

THE IMPORTANCE OF AIRPORT SPACE FROM A 3D VISUALIZATION PERSPECTIVE

Abstract: *This paper's main objective is to evaluate that, if showing animated scenes of modern technologies used in airports all around the world, passengers will trust and adopt more of these technologies to make their flight harmonious and less time consuming. To form the preliminary ideas of self-service technologies, SITA's IT Insights will be thoroughly analyzed. All gathered information will lay out the foundation of the survey and the 3D visualization that will be addressed to old and new Romanian passengers of all ages. The 3D visualization will focus on creating scenes of pre-departure area from an imaginary airport to pressure the passengers to make new connections between all the types of self-service technologies and traditional procedures in airports.*

Key words: *self-service technologies, time, 3d visualization, passenger experience, IT insights*

1. INTRODUCTION

Companies give their consumers one of the best communications possible when utilizing their services and own goods through self-service technologies (SSTs). Self-service technology is a technical and digital interface that enables the business owner to autonomously provide a service for its customers, without the help of its employees. In the last decade, SSTs have spread in each human service possible, mostly known in supermarkets where customers can scan and pay for their purchases. Usage of self-services technology is now a branded necessity for every system due to its common trait: time optimization through eliminating the interactions between customers and employees. Basically, modern technologies have altered all long-standing process patterns of a company, thus affecting productivity and employment, but enabling the interactions and cooperation with their customers [1].

It is commonly acknowledged that the growth and expansion of aviation was closely shaped by the growth and expansion of the global economy. High-speed access over great distance for trips and transportation of valuable goods was enabled through aviation all around the world, thus promoting competitiveness and economic development [2]. However, nowadays one of the key facilities that defines a country's degree of development is its airport. Therefore, airports service providers have taken into account new and innovative self-service technologies to meet the high level of passenger expectations and fulfill their demands [1]. Most used SSTs in airports are self-check-in kiosks, the baggage drop & check-in systems, the online check-in through web or mobile applications, automated machines for parking lots, luggage trolley systems, automated screening security, drones used for logistics and bird control, biometric technologies for check-in, and so much more. Essentially, SSTs are used to provide passengers a quicker, safer, and more effective processing experience that will help improve airport performance [3].

Airline business all the around the world are adopting modern technologies rapidly. However, several

researchers asserted that the thrill and joy of air travel had given away to unpleasant and stressful experiences. The way passengers interact with service providers might influence how they perceive the airport. Travelers all around the world have repeatedly expressed dissatisfaction with self-service technologies, especially those who refused to recognize the necessity of using these technologies as they do not understand how they work. It is commonly known that the issues with any type of technology adoption are not with the technology itself, but rather with the client's usage. However, adopting modern technologies in any organization has benefits and drawbacks for both the business and the clients [1].

2. SMART AIRPORTS

2.1 The concept of smart airports

The internet (technologies that link common objects and assist in the emergence of new business models) and industry (the union between cybernetic and physical worlds), which are synchronized with the rise in commercial air travel worldwide, gave birth to the idea of the smart airport. Nowadays, the smart airport concept is explored from a variety of perspective, including those of the passenger, the airline, management and the ideal of smart cities. Airports must focus on delivering to their passengers the finest, smoothest, and quickest experiences that can be achieved by utilizing the latest modern technologies. The passengers are considered today the main customers of airports; thus, the airline business needs to focus on investing in technology that addresses health, time, and safety issues [4].

To ensure effective and secured information management from all parties and applications, a horizontal transversal to all services technological platform is needed. Basically, this means that a real-time connectivity between all ecosystem components of an airport, logistic service and cities are necessary for smart airports. With the revolutionary IT technologies (such as satellite systems, wireless, portable systems, AI services, wearable technology, and other user-oriented technologies), different have advocated the use of

modern technologies in the aviation industry being aware of the advantages of employing biometrics to simplify and improve the process of air travelling for passengers [4].

Investments in self-services technologies, biometrics, cloud service, Cybersecurity, and business intelligence have been developed since 2019, with more than 80% of airports planning to employ or already utilizing them [5]. Moreover, airports must embrace technology if they are to be prepared to sudden pandemic situation or geopolitical developments. In response to the COVID-19 pandemic, higher levels of automation and an improvement in the flexibility of airport operations have been put on the line, especially when paired with personal devices to reduce contact between airport staff and passengers [4].

