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Security Baggage Process and on Time Performance at Guarulhos International Airport

Begara Diego
Embry-Riddle Aeronautical University

Adenil Oliveira
Embry-Riddle Aeronautical University

Davi Oliveira
Embry-Riddle Aeronautical University

Sabrina Santos
Embry-Riddle Aeronautical University

Ana Souza
Embry-Riddle Aeronautical University

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by

Diego Begara
Adenil Oliveira
Davi Oliveira
Sabrina Santos
Ana Souza

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This Capstone Project was prepared and approved under the direction of the Group's Capstone Project Chair, Dr. Peter E. O'Reilly. It was submitted to Embry-Riddle Aeronautical University in partial fulfillment of the requirements for the Aviation Management Certificate Program

Capstone Project Committee:

_____

Dr. Peter E. O'Reilly
Capstone Project Chair

_____

Fabio Barros Franco de Campos
Executive Director
Central & South America

_____

Date

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Abstract

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The study recommended starting the process of screening domestic passengers' checked baggage at Guarulhos – São Paulo International Airport – for airlines efficiency and security improvement reasons. The aviation industry in Brazil is at risk. Domestic flights, which accounts for over 85% of the airport activity at Guarulhos International Airport, do not have a process in which checked baggage of the boarding passengers are duly screened. That risk is significant to personal welfare and business. This Capstone Project demonstrated that such an issue should be addressed. Not only is there a potential risk involved in not screening baggage of domestic flights, but also airlines are not efficient when it comes to withdrawing pieces of luggage of passengers that do not board the flight. There is a security measure that forces the airlines to do so – eventually leading the flight to be delayed and having extra costs. The aim of this paper is to present an alternative to these issues. Through a financial assessment and statistical investigation, it has been proved that screening domestic checked baggage at Guarulhos airport could minimize delays and improve the overall security of domestic flights.

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Chapter I

Introduction

The aviation industry in Brazil is extremely competitive. It has four major domestic airlines sharing around 110 million annual passengers. The different airlines are sparring for every single customer in order to keep revenue flow and high profitability. The American Customer Satisfaction Index – ACSI 2017 states that the On-Time Performance (OTP) of airlines is among the main factors of client satisfaction. The concern about the punctuality of flights by airlines goes far beyond passenger perceptions. Flight delays are frustrating to air travelers, but also costly to airlines.

There is a range of events that can result in a delay. In Brazilian domestic flight operations, one of the most relevant detractors to the companies' punctuality of departure refers to Mandatory Security delays, which are the delays faced upon the checked baggage withdrawn in case of the passenger does not board the flight, among other security related delays. The present study analyzed the delays of Mandatory Security of two major Brazilian airlines, at Sao Paulo International Airport (Guarulhos Airport – GRU); compared GRU and Chicago O'Hare Airport Mandatory Security delays; and finally recommended Brazilian Airlines and Brazilian airports administrators ways to improve their OTP indicator and reduce delay costs.

Project Definition

Sao Paulo International Airport (GRU) is the largest airport in Brazil. It is also the busiest in Latin America in terms of passenger and traffic. As one of the main hubs of Latin America, GRU is the gateway to the world from Brazil and other countries of South America.

This project analyzed the aircraft Mandatory Security delays for two Brazilian domestic airlines that account for most of GRU's domestic traffic. Guarulhos Airport was chosen because of the volume of traffic and passengers that encumber a relevant impact to the airline operations.

With respect to Mandatory Security, International Civil Aviation Organization (ICAO) established standards and recommended practices for international civil aviation. Among these standards is the Annex 17th, which gathers the requirements to prevent and suppress unlawful interferences. Since the Pan Am Disaster in 1988, in which a bomb constructed with plastic explosive was hidden in a cassette player that was stored in a suitcase and loaded into the aircraft, exploding during the flight, ICAO has defined specific security measures related to the checked baggage of international flights.

Agência Nacional de Aviação Civil (ANAC), Brazil's civil aviation authority, as an ICAO member, has established on its' regulatory framework, the following security measure: The operator shall ensure that checked baggage may be transported only with the passenger boarding confirmation. The process of picking up luggage from non-boarding passengers alters the aircraft turnaround timeline, adding up an extra process, which can lead to delays in flights. Studying OTP on departures can make a more compelling link to passenger experience and satisfaction, as well as airline costs. As such, having a punctual operation is essential for competitiveness and profitability of an airline.

In this context, this project aimed to: (a) reduce the frequency of delays related to mandatory security baggage withdraw at GRU domestic flights operations, (b) evaluate the financial viability of baggage screening for domestic flights at GRU, (c) make

recommendations to improve security and efficiency related to mandatory security baggage withdraw at GRU domestic flights operations.

Project Goals and Scope

The goal of the project was to identify savings to the airlines by reducing the frequency of delays related to Mandatory Security luggage withdraw. In addition, the project also aimed to show that investment in security can reduce the number of delays and is financially feasible when compared to the costs of flight delays.

The purpose of this paper was to construct recommendations for airlines, airports and the Brazilian aviation industry. It expected to recommend an improvement in security processes. Since delays due to mandatory security problem are no longer faced in other countries, the security measure of screening checked baggage for domestic flights improves flight security and reduces costs of delays.

The paper aimed to answer the following question: how to reduce delays by Mandatory Security and the consequent costs with these delays of Brazilian domestic airlines. Although the study was focused on the operations of two domestic companies operating at Guarulhos Airport, the recommendations can be extended to operations in other Brazilian airports and for other airlines.

