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Camila Miliani, Fabio Sanches, Jonatta Haniere, Rodrigo Cortes, Tais Gargano, and Vanessa Reis

A Capstone Project Submitted to Embry-Riddle Aeronautical University in Partial Fulfillment of the Requirements for the Aviation Management Certificate Program

Embry-Riddle Aeronautical University
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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

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Abstract

Group: Camila Miliani, Fabio Sanches, Jonatta Haniere, Rodrigo Cortes, Tais Gargano, and Vanessa Reis

Title: Pre-Check Security Processes In Selected Brazil Airports - Changes And Gains

Institution: Embry-Riddle Aeronautical University

Year: 2022

The recommendation of this Research Project is to implement the precheck program at 10 Airports in Brazil with more than 5 million passengers a year. The passengers' satisfaction, security improvement and OPEX savings would be a reality.

The expectation of OPEX savings at these 10 Airports are R$ 3.360.000,00 per year, (US$ 634.000,00) due to the possibility of using the current infrastructure and yet, reduce one Protection Agent per inspection module, per airport.

The research topic was to understand the feasibility of implementing the precheck security process in Brazil Airports. Using the U.S. benchmark, and the current Brazilian legislation, GYN Airport (3.2 million passengers per year) was used to measure the current standard inspection time and to simulate a controlled precheck inspection. 402 passengers were observed in the standard process. This sample size had an average of 66.9 seconds of inspection time. The precheck simulation had an average of 16.7 seconds, considering a sample of 59 volunteers.

One of the most stressful processes in the Airport experience is the Security Inspection. Huge lines, removal of personal items and pat down are examples of what makes the process a moment of anxiety, besides the worry of missing the flight. To

expedite this process the TSA PreCheck® was created. Considering a risk assignment of the applicants, the precheck guarantees a major benefit of waiting less than 5 minutes in line. In addition, the precheck passengers do not need to remove shoes, laptops, liquids, belts, and light jackets. The program has 11 million passengers registered in the U.S, representing 6.8% of the air travelers. There is no program like this in Brazil.

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Chapter I

Introduction

Project Definition

Aviation continues to grow as the Brazilian economy expands. Intending to help ensure better and faster processes, this work aimed to analyze the application of the pre-check TSA, as an improvement here in Brazil. The objective was to enable the evolution of processes to meet the growing demand for air travel through new collaborations, technologies, and processes. The research proposes and supports the implementation of good practices already adopted in other countries.

TSA Pre-Check is a pre-inspection system that allows travelers considered to be at low risk to flight safety, to take advantage of a faster form of inspection. With TSA Pre-Check travelers are not required to remove shoes, belts, light jackets, laptops, and liquids from carry-on bags. According to the Transportation Security Administration, 94% of TSA Pre-Check passengers wait less than 5 minutes in inspection lines (TSA PreCheckTM, 2019). Based on this information, the main objective of this work was to study the application of this facility here in Brazil.

Problem Statement

Continuous improvement is always a major deal for any business. Being even more valuable in the aviation industry, since it is an extremely dynamic business. In this sense, implementing new technologies and innovative procedures to reduce time and increase efficiency will undoubtedly bring significant gains for clients and companies.

Taking into consideration this sense of improvement, we noticed that there is an important gap in Brazilian aviation that has to be filled. This issue is related to airport security procedures. Nowadays Brazilian airports use complex processes to accomplish international security standards. These could be annoying steps for frequent travelers or any other passenger traveling at peak times. It is common to see significant waiting times. This waiting time can and usually leads to huge lines. The main outcome is an increase in passengers' complaints about the time waited over the long screening processes.

To mitigate the problem mentioned above, countries like the United States have implemented a program for rapid screening of x-rays before accessing the restricted area of the airport. This program consists in a process that performs risk assessments on passengers before they arrive at airport checkpoints to enhance aviation security. In addition, the process provides a better travel experience, benefiting millions of passengers. It is a component of TSA's intelligence-driven, risk-based approach to security used to provide the most effective security in the most efficient manner.

Nowadays in Brazil, there is no similar procedure. All passengers follow the same procedure at the inspection channel. The result causes long lines and significant waiting times to get through inspections.

IATA expects a recovery in the Brazilian market until 2024, reaching an even higher level than in 2019, the previous year pre-pandemic, shown in Figure 1.1.

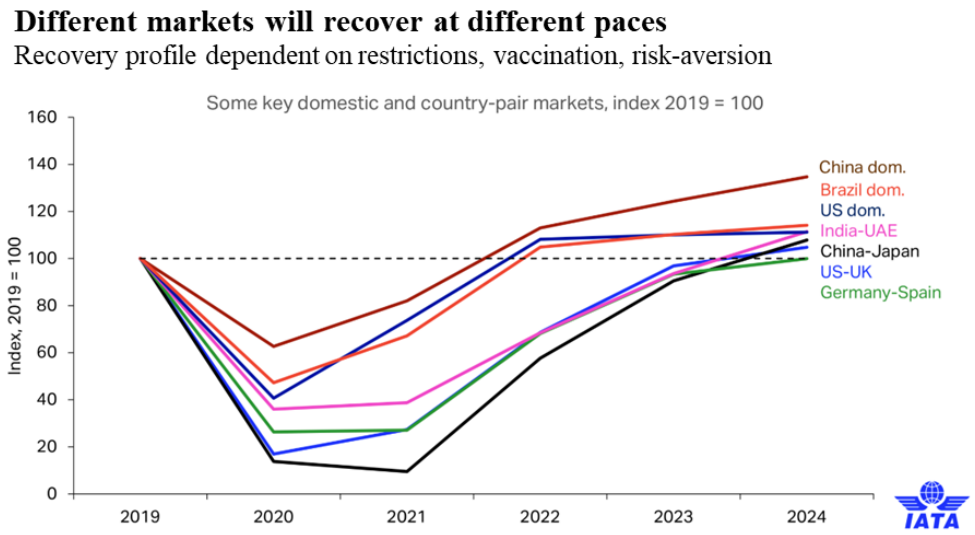

Figure 1.1. Market Recovery. IATA (2021).

According to Airbus, passenger traffic is expected to have a 3.6% CAGR from 2019 until 2041 showing a demand growth as well, as shown in Figure 1.2.

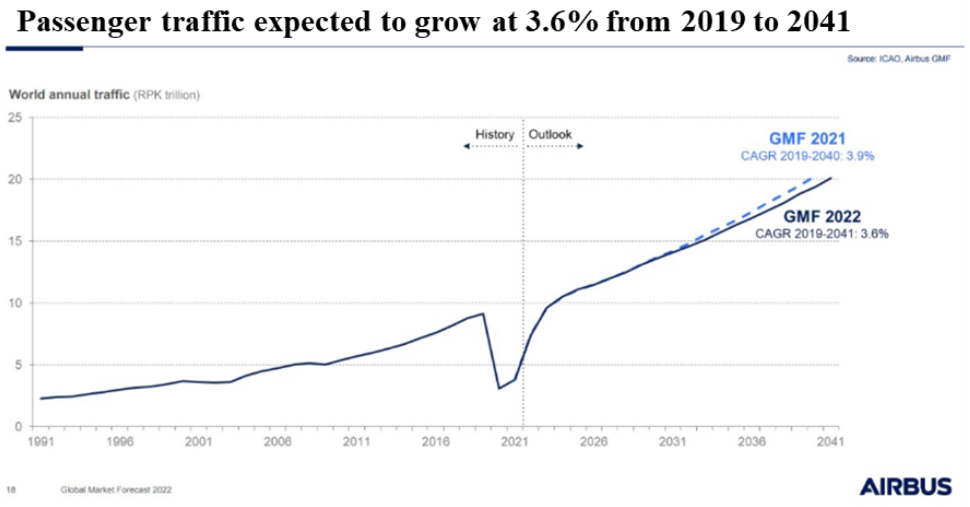

Figure 1.2. Growth in passenger traffic. AIRBUS (2022)

According to IATA Air Passenger Forecast, an 8% growth in the South American aviation market is expected in 2025 when compared with 2019, as shown in Figure 1.3.

Passenger numbers - share of 2019	2021	2022	2023	2024	2025
Industry-wide	47%	83%	94%	103%	111%
International	27%	69%	82%	92%	101%
Domestic	61%	93%	103%	111%	118%
Asia Pacific	40%	68%	84%	97%	109%
Europe	40%	86%	96%	105%	111%
North America	56%	94%	102%	107%	112%
Africa	46%	76%	85%	93%	101%
Middle East	42%	81%	90%	98%	105%
South America	51%	88%	97%	103%	108%
Central America	72%	96%	102%	109%	115%
Caribbean	44%	72%	82%	92%	101%

Figure 1.3. Air Passenger Forecast. IATA (2022)

Taking all these numbers into consideration, an increase in passenger demand in the coming years will probably lead to an even fuller airport. In order to best accommodate the passenger numbers increase at airports, a change in the inspection processes may be warranted.

Project Goals and Scope

The purpose of this study was to understand which changes should be made to implement Pre-Check processes in Brazil, and the benefits that this measure would bring. It is important to identify what would be the gains of this process in Brazilian airports

operations, once improved security at Brazilian airports is essential. In Brazil, only 0.5 of the population fly per year, so we believe that our research has shown that there is an opportunity to implement a Pre-Check process within the country in a less traumatic way for all stakeholders.

With that said, the main issues addressed throughout this study were the operational impacts of the proposed changes to security processes. Our research evaluated several regulatory guidelines as they related to passenger security at check-in stations. Another touchpoint that was very important for our journey is passenger satisfaction. The objective of implementing the measure will be to increase user satisfaction through greater security.

In this context, this study addressed the following research questions:

- Would there be benefits for Brazilian aviation in implementing a system similar to the TSA pre-check?
- Which changes could be made to implement Pre-Check processes in Brazil?
- What could be the customer satisfaction gains of this process?

This study created paths and encouraged the implementation of flexibility in Brazil regarding the x-ray safety procedure already practiced in developed countries and which are regulatory models to be followed by other countries. In this sense, it appears that the US is one of the strictest countries in terms of security, especially civil aviation security, and yet it has a pre-check TSA procedure, which makes security inspection more flexible. The replication of this flexibility procedure in Brazil benefits both passengers and airport administrators.

For passengers, especially frequent flyers, they can choose to hire the pre-check service, if they meet the requirements, to have a less rigid and therefore more agile x-ray inspection, increasing passenger satisfaction and improving their experience, especially at the busiest airports and at peak times.

For airport administrators, especially private administrators, who have quality indicators linked to the monitoring of the x-ray queue as a bonus or burden of their revenue. Therefore, easing the security requirements at the time of the x-ray will decrease the queue, providing a better score in the indicator referring to the security inspection queue. And the common benefit for the private (concessionaires) and public (Infraero) administrators will be the increase in grades in satisfaction surveys, given the increase in passenger satisfaction.

Definitions of Terms

AVSEC	Aviation Security – Aviation Security means safeguarding civil aviation against acts of unlawful interference (ANAC, 2018).
CAGR	Compound Annual Growth Rate (the mean annual growth rate over a specified period of time)
TMF	Tempo Médio de Fila (Queue Average Time).

List of Acronyms

ACI	Airports Council International
ANAC	Agência Nacional de Aviação Civil (National Agency of Civil Aviation).

APAC	Agente de Proteção da Aviação Civil (Civil Aviation Protection Agent).
BR	Brazil
CGH	Congonhas Airport
GIG	Tom Jobim International Airport - Galeão
GRU	Guarulhos International Airport
GYN	Goiania International Airport – Santa Genoveva
IATA	International Air Transportation Association
IBGE	Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics)
RBAC	Regulamentos Brasileiros da Aviação Civil (Brazilian Regulation of Civil Aviation)
SDU	Santos Dumont Airport
TSA	Transportation Security Administration
USA	United States of America

Plan of Study

Since the US currently employs these Pre-Check security methods, the research took into account the potential effects of the procedures and even benchmarked with the U.S. numbers. The goal was to examine the following analysis chapter by chapter in order to reach conclusions:

- Chapter Two: A literature review on TSA processes and their application.
- Chapter Three: Research methodology to compare the spent time on the

actual processes and the proposed processes with simulation measurements.

- Chapter Four: This study cover results for the time saving for passengers and the reduction of queue time at the airport.
- Chapter Five: Our research makes specific recommendations involving the possible use of the Pre-Check processes at the Goiania airport.

Chapter II

Review of the Relevant Literature

Overview of the Aviation Industry

The aviation industry is always growing, and the airport's infrastructure has been always a focus for future demands. According to IATA (2022), we will achieve an even higher passenger number in 2025 than the number we had before the pandemic in 2019. With that being said, the aviation industry will face more challenges in the future. Also, according to IATA, one of the many concerns is the security inspection and how to make it simultaneously agile and safe.

According to ANAC (2017), the estimated average queue time for inspection security for the largest Brazilian airports is 10 minutes at Guarulhos Airport (GRU), 28 minutes at Congonhas Airport (CGH), 15 minutes at Santos Dumont Airport (SDU), and 6 minutes in Galeão Airport (GIG) - considering only the peak time of the airports analyzed. The following ANAC recommendations must be followed to get the best passenger transition results:

- It is necessary that passengers arrive at airports two hours in advance
- When in the inspection queues, they need to remove belts and other metallic objects in advance before passing through the X-rays.
- A portable computer (notebook) must be placed in a separate tray.

In this sense, it is important to point out that the time spent in queues for security inspection has been an object of complaint from passengers in Brazil, especially after the change in the regulation in 2016, which increased the rigor in the inspection requiring

that hand luggage be inspected, as can be seen in the excerpts highlighted in the reports listed below:

"Passengers at Congonhas Airport, in the South Zone of São Paulo, faced long lines on Monday morning (18) after changes that made inspections stricter at all Brazilian airports. (…) In the morning, passengers waited an average of one hour to undergo the x-ray and one passenger told Bom Dia São Paulo that he missed his flight even though he arrived an hour and a half before boarding." (Paulo, 2016)

"New procedures cause queues at airports across the country" (Novos Procedimentos Causam Filas Em Aeroportos de Todo O País, n.d.)

"Passengers "suffer" with queues in the X-ray area of São Luís airport" (Passageiros "Sofrem" Com Filas Na Área Do Raio X Do Aeroporto de São Luís, 2019)

Therefore, it was important to search for new practices that can help reduce the average queue time for security inspection. This is imperative as most airports do not have physical spaces to increase their X-ray equipment. Initiatives in this regard can bring benefits to airport administrators who do not need to think about increasing their inspection security. The concept was to provide a different security service for passengers that do not want to spend time in line. This saves time for their passengers.

Applicable Legislation

To address this issue, it is important to keep in mind that current legislation has requirements on x-ray inspection procedures to access the restricted area of the airport, as provided in the topics below.

ICAO Annex 17 – Security

ICAO Annex 17 is a document part of the convention of the International Civil Aviation. In simple words, it defines general guidelines and procedures for the states in order to implement their local civil aviation security plan. These guidelines refer to airport operations, aircraft operations, and air traffic operations. There is a mention of quality control and qualification standards for the security guidelines provided and also preventive security measures on several occasions.

Referring to airport operators' security standards, this document establishes that the state should ensure that the airport operator is responsible for establishing, implementing, and maintaining a written airport security program. This document must meet all the requirements of the national civil aviation security program, which in Brazil is PNAVSEC. Annex 17 also establishes that the airport must establish an airport security committee to assist the local security authority to coordinate and implement the security controls according to the civil aviation security program. It also defines that the state must also ensure that the airport meets all design and architectural requirements necessary to implement the security measures defined by the security program already mentioned.

The document also defines measures related to access control, one of the most delicate security topics. It defines that the state is responsible to ensure that access to airside areas at airports must be controlled, either for people or vehicles. It establishes that screening methods must be capable of detecting explosives and explosive devices carried by anyone accessing the airside area or in their cabin baggage.

In general words, ICAO Annex 17 is a document to be used as a reference for all national civil aviation programs defined by the states. It gives a wide variety of security

instructions to be followed when producing the security program.

Brazilian legislation

In Brazil, the legislation that regulates airport security inspection is Decree No. 7.168/2010, which established the national civil aviation security program against acts of unlawful interference.

The Decree was prepared following the guidelines and internal rules of some international acts such as (i) Annex 9 of the Chicago Convention (1944), (ii) Annex 17 of the Chicago Convention (1944), (iii) Annex 18 of the Convention from Chicago (1944), (iv) Document 8973 - Safety Manual for the Protection of Civil Aviation against Acts of Unlawful Interference, prepared by ICAO; and (v) Document 9807 - Reference Manual for Civil Aviation Security Auditing, prepared by ICAO.

The aforementioned decree defines what is civil aviation security inspection, as the application of technical or other means, with the objective of identifying and detecting weapons, explosives, or other dangerous articles that could be used to commit an act of unlawful interference. (Decree No. 7.168 / 2010, s.d.)

In addition, the Decree also defines the roles and responsibilities of each stakeholder, deals with the security control of people and objects shipped at the airport, and differentiated inspection procedures, in short, everything related to the control of acts of illicit interference by aviation civilians at the airport.

Moreover, the Decree also establishes that passengers and their hand luggage must be inspected before accessing the aircraft or the ARS, according to ANAC normative acts (article 110), that is, the Brazilian Regulatory Agency is responsible for issuing acts

specific regulations to carry out inspection of passengers and their luggage, before passing through the restricted access of the airport.

During the studies of this work, Decree No. 7,168, of May 5, 2010, was replaced by Decree No. 11,195, of September 8, 2022, which aimed to incorporate the practices recommended by the International Civil Aviation Organization (ICAO).

The decree brings several innovations such as definitions and safety guidelines against acts of unlawful interference, especially related to public or airport areas whose access is not controlled. (New National Civil Aviation Security Program Against Acts of Unlawful Interference is Published - Novo Programa Nacional de Segurança Da Aviação Civil Contra Atos de Interferência Ilícita é Publicado, n.d.)

In addition to the rules to harmonize the regulations with the new international parameters, adjustments were also made with a view to reducing procedural details and synthesizing them into guidelines. With this, it is sought to leave its details to the responsible bodies, which will be able to more easily keep their routines updated with the development of the technology used. Another relevant update is the inclusion of behavioral analysis in aviation safety procedures.

Even the new wording of article 109 opens the way for the implementation of the model studied in this work in Brazil, since it makes the regulation more flexible, stating that the safety inspection can be replaced by other safety measures, based on risk assessment, regulated in normative acts of ANAC:

> *Art. 109. Before joining the ARS, all persons will undergo a security inspection, in accordance with the PNAVSEC.*

§ 1 The security inspection may be replaced by other security measures, based on risk assessment, regulated in ANAC normative acts.

See that this measure is part of one of the recommendations of this work, which will be the implementation, by ANAC, of regulatory legislation that makes the service studied compatible with Brazilian standards. Therefore, the legislative change mentioned above came at a good time, corroborating the proposal of the present study, that the solution of this work makes sense, that very soon it will be implemented in Brazil, and that it will be beneficial to all aviation players, both airport administrators, passengers, and airlines.

In this sense, article 8, item XI, of the ANAC Creation Law (Law No. 11,182/2005 n.d.) establishes the Agency's competence to also issue rules on security in the airport area.

Therefore, it is on this legal basis that RBAC 107 and IS 107 were issued, which brings more specifics about the safety inspection discussed in this study.

ANAC's Security Inspection Definition

The Brazilian Regulatory Agency was created to regulate and supervise civil aviation activities, as well as the aeronautical and airport infrastructure. In addition, the Agency acts to promote civil aviation safety and security.

According to ANAC (2019), safety inspection at airports is a standard procedure and is used by several countries around the world. The basic guidelines for that can be found in the International Civil Aviation Organization (ICAO), through Annex 17 of its Convention, of which Brazil is a signatory.

RBAC 107 (RBAC 107 EMD 07 — Agência Nacional de Aviação Civil ANAC, n.d). and IS 107 (Origem: SIA INSTRUÇÃO SUPLEMENTAR -IS, n.d.) describes the

inspection procedures at boarding entry and specifies the guidelines for each audience.

RBAC 107, Subpart A, item 107.9, defines 4 airports' categories, considering the type of service provided and amount of passengers/years.

1) Class AP-0: Only General Aviation, Executive Flights, and Charter Flights.

(2) Classe AP-1: Aerodromes with regular commercial flights or charter flights and less than 600.000 passengers in the last 3 years.

(3) Classe AP-2: Aerodromes with regular commercial flights or charter flights, 600.000 + and less than 5.000.000 passengers in the last 3 years.

(4) Classe AP-3: Aerodromes with regular commercial flights or charter flights and more than 5.000.000 passengers in the last 3 years

Table 2.1 below shows the 4 different airport security categories and the requirements for each one of them (RBAC 107, Subpart E).

Table 2.1 - Airport Security Categories and Requirements

Section	Description	Aerodromes			
		Class AP-0	Class AP-1	Class AP-2	Class AP-3
SECURITY CONTROL FOR PASSENGERS					
107.121	Passengers and personal belongings inspection	Not required	Required for aerodromes with 30+ seats aircrafts flights. Recommended for the others.	Required	Required
107.123	Passengers and personal belongings inspection	Not required	Required for aerodromes with 30+ seats aircrafts flights. Recommended for the others.	Required	Required
107.125	Connecting Passengers and Passengers in Transit	Not required	Required for aerodromes with 30+ seats aircrafts flights. Recommended for the others.	Required	Required
107.127	Passenger carrying a weapon	Not required	Required	Required	Required
107.129	Passenger in custody	Not required	Required	Required	Required
107.131	Unruly Passenger	Not required	Required for aerodromes with 30+ seats aircrafts flights. Recommended for the others.	Required	Required

Note. (RBAC 107, Subpart E, items 107.121-107.131).

The study intention was to implement a Pre-Check procedure in medium and large Airports AP-2 and AP-3, therefore, in compliance with the current regulation. Goiania Airport was chosen for the trials and simulations**.**

IS 107, Annex 4, shows the alternatives for the inspection model's configuration. Table 2.2 shows the alternatives for the inspection model's configuration. It is an example of how can we adapt the Pre-Check process with shorten staff.

Table 2.2 - Inspection Model's Configuration

	Anternative 01	Anternative 02	Anternative 03	Anternative 04	Anternative 05
Applicability	PAX INT PAX DOM	PAX INT PAX DOM	PAX INT PAX DOM	PAX INT PAX DOM	PAX INT PAX DOM
MINIMUM REQUIRED EQUIPMENT					
Body Scanner	1	-	-	-	-
Body Scanner or Metal Detection Portal	-	1	1	2	1
Portable Metal Detector	1	1	1	1	1
Baggage X-ray scanner	1	1	2	1	1
ETD (Explosive Trace Detector)	See item F.27.17	See item F.27.17	See item F.27.17	See item F.27.17	-
MINIMUM REQUIRED STAFF					
APAC - Function I	1	1	2	1	1
APAC or Security Guard - Function I	-	-	-	-	-
APAC - Function II	1	1	1	2	-
APAC - Function III	1	1	2	1	-
APAC - Function I, II and III	-	-	-	-	-
APAC - Function II and III	-	-	-	-	-
APAC - Function IV	1	1	2	1	1
APAC - Function V	See item F.27.17	See item F.27.17	See item F.27.17	See item F.27.17	See item F.27.17
APAC - Function VI	one for every 2 modules	one for every 2 modules	one for every 2 modules	one for every 2 modules	one for every 2 modules
APAC - Function VI (accumulating other functions)	-	-	-	-	-

Note. (IS 107, ANNEX 4, pages 141-144)

Concession Contract - Private Concessionaires

As of 2012, the Federal Government of Brazil began auctioning Brazilian airports, which until then were fully managed by a public company. Currently, more than

40 airports have already been concessioned to the private sector, and the 7th concession round was finished. (Estudos E Documents - 7th Round, n.d.).

At each Concession round, there is a Contract established between ANAC and the Concessionaire in order to establish the rights and duties of each of the parties, as well as the Concession guidelines.

In this sense, one of the established obligations refers to the quality of the provision of the service to the passenger. There are several quality indicators, one of which is the queue time in the security inspection channel. The contract establishes a standard for queues of up to 5 minutes and queues of up to 15 minutes, and failure to meet the established standard leads to millionaire fines. (02 Contract - PEA.pdf, n.d.).

Therefore, establishing procedures that will make the safety inspection faster, will help Concessionaires to reach the queue time standards established in the Concession Contracts.

In addition to the quality of service bias, the Contract brings minimum standards for sizing inspection channels based on m2 per passenger, which is why any change in procedure in relation to security inspection must be evaluated, so that it is possible to analyze the impacts of costs for implementing the change.

The Object of Study - US Procedure

Analyzing the airports in the United States, it was verified that there is a service offered to passengers in order to simplify the security requirements in the x-ray inspection.

TSA Security Screening

The Transportation Security Administration (TSA) incorporates unpredictable security measures, both seen and unseen, to accomplish our transportation security mission. (TSA website)

Security measures begin long before you arrive at the airport. TSA works closely with the intelligence and law enforcement communities to share information. Additionally, security measures are in place from the time you get to the airport until you get to your destination.

TSA adjusts processes and procedures to meet the evolving threat and to achieve the highest levels of transportation security." (TSA website)

TSA Pre-Check

TSA Pre-Check is a U.S. Government program that expedites the screening process for low-risk passengers.

With dedicated lanes, the program assures 5 minutes or less on queues.

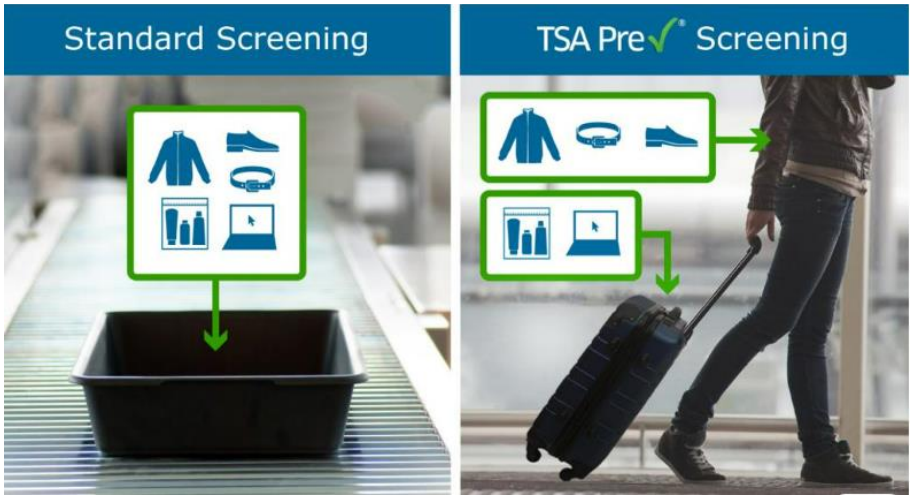

Figure 2.1. Pre-Check items Passengers don't have to remove. TSA (2022).

Summary

ANAC, as with the TSA, has specific procedures for the security checkpoints and the screening process. The regulation in the U.S. provides precedent to implement a similar solution as TSA Pre-Check at Brazilian Airports while keeping most of the existing Brazilian security regulation policies.

As described in this chapter, ANAC has all the capacity in terms of rules and applicability to make Brazil's airports a reference in aviation security and always with the aim of improving not only security but also the passenger experience, thus achieving a superior quality of service by airport administrators, especially those being granted to private companies.

The group proposal was to study the applicability of greater security and passenger experience at Class AP-2 and Class AP-3 airports according to table 2.1 and based on the existing regulation by ANAC and also a comparison with international regulations where the theme is already more mature than in Brazil.

Chapter III

Methodology

The objective of the study was to identify the feasibility of using a security system similar to TSA Pre-Check at airports in Brazil. Which we highlight below:

Our study explored the following issues:

1) What changes could be made to implement Pre-Check processes in Brazil?

2) What could be the financial and customer satisfaction gains from this process?

The study is based on the TSA pre-verification process in the United States, which was used as a model. In order to analyze the answers to these questions, an interview with the TSA Authority was conducted and several pieces of information were collected. This study focused on answering the questions brought up in Chapter I about the possible creation of a rapid screening process thus we divided the study into three sections:

- TSA data collection,
- Measurement of the current standard inspection times at GYN Airport
- Simulate controlled Pre-Check inspections at GYN Airport
- Simulate in the Arena program the standard and the Pre-Check Lane times
- Results

The division was done this way to ensure that all stakeholders were analyzed, and all variables were considered.

The Literature Review done in Chapter II helped us to better understand all the recommendations regarding Airport Security from the international organizations that regulate the aviation industry. The research took into consideration that in Brazil there is

a different requirement for the acceptance of liquids on domestic flights. In addition, there is no requirement for the removal of shoes.

The research identified ways to synchronize the controls of the security agencies with the data that the airlines have of the passengers. This would allow any of these stakeholders to have prior information about the passengers, bringing greater credibility and security in the process.

We sought with the Brazilian aviation authority the requirements for the implementation of a possible improved security solution in Brazil. Considering the particularity of each airport in Brazil, we tried to understand if the proposed solution would make sense for all airports or only for those with larger numbers of passengers, or even at airports with frequent passengers.

To test the model, we proposed a security pre-verification experiment at GYN Airport with the Brazilian Aviation Authority, in order to measure the times and passenger satisfaction for such a solution.

TSA data collection

The research team gathered information and spoke with TSA officers to understand:

- Pre-Check registered passengers,
- Average waiting times in the Pre-check lanes
- Pre-Check Passengers' Satisfaction Indicator

Considering the U.S. current information, the research team projected the Pre-Check scenario in Brazil.

For our Arena simulation, we needed information about the percentage of passengers who use Pre-Check in the US reality, which we assume would be the same when we implement it in the Brazilian reality.

To calculate this parameter, we get some information:

- According to TSA, we had 585,3 million air trips taken in 2021.
- According to Gallup, a high-profile independent market research firm, adult air travelers took an average of 3.6 trips in 2021.
- According to TSA, they had 11 million travelers in Pre-check in the same period.

Considering that we had 585.3 million air trips, and each adult air traveler took an average of 3.5 trips, it is possible to deduce, when we divided air trips by the average trips per person, that we had 162,58 million air travelers as an estimated number.

Therewith, as we had 11 million travelers in Pre-check and almost 162,6 million different air travelers, we get that approximately 6.8% of American air travelers are in Pre-check. And from now on we will use the same rate for Brazilian travelers.

Measurement of the current standard inspection times at GYN Airport

The research team went to GYN Airport and measured the inspection times of the passengers in the standard lane. We observed 402 passengers during the inspection, analyzing the process and the necessity of removing laptops, liquids, belts, shoes, and jackets, and how that impacts the screening process.

According to ANAC, Goiania airport embarked on approximately 174 thousand passengers in July 2022, a median of 5611 passengers per day. Already disregarding the connections passengers.

The first step is to determine the sample size to ensure that the sample represents the entire population. As a parameter, we defined a 95% of confidence level and a 5% of confidence interval (margin of error). The number of embarked passengers is our population size to determine the sample size necessary to go on the study.

According to Geopoll, "the confidence intervals measure the degree of uncertainty or certainty in a sampling method and how much uncertainty there is with any particular statistic. And the confidence level refers to the percentage of probability, or certainty that the confidence interval would contain the true population parameter when you draw a random sample many times."

The calculation formula is as follows:

$$\frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where: N is the population size, e is the margin of error and z is the score z. According to Statistics How To, the score z is a measure of how many standard deviations below or above the population mean a raw score is.

With that, it was determined that we need 384 samples to ensure a study with a 95% of confidence level and a 5% of margin of error.

We collect 402 samples during the period 17th September until 30th September, and we capture the following information:

- Did the passenger need to take out any items?
- Which items? (Notebook, Shoes, Belt, Watch, Liquid, Jewelry, Pocket items, Coat, Cell Phone)

- Did the passenger undergo any random inspection?
- How long did the X-ray process take?

To measure the time that the X-Ray process lasted, the time from the passenger's arrival at the X-Ray roller until he collected all his items and left the X-Ray was calculated.

Simulate controlled Pre-Check inspections at GYN Airport

Considering the TSA numbers, regarding the Pre-Check process, we already knew that around 95% of the Pre-Check passengers wait less than 5 minutes. Therefore, we needed to understand if a similar solution would have the same impact in Brazil, we decided to simulate the Pre-Check process at GYN Airport.

The research team gathered volunteers, and using the airport infrastructure, we simulate Pre-Check inspections using the same benefits to observe if the screening times would be the same as in the U.S. Airports. 59 samples of the simulated process were collected without the need to remove the items validated by the Pre-Check.

Simulate in the Arena Program the standard and the Pre-Check queue times

We used the Arena Program to predict the waiting times for the standard and the Pre-check queues, guaranteeing that the standard queue wouldn’t be impacted and that the Pre-check queue would be more efficient. Considering the measurements done in the previous paragraphs, it was necessary to assume a parameter on the passenger presentation curve at the X-ray since we do not have this information.

Table 3.1 - Passenger presentation curve on x-ray

Time before the departure time				
01:00	01:30	02:00	02:30	03:00
20%	25%	20%	15%	20%

Note. (parameter assumed by the group)

We chose to study the worst day at Goiania Airport, where we had a higher volume of take-offs from July 2022. On 21st July we had almost eight thousand embarked passengers, according to ANAC information. Considering the presentation curve defined, we had approximately the following volume of passengers every 30 minutes.

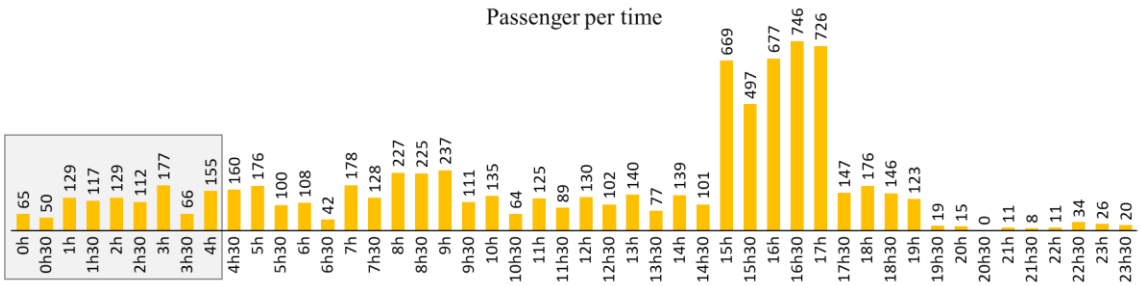

Figure 3.1. Estimated passengers per time at Goiania Airport x-ray – 21st July 2022.

Due to Arena limitations, it was necessary to study just a small piece of Goiania airport. It was considered the first 4.5 hours of the day. If we considered the peak time, that has more than 4 times than the period studied, it is possible to deduce that the queue time would be even bigger.

With all this data, we were able to proceed to the simulation of each scenario:

a) Actual Model

The actual model considers the sample collected at Goiania airport, 4 x-rays, and the division of passenger into 4 groups: those who do not have any item to get out, who just have 1 item, 2 items, and who has 3 or more items. In the diagram below it is possible to see how the process was designed. Basically, we divided the passengers into each group according to the distribution collected in the sample.

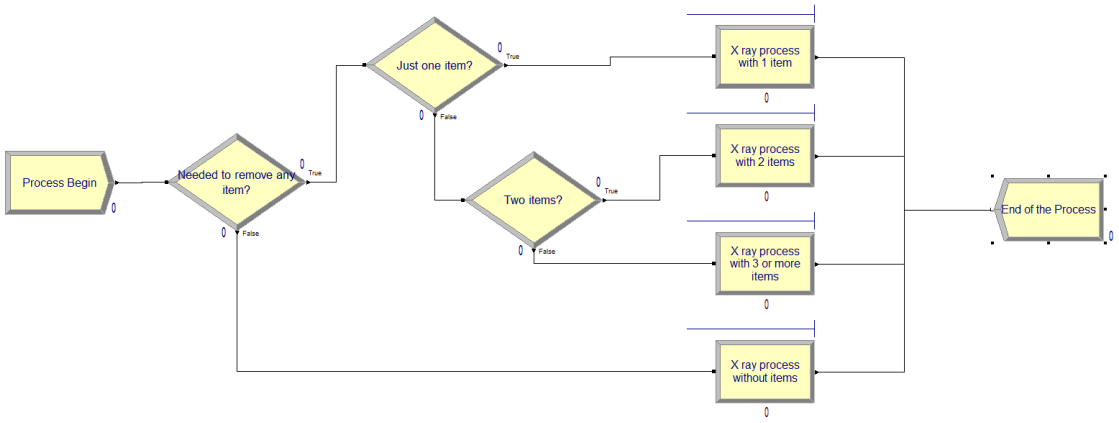

Figure 3.2. Arena Model considering the actual process.

We measured the time by the normal delay type which uses the average of each group and its standard deviation. All measurements are considered in seconds. By measuring the sample, it is possible to observe that the more items, the longer the processing time. The following parameters can be seen:

Process - Basic Process

	Name	Type	Action	Priority	Resources	Delay Type	Units	Allocation	Value	Std Dev	Report Statistics
1	X ray process without items	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	47.3	26.2	☑
2	X ray process with 1 item	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	63.2	26.4	☑
3	X ray process with 3 or more items	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	89	34.5	☑
4	X ray process with 2 items	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	69.6	34.3	☑

Figure 3.3. Arena parameters considering the actual process during times.

The passenger's division in each group was defined by the percentage collected on the sample as shown below:

Decide - Basic Process

	Name	Type	Percent True
1	Needed to remove any item?	2-way by Chance	81.7
2	Just one item?	2-way by Chance	34.3
3	Two items?	2-way by Chance	69.5

Figure 3.4. