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Management of passengers & luggage flows: The impact in total time spent in airports

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Master in Management of Services and Technologies

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Acknowledgements

The conclusion of my Master's Thesis is definitely a remarkable moment in my life, as it also means the end of my academic journey. The last 5 years at ISCTE, since I joined this university in 2017, were amazing in so many ways. I had the opportunity to meet people from many different places, make friendships, learn from experienced Portuguese and foreign teachers and to develop in professional and personal aspects. Meanwhile, I enjoyed many networking moments both in and outside the campus of this university, which has a great academic spirit and where I concluded my Bachelor's degree and will now conclude my Master's degree.

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Resumo

Os aeroportos são, à semelhança de: estações de comboios, paragens de autocarro, praças de táxis entre outros, locais onde as pessoas esperam, quase sempre, com o objetivo de realizar uma viagem. Porém, ao contrário dos restantes mencionados, o excessivo tempo que é gasto em aeroportos sempre que um passageiro quer viajar foi algo que sempre me despertou interesse. O porquê de a realização de todos os processos necessários antes de viajar de avião levar tanto tempo e fazer com que na maioria dos casos, o passageiro ter que estar várias horas antes da viagem no aeroporto é algo que sempre me gerou dúvidas.

Hoje em dia, e depois de muitas melhorias e inovações na logística de aeroportos a todos os níveis, um passageiro pode esperar ter que passar pelos seguintes processos: check-in, controlo de segurança, controlo de passaportes (caso se justifique), embarque e só então se inicia a viagem. Para além destes processos principais, há ainda processos secundários que interferem também no tempo total despendido no aeroporto, por exemplos a triagem de bagagens e até o estacionamento.

Foi com base no meu interesse por este tema aliado à análise dos processos mencionados anteriormente que decidi realizar esta dissertação. A pergunta central que procuro responder é: “Será possível diminuir o tempo total despendido em aeroportos através de uma melhor gestão de fluxos de passageiros e de bagagens?”. No fundo, o meu objetivo é procurar uma solução que otimize qualquer um dos processos previamente mencionados e justificar como isso pode otimizar a experiência do passageiro.

Para alcançar o referido objetivo, pretendo estudar ao pormenor a forma como a gestão dos fluxos de passageiro e bagagens é feita atualmente bem como a gestão logística de todos os processos que se realizam nos aeroportos. Só assim poderei analisar que melhorias podem ser feitas e em que fase da operação.

Palavras-chave: Logística de aeroportos, fluxos de passageiros e bagagens, gestão de processos, experiência do passageiro, inovação de processos logísticos, tempos de espera.

Abstract

Airports are, like train stations, bus stops, taxi ranks, among others, places where people wait, almost always, to make a trip. However, unlike the others mentioned, the time spent at an airport whenever a passenger wants to travel, is something that has always confused me. Why it has to be so difficult and stressful flight to somewhere else and why it takes so long to perform everything in order to being able to flight always generated some doubts in me.

Nowadays, and after improvements and improvements in airport logistics, a passenger can expect to go through the following processes: check-in, security control, passports (if justified), boarding, only then does the trip begin. In addition to these main processes, there are also secondary processes that also interfere with the total time spent at the airport, such as baggage sorting and even parking.

It was based on my interest combined with the analysis of the processes mentioned above that I decided to carry out this dissertation. The central question that I seek to answer is: “Will it be possible to reduce the total time spent at airports through better management of passenger and baggage flows?”. Basically, my goal is to look for a solution that optimizes one of the processes mentioned above and justify how that can optimize the passenger experience.

To meet the objective, I intend to study the way in which the management of passenger and baggage flows is done as well as the management of the logistics carried out at airports. Only at this stage I will be able to analyze what can be done to improve the total time spent in airports.

Keywords: Airport logistics, passenger and baggage flows, process management, passenger experience, logistics processes innovation, waiting/queueing times.

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1. Introduction

1.1 Theme Relevance

As the world gets more industrialized throughout the years, there are needs that must be fulfilled and improvements that must be made at all levels. One example of this is, how the transportation/travel is done nowadays and how different it is from how it used to be done 20 years ago. Among all the transportations methods that we can use, the one that is still the most complex and that requires more attention is the air transportation. It is still totally different the process of driving a car when compared to flying a plane with hundreds of people inside it.

Since the first airline began flying by the first years of the previous century, a lot of things changed and a lot of improvements were made. Air transportation allows people to get connected easily and enable us to travel to the other side of the world in just hours. This improvements and advantages that air transportation provides is what makes more and more people use this kind of transportation every year, is also what results in the creation of new plane routes frequently.

Reaching now the main topic of the dissertation, it's important to understand that before being able to flight, there are a lot of in-ground processes that every passenger needs to perform. Here it's where the main problem will be centered, because, although the improvements that we know that were made recently, per example the online check-in that reduces time spent in queues, there are other processes and flows that can be optimized and that will result in less time spend in airports.

I believe that the stressful process, for many people, of traveling by plane can be softened by a better management of airport flows, such as passenger flows and baggage flows and despite the complexity of an airport, there are improvements at logistics and even engineering levels that can reduce the excessive time that most passengers have to spend there.

1.2 Research Problem

A research problem is a specific issue, difficulty, contradiction, or gap in knowledge that you want to focus on your research. In this case, the research will be based in processes that can be improved in an operation and the difficulties faced by a specific group of people upon having to use air transportation methods.

As mentioned before, the main problem that will be addressed with this dissertation will be the excessive time that passengers must spend in airports before being able to flight, the problem is due to a non-perfect management of all the processes that occur inside the airport, examples of this processes are the check-in, security and boarding.

I strongly believe that a better management of airport flows can improve the total time spent in there and improve the customer experience. In conclusion, I can resume the research problem as:

“How a better management of both passenger and baggage flows can reduce total time spent in airport?”

1.3 Research Goals

The main objective of this research is to propose and evaluate alternative ways of managing the airport flows. Alternatives and improvements at any level such as logistics and engineering and at any time of the in-ground processes realized at an airport like luggage sorting, passport control, boarding and others.

To achieve the main objective and hopefully find a completely new way of managing those flows it's important to achieve intermediate objectives first. These specific objectives are set to be achieved, in the following sequential ordering:

- Map, understand and detail the general flow of a passenger inside an airport. Basically, study every step of a passenger since the moment he steps inside the airport until he begins flying.
- Study and detail how the management of luggage flows are made since the passenger leaves it for sorting and understand if the process has any failure points and improvements to be done.
- Map and detail the general airport logistics and find out if the layout, engineering and other aspects, have impact in the passenger journey inside the airport and if that impacts the time spent by them.
- Deeply study and detail every process that a passenger has to do before being able to flight, this includes the very first process, the check-in, and later every other process

needed such as the security, luggage sorting, passport control and finally the boarding stage.

- With all the data collected before, think about possible improvements and how can they impact the problem I want to solve.
- Sort out the improvements I consider the best and explain it very deeply detailing what are the pros and cons of implementing them.

These intermediate objectives address the needs and information's I must collect before being able to really focus on the main problem that is finding new ways or improvements throughout the whole process that can reduce the time spent in airports.

1.4 Methodology Resume

The research problem of the dissertation is expected to be solved through a methodology of, firstly, search, study and detail every information and sources available that can be used and then utilize that information and data to study and look for improvements related to the central problem. I consider this the best method to understand this not fully-researched topic and my aim is to establish a cause-and-effect relationship that enables me to deepen my knowledge about that cause and later find improvements regarding that specific point of failure.

The main topic of the dissertation is mainly about a giant operation that is used by millions of people every day, the air transportation. So, to find new things related to that is necessary all kind of information that I can find, both qualitative and quantitative data, both data collected by myself and already existing one.