Definitions of Terms

ABEAR "Brazilian Association of Airlines, founded by Avianca, Azul, Gol and Latam, and also has associated companies like Latam CargoTap Portugal, Bombardier and Boeing." (AGENCIA ABEAR, 2017)

ANAC	"The National Civil Aviation Agency (ANAC) is responsible for civil aviation regulation and safety oversight in Brazil." It was established in March 2006. (anac.gov.br, 2017)
ANNEX 17	The most important technical annexes of the Convention of International Civil Aviation, also known as the Chicago Convention, that presents the measures taken by ICAO to prevent and suppress all acts of unlawful interference against civil aviation (ICAO, 2017)
IATA	"The International Air Transport Association (IATA) is the trade association for the world's airlines, representing some 275 airlines or 83% of total air traffic". IATA "supports many areas of aviation activity and help formulate industry policy on critical aviation issues." (iata.org, 2017)
ICAO	"The International Civil Aviation Organization (ICAO) is a UN specialized agency, established by States in 1944 to manage the administration and governance of the Convention on International Civil Aviation (Chicago Convention). ICAO works with the Convention's 191 Member States and industry groups to reach consensus on international civil aviation Standards and Recommended Practices (SARPs) and policies in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector." (icao.int, 2017)
Mandatory	Code 85 or AS defined by IATA corresponds to Mandatory

	Security delays, which may be caused by mandatory passenger or baggage.
Narrow-body	Single aisle passenger transport aircraft such as the Boeing B717, B727, B737, McDonnell Douglas DC9, MD83, and MD87 and Fokker F28 & F100, and other aircrafts seating up to around 150 passengers. (Dell, 2007, p.193)
OTP	Definition of on-time performance (OTP) is a flight that arrives or departs within 14 minutes and 59 seconds (under 15 minutes) of its scheduled arrival/ departure time.
Wide-body	"a large transport aircraft with internal cabin width sufficient for normal passenger seating to be divided into three axial groups by two aisles (in practice this means not less than 4.72 metres (15.6 feet)". (ICAO, 2004)

List of Acronyms

ANAC	National Civil Aviation Agency
ANEAA	National Association of Airport Administration Companies
ATSA	Aviation and Transportation Security Act
BHS	Baggage Handling System
BRS	Baggage Reconciliation System
B744	ICAO aircraft type designator for Boeing 747-400
CASA	Canadian Air Transport Safety Authority
DHS	Department of Homeland Security
FAA	Federal Aviation Administration

GRU	Guarulhos – São Paulo International Airport – Governador José Franco Montoro
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
NPV	Net Present Value
ORD	Chicago O'Hare International Airport
OTP	On-Time Performance
STD	Scheduled Time of Departure
TSA	Transportation Security Administration

Chapter II

Review of the Relevant Literature

In order to study flight delays by Mandatory Security, literature research was divided into three parts: Security, Baggage Handling and Flight Delays. The purpose of this division was (a) to explain how security measures at airport operations work regarding baggage process; (b) to present the processes of baggage handling, understanding baggage path and processes through airport terminal; and (c) to understand the impact of flight delays to airlines, how delays are codified, what a delay in Mandatory Security is and how much flight delays cost for airlines.

Security

Over the past 45 years, the civil aviation industry in the world has grown significantly, reaching in 2013 approximately 3.1 billion air passengers transported. However, civil aviation has been the target of attacks of violence and terrorism. Aviation Security involves a combination of measures to safeguard the civil aviation against acts of unlawful interferences. From the 1970s, aircraft attacks were mostly hijackings. In the 80's bomb attacks. The number of attacks falls according to the evolution of Aviation Security and security measures implementation, as shown in the figure below (Gillen & Morrison, 2015).

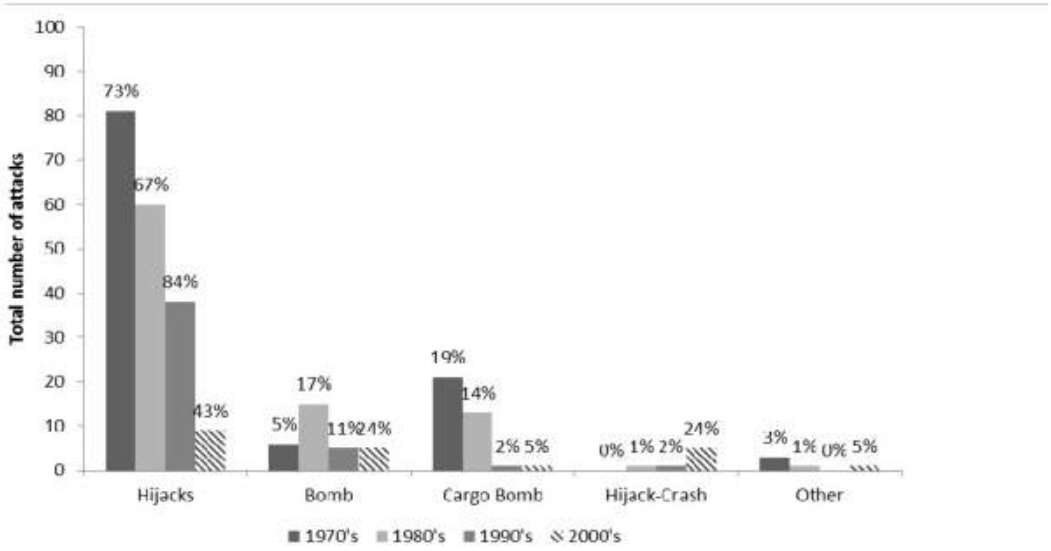

Figure 1. Total worldwide attacks inside aircraft by type of attack; 1970–2009. Adapted from "Rand Database of Worldwide Terror Incidents", by Gillen & Morrison, 2015. Retrieved from https://www.researchgate.net/publication/282533781_Aviation_security_Costing_pricing_finance_and_performance. Copyright 2015 by Gillen & Morrison.

Malik, Moran and Pilbeam (2015) argued that there were over one hundred definitions of terrorism, including 'violence', 'political goals', 'indiscrimination of targets' and 'victimization of civilians'. Terrorism is a concern to the civil aviation industry because aircrafts can be used for major incidents, with a large loss of lives.

ICAO is responsible to establish security standards and to recommend practices to the associate States. It requires that each contracting State shall apply security procedures for international flights to prevent an unlawful interference. In case of domestic flights, the measures may be applied based on risk analysis, according to Annex 17, 2011.

The terrorist attacks on September 11, 2001 exposed the vulnerabilities of the aviation industry. After the attack, some security measures were applied around the world, by ICAO and Local Authorities. Since 2001, governments have created new organizations to implement airport security systems, and there have been investments in

both technology and hiring and training of security personnel (Gillen & Morrison, 2015). In the United States, the Aviation and Transportation Security Act (ATSA) was signed by the U.S. President in November, 2001. This Act consisted of the implementing of screening all checked baggage by an explosive detection system.

Gillen & Morrison (2015) explained that:

> Checked luggage is passed through machines that can detect certain materials, liquids, explosives and identify objects that could be a threat. In the early 2000s when there were not enough machines to screen checked baggage there was a positive bag match program put in place. This required that any bag on a flight had to match with a corresponding passenger on that flight. This program has evolved such that a passenger cannot have control of their checked luggage. All checked luggage is screened but may be placed on an earlier or later flight, the passenger whose bag it is, does not know this. On long haul flights for all intents and purposes, checked baggage and passengers match (p. 7).

In 2010, the European Union created a regulation requiring screening of checked baggage process in all domestic and international flights (UK Department for Transport, 2015). In Brazil, according to ANAC, screening of checked baggage is required only for international flights. In domestic fights, the regulation established the baggage reconciliation as a security measure. In other words, when a passenger does not board the aircraft, intentionally or not, the checked baggage must be unloaded from the flight.

According to the Brazilian Civil Aviation Secretariat (SAC), Brazil has 2,463 airports listed on ANAC (2015). Among this total, 65 airports (international, national and

regional) are responsible for 98% of all departures and rrivals. Only two of those airports – Guarulhos International Airport and Viracopos Airport – invested, by the time this research was conducted, in a solution to integrate systems for security screening, storage and sort of baggage for domestic flights, through Baggage Handling System (BHS).

The lack of infrastructure at airports, lack of technology investments by the airport authority and airlines, and ANAC's regulations for baggage handling, security inspections contribute to the difficulty of implementing an appropriate baggage security process by airlines in Brazil, said Ticianne Sanches, Security Coordinator for a Brazilian airline (Septeber, 2017).

According to GRU Airport Operational Director, Capt. Miguel Dau, BHS allows a significant increase in operational efficiency, especially in the agility of the baggage process and security issues. There is control of all the baggage that go through the system. In addition, there is a reduction of mishandled baggage, mainly because the distribution to flights is done automatically, without human interference (ANNEA, 2014).

Costs of aviation security. Total aviation security costs at European airports are estimated at € 5.7 billion (US $ 7.6 billion US dollars) in 2011. In the United States, investment in security increased from US $ 2.2 billion in 2002 to almost $ 8 billion in 2013 (Gillen & Morrison, 2015).

In aviation, the relationship between new technologies and human work has important implications for the security efficiency provided. Technology is essential to improve the level and efficiency of security measures, and to provide passengers with a better travel experience (Gillen & Morrison, 2015).

Benda, P. (2015) was the former head of research and development for the US Department of Homeland Security (DHS). According to Benda, the biggest challenge is to develop and implement an aviation security system that is effective, economical, and able to handle the volume of passengers, baggage and cargo. Investments for new security measures and technologies should also focus on the increasing number of passengers expected over the next few years, in order to not slow or be ineffective against potential terrorist threats. Therefore, it is necessary to be open to new ideas, new technologies and leveraging innovations.

After the attacks of September 11th, financing in security measures did not happen at the same way around the world. The US and Canadian governments have chosen different models for Security management. The US has created a federal government department (TSA). Much of the cost of aviation security in the United States was financed from general tax revenues and from a security tax levied on air travelers introduced in 2001 (Gillen & Morrison, 2015).

In Canada an independent agency – Canadian Air Transport Safety Authority (CASA) was created. Unlike the US, the CASA security team is provided by private market companies. All expenses are derived from a federal tax on air passengers. (Gillen & Morrison, 2015).

Baggage Handling

Baggage Handling System. BHS is a system where the baggage is transported by the passenger terminal at the level below where the passengers transit, allowing high speed, reducing delivery times and increasing the efficiency in baggage handling, practically without human interference. As an example, Heathrow's Terminal 5 BHS is

designed to transfer 12,000 bags per hour. Designing and controlling BHS bottlenecks is critical to defining system-wide productivity. (Johnstone, Creighton & Nahavandi, 2015).

Baggage Journey. Schiphol Airport in Amsterdam has the most modern baggage system in the world. Per year, it processes 55 million items (Romero, Quick & Veronezi, 2012). Terminal 5 at Heathrow Airport in London has the largest single-terminal baggage system in Europe. There are 30 miles of haulers at Heathrow – with 2.8 miles of tunnels, 44 baggage retrieval belts and about 53 million bags processed each year. The baggage handling system tunnel cost £ 26 million, but it ensured that all passengers at the airport fly together with their luggage. The baggage journey at an airport passes through several processes, from check in counter to the moment it is delivered to the passenger in its final destination (Duell, 2014).

Figure 2. Heathrow Terminal 5 baggage handling system. Adapted from "Ever wondered what happens to your bag at an airport? Behind the scenes on the luggage conveyor belts of Heathrow Terminal 5", by Duell, 2014. Retrieved from http://www.dailymail.co.uk/news/. Copyright 2014 by Duell.

When a passenger checks in, the agent raises their itinerary on the computer and prints one or more tags to attach to each of their baggage. The label has all the

information about the flight, including destination and connections, as well as a bar code. The code is scanned and the system knows which direction the bag should go (Nice, 2017).

In the conveyor belt the baggage passes through an X-ray machine. As it does not have to be handled, the process is accelerated. The baggage falls on a belt with individual stands. As the system knows where each item should go and the way to get there, it tilts the holder and tucks the bag in the exact place. The baggage is collected by an employee or by mechanical arms. It is then placed in bag carts (for small airplanes) or containers (for large aircraft), driven by tractors to the aircraft holds. (Romero, Quick & Veronezi, 2012).

