



An examination of Shanghai Airport's Full Passenger Service Process's Digital Transformation Trajectory

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Abstract. Shanghai Airport, a major international aviation hub in China, faces the dual challenges of improving passenger service experience and maximizing operational efficiency against the backdrop of growing competition in the global aviation business. China's international aviation hubs have the twin challenges of improving the quality of passenger service and increasing operational effectiveness. The swift development of information technology has made digital and intelligent transformation an essential strategy for Shanghai Airport to overcome these obstacles and attain operational effectiveness. As information technology advances at a quick pace, digital and intelligent transformation has become a key strategy for Shanghai Airport to overcome these obstacles and accomplish high-caliber development.

In order to provide intelligent, customized, and effective services, this transformation aims to reorganize passenger service procedures using cutting-edge digital technologies. Every link in the passenger service process, from check-in and security screening to boarding, is crucial. Every link, from screening to boarding, has the opportunity for intelligent and digital transformation with the goal of addressing the pain spots and bottlenecks in Every link, from check-in to security screening to boarding, has the potential for intelligent and digital transformation with the goal of resolving the problems and bottlenecks in conventional service procedures and providing travelers with a more convenient and comfortable journey. In addition to analyzing the existing state of the complete passenger process at Shanghai Airport, this study investigates the application scenarios of domestic smart airports.

In particular, this study examines the use cases of domestic smart airports, evaluates the state of the Shanghai Airport passenger process as it stands today, and suggests the main ideas and actions for the intelligent and digital transformation of Shanghai Airport.

Keywords: Passenger service, smart airport, digital and intelligent transformation

1 Introduction

Because of the quick development of science and technology as well as the quick modernization of society, there has been an annual increase in the demand for passenger transport. Digital technology must be fully integrated into the core functions of airport travel as the civil aviation industry enters a new era of increasingly sophisticated digital technology. The digital upgrading of passenger service processes at airport terminals is one of the top strategic initiatives for civil aviation corporations. Driven by Digital China and the digital transformation of state-owned assets, airport construction has also represented the apex of digital transformation^[1]. According to Ding Zhaowei ^[2], airports have evolved into the link and bridge that connects the world in the current era of globalization. Airports also have to contend with issues including low-quality service, frequent aircraft delays, complicated operations, and competition from high-speed rails^[3]. Travelers' need for individualized services and information is growing as a result of the popularity of online booking, Internet check-in, and self-check-in. Additionally, airport infrastructure has to be upgraded. More than ever, the aviation sector depends on research and technology, and airports should go in the direction of smart airports in the future^[4]. The next wave of aviation sector reform, which includes paperless boarding, self-service check-in, tailored services, airport security, and passenger location in airports, is primarily driven by modern technology, of which artificial intelligence is a prominent example. All of them need a human identification system that uses big data technologies to retain passenger information and uses artificial intelligence algorithms to identify the passenger before providing the service^[5]. A framework for resource integration and unified standards are provided to the industry by the national-level top-level design, which also outlines the objectives, development direction, and implementation path of smart airports. The "Action Program for the Construction of Four Types of Airports (2020-2035)" suggests building four different kinds of airports: safe, green, smart, and humanistic. "Smart airports" emphasize using digital technology to improve passenger experience and operational efficiency, and they encourage the widespread use of technologies like 5G, IoT, and big data in airports. While the Digital Europe Program considers funding airport digital transformation projects like digital twins, AI-driven airports, and the construction of new airport infrastructure, the FAA NextGen Program mentions lowering flight delays and increasing airport capacity by modernizing air traffic control systems and airport infrastructure, encouraging data sharing, and implementing automation technologies. AI-powered resource scheduling, twins, etc. In the meantime, since 2020, the central and local governments have made smart airports a major component of "new infrastructure," assisting in the strategic modernization of airports like Beijing Daxing and Shanghai Pudong.

A number of national policies, such as the "Outline of Action for the Construction of Four Types of Airports (2020-2035)," the "14th Five-Year Plan for the Development of a Modern and Comprehensive Transportation System," and the "Outline of Action for the Construction of Four Types of Airports for Civil Aviation of China (2021-2025)," have encouraged technological innovation and digital transformation, and China has placed a high priority on the construction of smart airports in recent years. 2021-2025) and the guiding principles for the growth of big data construction in civil

aviation. According to Nigel Halpern^[6], airports are now embracing digital change, whether it is through the conversion of analog information into a digital format or the use of technology to enhance and modify current procedures and features. Some people believe that new or developing technologies like blockchain^[7], big data analytics^[8], augmented reality^[9], cognitive computing^[10], and cybersecurity^[11] are what are driving change. Airports can use these technologies to build ecosystems that link all stakeholders and to monitor, visualize, and react to digital processes and functions in real-time^[12].

Shanghai Airport is one of the busiest airports in the world, handling tens of thousands of people daily along with several domestic and international aircraft. The airport's operational effectiveness, service quality, and safety management are severely strained by this massive passenger volume. In the course of digital transformation, Shanghai airports must integrate a variety of technological platforms and systems, such as security monitoring systems, baggage handling systems, and flight information systems. It is challenging to integrate these systems, which must guarantee real-time monitoring, process synergy, and data sharing. In order to achieve smooth information exchange and process operation, Shanghai airports must also take into account collaboration with both local and international airlines, ground service providers, and other stakeholders. Shanghai airports must gather and handle a lot of passenger data, like as personal information, flight information, luggage information, and so forth, as the digital transformation continues. Protecting these data's security and privacy has grown to be a significant concern.

Since smart airports are more than just "artificially intelligent airports," they are also humanized smart airports, which have higher standards for internal multisectoral synergy, all-process intelligent services, and commercial services. The majority of current research focuses on the intelligent application of specific technologies for the construction of smart airports. Therefore, we suggest pertinent routes and actions for Shanghai airports' transition to digital intelligence based on current research, by examining the state of intelligent apps in domestic airports and taking into account the actual demands and forms of Shanghai airports.

2 Examining how the Entire Passenger Process is Currently Operating in Both Domestic and International Smart Airports

2.1 Beijing Capital Airport

It offers "fixed point+ mobile" intelligent information, all-process digitalized flights, all-process baggage tracking, and parking reservation services during the departure process. The APM system is used in the arrival process, which also shows the baggage procedure and offers the airport and hotel joint baggage transportation services. In the transit process, it uses the APM system for transit ferries; in the special passenger process, it has implemented the "loving companion service" for elderly passengers and the

"local accent" special service, which offers dialect services with humanistic care for passengers in need.

2.2 Chongqing Jiangbei International Airport

Self-check-in and self-check-in machines are used in the departure process, which is the first baggage handling system in China to use "open-loop" RFID radio-frequency identification technology, which has a 99% baggage identification rate. Passengers may conveniently follow the status of their baggage during the arrival process thanks to a huge screen for baggage claims. The "YuYue Transit" service is offered for the transit process; it can be chosen in a small program area to conveniently save transit time.

In order to make it easier for travelers to handle the pertinent business and identification signs, the facility layout includes the use of self-service check-in and baggage check-in integrated machine equipment, a reduction in manual counters, the integration of electronic media sound and light unique features, and the airport led to screen advertising media. In terms of business, the global travel retail behemoth DFS Group was launched, offering a wide range of products such as jewelry, accessories, watches, and clothing.

The "90 days of global no-excuses returns and exchanges, within 30 minutes to deal with customer inquiries and complaints, and within 2 days to give customers a solution" after-sales service was initially offered, along with the addition of cultural intangible heritage. In order to incorporate intangible cultural heritage, an exhibition space was also built.

2.3 Shenzhen Bao'an International Airport

Regarding passenger procedures. In the departure process, four intelligent business systems and five types of intelligent business terminals are developed, research on the application of passenger service intelligence in large and complex airports is conducted, and a passenger service architecture of large and complex airports with an intelligent support platform for passenger service at its core is constructed. Vertical elevators, blind alleys, ramps, barrier-free restrooms, separate rooms for mothers and babies, and sections for children's activities are all designed to accommodate unique passenger procedures.

The airport eliminated the need for manual verification by achieving 100% coverage of self-service equipment at domestic gates in terms of facility layout. The terminal business will be promoted to "the same city, the same quality, and the same price" in addition to the special cultural exhibitions that will occasionally be held in conjunction with the city's features. The terminal shopping environment will also be optimized, and the food and beverage business combination will continue to be enriched.

2.4 Singapore Changi Airport

The airport's state-of-the-art contactless self-check-in terminals minimize waiting times and contact risks by allowing travelers to effortlessly complete check-in procedures by

simply hovering their fingers over the top of the screen. Additionally, visitors can now conveniently submit their eHealth Declaration Card through the Singapore Arrival Card (SGAC) eService prior to checking in at the arrivals area. This e-service increases process efficiency and decreases the need for paper declaration cards. At Changi Airport, passengers can take the elevated Light Rail Transit (LRT) between terminals for free.

A lot of facial feature recognition technology is used in the facility layout to give passengers autonomous, self-service, seamless, and real-time interactions. This eliminates the need for interaction with airport staff during the entire process of checking in, baggage check-in, immigration clearance, and boarding, except for security checks.

Commercially, airports can create duty-free merchandise zones with saved physical space thanks to the extensive passenger self-service and infrastructure. This increases revenue and saves travelers a significant amount of time waiting in line for boarding, security, and check-in, giving them more time to visit the merchandise zones. The aforementioned benefits have significantly raised Singapore Changi Airport's non-airline revenue. Changi Airport currently has a 50% non-airline revenue share.

2.5 Frankfurt Airport, Germany

In terms of procedures, the airport provides a range of services, including AIRail air-rail check-in, self-check-in, and overnight check-in prior to aircraft departure. Travelers can enter and depart border control more easily with EasyPASS and EasyPASS-RTP.

In terms of facility design, travelers can quickly pass through passport control thanks to the EasyPASS/EasyPASS-RTP automated border control system. In the meantime, the Fast Lanes service can be utilized to swiftly reach the boarding gate at Frankfurt Airport if the transfer time is really limited. The flights that are now available are indicated by the Fast Lane sign at the security checkpoints, and passengers on these flights are given priority.

The airport's official website offers an alphabetical store guide that allows travelers to quickly and accurately view their favorite stores and their details. On the commercial side, there are hundreds of dining and shopping options.

2.6 Tokyo Haneda Airport

The airport provides the following services in terms of procedures: coin-operated lockers with a storage period of three or seven days; a hands-free service for receiving luggage from home to the airport beforehand; a mobile app that offers travelers a four-language transportation guide; and a baggage-handling service that moves luggage from any location in the terminal area to the check-in counters for flights prior to take-off. For travelers heading to Haneda Airport, the Access Line is an incredibly practical transfer system.

A split-level space arrangement is used at Tokyo Haneda Airport to maximize space use. Vertical transit devices like elevators, escalators, and stairs are used to connect check-in sections at separate levels. The terminal building's interior has a run-through spatial arrangement. The airport's terminal building uses a run-through spatial plan to

reduce passenger wait times. This means that travelers move through the various check-in steps, including passport swiping, baggage checking, and security checking, in a straight line.

As the busiest airport in Japan (and among the top five in the world), Haneda offers all the conveniences of contemporary domestic and international airports, including free Wi-Fi, waiting areas, and a large selection of nearby restaurants and shopping options.

3 An examination of Shanghai Airports' Current State

3.1 Ease of Transportation

With the close connections of public buses, metros, highways, and other forms of transportation, the transportation network surrounding airports is getting more and better, giving travelers more options and minimizing travel annoyance. In order to reduce traffic congestion and enhance the effectiveness of travelers arriving at and departing from the airport, Shanghai Airport additionally encourages the development of intelligent traffic management systems through real-time data analysis and intelligent scheduling.

3.2 Mobility

Shanghai Airports fully utilizes mobile Internet technologies to enhance passenger convenience during travel. Travelers may now receive real-time information about the airport, airline movements, parking information, and commercial offers at any time and from any location thanks to the advent of the official app and small programs. In addition to offering easy access to information, this trend of travel mobility facilitates electronic boarding cards, online check-in, baggage tracking, and other features that make the entire travel process more efficient and convenient. Additionally, self-service and self-check-in were implemented at the airport. Passengers can expedite boarding processes, cut down on line wait times, and increase travel efficiency with the use of sophisticated terminal equipment.