2.2 SITA's study

Old studies and articles will argue that research-based literature on travelers' satisfaction and dissatisfaction is scarce. This is a stated fact for the first decade of this century, whereas, with the grand evolution of technology all around the globe, the airports haven't fallen short of catching up, thus, there are new studies and programs that focus on enhancing passengers' experiences. After a thorough research, one major program stood out: SITA [6]. SITA is a worldwide company that provides telecommunication and IT services to airline business. The company accounts for covering 90% of international destinations, with more than 2500 customers in more than 200 hundred countries and territories! The company claims that not only do they link the world's aviation industry, but they address every fundamental commercial, operational, baggage and passenger procedures using their decades of knowledge and expertise. These bits of information can be found on their website, along with all the services for the air transport industry provided by them and their yearly IT insights that will be used to demonstrate the growth of self-service technologies.

The SITA IT Insights are yearly research that analyzes technology adoptions, emotional experiences of passengers, passenger comfort levels, sustainable information, price sensitivity, flight barriers, and sustainable initiatives valued by passengers [6]. To make this case study much more accurate, data has been gathered from 3 important years: 2014 [7] (a year when Europe's economies falter), 2019 [5] (a year of protests and burning Amazon rainforests) and 2022 (a year of war, closing pandemic and major inflation). Putting together all the data concerning passenger technology adoption in the year listed above, it is safe to admit that the consumption of self-service technologies has exponentially increased. Furthermore, after the COVID-19 pandemic, the passengers are demanding more air traveling services that will make their trips as comfortable and flawless as possible [8].

The numbers shown in Figure 1 and Figure 2 are courtesy of SITA [7], [5], [8]. Figure 1 represents the 2014 research of self-service technologies compared to 2010 and their prediction for 2017, while Figure 2 stand for a comparison between 2019 and 2022. It is easy to

acknowledge that in the last years more technology has been implemented in airports all around the world.

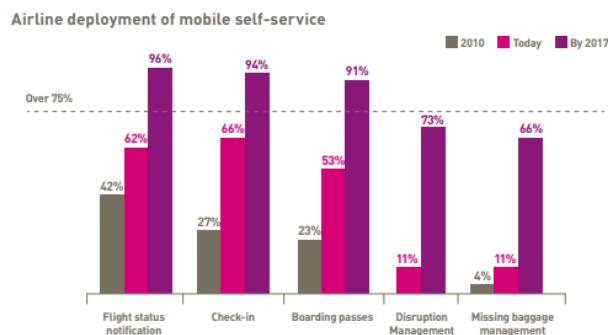


Figure 1 SITA IT Insights in 2014 [7].

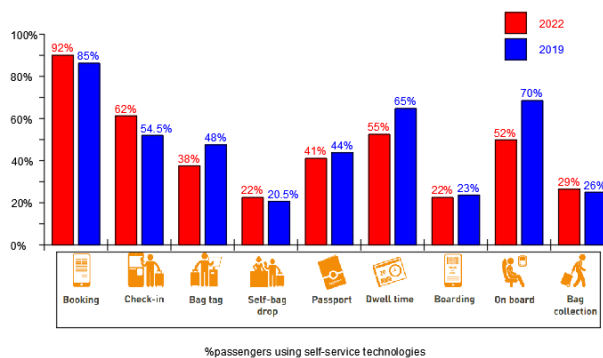


Figure 2 SITA IT Insights (2022 vs 2019) [8].

Therefore, according to SITA's study more passengers used self-services for booking, bag collecting and on board while also adopting automated gates for identification, border check and boarding. End-to-end automation has been slowed down by health verification, which is still primarily human. Two main areas where self-service technology has risen the most are the identity control (up to 11%) and bag collecting (up to 9%) in the past years. Biometric identification is another area that was given the thumbs up by the passengers with an average score of 7.3 out of 10 (where 10 represent the utmost comfort). After the pandemic, the primary deterrents to flying are health problems, geopolitical threats, and the overpriced cost of tickets [8].