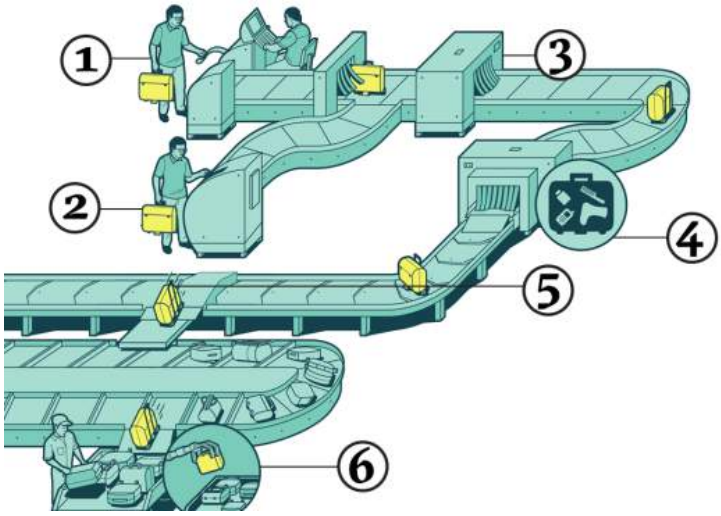

Figure 3. Baggage journey at Schiphol airport in the Netherlands: 1. Manual check-in; 2. Automatic check-in; 3. Bag code bar; 4. X-ray; 5. Conveyor belt; 6. Sorting Area. Adapted from "A vida secreta da sua mala no aeroporto", by Romero, Quick & Veronezi, 2012. Retrieved from https://super.abril.com.br/comportamento/a-vida-secreta-da-sua-mala-no-aeroporto. Copyright 2012 by Romero, Quick & Veronezi.

When the connecting flight will be delayed, the bag is stored on shelves. At the right time, it is taken by mechanical arms, placed on the container or cart and taken to the

plane. The baggage of connecting passengers is loaded by special carriages, which ride at high speed. At destination, the system takes the baggage to the terminal where the passenger landed, after reading the code bar bag tag information. (Romero, Quick & Veronezi, 2012). Heathrow Terminal 5 baggage system can store almost 4,000 items, which are the luggage of connecting customers (Duell, 2014).

Figure 4. Heathrow Terminal 5 baggage handling system – Storage. Adapted from "Ever wondered what happens to your bag at an airport? Behind the scenes on the luggage conveyor belts of Heathrow Terminal 5", by Duell, 2014. Retrieved from http://www.dailymail.co.uk/news/. Copyright 2014 by Duell.

Automated baggage handling system. Baggage segregation is essential for a fast and efficient airport operation. According to Rezwan, Hasan, Prachurja & Minhajul Anwar (2012), to have an efficient baggage process is necessary the implementation of an automated baggage handling system. But many small to medium sized airports (between 1.5 and 6 million passengers a year) still have not automated their systems. Most automated baggage handling system solutions are designed for large-volume airports, the

cost of implementation is very high and its structure is not ideal for smaller passenger terminal, becoming a non-viable project.

The project developed by Rezwan, Hasan, Prachurja & Minhajul Anwar (2012) simplified the barcode of the baggage tag to a bit counter reader, which is easier to detect and read. The project is based on reading the bit tags and segregating the baggage to their flights. This system can be implemented in small for medium airports, saving time and human effort, and it is a solution for the more than 100 small and medium airports in Europe.

The manual process of transportation, loading and unloading of baggage present several problems: labor intensive work; risk of damage and loss of luggage; and reducing the level of security. Major airports are investing in fully automated sorting and handling system. (Rijsenbrij & Ottjes, 2007)

In Australia, 25 airlines have chosen the same baggage handling system provider for seven major Australian airports. The system generates a link between passengers and their luggage during the whole process and helps airlines to comply with security's regulation on baggage handling. In conclusion, it promotes security and improvement in the passenger experience (Koumelis, 2015).

Each checked bag receives a tag with a barcode, which is scanned and reconciled with a passenger ticket. As the airline scans and tracks the order of loading, if a passenger does not board, his baggage can be found easily. This process avoids unaccompanied

baggage on the flight and ensures the reconciliation of passenger, baggage and crew (Koumelis, 2015).

The automation of airport baggage handling processes is advocated by Rijsenbrij & Ottjes (2008) as it also brings considerable savings to companies and airports. Ottjes presents in his study a simulation for use of a new baggage vehicle, with the use of the bag truck concept, avoiding manual handling between sorting area, baggage carts and the aircraft.

Despite all the investment in airport baggage handling around the world, the automation of the baggage handling process is a special concern about narrow-body aircrafts, since the process of loading and unloading wide body aircrafts is automated, through containers, pallets and lifts. In narrow-body aircraft, baggage is sorted, loaded, and stowed in aircraft hold manually. At Amsterdam Schiphol Airport, the baggage is loaded and unloaded by baggage carts at the sorting area and then onto the conveyor belt to the aircraft, being manually organized at the holds (Rijsenbrij & Ottjes, 2008)

According to Rijsenbrij and Ottjes (2008), new baggage handling systems are needed to (a) increase the speed of the process; (b) improve the turnaround aircraft time; (c) improve customer service by reducing retention time; (d) allow faster connections from one flight to another; and (e) improve Security and crime prevention. Still according to the authors:

> The avoidance of manual intervention in the baggage handling process between aircraft and terminal will contribute to improved security and reduced damage/pilferage, and the introduction of a baggage truck will transfer the

baggage handling from check-in/reclaim area to aircraft into a real automated warehouse (p. 425).

Figure 5. Manual loading of aircraft. Adapted from "New developments in airport baggage handling systems", by Rijsenbrij & Ottjes (2008). Retrieved from http://www.tandfonline.com.ezproxy.libproxy.db.erau.edu/doi/abs/10.1080/03081060701030810. Copyright 2008 by Rijsenbrij & Ottjes.

AuYeung (2014) analyzed and tested a baggage loading process on an Embraer 190, a narrow-body aircraft, through containers and equipment that are faster than manual, generating a four-minute saving in the aircraft's turn around process.

In 2010, Middle East Airlines announced that it had implemented a new baggage handling system at Hafic Hariri International Airport in Beirut, the capital of Lebanon. The system called Bag Manager and Bag Message monitors all movement of baggage. With this investment, the forecast was to reduce costs with mishandled baggage by 30%, in addition to reducing flight delays and improving security by ensuring that passengers and baggage are flying on the same flight. (Vogel, 2010)

Guarulhos Airport. Guarulhos Airport is composed of three terminals. In Terminal 1 there are only domestic flights. In Terminal 2 there are mostly domestic

flights, but also some international flights. And in Terminal 3 there are only international flights (GRU Airport, 2017).