3.3 Universalization of Smart Facilities

Airports make extensive use of Internet of Things (IoT) technology, including automated luggage transfer systems, smart parking systems, and smart security screening equipment. In addition to offering quicker and more convenient services, these intelligent facilities increase the effectiveness of airport operations. Airports are also seeing an increase of self-service terminals, which let passengers check flight information, self-check in, and locate shops and dining options.

3.4 Customs Clearance Without Inductions

For customs clearance, sophisticated biometric technologies like biometrics and facial recognition have been introduced. The convenience and speed of customs clearance are

increased because travelers only need to complete facial or biometric enrollment once and do not need to show their passports or identity cards again during the clearance procedure. Additionally, the airport encourages e-endorsement and e-customs declaration, which facilitates international travel by cutting down on wait times and enhancing the efficiency of entrance and clearance.

3.5 Efficient Space Intensification

The terminal building's layout and design fully take into account the effective intensification of space. Airports can handle more travelers and flights while increasing resource efficiency through logical layout and adaptable internal space use. Additionally, despite the terminal building's size, travelers may swiftly access various sections using moving walkways and convenient modes of transit, cutting down on the amount of time and distance they must spend walking. The commercial area's logical design and navigation system enhance the convenience and shopping experience by making it simpler for visitors to locate the stores they are interested in.

3.6 Rapid Development of Non-Aviation Businesses

Digitalization is another indicator of the non-aviation industries' quick growth. In order to establish the "Shanghai Shopping" brand and draw more tourists to shop and spend money at the airport, the airport has introduced a number of well-known domestic and worldwide brands, as well as trendy and internet brands. To encourage tourists to purchase, the airport also hosts a range of commercial campaigns, including discount coupons and exclusive deals.

In addition to improving customers' travel experiences, the aforementioned elements also help the airport's long-term growth and the city's reputation. Even though Shanghai Airports has demonstrated several noteworthy digital application features, there is still room for development.

3.7 Full Flow of Travelers

- Airports ought to offer individualized passenger services that provide guidance and support according to the needs and preferences of each traveler. This can entail offering pertinent information based on a visitor's past visits, including suggested restaurants and shops and tailored trip suggestions. Although Shanghai airports scored highly on general cleanliness, shopping, and food options, certain passenger satisfaction surveys indicate that process efficiency, instruction clarity, and personnel service attitude still need to be improved. For instance, unclear signage sometimes lead to confusion and extra walking trip; other tourists complained that the process of getting assistance when they ran into issues wasn't easy enough.
- As a result, passage senselessness has to be improved. Airports have started implementing Passenger Sensorless, however both arrivals and departures could still benefit from this technology. Improving passenger pleasure requires making sure these facilities are reliable and simple to use.

- Therefore, security must be enhanced. The speed and ease of customs clearance can be increased by using more biometrics, but security and privacy concerns must also be addressed.

3.8 Facility Layout

Two viewpoints can be used to elaborate on the possible issues, beginning with the areas of arrival and departure:

- There are not enough parking spaces and quite crowded lanes for landside traffic. On an airplane, passengers often arrive at the departure location at roughly the same time. Landside traffic might get backed up during peak departure times, and parking spots can be hard to locate.
- During periods of high passenger arrival, lines are likely to form for security checks, check-ins, and on-site check-ins. Due to the high volume of passengers, there will be increased wait times at the security and check-in checkpoints during the peak arrival period, which will wear out the passengers. Too many self-service locations are unoccupied during off-peak hours. In certain instances, particularly for foreign flights or passengers who need baggage check-in, travelers still have to wait in line for manual counter services, which could reduce the process' efficiency even if the majority of airlines currently offer self-check-in and e-boarding pass services. According to reports, customers' travel experiences are negatively impacted by the sometimes 30-minute or longer wait times for security inspections during peak hours.
- crowded terminal when flights are delayed. There are typically not enough seats near the gate and people are left waiting at the gate if the plane is late, which can quickly result in agitated customers and disruptive situations.

Additionally, there are certain issues related to the arriving area.