2.3 2022 Passenger's IT insights

All in all, the adoption of self-service technology in 2022 has taken into account the pandemic's implications on travel. It is easier to spot the slight decreases in pre-departure use of technologies due to the pandemic's restrictions on traveling, thus passengers have not had the opportunity to become familiar with modern technologies. Some passengers may have felt the need for greater staff engagement at the beginning of the trip (to assure themselves they were doing the right things) but felt more comfortable in relying on technology in the second part of the journey [8].

Additionally, while researching this study, it is slightly important to mention the other IT insights that the papers conclude:

- The ongoing development of touchless and mobile technologies has positive signs;
- Health verification is still mostly performed manually;
- Real time data and mobile usage of bag collecting has increased;
- More favorable feelings are associated with increased self-service technologies used during crucial travel stages;
- Demand from recent passengers has increased to pre-pandemic levels and almost surpassed them;
- Predicted challenges to flying are the current economic and geopolitical factors;
- IT technologies is becoming more popular to promote sustainability;
- The information sustainable for passengers is always action-oriented and concrete.

To conclude SITA's 2022 study, divergent viewpoints exist on the airline industry's sustainability efforts while the communications must be improved. The study ends with a question and the answers are shown in Figure 3.

Divergent viewpoints exist on the airline industry's sustainability efforts while the communications must be improved. The study ends with a question and the answers are shown in Figure 4. Consequently, a slim majority of passengers either believe the contrary or are unsure, yet almost half believe that the aviation sector is making adequate efforts to become more sustainable.

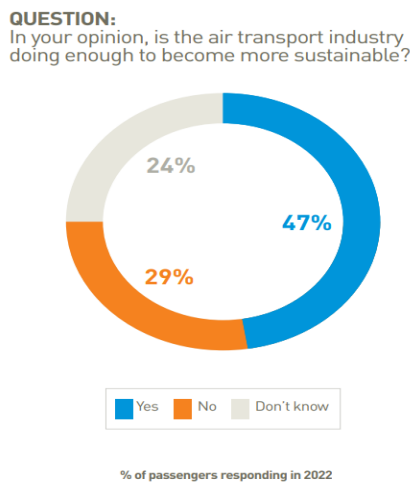


Figure 3 SITA's sustainability question [8].

Consequently, a slim majority of passengers either believe the contrary or are unsure, yet almost half believe that the aviation sector is making adequate efforts to become more sustainable [8].

Considering all of the above, this paper's main goal is to identify if, considering the studies in [8], passengers are more likely to adopt more self-service technologies in the pre-departure area by being presented with animated scenes of these technologies.

2.4 2022 pre-departure procedures

If a passenger has his first flight, he will try to search the internet for the procedures that he will partake in the airport before the flight. At a first glance, the answers

will be a short list of seven main procedures, but with no more explanatory, as seen in the list below.

- Buy your flight tickets;
- Arrive at the airport 2-3 hours before your flight;
- Check-in and drop off your luggage;
- Go through security;
- Find the gate of your flight;
- Wait for the gate to open;
- Board the airplane safely.

Nowadays, there are several methods to complete all the main procedures. It is important for passengers to know how to be more smart, effective, and fast when completing airflight procedures inside the airport. In this study, the following Figure 4 was made with the sole purpose of explaining all the different procedures that a passenger can use in the pre-departure stages in Romania. Other airports might use more SSTs, such as railway station check-ins, check-ins by phone calls, biometric indentifications, security screening, and much more.

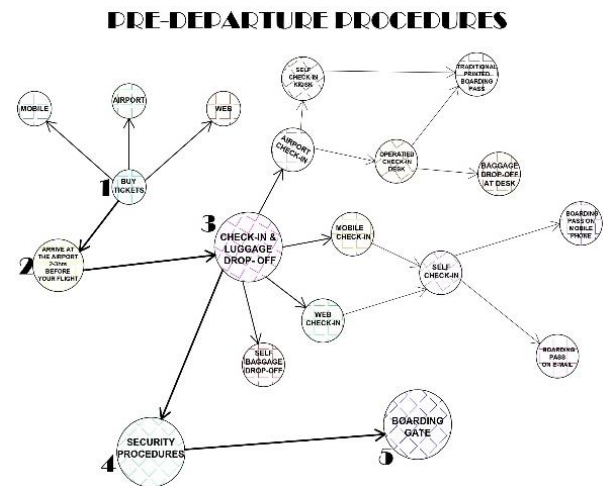


Figure 4 2022 pre-departure procedures.