*Figure 6.*Guarulhos Airport Map. Adapted from "Aeroporto de Guarulhos perde um terminal", by Meier (2015). Retrieved from https://airway.uol.com.br/aeroporto-de-guarulhos-perde-um-terminal. Copyright 2015 by Meier.

The airport is managed by Consórcio Invepar-ACSA since 2012. In 2013 the operator of GRU signed a contract with Vanderlande Industries, for the deployment of a new BHS at the airport. The new BHS was part of the planning for the 2014 World Cup and the 2016 Olympics in Brazil. Terminal 3, inaugurated in May 2014 and has a fully automated BHS. The BHS has 5 miles of treadmills and a capacity to process around 5,000 baggages per hour, with intelligent control, which allows tracking and locate luggage in real time through infrared rays distributed throughout the system. The entire baggage Screening, Transport and Sorting processes are done by the BHS (ANNEA, 2014).

Flight Delay

According to the European Observatory on Airport Capacity & Quality (2015), delay is the time lapse which occurs when a planned event does not happen at the planned time. ‘All-causes departure delay’ is calculated as the difference between the scheduled time of departure (STD) as communicated to the passenger and the actual off-block time (European Observatory on Airport Capacity & Quality, European Commission, 2015).

In accordance with the Bureau of Transportation Statistics (2017), a flight is counted as "on time" if it operated less than 15 minutes later the scheduled time. The Federal Aviation Administration (FAA) categorizes delays in gate delay, taxi delay, delay in route, delay in the terminal and delay in taxi-in. ANAC considers on time a flight with a difference of up to 15 minutes in relation to the scheduled time of departure (ANAC, 2012).

Impact of flight delays. One of the concepts of the Aviation Industry is that aircraft only make money for airlines when they are flying. Therefore, many analysis and studies were made to minimize aircraft ground time. To minimize ground time, it is natural for any company to try to maximize its processes (AuYeung, 2014).

Peterson, Neels, Barczi, & Graham (2013) conducted a study to determine the economic impacts of flight delay on the US economy. The costs of flight delays exceed what we might call direct expenses, which are the costs of Airlines. For Airlines, there are increased costs mainly with crew, fuel, aircraft, and maintenance. Passengers spend more time on their travels, which can result in lost business, productivity and lost opportunities for leisure activities. And finally, the increase in the costs of Airlines is

transferred to the costs of tickets, changing the relation of consumption of leisure travel and other tourism-related products and services, such as hotels and restaurants.

Flight delay is costly for the airlines and for the passengers. The National Center of Excellence for Aviation Operations Research (NEXTOR) has done a study on flight delay and concluded that flight delay cost airlines $8.3 billion in 2007 in the USA. (Peterson, Neels, Barczi, & Graham, 2013)

A flight delay requires extra fuel consumption, labor, capital, and other inputs, making operating costs higher to airlines. Zou (2014) made an empirical analysis using U.S. data confirms that, facing flight delays, airlines tend to increase fare and flight frequency.

In Brazil, the punctuality of flights is regulated by the responsible agency – ANAC, which helps to protect passenger from delayed flights. The agency attempts to persuade airlines to offer assistance (like hotel accommodation, meals, telephone, Internet access) to passengers. According to the time of the delays, these services can result in making delayed flights even more costly for airline companies. (ANAC, 2017)

Flight delay is a serious and widespread problem in the United States. Increasing flight delays place a significant strain on the US air travel system and cost to airlines, passengers, and society (Michael Ball, Cynthia Barnhart, Bo Zou, 2010).

US airline passengers increasingly have access to flight delay information from online sources. As a result, air passenger travel decisions can be expected to be influenced by delay information. In addition, delays affect airline operations, resulting in increased block times on routes and, in general, higher carrier costs and airfares (Brito, 2012).

Types of Flight Departure Delays. Sources of airport delay include many elements, such as weather, airport congestion, luggage loading, connecting passengers (Aisling and Kenneth, 1999). IATA created the IATA Delay Codes to standardize the reporting by airlines of commercial flight departure delays.

Previously, every airline had its own system, which made the aggregation of flight delay information difficult. There are 74 IATA Delay Codes. These codes are aggregated in 12 groups: Passenger and Baggage, Cargo and Mall, Aircraft and Ram Handling, Technical and Aircraft Equipment, Damage to Aircraft & EDP/Automated Equipment Failure, Flight Operations and Crewing, Weather, Air Traffic Flow Management Restrictions, Airport and Governmental Authorities, Reactionary, Miscellaneous, Others. (IATA, 2017)

Mandatory Security Delays. According to Bureau of Transportation Statistics (2017), a delay is reported as security reason when it is caused by evacuation of a terminal or concourse, re-boarding of aircraft because of security breach, inoperative screening equipment and/or long lines in excess of 29 minutes at screening areas.

From the Brazilian Civil Aviation Regulatory 108, the airline must ensure that accompanied baggage is transported only with the confirmation of boarding of the passenger, including in cases of transit or connection. In case the passenger does not board, his or her baggage must be removed from the aircraft and subject to security controls, including safety inspection. (ANAC 2018). This procedure is known as “baggage reconciliation”.

According to IATA (2013), the procedure known as "baggage reconciliation" attempts to ensure that the only baggage loaded onto an aircraft is that belonging to passengers of that flight who have actually boarded the aircraft.

Cost of Delay. According to the Total Delay Impact Study, Bo Zou, (2010) estimated that the total cost of all US air transportation delays in 2007 was $31.2 billion. Of that number, $8.3 billion was related to airline components, such as increased expenses for crew, fuel, and maintenance, among others. There was a $16.7 billion passenger component that was based on the passenger time lost due to schedule buffer, delayed flights, flight cancellations, and missed connections. The remaining cost of $2.2 billion cost from lost demand was an estimate of the welfare loss incurred by passengers, who avoid air travel due the fear of delays.