- Long hallways upon arrival. Upon arrival, passengers must walk a considerable distance to access the pertinent areas due to the terminal building's enlargement.
- There was a lot of people at the baggage claim area. International travelers must go through inspection, quarantine, and border control before they can access the baggage claim hall. They also have to go through customs inspection once they leave the baggage claim hall. people with checked baggage typically have to wait for their checked baggage to arrive after arriving at the baggage claim hall; as a result, the baggage claim hall is frequently overcrowded with people waiting for their checked baggage. Travelers must wait longer for their luggage to arrive, and although while lost or delayed luggage is rare, the processing can result in more waiting time.
- As a result, improvements must be made to public transit. Public transportation coverage in the neighborhoods surrounding Shanghai airports is still restricted, despite the fact that the airports provide public transportation choices like metro, express buses, and public buses. In the meantime, during peak hours, passengers may encounter lengthy lines while waiting for taxis.

3.9 Business Services

- Absence of Characteristics and Diversity.

The Shanghai airport terminal has a sizable commercial space, although the store kinds are somewhat uniform and lack individuality and variation. Similar products are sold in many retailers with no creativity or customization.

3.10 Inequitable Commodity Price Distribution

The Shanghai airport terminal's commercial sector offers significantly more expensive goods than the going rate. Because of this, many tourists believe that shopping is too expensive and decide to purchase items in the city.

- Inadequate experience with service mobility.

The commercial space within the Shanghai airport terminal needs to increase its quality of service, including cross-regional service, postal service, and after-sales service for items. Travelers' satisfaction and shopping experiences are also impacted by these problems.

3.11 Absence of Regional Cultural Components

The internal commercial section of the Shanghai airport terminal has relatively little reflection on local cultural aspects, despite the fact that Shanghai is a city with significant local cultural traits. This has an impact on tourists' comprehension and cognition of Shanghai's local culture.

4 Essentials of Digital Transformation

4.1 Optimization of the Terminal Building's Overall Passenger Flow

For the off-site link, its primary issues are the traffic jams and cumbersome routes of transit that are created when travelers arrive at the airport. The traffic congestion caused by travelers on their way to the airport, particularly in super first-tier cities like Shanghai, can be reduced by expanding and widening the traffic channels in and out of the terminals. Shanghai airports can also work with online mapping companies to provide real-time traffic information on their websites, mobile apps, or information screens. This software gives travelers the best arrival services based on real-time information, and they can also increase their publicity and education efforts to remind travelers to plan their travel times to avoid peak times.

Green travel can help lessen environmental problems at the airport, and travelers are urged to share transportation and use less private vehicles, which will minimize traffic congestion; In order to optimize and modify the main highways leading to the airport, including the road layout and traffic light settings, Shanghai airports have collaborated with the government's transportation department. The most practical way to get to

Shanghai Hongqiao and Pudong airports is still by metro, with lines 2, 10, and 17 at Shanghai Hongqiao Airport and line 2 at Pudong International Airport. Therefore, future planning can increase the transportation arteries at the airports to allow passengers to get there faster; this will improve traffic flow and reduce congestion; similar to the "online taxi-hailing" method, where passengers can directly book door-to-door transportation services using the service system in the airport's APP, Shanghai airports may eventually introduce driverless shuttle buses or unmanned consignment vehicles for passengers to use when digital technology matures.

Through the terminal link, travelers can check in and check their baggage at hotels in conjunction with Shanghai airports, and they can depart straight to the airport. Face recognition technology can digitize the entire security check-in and boarding process; In order to provide more convenient and effective travel, Shanghai airports can remove the time and place limits on baggage check-in and enable travelers to make bookings at hotels or at home using their cell phones and complete self-service baggage check-in. This makes traveling easier and more effective by enabling passengers to manage their luggage without having to go to the airport counter; Shanghai airports are able to implement on-the-go screening, which eliminates the need for passengers to stop or open their bags. Similar to a daily walk through the channel, the security channel can be arranged as an archway. Use intelligent recommendation systems that use artificial intelligence (AI) to assess past passenger behaviors and preferences to offer individualized travel suggestions, seat selection, and other service alternatives; To assist travelers in finding boarding gates, parking lots, dining options, and other facilities swiftly, use IoT technology to provide real-time navigation through smartphone apps or digital screens in airports; With the help of AI-powered self-check-in kiosks and smartphone apps, check-in procedures can be streamlined and wait times decreased. Contactless operations like passport scanning and face recognition are supported, and AI image recognition technology is used to speed up baggage screening and identify potentially dangerous items. IoT sensors are combined to enable quick and precise passenger body temperature detection and identity verification. Combine IoT sensors to achieve fast and accurate passenger body temperature detection and identity verification.