Before arriving at the airport, passengers must search and look for all the necessary procedures. Additionally, being shown all kinds of visualization of the airports procedures will make all the flight activities more pleasant and seamless for old and new passengers. This paper will focus on exhibiting more self-service technologies through 3D visualizations.

3. 3D visualization of SSTs

3.1 The concept of 3D visualization

The use of interactive, computer-supported, visual representation of data to enhance cognition – the process by which knowledge is used or acquired – is known as visualization. These graphical representations may effectively, precisely, and clearly communicate abstract ideas. *Scientific Visualization* and *Information Visualization* have become the two main subfields that make up the research area of visualization. Nonspatial data, complicated concepts and abstract theories are usually used in information visualization (e.g., diagrams, software, financial data, or bibliographic sources), while

scientific visualization frequently depicts items or ideas that are connected to occurrences from the physical world (e.g., anatomy, chemistry, meteorology, or biology). The study of software visualization in 2D space has been active researched for the past decades, whereas the 3D visualization had been given a lot of consideration only in the past 15 years [9].

In definition, the phrase “3D visualization technology” represent the creation of 3D models (computer graphics) that support a 3D application, such as VR environments, 3D animated graphics, static 3D shapes, interactive simulations, etc. While VE (Virtual Reality) is a 3D environment with detailed graphics that the user may explore and interact with on different types of immersion; the 3D visualizations are commonly used for understanding abstract concepts. Succinctly, 3D techniques aim to provide more and in-depth visuals that are more resemblant to the real world due to lack of understanding complicated concepts, using larger scales of prototypes, and safety problems [10].

In recent years, the usefulness of these immersive technologies has expanded through simulations of prospective environments and visualizing product features for gaining a deeper grasp of the in-situ context. The root cause of developing such technologies have been proven to provide additional feedback that offers insights on physiological, cognitive, and behavioral traits. The usage of the 3D visualization of an imaginary airport sought to understand how animated interior airport facilities are received by passengers [11].

3.2 3D imaginary airport design

The imaginary airport [12] was set to be designed for this purpose; therefore, it consists only of a 2 floored passenger terminal. The ground floor hosts all the facilities for the departure, while the first floor is for the arrivals. The 3D visualization will be focused on showing self-service technologies displayed in the imaginary airport. All 2D and 3D objects and actions have been made using CAD software such as AutoCAD, Sketch-up, MAYA and graphic design software such as Adobe Photoshop. In short, the imaginary airport was designed considering a symbolic structure for the passengers terminals (using a stag to express the connection with the earth and the sky), new international signage (using special colorful fonts to easily attract the attention of the passengers – see Figure 5), and colorful maps to identify the facilities in both terminals.



Figure 5 Signage inside the imaginary airport [12].

It is important to mention that signage used for orientation go hand in hand with the terminals map. It is of utmost importance that the signage must meet the following graphic-visual requirements: they must be legible, with a simple design, functional and efficient with an identity and a precise informative character. Inside the airport, all the specific signage will have an indicator arrow next to it so that the passenger can be easily informed where to find what they need. The colors used are crucial! Therefore, the yellow background is used to send out the information much easier in a crowded environment, whereas the purple used for the symbols, will create a strong contrast with a bigger impact on the viewer [12].

Figure 6 shows the maps with the manufactured signage of both floors. The isometric views of both floors will be used in the survey with the purpose of finding out if people can easily identify a certain point of interest inside the airport only by looking at the pictures. It is safe to assume that the more explanatory the maps are, the easier will the passenger know where to go.