The following table is useful to better explain, in a very detailed way, how I pretend to use data collect methods to answer the research problem:

	Data collection	Description	Goals
Quantitative Methods	Survey	• Important questions related to airport experience. • Online format. • More than 200 answers • Focused on people that are used to travel by plane and that went through airport operations at least 1 time.	• Understand how passengers feel about the time spent in airports. • Study passenger behavior during the in-ground processes. • Identify possible failure points mentioned by the participants.
	Existing data	• Collect quantitative data from already existing sources, per example, master thesis, websites, videos, documents, and others.	• Deepen my knowledge and better understand everything about how the operation is managed nowadays.
Qualitative Methods	Interviews	• Group interviews with people with different backgrounds. • Specific questions about experiences and suggestions. • Structured interviews that take no longer than 15 minutes.	• Perceive the passengers experience and needs regarding the overall processes. • Identify useful solutions and tips for my study.
	Existing data	• Collect qualitative data from already existing sources, per example, master thesis, websites, videos, documents, and others.	• Better understand and compare the data with the one gathered with in the interviews.

Table 1.1 - Data collection methods

1.5 Thesis Structure

This project structure will be divided in 5 chapters, all detailed below:

Chapter 1: Introduction – Introduces the overall dissertation by presenting its importance and relevance. It also explains the research problem and the tools that will help me to solve that problem.

Finally, the introduction maps the methodology that will be applied very briefly and the general structure is outlined.

Chapter 2: Literature Review – This chapter contains a review of all the topics and theoretical concepts that are relevant to be addressed for the development of the dissertation. It will be divided in three main sections: Passengers Flows, Luggage flows and Airport general operations and logistics. Each of this section will be very detailed so it can help solving the research problem.

Chapter 3: Methodology – Explaining and implementing a methodology that aims to achieve meaningful results for the development of the dissertation. It includes all the research tools that helped to gather information. Each of these tools will be very detailed and will explain how they were useful to enrich the research.

Chapter 4: Results Analysis – General analysis of all the results and data collected after the implementation of the methodology. Evaluate the performance of data collected aiming to solve the research problem.

Chapter 5: Conclusion – Summary of the important conclusions gathered from the analysis previously developed. Description of the innovations or improvements found throughout the development of the project and how that can answer to the research problem. Identify limitations to the study and suggest guidelines for further investigation.

2. Literature Review

This chapter contains the three main sections that are fully detailed to understand and deepen knowledge about the main problem. The literature review also consists in the theoretical basis that is relevant for the development of the research. The three sections necessary to fulfill the research needs and that will help to reach the objectives of the dissertation are:

- Passenger Flows inside the airport – at this stage it's critical to understand all about the path of a passenger since he steps inside an airport. It's necessary to observe and study his behavior, difficulties and every other step so conclusions can be made and improvements can be found. With the help of already existing data, in local observation and surveys the aim is that no doubts are left about all the processes that a passenger must go through inside the airport.
- Luggage Flows inside the airport – This section, like the previous one, is related with flows. But, this time, from a more manageable point of view because luggage can be controlled more easily than people. The goal here is to study, map and detail the luggage flow after the passenger leave it for sorting and identify if there is any failure point that later will extend the time needed before being able to flight. It also studies the general process of security aiming to reduce this excessive time spending stage.
- Airport general operations and logistics – Finally, and almost as a summary of the previous stages, the last section is useful to study and understand how the airport logistics can interfere with both passenger and luggage flows. Basically, how layout, logistics and even engineering can change the behavior of a passenger inside an airport and how it can also affect the luggage flows.

The research conducted for this literature review was developed with the objectives proposed for the project. Therefore, keywords like "Airport Processes", "Passengers Flows inside airports", "Luggage Flows inside airports", "Process Management", "Customer Experience", "General Logistics", "Innovative Layouts", "Time spent in Airports" and others were used throughout the research process. The literature about time spent in airports is still very limited, but we can find some mainly on online research articles and then complement with other sources of data collection like videos, surveys and even interviews.

2.1 Passenger Flows inside the airport

According to Gatersleben, M. R., & Van der Weij, S. W. (1999, December): “As human behavior is often thought to be hard to define in models, simulations of processes with people involved are less common than industrial simulations. Nevertheless, simulation has been very valuable in passenger logistics to study bottlenecks and test potential solutions”

From the moment a passenger journeys to the departure terminal, they're faced with a series of small but potentially stressful challenges.

Find parking. Find a baggage cart. Find the correct departure terminal. Find the check-in desk. All the while wondering if they will make it to the departure gate on time. Each step in this journey through the airport leaves an impression on the passenger – good, not so good, or downright frustrating.

2.1.1 Vertical and Lateral Passenger Flows

Airports feature a well-organized vertical and lateral passenger flow sequence to meet all the operational and regulatory requirements for air travel. Because it can only process a certain number of passengers and because flows vary during the day, each of the requirements usually results in a queue. Security checkpoint queues, per example, have grown significantly because of stricter security standards and a rising predominance of carry-on bags. According to Daamen, W. (2002), “Since the available space for such facilities is increasingly under pressure, the space efficiency and walking comfort is becoming more and more important”.

A traveler must go through various stages and lineups after exiting ground transportation, some of which are arbitrary. A domestic passenger with carry-on luggage who has checked in online and received an electronic boarding card, for example, would proceed directly to the security line at the checkpoint. Security lines are frequently divided by fare (for example, business class) and security pre-clearance programs. An international traveler with multiple pieces of luggage, on the other hand, would have to queue at the check-in / luggage drop counter, then go through customs (sometimes after security), and then security. Because travelers are spending more time at airports due to lines and delays, waiting-area activities, such as restaurants and shops, have become more prevalent, as they have become an important source of revenue. The final line is for boarding, which is often divided by fare class. Airlines that sell earlier boarding access have turned to boarding queues as a source of revenue.

Below, it is in a very detailed way, the general flow of any passenger inside an airport and every step he needs to execute before being able to board:

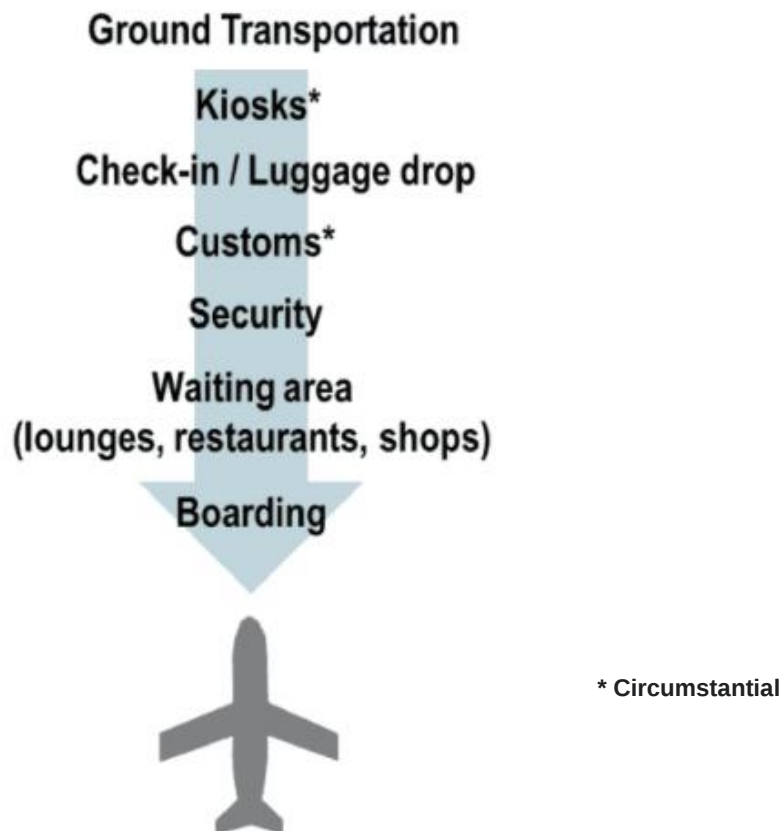


Figure 2.1 - Passenger Flow inside the airport

2.1.2 Passenger Flow Management

Passenger Flow Management (PFM) entails more than just data collection, while that is an important component. It uses Wi-Fi, Bluetooth, 3D sensors, boarding card scans, and other third-party data to create a real-time image of how people move and dwell as they travel around the airport. The true benefit comes from the analysis of that data, which, when combined with flight data, yields powerful insights, such as the ability to identify bottlenecks, estimate the impact of unexpected changes on flow, and suggest the best measures for smooth throughput.

Airports frequently inquire about how flow management may improve their Airport Service Quality (ASQ) scores. It's all about looking at each measured process and stitching it all together so that problems don't jump from one to the next.

Here are some of the ASQ measured processes and how flow management can make a difference:

Parking and ground transportation

Can a traveler forecast how easy the journey from their door to the departure gate would be before leaving their home or hotel? Normally, no.

They may, however, with a comprehensive flow management system. It can account for traffic congestion on the highways leading to the airport, detect delays in public transit, and connect to parking systems to inform passengers of the number of available spaces. For example, flow management is used at Auckland Airport to regulate traffic minute by minute. On its app, the airport has also launched a home-to-gate travel planner, which provides information on driving hours, parking, and anticipated screening and processing times all in one place.

Check in

Airports that analyze queue formations and check-in processing are significantly more capable of dealing with congestion and safety issues than those that do not.

Fixed counter time limits can result in a considerable reduction in capacity as well as lost retail dwell time for the airport. Airports can dynamically predict resource demand and change desk allocation by integrating show-up projections per aircraft with check-in preferences and real-time transportation data, enabling a seamless check-in procedure.

Security and Passports

While disclosing wait times is a popular strategy for managing expectations and reducing stress, airports that use historical data to predict show-up patterns for capacity planning can enhance throughput and cut wait time.

Passengers will be able to better plan their journeys thanks to this more predictive approach to queue management. A passenger can, for example, receive a reminder on their travel app a day

before departure indicating the expected journey/queue time as well as a recommended airport arrival time.

Facilities and Comfort

It's easier to understand where passengers move, what they use, and when they use it with passenger behavior analytics, allowing airports to define short-term activities and long-term planning decisions.

If piers are at risk of overcrowding, passenger flow data combined with information displays can guide consumers to alternate facilities or keep them in concession areas longer.

2.1.3 PFM Objectives

As mentioned earlier, a good PFM can be decisive for the success of the airport, below are described the main objectives when investing in these solutions:

- Ensure smooth passenger trips across the airport, decreasing and removing bottlenecks; performance is often measured in terms of passenger wait times, line lengths at key touchpoints, footfall, and occupancy in specific regions.
- Customer satisfaction is monitored by airport sponsored and independent surveys, as well as feedback from ground workers, to improve the airport passenger experience.
- Allow airlines to have better ground operations; this is part of the added value that airports hope to provide to airline tenants.
- Allow for new revenue streams to emerge; With non-aeronautical income become more important, technology allows airports and passengers to have a more direct contact.

2.1.4 Passenger Flow Management Systems

To secure that the passenger flow management works perfectly and achieve its goals, there are tools/systems that need to be implemented, some examples of this systems are described in the following table:

System	Description	Goals
One-Way Security Corridors	Two sets of interlocking doors that open automatically in the direction of traffic, allowing movement one way but not the other. In the event of a stationary item or movement in the wrong direction, sensors can alert a controlling officer and close the door, preventing unauthorized movement.	• Secure areas • Remove need for security in specific areas • Designed to only allow one-way pedestrian access
Express access gate	Access corridor controlled by hidden panels. An elegant module supports the glass panels as well as the control photocells	• Maximum anti-blocking security for persons. • Maximum antifraud control by movement supervision. • Adaptable to other security systems. • Adaptable to any architectonic project.
Slim access gate	Access corridor controlled by swing glass panels Innovation that focusses on security, high comfort and design.	• Maximum security for anti-blocking. • Maximum anti-blocking security for persons. • Adaptable to any architectonic project.

Table 2.1 - Passenger Flow Management Systems

2.2 Luggage Flows inside the airport

According to Dong, F., Luo, L., Gao, Y., Zhang, P., Zhou, X., & Yang, L. (2019, October), “carrying luggage can lead to “unequal avoidance” and other phenomena which will never happen without luggage, and variables of pedestrian flows, density and velocity are also changing diversely”.

While most people are familiar with the passenger process, the baggage process is less visible, with a lot more going on behind the scenes. The baggage process appears to passengers to be as simple as delivering bags from the departure airport during check-in to the baggage carousel at the destination airport – but the reality is far more complex, as bags are tagged, screened, sorted, loaded, unloaded, and tracked by various technologies throughout.

As a result, accurate luggage inventory has a higher chance of:

- Improve overall passenger satisfaction by preventing and reducing baggage maltreatment by determining custody of each bag at various stages of the baggage chain.
- Allow exceptions to be recognized where baggage is given to a party to reduce the likelihood of baggage fraud.
- Reconciliation and flight preparedness for leaving flights should be completed as soon as possible.

2.2.1. Luggage Tracking

According to Gupta, V., Kumar, R., Mishra, R. G., Semwal, A., & Siwach, S. (2017), “The loss or mishandling of luggage in airports is increasing nowadays, tremendously raising its associated costs. It is expected that the constant monitoring detects possible errors in a timely manner, allowing a proactive attitude when correcting this kind of situations”.

In 2018, almost 25 million bags were mislaid by airlines and airports. Technology, such as tracking apps and RFID tags, could make all the difference when it comes to ensuring passengers aren’t left disconsolate around the baggage carousel. These technologies can also fasten the passenger journey by optimizing a crucial process.

The technology available, nowadays, for luggage tracking is briefly explained below:

Manual tracking

It's a valid method for collection of recording point data. As the tracking information is printed on the tag, it does not require information from external systems to obtain a manual reading / recording. Data is typically not shared in real-time, when using manual recording.

Tracking using technology

Several technologies now allow for accurate baggage tracking from the drop-off point to the passenger's recovery at their destination. Among these various solutions, we can note:

- Identification with laser barcode readers.
- Identification with Optical Character Recognition (OCR).
- Identification with camera technology.
- Identification with Radio Frequency Identification (RFID).

At the end of the day, travelers are less likely to experience a stressful voyage if they can anticipate the arrival of their luggage and depart on time. This is beneficial not only to the traveler, but also to the airport's relationship with airlines. Airports can better recruit and retain airlines, enabling airlines to track and trace baggage around the world, enhance public views by improving passenger safety, and absorb significant growth in passenger and baggage volumes. Proper luggage tracking is beneficial to travelers, airlines, and airports alike.

[2.2.2. Luggage Handling](#)

While baggage management at small airports is generally easy, baggage handling at major international airports is more difficult due to several factors, which can have a substantial impact on both prices and service quality.

Most major international and domestic hub airports handle considerable amounts of transfer luggage, posing a sorting challenge. Congestion, routing faults, and control issues are all possible outcomes of the massive amount of baggage handled. Furthermore, the physical size of the airport in many cases considerably increases travel times to and from the plane, leaving less time for actual baggage sorting and handling.

In addition, when it comes to luggage handling, there are normally at least five parties engaged, each with their own set of expectations and potential conflicts of interest:

- Passengers - expect a hassle-free, quick, and reliable process with short transfers. They also desire the freedom to bring a variety of weights, sizes, and forms of luggage.
- Airlines - strive to combine customer happiness and fleet utilization (turnaround time). In this case, error rates are critical because airlines bear the costs of delivery and damage penalties.
- Airports - strive for optimum quality with minimal investment. Because passengers tend to blame the airport for luggage handling faults and delays, quality is a crucial factor. Furthermore, the airport owns the airport space, which is usually limited, making increased capacity difficult to accommodate, especially given the intended short travel distances.
- Security - Luggage handling is a high priority for security officers, necessitating in-line screening measures for questionable luggage. The airport is expected to integrate in-line security operations and provide handling spaces, according to security.
- Handling agents - costs are a major concern for handling agents. They expect the airport to provide spaces and procedures that make processing as simple as possible.

In conclusion, a good management of all the 5 parties' interests is crucial for the process of luggage handling and can result in a better general passenger experience and in an optimization of total time spent in the airport.

2.2.2.1. Speed vs Quality

Aircraft turnaround is, not only, a major focus for airlines to enhance utilization, but also for passenger satisfaction. The minimum connecting time achievable for transfers is a major element of competition for airlines and is significantly influenced by aircraft turnaround processes.

The speed with which all screening, sorting and transportation processes are executed is a very important factor. The baggage handling process can impact aircraft turnaround in several ways, mainly the time required for the actual unloading and consecutive loading of the luggage at the aircraft stand. This will later increase the time spent by the passenger.

On the other hand, if the handling luggage process are unreliable and of poor quality, late or misdirected baggage may result, causing delays in aircraft departure. If security procedures such as

luggage reconciliation and hold luggage screening are added late in the handling chain, or if they have a high false alert rate, they could be a major source of delays that also impacts the passenger journey.

There are several process aspects that are critical for overall luggage handling quality, including:

- The interaction between parties, particularly the handoff between the luggage handling system and the luggage handler, can be a major cause of issues and delays. Queues, waiting times, and information loss are common at these locations if they are not adequately structured. This also applies to inter-handler operations in which incoming luggage must be transferred from one handler to another, and priority setting of own against another handler's baggage is an item.
- Efficient item handling. Even if 95% of the baggage is handled to a high standard, poor performance on the remaining 5% of out-of-gauge items might derail everything.
- Timeliness vs. speed. Only a small percentage of time-critical items require immediate attention, while the vast majority only require timely attention. Making a clear distinction between the two flows and building processes that can meet both speed and timeliness needs, depending on the requirements, can assist improve quality and lower costs.
- Growth and change are industry's two most important characteristics. This necessitates constant focus on how to improve or extend the luggage handling process. Without some master planning, scenario thinking, or sensitivity analysis, processes and systems customized entirely to today's requirements may be obsolete tomorrow.

In sum, both speed and quality impact a lot the process of luggage handling and when not managed properly can result in a worse customer experience as well as higher operational cost for the airport.

2.2.2.2. Forecasts & Design

The forecasts of luggage handling are a very important stage that will impact the efficiency of the general handling process.

Because of the high growth rates at most major airports, luggage handling systems must be enlarged and rebuilt on a regular basis to keep up with throughput demands. This requires accurate timing and anticipation, which can only be achieved by regularly updating and analyzing passenger and luggage flow estimates, as well as peak rates and connecting times.

There should also be enough spare capacity available to allow for the temporary shutdown of lines needed to connect current and new facilities. Such flow evaluations should be carried out for the entire baggage handling chain to avoid the use of unrealistic quality and throughput expectations by various parties and to develop information in the room for process improvement.

Static capacity and forecast analyses are frequently insufficient when specifying the architecture of the luggage handling system. More information about system behavior at peak loads, including queuing impacts and waiting times, as well as the impact of flight schedule changes, is needed.

Computer simulation is a powerful tool for performing dynamic testing, but it is not as straightforward as it appears. A good model can not only provide insight into overall system performance throughout various operational modes, but it can also identify possible bottlenecks and system control issues early in the design process.

2.2.2.3. Manual labor vs Automation

At different airports around the world, the degree of automation and mechanization of the luggage handling operation varies greatly. The decision to automate is influenced by several factors, including the expense of manual labor in the area, labor rules, faith in technology (which is linked to the quality and dedication of local workers), and the roles of the airport operator, ground handler, and airline. This decision to automate can change the time needed to perform the operation and impact significantly this step associated indirectly to the passenger journey. There are some arguments in favor of both options, the following table will help to understand the pros and cons of manual labor when related to automation:

Manual Labor	Automation
Less investment needed. More flexible, easy to extend and expand. Less space required. More flexible related to exceptional luggage sizes.	Easier to control. Cheaper when we talk about large volumes. Easier to predict mistakes and performance. Faster. Reduce heavy labor conditions.

Table 2.2 - Luggage Handling. Manual Labor vs Automation

As said before, there are a various advantages and disadvantages of choosing each option, it will always depend in a lot of different factors that the airport must analyze and conclude which one fits better in their operation.

2.2.2.4. Handling techniques

The luggage handling industry has historically been dominated by technology. In fact, rather than the other way around, new baggage handling processes are frequently triggered by new technologies created and offered by specialized providers. Specific characteristics of luggage items and luggage handling equipment's can be combined with technologies of non-luggage applications, examples of that are:

- Standard trays or vehicles – helps identification during various process steps and adds uniform properties to the items allowing the application of a wider range of other handling systems that are not normally suited for luggage handling.
- Storage of early luggage – applying conventional warehousing technology can render a much more efficient use of space and increases flow control and flexibility.

- New luggage label design – supports the optimum control to have location information at any moment during the process. Technologies like radio frequency identification can give technical possibilities and new developments like the permanent tags to the process.
- Improving labor conditions – there are a lot of special techniques that when applied can give a true support to the operators. A good example are the lifting aids that is very simple to handle but can soften a lot the manual work.

The examples given above are perfect to establish that the luggage handling process still have gaps and can still be improved to optimize the passenger experience and reduce time spent. Studying the gaps and combining the process with already existing ones enable me to explore some improvements that can be made in the luggage handling general process, such as:

- Integration of processes - the idea to take the luggage handling process as a true supply chain approach with the objectives of avoid queues and double handling. There are some factors crucial for the process integration work, like the total share of data between parties and the full cooperation in design and in the execution of the process.
- Automation of luggage container transport – consists in small scale systems for automatic container transport that will fasten the overall process.

This chapter of luggage flow management inside airports is important to understand that not only the passenger flows impact the overall journey but also the management of luggage flows can impact a lot the passenger experience. The chapter also helps to study and analyze data, recognize possible gaps and discover potential solutions that will be needed to solve the research question.

2.3. Airport General Operations and Logistics

Airport operations refers to all the procedures that take place in an airport to ensure that your trip goes as smoothly as possible. This includes things like airport customer service, gateway operators, among other things. Given the sometimes crowded nature of airports, good operations are critical to ensuring that the thousands of travelers that pass through its gates arrive safely at their destinations.

Airport operations, like many other industries, is a broad industry with a wide range of chances to pursue. Airport operations are divided into four categories:

- Landside Operations
- Airside Operations
- Billing and invoicing
- Information management

Each one is critical to the smooth operation of an airport. Without an airport operations department, there would be a lot of missed flights, bad security checks, and general confusion.

This chapter will focus mainly on the landside operations because those are the ones that are more related to the research problem.

2.3.1. Landside Operations

Landside operations employees are responsible for monitoring the airport's terminals, concourses, highways, and properties, as well as providing customer service. They are also in charge of the day-to-day operations within the terminals and parking decks. Landside, like airside, is concerned with safety and security. The passenger's experience at the airport depends on how well the airport's landside operations are run.

The landside area encompasses the region within the airport terminal as well as the land adjacent to the city. It has access to city roadways and has a parking lot as well as a public transportation station. In the landside area are included:

- The Terminal - is a section of an airport facility where passengers arrive to board or depart from a flight. The terminal has security checkpoints, luggage checkpoints, amenities, and waiting spaces.
- Car Parking - This space is located outside but close to the terminal and allows vehicles to be parked on a pay-per-use basis.