Shanghai airports can begin the waiting process by constructing a smart terminal to implement the digital intelligence transition. A 3D naked eye screen, a smart massage chair, easy wireless charging, and a fitness power generator can all be installed in the rest area. IoT sensors track inventory and customer flow, AI suggests tailored products and services, facilitates mobile payments, and allows for unattended delivery; AR/VR technology offers immersive entertainment, and AI analyzes passenger interests to deliver personalized news, movie trailers, and more; To guarantee that travelers have the best possible sleep, IoT sensors track seat occupancy and comfort, and AI algorithms optimize seat allocation.

The research analysis indicates that visitors' anxiety levels gradually rise before to their arrival at the airport, as well as during the check-in, border, and security procedures. Because it is unsure how long it will take to get to the boarding gate, the delay after passing through the border and security check increases anxiety. The traveler's worry will increase once more as the boarding process draws closer to the scheduled boarding time, as seen in Fig 1. As a result, anxiety is experienced during the entire passenger

journey, during the "waiting time" to reach its lowest point, how to prolong the passenger's "waiting time" as much as possible, how to cut down on time spent on other procedures, and how to provide prompt, individualized service when the passenger needs to feel less anxious. One of the main obstacles to enhancing the terminal's commercial and humanistic experience is passenger fear.

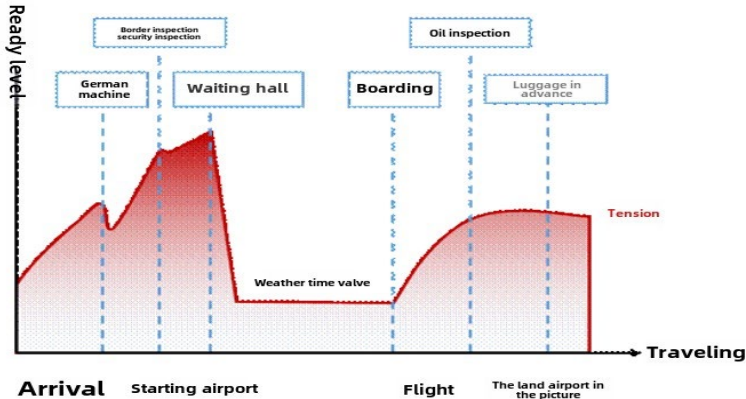


Fig. 1. Regional mood map of passengers

4.2 Layout of Terminal Facilities using Intelligent Design

In order to ensure that passengers can swiftly and conveniently finish the travel process, the terminal building's overall layout should be reasonable and scientific, with an emphasis on the efficiency and smoothness of the passenger process, making the most use of available space, and logically placing functional areas like waiting areas, boarding gates, and security check areas. In order to accommodate the needs of special passengers, Shanghai airports can offer a range of convenient amenities, such as ramps, blind alleys, vertical elevators, barrier-free restrooms, independent mother and baby rooms, and children's activities. In addition, the elderly, the weak, the ill, and other special passengers can enjoy free wheelchair and cart service, as well as free rides on the MRT electric car service.

The structure of the security check boarding process has been streamlined, and the efficiency of the security check has been increased by setting up self-service security check equipment and enough security check channels. In the meantime, the boarding gates are meticulously planned to guarantee a large percentage of seats close to the aircraft and shorten passengers' walking distances; the domestic and international waiting areas are thoughtfully separated to give passengers ample room to rest and wait. In order to improve the waiting experience for travelers, extra amenities including an aerial observation platform are also placed up. The experiential business concept is used in the design of commercial service facilities to give visitors a fresh urban living room experience that blends shopping, dining, entertainment, and art exhibits. In order for passengers to experience a first-rate commercial environment during the entire process of departure, arrival, check-in, and waiting, commercial amenities should be arranged sensibly.