In a well-constructed manner, The University of Westminster came up with an estimation of what the average cost of delay per minute is, which is 81 euros (Cook and Tenner, 2015).

Summary

Aviation Security safeguards civil aviation against acts of unlawful interferences. The ICAO mandatory measure since the Pam Am accident in 1988 states that every baggage must be conciliated with passenger and crew. Since the September 11 terrorist attacks, security aviation rules are more restricted. The United States and European Union countries have adopted security measures by scanning all checked baggage in all domestic and international flights.

In Brazil, regulation does not require domestic flight baggage to be scanned by x-ray and explosives detectors. However, the baggage reconciliation process is guaranteed

by airlines, which requires the removal of baggage from the airplane hold, if the passenger does not board the flight.

After being checked, the luggage undergoes a long and complex way inside the airports, passing through several different processes. Most airports and countries have invested in a Baggage Handling System. Some of which are extremely modern and automated, such as Schiphol Airport in Amsterdam and Heathrow Airport in London.

The BHS System contributes to the operational efficiency of the airport. The segregation process becomes faster, reduces the possibility of damage and mishandled baggage, and increases security, since there is no human interference. The more automated the baggage handling process, the higher the level of security. Some studies looked for solutions for the whole process to be automated, including the loading and unloading of narrow body aircrafts, which today is still done manually.

Through an automated system of baggage handling, airlines can scan the bar code of checked bags and track exactly where the bag is in the system and the order of loading into the aircraft, as it happens in the major Australian Airports. If a passenger does not board through the system, it is easy to locate the luggage in the aircraft hold, guaranteeing the security process and the flight punctuality.

Flight delays are extremely impacting to the airlines, affecting passenger perceptions (OTP of airlines is among the main factors of client satisfaction), increasing aircraft turnaround time and generating additional costs for airlines. A study done by University of Westminster concluded that the cost of a flight delay per minute was approximately 81 euros.

Chapter III

Methodology

The analysis was divided into two different parts, conducted in a chronological order: a statistical investigation and a financial project assessment.

Experimental Design

The statistical investigation conducted used a Two-sample T-test comparing the average percentage of delays related to security in two different airports, one in the United States and one in Brazil.

During the assessment of this study, it was determined that the intention was to prove whether two sets of data were significantly different of each other. Statistically speaking, the T-test is the most recommended tool when this type of hypothesis should be proved. To apply such a test, it is important however to test the equality of variances. If the variances are equal the T-test used must be a Pooled Variances T-test, if the variances are not equal the T-test used must be an Unpooled or Separated Variances T-Test.

Brazilian authorities require airlines to withdraw any unaccompanied luggage from the airplane in domestic flights, causing several delays on the flights departures. Opposite to that, in the United States there is no mandatory security baggage withdraw in domestic flights when the passenger does not board the airplane, since all the luggage has been inspected.

As shown in the previous chapter, through the ATSA, signing after the September 11th attacks in the United States, all checked luggage passes through machines that detect any type of liquid, material, explosive or other objects that are considered as threats. This measure is applied to all checked bags of domestic flights and international flights. For

that reason, on domestic flights, it is possible that a baggage is placed on a flight before or after its passenger. However, in Brazil, the security measure is still the same as in the US in the early 2000s when the positive bag match was applied.

Thus, comparing the average of daily percentage of delays caused by security reasons in the two countries makes a relevant case as per the validity of baggage inspections at the airport. Comparing the two variables, enabled this study to rely on the t-test, as previously mentioned.

Apart of proving the validity of the baggage inspections at the airport, a financial project assessment was conducted to show the feasibility of this solution. Net Present Value (NPV) estimates were conducted considering the cost of the inspections and the cost of delays. Net Present Value was chosen because it premises rely on the difference between the present value of cash inflows and outflows. In the financial world, NPV is widely used when capital budgeting needs to be assessed and give investors the possible profitability of a projected investment of project.

Data Source(s), Collection, and Analysis

Statistical Investigation. To conduct the hypothesis test, Chicago O'Hare International Airport were selected because it is the second busiest airport in the United States operating nearly 875,000 flights per year (2016). As it is also an airport hub, it will provide a basis for comparison in the analysis of Guarulhos Airport. GRU is the main hub in Brazil operating around 270,000 total flights yearly (2016).

Both airports are important connecting points, having high volumes of connecting passengers, but also with high volumes of local passengers. As domestic flights luggage is inspected in the US and not in Brazil, the study considered a sample of domestic flights

departing from those two airports. This approach allowed the researchers to compare the two different security measures – positive baggage match and baggage screening - with regards to its´ efficiency in on-time performance. Furthermore, the availability of BHS - Baggage Handling Systems in both airports, ORD and GRU, that can handle and inspect the total volume of local and connecting passengers' luggage, makes a compelling case for the comparison of those two airports. The data was collected for the first semester of 2017, January to June.

The Bureau of Transportation Statistics was the data source in the case of the Chicago O'Hare International Airport. Data included all the domestic operations, the Standard Time of Departure, Actual Time of Departure, Total Delay Minutes and Minutes of Delay for each reason: Carrier, Weather, National Air System, Security and Late Aircraft Delay.

For the Guarulhos – São Paulo International Airport, departing flights data was collected directly with the two major airlines operators of that airport. Brazilian authorities require the airlines to inform on time performance using the IATA Delay Codification, hence, both airlines studied report their delays in the same manner, making the database duly comparable. Data included all the airlines' operations, Standard Time of Departure, Actual Time of Departure, Total Delay Minutes and Minutes of Delay for each reason of the IATA coded delays. IATA Codification had a specific delay code for Mandatory Security (85 - AS), which was used in comparison to the Bureau of Transportation Statistics Security Delays.

The two data are secondary, because as described above they were collected from existing data. On Time Performance data used in both data describe delays of 1 minute

delay after Schedule Departure Time (STD), and for this reason it was possible to compare the data.

From the mentioned data, daily values of on time performance were calculated, dividing the number of flights not affected by Security Delays by the total number of flights on the sample, hence generating the percentage of on time operations. For each airport a total of 181 daily values were calculated.