The figure below helps to understand and map the general landside operations, the yellow part is the one where the research question will focus and where improvements can be made:

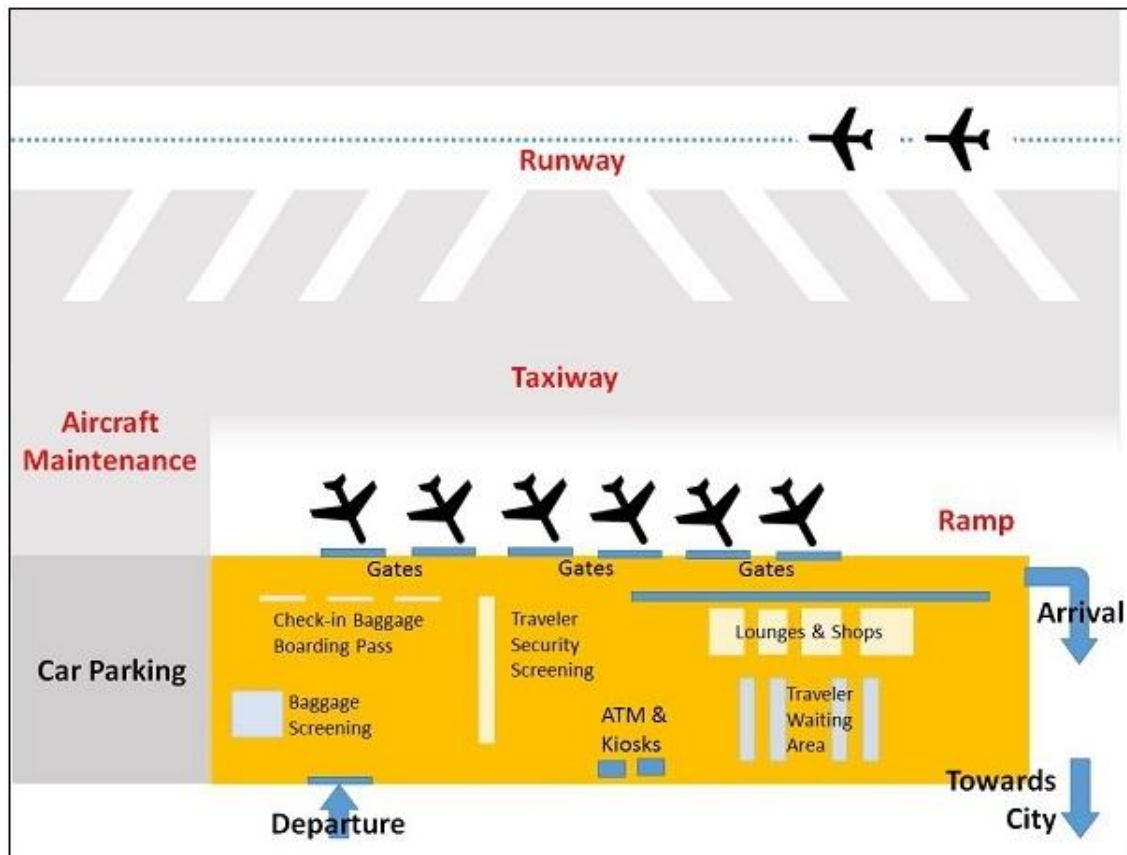


Figure 2.2 - Landside Operations

2.3.2. Airport engineering and logistics

A terminal facility serves as a takeoff and landing point for planes, as well as passenger and cargo handling and aircraft maintenance. Airside facilities begin at the secured boundary between the terminal and the apron and extend to the runway and beyond, including facilities such as navigational or remote air-traffic-control emplacements; and landside facilities include the terminal, cargo-processing, and land-vehicle approach facilities.

The layout of the airport allows for easy passenger access, effective aircraft operations, and the transportation of cargo and support resources. People switching from vehicles and buses to planes, freight transferring from shipping containers to trucks, and regional aircraft feeding passengers and cargo for intercontinental planes all use airports. Engineers prepare detailed layouts of the essential airport elements, including:

- Airport site boundaries
- Runway layout
- Terminal-building configuration
- Support-building locations

- Roadway and rail access
- Supporting utility layouts

A good management of these airport elements increases the aircraft performance characteristics, cost benefit analysis, and established building codes. Airport engineers are always on the lookout for new mechanical and computer technologies that could help them enhance baggage, cargo, and passenger throughput.

2.3.3. Design and Layout

As airport passenger traffic grows, the passenger terminal becomes an increasingly essential part of the airport, eventually assuming a dominant position in the largest facilities. In a small airport, the passenger terminal may account for less than 10% of overall investment, but at large airports, terminals often account for more than 70% of infrastructural investment. The final design will be determined mostly by the number of passengers to be served and the type of traveler engaged. Passengers are frequently classified as:

- Business or leisure
- Scheduled or charter
- Originating or destined
- Transfer or transit.

Each type of passengers has different needs and expectations that must be achieved to improve the overall experience.

There are different types of terminal layouts, each one should be chosen according to different factors, examples of nowadays designs are:

- **Open apron and linear designs** - Passengers walk over the apron to board the aircraft using moveable steps, and aircraft park on the apron directly near to the terminal. Frequently, the aircraft navigate themselves into and out of parking spots. However, when airports expand, big crowds of passengers will be unable to stroll across the apron. In this instance, it's usual to see terminals built along a straight line, with aircraft parked at gates right next to the terminal. Air bridges are typically used to transport passengers straight from the terminal building to the

aircraft. The linear approach is frequently limited by the large building proportions required, which might result in long walking distances for transferring passengers and other building-related difficulties.

- **Pier and satellite designs** - one building must serve a larger number of aircraft gates. The problem is as the number of airplane gates increases, passengers may have to walk longer distances within a pier-type terminal, passenger circulation volumes increase, and the terminal itself becomes uncomfortable and unattractive to use. Beginning in the 1960s, some terminals were developed on the satellite concept to reduce walking distances. Passengers are frequently transported to satellites through an automated people mover or automatic railway.

Although it may not be as related, even the terminal layout can interfere with the time spent by a passenger inside the airport and his general experience. Therefore, it is important to study every process and step inside the passenger journey.

2.3.3.1. The design process and airport capacity

The design of airport passenger terminals is a complicated process that is usually handled by experts alone. According to Medvedev, A., Alomar, I., & Augustyn, S. (2017), “The issue of innovation in airport design is supported by aviation project management. This is why the decision-making process on innovation in an airport’s design should correlate with future perspectives in aviation”. Buildings are being designed to easily accommodate passenger flows that are expected at some point in the future. Additionally, terminals are expected to operate at significantly above capacity for short periods of time. The metrics utilized vary, including words like standard busy rate and typical peak-hour passenger flow, although it is conceivable to develop a facility with insufficient capacity for no more than 30 operational hours per year utilizing these design approaches. Only approximately 5% of passengers would be inconvenienced because of the lack of capacity under such circumstances.

An airport's different facilities are intended to accommodate the expected flow of passengers and cargo. The amount of traffic that a facility can handle without causing significant annoyance to its customers is referred to as its capacity. Limits on the amount of traffic that can be accommodated at an airport can be set in a variety of ways. Air traffic delays to landing and takeoff movements; congestion on runways, taxiways, and aprons; crowding and delays in terminal buildings; or extreme

congestion in access facilities such as parking lots, internal roadways, and public transportation are just a few examples.

In conclusion, there are a lot of different needs that must be addressed when designing and planning an airport:

- **Convenience of passengers** - When designing the various facilities at the airport, a great level of service and convenience for both passengers and airport workers should be considered. Passengers, for example, should have convenience at the airport. We understand that a variety of factors influence passengers' perceptions of convenience. As a result, the terminal should have adequate amenities and ambiance, walking distances in the terminal should be kept low and easy, and travelling about the terminal should take less time.
- **Terminal Signage and path finding** - The most significant objective of any airport terminal complex is to allow efficient flow of passengers and vehicles on the terminal as well as on the roadways and other modes of transportation utilized inside and outside the airport. The major purpose while designing a terminal complex is to make crisscrossing the facilities as intuitive as possible for each user.
- **Flexibility in the terminal building** - Though the architects make every effort to ensure that the airport terminal is long-lasting or permanent, they are vulnerable due to quick changes in technology, operations, business factors, new regulatory requirements, airline demand patterns, and the airline sector. It is quite tough to progress in all aspects of an airport terminal. However, if the structure is given some room or flexibility, some adjustments can be made to the existing structure, and the building's life can be prolonged based on current need.
- **Security** - It is an important factor in terminal planning since it protects the people that are present at the airport. Only when the airport layout and terminal design complement the airport security plan can enhanced security be achieved. The security plan should be implemented in all areas, including parking, taxiways, highways, and mass transit networks. Apart from the security strategy, security equipment such as screening machines and portable checking devices for individual customers or visitors should be of great quality, ensuring a high level of security at airports.

Summing up the last chapter of literature review, it is easy to understand that the airport operations and logistics are a lot related to the customer experience throughout his journey. A good management of both passenger and luggage flows allied with a good planning of the airport

infrastructure allows the maximum output of the customer experience and enables the passenger to spend less time before being able to flight, answering the research question.

3. Methodology

This chapter aims to explain the methodology that was followed in order to achieve the main objective. To answer the research question there were utilized a lot of different data collection methods, both qualitative and quantitative. I consider this the best way to find improvements because it's an already deepen explored area and all sources of information are useful to discover new optimizations.

The study was conducted firstly by studying existing data from websites, articles, newspapers and others and it was later completed with data from a survey and in-local observation.

In sum, in this chapter, I will detail every method utilized and explain why it was worth to study each one in order to answer the central question of the dissertation.

3.1. Methodological Approach

To begin studying the problem its necessary to fully understand it and map every intermediary step needed to be achieved to solve the main problem later.

The main question of the dissertation is “why passengers have to spend that much time inside the airport before being able to flight?”. This problem contains a lot of different processes and that's why the best data collection methods for each one of these processes can vary.

Quantitative methods are best for measuring, ranking, identifying patterns and aim to produce generalizable knowledge about the causes of a phenomenon, in this case, these methods are useful to study per example queues and waiting times. On the other hand, qualitative methods are best for describing, interpreting and gaining in-depth insight into specific concepts. In this case, this method is useful to study behaviors of a specific group of people (passengers). So, and as before explained both are needed to fully understand the topic.

3.2. Methods of data collection description

After a deep analysis and study of the material available on the internet, I decided that an important step to better understand the main problem was to do a survey. I consider the idea of doing a survey essential because it helps to fully understand the opinion perceived by passengers about this topic and what improvements that can be made at this level, according to them.

3.2.1. Survey

The survey I developed aims to answer important questions that can help in my studies, the survey was made in Google Forms and was shared through my network. After two days of easy and quick data collection I “closed” the survey with a total of 208 answers.

Why have I decided to use an online survey?

The advantages of using an online survey are numerous, such as:

- The ability to reach many people in various locations and with different backgrounds and experiences.
- The anonymity as well as the convenience of the responses.
- The respondent doesn't get influenced by the researcher and really answers what he thinks he should.

Despite presenting some advantages, I recognize that online surveys also have some disadvantages that must be considered such as: lack of penetration in some population that can result in misleading information, that why I use the survey results only as a support tool for my research.

Going in more detail of what the survey aimed to answer, I will explain every question presented there and explain why I considered it relevant. (The analysis of the results obtained in the survey will only be made in a later stage):

1. Age?

I considered the age an important input to understand how old the people answering the questionnaire are, this point was also important to discard answers from people whose age ranges are not relevant for my studies.

2. Plane travel Frequency?

This is, of course, an essential input from the survey. It helps to perceive which people travel more often and what are their opinions about the next question. It basically helps to establish relative importance of the answers, per example: a passenger who travels 20 times per year is more relevant for the study when compared to a passenger who travels once a year.

3. How many time (average) does the passenger arrives at the airport before the flight?

This is another essential question. It basically shows if the people who answered have a similar vision to this problem that I have. It also helped me establish relations with other question's answers. Per example and as expected, people who travels more often tend to arrive later to the airport.

4. Does the passenger find difficult to find the boarding gate?

This question was asked to analyze and study one of the main issues I consider that can affect the time spent in airports. It was a "test" to check if the passengers also find this an issue in this operation.

5. What causes this difficulties?

An open answer question that aims to find improvements that will be studied in a later stage. Basically, this question is useful to find potential improvements and study if they are applicable or not.

6. Does the passenger think it's excessive the time spent before being able to flight?

This is another question that helps me understand if a lot of passengers perceive this problem as I do. Basically, what % of passengers recognize this as a problem that needs to be optimized/solved.

7. What processes does he consider that takes more time?

Useful question to study and deepen knowledge about the processes/activities inside the airport. It's essential to analyze in which activities does the passengers consider the problem is and in which are not worth to study improvements.

8. What improvements can be made to reduce the time needed to perform those processes?

Another open answer question that also aims to find improvements that will be studied later. Perceive passengers experience in relation with every stage of the process before flight.

4. Results and choices evaluation

4.1. Methodological choices evaluation

This section aims to evaluate the methodological choices and how did every single one of them performed in relation to what was supposed to be tested/studied. The following table simplifies the choices made and the pros and cons of each one of them as well as a general evaluation in a scale from 1 (not useful) to 10 (helped a lot):

		Relevance for the study	Pros	Cons	Evaluation (0-10)
Quantitative choices	Survey	The realization of a survey was important for my research because it supports the information already available, it also allows closer insights for the topic that you may not find on the Internet. Above all of that, a survey also enables you to understand the passenger experience/opinions and if they also find the research question a thing that can be improved.	• Closer insights from people from your network. • Easy and quick information gathered. • Allows comparisons with already existing data. • Understand passengers' point of view. • Recognize improvements suggested by the passengers. • Recognize main issues related and explained by people who went through it.	• Limited number of answers. • Hard to penetrate in every target group. • Can be misleading due to the "low" number of answers.	9
	Existing data	Of course, a dissertation cannot be made without fully understand the already existing materials, on a quantitative level, the already existing data helped me to compare to the results of my survey and allowed me to take conclusion based on both.	• Being an already deepen explored topic it's easy to find quantitative data. • Allows comparisons with the survey.	• Not that easy to find updated data. • Divergent data from website to website.	7

Qualitative data	Existing data	In similarity with existing quantitative data, you can't make a theoretical dissertation without the full knowledge of already existing data. The materials available on the internet from YouTube videos to research papers and newspapers opinions helped a lot to develop my studies.	• Easy to find information, lots of online materials. • Improvement ideas suggested (not deepen explored)	• Again, some divergent information from one place to another.	10
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Table 3.1 - Methodological Choices Evaluation

4.2. Data Analysis

This chapter aims to analyze all the data studied and detailed before. The data was acquired by a deep search of already existing information and is supported with data collected by me. The goal is to understand the general passenger experience upon reaching an airport and having to perform every task before being able to flight and after study the main problems present by them.

The survey's results in comparison with quantitative data available online will be very useful in this chapter to study the "numbers" of this issue (percentages etc.). The open questions presented in the survey supported by qualitative data available online will also be essential to understand passenger's opinions and suggestions.

4.2.1. General passenger's perception

How many time, on average, do you normally arrive at the airport before the flight?

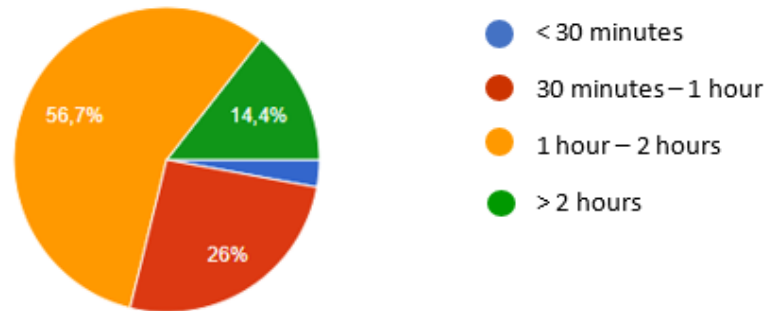


Figure 3.1 - Airport arrival time

This question aimed to analyze how passengers visualize the dissertation question. Basically, how they manage their arriving time to the airport having in consideration what they will have to do and how they will manage the intermediary steps.

After a careful evaluation of the 208 answers of the survey is easy to understand that most people are really worried about not having time to perform every activity. More than 70% of the passengers arrive at the airport more than 1 hour before the flight and this results really shows that some improvements should be made to reduce this time spent.

The blue and red slices of the graph represent the people who are not that worried about the arrival time but, after a deep investigation of this passengers, realized that almost all of them are people who are really used to travel (more than 20 times per year). These results can be a little contradictory, because at the same time it shows that the general process can be more efficient than what I thought but also that if this lower number of passengers can take a comparatively reduced time to perform all the activities why can't the majority of the passengers do the same?

Another conclusion I took after results analysis is that the passengers who arrive at the airport more than 2 hours before the flight tend to explain that due to the stress the flight generates on them. I considered these answers important because it might help to find improvements at other levels of the operation (not only operational issues but behavior issues).