In order to help visitors reach their destinations more quickly and cut down on waiting time, Shanghai airports may also think about using intelligent technologies that give them real-time flight information, boarding gate instructions, security check process recommendations, etc. For instance, the use of sensors and other technological tools to monitor temperature, humidity, air quality, and other environmental parameters in the terminal building in real-time, and the automatic adjustment of lighting, air conditioning, and other systems based on the actual situation to give passengers a comfortable and healthy environment while they wait for their flights; the use of indoor positioning technology and smartphone applications to provide real-time navigation services for passengers; intelligent management system, optimal energy use modification in the terminal building, and real-time monitoring. The terminal building's energy use is tracked and optimized via the intelligent management system. For instance, a rainwater collection system and a roof-mounted photovoltaic power generation system are installed to achieve green energy conservation; the cable TV system can offer passengers advertisements, TV entertainment programs, and flight dynamic information while simultaneously giving staff access to inbound and outbound flight dynamic information. To satisfy the demands of future development, the system's scalability and multifunctionality should be taken into account throughout design. Through platforms like airport applications and WeChat apps, intelligent navigation and wayfinding systems offer passengers real-time navigation, route planning, facility inquiries, and other services; In order to analyze passenger behavior, forecast flight traffic, and support airport operations' decision-making, data is gathered via sensors, RFIDs, and other devices. Internet of Things (IoT) technology is utilized for baggage tracking, airport facility management, and other purposes. High-speed, low-latency network connectivity is made possible by 5G and Wi-Fi 6 technologies, which enable a variety of smart devices and applications to function in airports.

4.3 Modernization of Terminal Commercial Services Using Digital Means

In the commercial function area, Shanghai airports can offer shopping, catering, and services for cultural and technology exhibitions. In addition to meeting the diverse needs of travelers, the shopping and catering areas can enhance the airport's economic benefits by creating a composite business model that combines shopping, catering, and leisure. Cultural, scientific, and technological display services can offer both domestic and foreign tourists the opportunity to learn about the cultural development of the Shanghai region and to see the newest modern scientific and technological technology. These services fully utilize Shanghai's history and culture for publicity in order to promote tourism, humanism publicity, and other hidden profits. In the public function area, Shanghai airports can offer intelligent flight display services, intelligent health areas, and intelligent robotics. Intelligent robot services include both a virtual and physical robot. The virtual robot can help airport service ambassadors usher in and out travelers, communicate and interact with travelers through voice and screen terminals, and provide intelligent robot services. The intelligent sanitary area has a one-key alarm, a human flow monitoring function (i.e., showing unused rooms in the display), an automatic door lock function, an environment monitoring function (temperature, humidity, etc.),

and deodorizing and sterilizing functions. Through speech and screen terminals, VR virtual robots can help airport service ambassadors usher passengers in and out of the airport and provide them with information about flights, service protocols, airport amenities, and other topics. The robots can precisely find and offer travelers the best path direction as long as they are in use. In order to communicate with travelers in various languages worldwide for interactive voice Q&A, online video, and video, the physical robots are outfitted with high-definition cameras and sensor systems, embedded with touch-screen tablet PCs, and internally integrated with a central processing system that has location positioning, face recognition, multi-language interactions, and information interconnections. Online video services, interactive voice Q&A, luggage assistance, navigation services, etc. The system may match and show the passenger's flight number, gate position, and itinerary based on the identification result using the face recognition algorithm, giving the guests individualized service.

5 Conclusion

Even though digital apps at Shanghai airports have advanced significantly, a lot of problems still need to be resolved to improve the shopping experience and passenger pleasure even more. To further improve the travel experience and happiness of passengers, airport management can keep working on enhancing landside traffic, modernizing customs clearance technology, increasing the smart facilities' user experience, and enhancing the variety of commercial areas. In order to better serve the demands of upcoming travelers, Shanghai airports should keep improving their digital offerings as feedback builds and technology advances. In order to create a five-in-one "smart airport" with an emphasis on smart service, smart production, smart security, smart business, and smart management, Shanghai airports should develop the "strongest brain" for airport innovation in "smart travel" for travelers through digital transformation. The "Smart Airport" product system is developed with smart service, smart production, smart security, smart business, and smart management as the key points. To improve travelers' comfort at the airport, a comprehensive, multi-process passenger self-service system will be established, with passenger service as the primary focus.