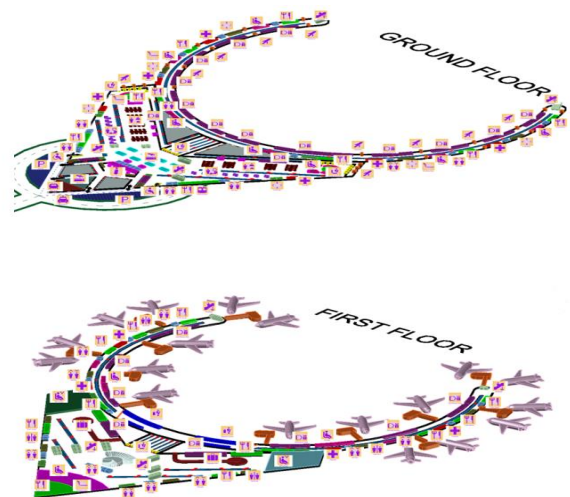


Figure 6 Ground floor & first floor.

3.3 Self-service 3D designs

Creating the imaginary airport was a horrendous task that took weeks upon weeks to finish. The 2D structure was created first, followed up by 2D sketches of facilities placement. Then it was time for the self-service designs which were first created as low poly objects in MAYA [12]. For this paper and the final animation, a new design was born using another CAD, Sketch Up. The scenes in this software are resemblant to those in MAYA, but now the emphasis was placed on the check-in kiosk and the baggage drop-off, which can be found in Figure 7.

These two self-services have been designed intuitively with specific geometry. The check-in kiosk is of moderate height, has an inbuilt software that helps with the check-in registration and a touch display that the passenger can use with ease because it supports more than 35 languages. The baggage drop-off machine is made of two main parts: the information display where passengers can scan up their tickets and boarding passes, and the vat part where they can place their luggage to be measured and weighed. The vat is double, meaning the

passengers can load up 2 baggage pieces in the same (a necessary measure for families). After the procedure is finished, the passenger will receive a baggage pass that must be presented at the security check-in. The baggage pass has a unique code that can be used in the mobile application to track the luggage's whereabouts constantly. Nevertheless, airport staff will be close by to help with any kind of information a passenger needs.



Figure 7 3D visualization of self-service technologies.

The rest of the airports traditional technologies were exaggerated to impose the immediate need of modern technologies usage. This is a key concept in the animation and the survey because the participants will be given some exaggerated scene such as Figure 8, to see if they are still willing to use traditional procedures over modern ones. The author is positive that the exaggeration will be in favor of self-services.



Figure 8 Exaggerated scene of the check-in.

The animation will be assembled using Sketch-up and MAYA. Sketch-up will be used for the 3D design visualization, while MAYA is used for scenes with explanatory texts of all the steps a passenger must complete when using a check-in kiosk and a baggage drop-off machine. The resulting animation will be presented to the survey responders, only after they have answered all the questions in the survey.

4. SURVEY ON ROMANIAN AIRPORTS SSTs

Last but not least, in this paper, the author has conducted a survey on Romanian passengers of all ages. The survey consists of 18 question that discuss different types of self-service technology in the airport. To make sure every responder was a passenger at least once, the first question is asking if they have ever flown. Assuring this first important task, the 35 responders engaged in the next 17 insightful and intuitive questions. The average

age of the responders was between 20-45. The author has closely watched the development of the answers percentages and the outcome was quite expected. The most chosen answers for the rest of the questions will be presented in Table 1.

Table 1

Most chosen answers for the rest of the questions.