Finally, and to complement the information gathered with this question, I searched online data and I noticed that the results are approximately the same. The explanations of why passengers arrive to early or too late to the airport are also very similar when comparing the survey and online data.

Do you normally have difficulties to find the boarding gate for your flight?

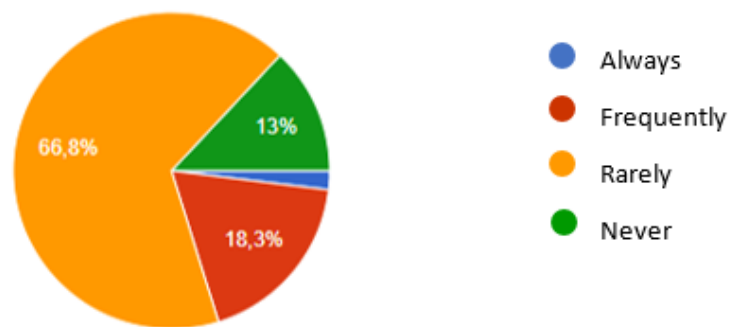


Figure 3.2 - Difficulties finding boarding gate

I decided to ask this question on the survey based on online data collection that made me realize that a lot of problems detailed by passengers were related to finding the boarding gate. Although it seemed to be a major issue with a lot of improvements to be made, only 20% of the passengers found it a big issue but, once again, this result can be a little misleading. Even though 20% may seem a relatively low percentage when we talk about improvements based on current issues, this percentage has to be taken into consideration because if 200 people out of 1000 have issues finding the boarding gate, it can affect the general process for everyone at a later stage.

This point of view made me realize that this issue is still important even though I didn't reach the results I expected and that can still find improvements in this area!

Do you consider excessive the time needed to perform every activity before being able to board/flight?

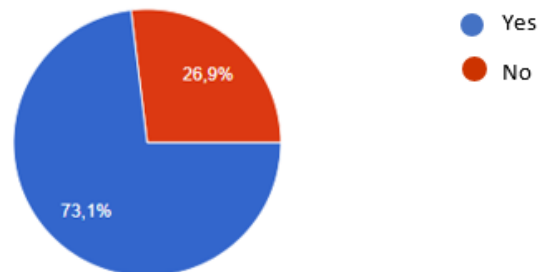


Figure 3.3 - Time to perform every activity

This question's results are relatively easy to understand, it is basically a yes or no question that focus precisely on the dissertation topic. Of the 208 people that answered the survey, 152 consider excessive the time needed to perform every activity before being able to flight. These results made me acknowledge that a lot of people also find the dissertation problem something that can be improved.

Although I was already convinced that improvements can be made in the general airport processes (at both passenger and luggage flows levels) the answers to this question supported by comments and papers available online made me be 100% sure.

Which process do you consider the one that requires more time (you can choose more than one)?

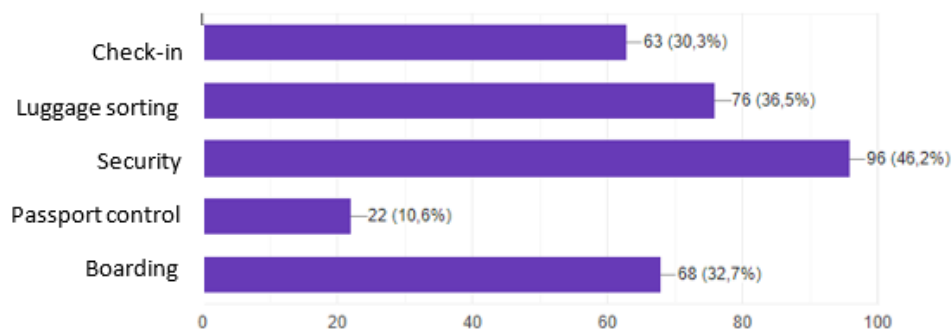


Figure 3.4 - Airport processes

The goal I aimed to achieve when I decided to ask this question was to understand what processes the passengers think that take more time before the flight. Before the results to this question, I already studied each one of the activities and had an idea of which one of them should take more time but after these results supported with data from internet, I can establish relative importance between them and find out in which one I should focus my improvements efforts on.

After analyzing in detail, the answers, it's easy to see which activities the passengers consider that requires more time but as mentioned before, some extra research is needed because the results can sometimes be misleading.

One example of why extra research is needed is: The "passport control" results, it may seem that this is not considered an activity that requires a lot of time but after a deep analysis it's easy to understand that many people do not consider this a bottleneck because they've never faced it (due to the fact that this activity is only needed to perform in some occasions). This is only one of a lot of examples that shows that I can't rely on only one source of information.

To conclude the analysis of this question it's relevant to say that the results are very helpful to understand where the improvements can be made, for example at security, Luggage sorting and Boarding levels.

4.2.2. Main problems

This section aims to evaluate the major problems described by passengers when confronted to the airport operations, these problems will be studied having into consideration the survey answers to the open answer questions and will be supported with online data from multiple sources like papers and videos available online.

4.2.2.1. Difficulties finding boarding gate

The first open-answer question I decided to ask in the survey is related to the difficulties finding the boarding gate, from my research and personal experience, I decided to ask this question because I found it very common for passengers to have trouble with this issue.

There were a lot of answers but the ones that appeared more times and that I consider more relevant are:

- No support – this was a very common answer. Basically, passengers who answered this think that when they really need help to find the boarding gate, there is no one to ask.
- Low level of signalization – This was also one of the most popular answers. Passengers who answered this think that there are a little number of signals to guide them through the operation. This will of course increase the time spent because passengers will lose time searching for that needed information's.
- Excessive signalization – On the other side, there are a lot of passengers who think that airports have too much signalization and that it can be very confusing sometimes. This contrast between too much and too little signalization it's very important for my research and can be crucial when trying to find improvements.
- Stress because of the flight – Other issue found is the stress related to the flight, some passengers normally take more time performing the activities due to the stress they face before being able to flight. Although is not related wit operations improvements itself, this problem also has to be taken into consideration.

4.2.2.2. Time spent in activities (problems & suggestions)

The second open-answer question I decided to ask, aimed to get some feedback from the passengers about the time spent in activities. With the answers more detailed below, I was able to understand the suggestions that they find relevant to reduce the time spent in the multiple activities needed to be performed.

- More staff – This was one of the most common answers to the question. Basically, a lot of passengers consider the lack of more staff elements inside the airport something that delays crucial activities (security and check-in i.e.)
- Excessive time waiting for boarding – This was another frequent answer. Passengers who answered this consider that the time after all other activities and before the boarding takes to long and can be reduced significantly.
- Automatization of security control – This was a suggestion given by a few passengers. As of today, the security control works on a hybrid basis, with both machine and human control.

Some passengers consider that a fully automated security control can optimize the time spent in this step.

- Split corporate and family/groups paths – This answer was given a lot by people who travels more than 20 times per year. They think that passengers who travels in big groups (like families) tend to take a lot more time to perform the activities and most of the times this delays their paths and the general operations as well.
- Face recognition apps – This was another suggestion I considered interesting. Basically, some passengers consider that activities like passport control and ID verification can be improved with technologies that use face recognition.
- Reduce number of flights per control stage – Another suggestion given that can be explored. In modern airports, one control stage is used to multiple flights. Passengers think that by reducing this number of flights per control stage, the time spent in each one can be optimized.
- Creation of free pass zones – Other answer very common between the passengers that travels a lot was the creation of free pass zones where everything is more automated and is dedicated to frequent travelers. By doing this, we reduce the time spent by these passengers and we also reduce the number of people in the control stage area.

The answers to the open-answer questions of the survey presented above were the ones that I considered more relevant in the development of the research and will certainly help a lot in the next chapter, which is the Improvement's one.

5. Improvements

This stage of the dissertation can be considered the turning point where I start to evaluate the theoretical information acquired before and use it in a more practical way. It's where I gather the whole thesis information to find improvements to the initial problem.

The improvements detailed below are a result of my creative thinking supported by already data and studies available online.

5.1. Free Pass Zone

The creation of free-pass zones focusses on tackling some of airport's major bottlenecks such as queues in security and in passport control (i.e.).