The process of intelligent transformation presents a number of issues for airports as well. The lack of unified data standards and interface specifications makes technical integration more difficult. In terms of data security and privacy protection, digital transformation entails the collection, storage, and processing of a significant amount of sensitive data; how to ensure that the security of these data has become a major challenge! Technical compatibility and interoperability issues can arise between various technical platforms and systems, preventing data from flowing or integrating smoothly. Technical obstacles including incompatible architectures and mismatched interfaces, among others, may make it difficult to integrate and upgrade current systems with new technologies. Rapid technological advancement necessitates that the system be able to be updated flexibly to accommodate evolving requirements; in terms of talent and skill gaps, there is a deficiency of composite talents with cross-disciplinary knowledge and skills, which

makes it challenging to advance technology integration effectively; and employee acceptance and application of new technologies vary, which impacts the digital transformation. Employee adoption and use of new technologies varies, which hinders the efficiency and advancement of digital transformation; When it comes to organizational and cultural change, digital transformation frequently brings about changes in organizational structure and culture. This calls for overcoming internal resistance and encouraging full participation, and the adoption and promotion of new technologies may be hampered by traditional work processes and decision-making mechanisms.

Airports should have risk response plans in place to prevent the aforementioned hazards. In order to facilitate the seamless transfer of information between various systems, Shanghai airports should think about creating a scalable and adaptable technology architecture that facilitates the integration and interoperability of various technology platforms; creating uniform data standards and interface specifications; and putting stringent data access control and encryption measures in place to safeguard sensitive data. Adopt modularized design, divide the system into several independent and reusable components for simple integration and upgrading, and use microservice architecture to achieve flexible deployment and dynamic expansion of services, all while adhering to pertinent laws and regulations and establishing data protection policies and procedures to ensure compliance.; Regarding the development of talent, improve internal training and staff comprehension and utilization of new technologies. The development of talent should include strengthening internal training to improve employees' comprehension and use of new technologies, introducing composite talents with knowledge and skills from multiple disciplines to encourage full participation in digital transformation, and establishing a mechanism for cross-departmental collaboration to ensure the transformation is implemented smoothly. Most crucially, in order to guarantee a seamless transition, a comprehensive plan for digital transformation must be created, with distinct objectives and milestones for every stage and an iterative development methodology to progressively encourage technology integration and system upgrades.

A number of immediate and long-term economic effects, including cost-benefit analysis and several dimensions including revenue growth and competitiveness enhancement, could result from Shanghai airports implementing digital transformation. Significant investments in system development, employee training, and technological improvements are necessary for digital transformation. In the short run, this can result in increased operating expenses. There may be several commissioning and optimization issues throughout the rollout of new systems and technologies, which would raise maintenance expenses. Airport operational efficiency may be greatly increased by implementing automation and intelligent technology, which will lower mistake rates and manual intervention. While these reductions might not immediately cover the initial investment, digital transformation can aid in resource allocation optimization and operational cost reduction. The improved traveler experience would encourage more travelers to use Shanghai airports, which would somewhat boost airport traffic and income.

However, it can take some time for this revenue growth to become apparent, so it might not be seen right away. Automation and smart technology will result in long-term cost savings and increase airport operational efficiency as digital transformation is further implemented. These savings will eventually greatly exceed the original investment,

giving airports substantial financial returns. Airports will be able to better understand passenger needs, offer specialized services, and boost income with the use of data analytics and precision marketing. Shanghai airports will be in a better position to compete in the global airport competition thanks to the major improvements in service quality and operational efficiency brought about by digital transformation. Shanghai airports are anticipated to draw more foreign flights and passengers as a result of increased competition, hence increasing their market share. Shanghai airports will advance technical innovation and sustainable growth, including green airport building and intelligent energy management, as a result of digital transformation. Airports will be able to lower operational costs, increase resource usage efficiency, and achieve long-term sustainable development with the aid of these innovations.

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