Question	Most chosen answer	Percentage (%)
Q2: How often do you fly per year?	At least once a year	65%
Q3: What do you find most enjoyable about flying?	The flight itself and being inside the airplane	35%
Q4: What do you find least enjoyable about flying?	Arriving 2-3hrs before the flight departure	52%
Q5: What is a smart airport?	An airport that uses modern technologies for passengers	69%
Q6: How often do you buy tickets online?	For every flight	88%
Q7: Imagine you are in the check-in area in the scene shown. Do you prefer standing in line or checking in at a kiosk? (Figure 8)	Check-in at a kiosk	92%
Q8: Do you think using kiosks for check-in takes less or more time than a traditional check-in?	It needs less time	94%
Q9: In the picture below there are schematically represented types of procedures that you can use for boarding (Figure 4). Which of these do you use most often?	Online Check-in (web or phone)	63%
Q10: Imagine purchasing tickets for an international flight and never stepping foot in that airport. Do you want to know in advance? You will use explanatory maps to identify points of interest within that airport?	Yes	80%
Q11: After looking at the panel in the picture below, can you tell which way the check-in kiosks are? (Figure 5)	To right	72%
Q12: After a brief analysis of the signage airport maps, which floor represents the arrival terminal between the two? (Figure 6)	First floor	67%
Q13: Do you know what online check-in entails?	Filling in information about yourself, baggage and flight, receiving an email that you present at the check-in counter to receive your boarding pass	52%
Q14: Where should you go immediately after the check-in kiosk if you don't have any checked baggage?	To security	47%
Q15: Where should you go immediately after the check-in kiosk if you have checked baggage?	To check-in desk or baggage drop-off to hand in the luggage	77%
Q16: Have you ever lost your way inside and airport?	No	68%
Q17: Is it important to familiarize yourself with the areas of interest in the airport?	Yes	97%
Q18: If given the chance, would you like to watch an interactive animation of an airport you've never seen to familiarize yourself with it?	Yes	80%

5. CONCLUSIONS

This paper represents an empirical study that aims to understand how self-service technologies are perceived by travelers. The first part of the papers focused on the theoretical part, how the self-service technologies came to be and passengers' reactions in the last 2 decades. It was important to prove that airline business all around

the world try to give their customers the best up-to date technologies to make their flights as seamless as possible. Up to this date, the pandemic had a big impact in the industry and new measures have been put in place, this made the passenger wary of using some self-services because they are not yet familiar with these. Furthermore, using SITA's Passenger IT Insight, the increased need and usage of SSTs was presented. Therefore, the author has a positive insight in the survey: if the need for modern technology all around the world has increased, Romania will not fall short.

To prove this point, a 3D imaginary airport was created using different software. Two scenes were mainly created from the passengers terminal: the ground floor (Departures) and the first floor (Arrivals), for these are the critical areas that interest most passengers. Additionally, the self-check-in kiosk and baggage drop-off were highlighted with new scenes and new designed as shown above. All these scenes were used in the survey and the animation. The survey consisted of 18 questions. It was an interactive survey that showed scenes from the imaginary airport and that had the responders think more about all their experiences inside airports so that they could make easy connections, to agree or disagree with the facts stated and so much more. In the end, the survey highlighted that in Romania more and more passengers use or try to use self-service technology. When asked about the less pleasant thing about flying the most picked answer (52%) was the arrival 2-3hrs before the flight. If this the main concern of the passenger, the airline must adopt more SSTs to solve this problem. When asked about a smart airport more than 69% of them thought that it has something to do with helping the passengers, this shows that travelers strongly agree that airlines business use modern technologies for them, not only for flights or other airline companies. When asked about buying tickets online, more than 88% affirmed they buy the tickets online for every flight. When presented with an exaggerated scene of a full check-in desk, more than 91% chose to use check-in kiosk thinking it will be faster. 94% answered this for the next question). When asked what is their most used SSTs, the online check-in won with almost 63%. This will be a colossal step to the usage of new technologies! When asked to consult maps when visiting a new airport more than 80% agreed. When presented with new designed signage and forced to point out a facility 72% figured out correctly, this means that the signage was ideally designed. When presented with both maps of the ground and first floor of the imaginary airport, more than 66% correctly guessed the arrivals terminal. This concludes that the responders were starting to get familiar with the signage and explicit maps. The questions about check-in kiosk and baggage drop were trickier for the responders, and the answer can represent their limited knowledge on these types of self-service technologies. Therefore, there must be more SSTs implemented inside Romanian airports. When asked about the importance of knowing different areas of interest in the airport more than 97% agreed. And last but not least, when presented with a possibility of watching a 3D animation of an airport they have never seen before,

the author was pleased to find out that more than 80% were willing to watch this animation.

To sum up this paper, all around the world, as technologies are progressing, each industry is trying to keep up. The air industry is not falling behind, and airports have evolved exponentially in the last two decades. The potential of each airport growth stands in the adoption of modern technologies and the passengers that are willing or not to use them. In Romania, the modern SSTs are still a slight new concept, but the will to try and grasp the modern technologies is going to push the airports all around the country to new horizons.

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