission of my personal data:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

15. I feel confident in using self-service kiosks at the airport because I believe my personal data is secure and well-protected:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

16. I prefer interacting with a real person who provides check-in or baggage services:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

17. I would recommend the use of self-service kiosks to friends:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree

18. I intend to use self-service kiosks in the future:
    - Strongly agree
    - Agree
    - Neutral
    - Disagree
    - Strongly disagree