These zones, where everything is more automated, aim to separate passengers who normally take more time to perform the processes (such as families and passengers that are not used to travel a lot) to the ones who can do it in a quicker way (like business trips by individuals or small groups i.e.). By separating the above mentioned passengers, everyone can perform the activities faster: the passengers who travel a lot doesn't have to wait in long queues and, by taking off those passengers from the normal queues, the number of passengers there will also be reduced.

The question here is, who can access this free pass zones?

If we do not limit the number of people that can access these zones, they will have no value so, the passengers that can access the free pass zones are:

- Passengers who utilize that airport many times a month (for work purposes i.e.). In this case, the airport can establish some deals with companies in which the company pays a fixed value per month or per year and all the workers can access the free pass zone whenever they have to go on a business trip or even if their normal work requires a small flight every day.
- Passengers that acknowledge they will have little time and have to do the processes very quick, in this case they can buy a pass to the zone. The pass can be bought days before the flight (online check-in i.e.) and its valid for that travel only. Of course, in this case, the numbers of passes sold per day have to be limited according to the flights scheduled in that day.

5.2. Clear and Efficient Signage

When searching about the topic, one of the most critical issue that passengers pointed was related to the signage.

There were 2 opinions about the airport signage, described below:

- Many passengers consider that airports don't have enough signage and that is very difficult to find directions towards their destination.
- On the other hand, a lot of passengers pointed that there is too much signage and information available and that this over signalization can become misleading and confusing.

The improvement I suggest related to this matter is trying to use clear signage that allow every passenger to be able to find the path they need to do. It is necessary to understand what kind of signage does not need to be there and at what points the passengers might require additional information. By managing both needs correctly, it is possible to reduce the occurrence of bottlenecks.

Another improvement still related to signage that I studied and that is applied in other environments in which there are a lot of people is the digital signage. The digital signage is used per example in theme parks (attractions) and its useful to provide real time information about expected waiting times. Applying it to airports will help passengers to manage expectations and be prepared to what they will have to face.

In addition to in-local digital signage, airports can opt to develop an app to the customers that shows real-time waiting times in queues (i.e.), this will enable the passenger to manage better his time even before reaching the airport.

5.3. Airport Intuitive Architecture

Everything from signs, walkways, seats, check-in desks (...) can be designed to control passenger movements, we can create a set of visual cues that naturally lead and guide passengers. Airport architecture can make the passenger experience easy, natural, fluid and intuitive.

Examples of how architecture can transform the passenger journey and make it quicker are:

- Directional flooring and lighting – the space itself tell the passenger where to go while the signs merely assist.

- S-shaped lines in queues – by doing this nobody moves faster than anybody else and no one becomes stressed by the time when performing activities is needed. When passengers are not stressed, they perform the processes in a faster and natural way.

These are few examples of how the airport design and architecture can, without anyone noticing, reduce the time spent by the passengers.

5.4. Automate Security

Other improvements suggested a lot by passengers are related to the security control. This is, according to most of them, the process that normally takes more time to do. The main reasons pointed are:

- Big queues which are the result of people from many different flights having to go through the same security zone.
- Inexperienced passengers that don't know what to do at this stage and take a lot of time to send everything needed to the scanners (metallic objects, phones, laptops, belts etc.).

In order to solve this bottleneck, there are some improvements that came to my mind, one very logic is: Why not open more security control zones? Of course, if this solution is possible it will help to spread more the passengers and make everyone's path quicker, the problem here is that in most cases, we cannot just add more security zones to the airport because that may require layout changes and can be very costly.

So, if it's hard to build more security zones, why not just make the ones already existing more automated. This solution will also be expensive but, at least we don't have to make architectural changes to the airport. By investing in already existing technologies that moves luggage quicker and in a safer way, the time required to perform this activity will significantly decrease.

To tackle the other issue pointed related to the inexperienced passengers, we can just provide digital information and guidelines that they can observe and understand while waiting on the line. This might seem a very easy solution but it's very common for the passengers to ask the security workers what they have to put on the bin that goes to the scanner. If they have access to this information before coming to that point, it will reduce the time they take to perform the activity.

5.5. Face Recognition Apps

Even though it's not the most known process, the passport control is very important for passengers that want to travel to outside the Schengen area.

For that reason, it is still important to find improvements to this process. One that came to my mind after studying the matter and by my personal experience is related to the face recognition.

When in this stage, the time wasted is only related to the worker confirming that you really are the person that shows in your passport so, why don't we make it automatic.

How can we do it?

Through a face recognition system placed at the beginning at this process where you scan your passport and the app confirm if the biometric data is similar. By doing this, the airport workers in this area are just a support for the app if something is unusual. With this improvement and even if the time reduced per passenger is really low, when we take that time reduction to all the passengers that goes through this stage, it will make a huge difference.

To finish this chapter, it is important to acknowledge that this improvements were mainly created by my creative thinking and may not be applied to every situation.

Also, it's possible that there are already similar studies in airports all over the world making it impossible for me to be sure that this is really something new.

In sum, I would like to explain that some improvements suggested may not interfere a lot with time spent by passengers but if we consider that each one of them reduces that time even if it is a fraction of a second, it will make a huge difference because we are talking about a massive operation.

"A fraction of a second for the passenger, a million seconds for the airport"

6. Conclusion

The aim of the dissertation was to clarify if there are still improvements that can be made in airport landside operations that can reduce the total time a passenger needs to spend there. While focused on passenger and luggage management throughout the process, the goal was always about finding little things that can optimize the general operation. It was never easy to find these little things as airports operations are a vastly deeply explored area. But, with the help of many sources, authors, videos (...) and mainly, with the help of my personal experience as well as the experience of my network, I'm proud to say that I reached some improvements that can be still applied in a lot of airports throughout the world.

Being an almost 100% theoretical dissertation, I consider that the methodology I utilized was the best to answer the central problem. It is really important to understand what people with different backgrounds and experiences think about a such complex problem. I couldn't rely my improvements studies based only on my opinion and experience in airports that's why the survey and conversations with many different people helped a lot in this effort.

Having into consideration the conclusion that I got, further studies can be developed because the improvements I presented are based on a general point of view and not based in particular airports. I really suggest anyone that wants to develop a research about a specific airport to analyze if any and which of the improvements can be applied there and how it will impact the general operation and the processes individually.

Finally, I want to emphasize that my work enables any reader to understand how really everything work inside an airport (processes, flows, bottlenecks...) and to share with everyone that reads this dissertation that I'm really proud to be part of the creative minds that explored this so special topic. Airport operation and Logistics are NOT a fully explored matter!

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Annexes

Annex 1 – Survey

Idade *

- ☐ <18 anos
- ☐ 18-29 anos
- ☐ 30-44 anos
- ☐ 45-65 anos
- ☐ >65 anos

Com que frequência viaja de avião? *

- ☐ 1-5 vezes por ano
- ☐ 6-10 vezes por ano
- ☐ 11-20 vezes por ano
- ☐ + de 20 vezes por ano

Quanto tempo, em média, costuma estar no aeroporto antes de iniciar a viagem de avião? *

- ☐ < 30 minutos
- ☐ 30 minutos - 1 hora
- ☐ 1 hora - 2 horas
- ☐ > 2 horas

...

Costuma ter dificuldades a encontrar o seu destino (porta de embarque)? *

- ☐ Sempre
- ☐ Quase sempre
- ☐ Raramente
- ☐ Nunca

No caso de se aplicar, o que causa estas dificuldades? (ex: falta de sinalização, falta de assistência...)

Texto de resposta longa

...

Considera excessivo o tempo necessário para a realização de todas as etapas antes de poder fazer o embarque? *

- ☐ Sim
- ☐ Não

Qual considera ser o processo que leva mais tempo? (pode escolher mais que 1) *

- ☐ Check-in
- ☐ Despacho de bagagem
- ☐ Segurança (verificação de roupas e malas/mochilas)
- ☐ Controlo de passaporte
- ☐ Embarque
- ☐ Outra opção...

Como acha que os tempos despendidos na realização de qualquer um dos processos referidos anteriormente podem ser reduzidos/otimizados? (Opcional)

Texto de resposta longa