To conduct the Two-sample T-Test, the two groups of values, ORD and GRU daily on time performance, were tested with regards to the variances within and among groups. A Levene Variance Test was the selected statistical technique for this purpose, as it does evaluate the similarities of the two samples. From the outcome of this test, the proper Two-sample T-Test was conducted, aiming to prove the differences in on time performance related to Security between Guarulhos – São Paulo International Airport and Chicago O'Hare International Airport. The statistical investigation was conducted using a freeware statistical package add-on to Microsoft Excel named Action Stat 2.9, available at http://www.portalaction.com.br/.

Financial Assessment. The second part of the analysis considered the financial assessment of the implementation of baggage inspection on domestic flights in GRU. For the purpose of this assessment, the cost of inspecting passengers' bags and cost of delays related to security were considered for the calculation of the Net Present Values of the baggage inspection project.

At Guarulhos – São Paulo International Airport baggage inspection was already in place for international flights. The BHS, implemented by the airport operator in 2014 has a capacity of inspecting 5,000 bags per hour. It also has the capacity of inspecting the

luggage for domestic flights. For the inspection at the airport, the airport operator GRU Airport charges airlines R$1,25 (U$0.39) per inspected bag – value defined in contract with the airlines that operate at GRU. This cost was the rate considered in this analysis.

To estimate total volume of the inspections that would be conducted, the following variables were considered: average load factor for the studied airlines, the size of its' aircrafts, the number of daily flights departing from GRU, the passengers bag dispatch rate and an estimated growth rate for the number of passengers. Data was provided by the studied airlines.

On the other hand, the cost of delays related to security, considered the estimates of The University of Westminster for the Eurocontrol, at €81,00 (U$95.68) per minute. As information on the cost of delays was not available at a country level in Brazil, this value was taken as a reference as the most accurate continuously updated number in the industry.

The sum of delays considered such factors as the average length of the mandatory security delay calculated from the database of the study, the percentage of occurrence previously presented and the estimated growth rate in operations. Cost avoidance was considered the difference in the percentage of occurrence shown on the data of GRU and ORD. The on time performance related to security in GRU was assumed to be the same observed in ORD for the purpose of the financial assessment.

In order to estimate the Net Present Value, the discount rate considered was the Brazilian Bounds Interest Rate – SELIC. By the time this study was conducted (September 2017) this rate was 8.25% per year, thus 0.6628% monthly.

Chapter IV

Outcomes

The outcomes were divided into two different sets which were based on the experimental design mentioned before: the statistical investigation outcomes, with the results of the statistical tests conducted and inferences about it; and the financial assessment outcomes, considering the calculations of the net present value of inspecting the baggage for domestic flights in GRU.

Statistical Investigation

The statistical analysis conducted a Two-sample T-Test. It required that the baseline of both data groups, GRU and ORD, were duly tested in their equality of variances. In order to do so an additional test had to be performed, a Levene Test, and the results are shown in Table 1.

Table 1

Levene Test Results

Information	***Value***		
Levene (test statistics)	314,2578777		
Degrees of freedom	1		
P-value	5,41575E-51		
Confidence Intervals for the Standard Deviation			
Factor	***Inferior Limit***	***Standard Deviation***	***Superior Limit***
GRU	0,017595198	0,02000236	0,023106627
ORD	0,000432434	0,000491595	0,000567888

The result indicated that there was no statistical evidence of the equality of variance. Hence, the Two-sample T-Test to compare the means of the daily percentage of on time performance related exclusively to security of both ORD and GRU departures

must consider that characteristic of the data. The result of the Separated Variances Two-sample T-Test is displayed on Table 2.

Table 2

Two-sample T-Test Result

Information	***Value***
T	-29,05121002
Degrees of freedom	180,2174474
P-value	3,31E-70
Mean of group 1: GRU	0,956652485
Mean of group 2: ORD	0,999857813
Mean 1 - Mean 2:	-0,043205328
Sample Standard Deviation group 1: GRU	0,02000236
Sample Standard Deviation group 2: ORD	0,000491595
Alternative Hypothesis: Smaller than	0
Confidence Interval	95%
Superior Limit	-0,040746441

The result suggested, at a confidence level of 95%, that the difference of the mean daily on time performance exclusively related to security reasons in GRU was smaller than in ORD. This virtually corroborates the full hypothesis of this study that screening checked baggage at the airport improves airlines efficiency when it comes to on time performance.

Assuming that implementing baggage inspection in GRU would lead this airport to perform at the same level of on-time efficiency as ORD does, considering security delays, and that this difference is around 4,0%, it is theoretically possible to estimate the impact on the efficiency of domestic flight operations in GRU. If we consider the amount

of 97,000 domestic departures in GRU yearly (as per ANAC and experts' information), the efficiency gain could be around 3,900 flights that would depart without security related delays.

Financial Assessment

After the statistical investigation, to reinforce the importance of the checked baggage screening on domestic flights in GRU, a financial assessment of the associated costs on that operation needed to be conducted. The Net Present Value of the baggage inspection considered five years of estimated cash inflows and outflows, starting on January 2018. Actual costs of delays and baggage inspection were used as the reference values, duly corrected by the 5-year average inflation on the following years. Table 3 shows the summary of the premises of the estimated cash flows and other assumptions for the calculation.

Table 3

Assumptions for the Net Present Value Calculation

Information	***Value***	***Unit***
Average Airplane Capacity	173,13	passengers
Load Factor	86%	
Dispatched Bag Rate	54%	of the passengers
Operations Growth Rate	5%	Yearly
Inflation	4,50%	Yearly
Inspection Cost per Bag	0,39	USD
Average Quantity of Flights	270	Daily
Average Length of Security Delay	8,2	minutes
Delay Cost per Minute	95,68	USD
Avoided Delays	4%	
Monthly SELIC	0,66%	
Exchange Rate 1	3,205128	BRL to 1 USD
Exchange Rate 2	0,846572	EUR to 1 USD

The results of the estimates indicated a Net Present Value of U$12,613.53, thus a positive result that indicates the feasibility of the implementation of baggage screening process for domestic flights in GRU. Since no initial investments were considered, it is theoretically possible to assume that if any were required, the project would have no payoff whatsoever. Even though the financial analysis indicated the cost of inspections and cost of delays are barely different, the improvements in security on domestic operations are to be considered as an advantage for the industry in Brazil. Always taken for granted, it is worth mentioning that the aviation in Brazil is so vulnerable to attacks of any kind that there is a growing feeling, whether it is real or not, that this country will eventually be struck by a massive disaster, be it an action of a lone wolf of even a terrorist attack.

Furthermore, the inspection of baggage would allow the minimization of variability on the airplanes dispatch, as no unpredictable and unexpected baggage withdraw would have to be performed. It means that the aircraft will depart anyway, whether the passenger boards or not. Next chapter embodies the recommendation where it was discussed even further, nonetheless it is of serious and legal importance that some changes on the laws behind this procedure is made. ANAC should come up with some alternatives for the airlines to work around this subject as it is proven to be an inconvenience for both the airline and the airports.

At last, the Baggage Handling System is already installed, up and running at Guarulhos – São Paulo International Airport, as it is used to screen baggage dispatched to international locations. It is therefore possible to infer that the luggage inspection for

domestic flights would generate value for the airlines, considering both the associated savings and the security aspects of the business.

Chapter V

Conclusions and Recommendations

The mainobjective of this project was to make recommendations to reduce delays by mandatory security for Brazilian domestic airline operations. In order to accomplish so, this project conducted and analyzed the feasibility and possibility of screening all passengers' baggage at Guarulhos – São Paulo International Airport. In order to enable this study to be conducted in an environment where some conclusions could be taken, Chicago O'Hare International Airport was considered as a fitted comparison given the nature of its operation. Both are connecting points and have a huge activity when it comes to domestic flights. Our analysis proved that the impact of the baggage inspection on delays was relevant.

In addition, a financial assessment was undertaken to estimate the financial viability (and possible profitability) of such practice for Guarulhos – São Paulo International Airport.

Conclusions

The results of the performed statistical investigation showed the average on time performance related to security reasons in O'Hare is higher than in Guarulhos. That was considered to be a consequent effect of the rougher security measures – checked baggage screening – for domestic operations at that airport. Thus, it is theoretically possible to infer that the baggage inspection helped the airlines to be more efficient with regards to punctuality.

Considering the results of the statistical investigation, the focus shifted to the viability of inspecting the domestic flights passengers' baggage. The assessment

compared the costs to perform such inspections and the costs of delays related to security reasons at Guarulhos – São Paulo International Airport. An aircraft to be delayed on ground is a massive cost to airlines. It disrupts the operation and causes the passengers to have a possible bad perception concerning the service. Therefore, screening checked bags in an already in place infrastructure, ended up to have lower costs than the costs related to the delays. Thus, the cost is no issue to implement such a procedure.

Besides the savings indicated by the financial analysis, the baggage inspections could offer other benefits to the airlines operations. The improvement in security of the operations is clear in that sense. Apart of that the homogeneity of operations, not being interrupted unforeseen by the need of withdrawing a bag of a missing passenger is also a benefit.

The cost caused by flight delays are often not considered by Brazilian airlines and by Brazilian civil aviation. Investment and new technologies are essential for a fast and efficient airport operation. The cost of implementing new processes may seem very high initially, but as proven in this project, investing in new security measures and technologies can bring operating efficiency gains to airlines.

In addition, there is an extremely important gain in terms of stronger rules for baggage handling security inspections, as is the case in other countries such as the United States and Canada. And finally, there is the gain in Customer Satisfaction and in the image of the airlines, by having a better On Time Performance.

Recommendations

The study showed the validity of screening domestic passengers' baggage at Guarulhos – São Paulo International Airport for airlines efficiency and security improvement. From this outcome three recommendations were made:

Inspect luggage of all passengers in domestic flights at GRU. As showed on the statistical investigation conducted, airports such as ORD, which inspect all passengers' baggage, have lower levels of delays related to security than GRU, where luggage is not inspected in domestic flights. Therefore, the researchers' recommendation was that the airlines inspect the baggage of domestic passengers. However, to capture the benefits of such a procedure, a legal framework must be changed, as noted in the last chapter of this study. These actions will only be worthy if the missing passengers' baggage does not have to be removed from the airplanes. Thus, the recommendation of the researchers must be preceded by a claim from the airlines and the airport operator to the competent authorities, that this legal requirement is amended.

Re-negotiate the baggage inspection fees with the airport authorities. Considering that at the current unit cost for baggage inspection, the Net Present Value for the inspections is just above zero (U$12,613.53), the decrease of the unit cost could help the airlines to save thousands of dollars yearly. Using the high volume of passengers' bags to be inspected in all domestic operations as leverage, the airlines should pressure the airport authorities to decrease the unitary inspected bag fee. That could be beneficial to the airlines but also for the airport operator, as it could increase its baggage inspection revenues including the millions of passengers traveling in domestic flights. A small decrease on the inspection fee per bag, -4% from R$1.25 to R$1.20, could generate a

revenue of nearly U$2.96 million dollars for the airport in the first year and a Net Present Value for the project of US621,092.66.

Include the cost on the boarding fee. Embarkation taxes are collected by passenger to remunerate the use of facilities, equipment and services of airport. Therefore, the inclusion of the checked baggage screening cost (USD 0,39) on the embarkation fee, considering as a service provided to the passengers, to ensure the safety of them is an alternative reduce the financial impact to the airlines and airports, because the cost can be diluted, permitting the execution of baggage inspection. According to the model that is currently happening in the United States and Canada, where Security Cost is also financed by security tax on air travelers.

Key Lesson Learned

The researchers learned during the development of the study that the definition and scope of the project should be extensively reviewed before starting the project. Analyzing alternatives for the project scope and also similar projects may have led to an easier and more straightforward approach to the research. Delays in research could be avoided this way.

Data availability and comparability were also important issues the researchers understood to be considered prior to the development of the study. Although data on airport and airlines operations are kept by the national authorities, some of this data is not always made available for external research projects. Furthermore, not always data is comparable from one source to another, making comparisons exceedingly difficult. It was beneficial to this project that the researchers were airline employees. This helped in the data collection.

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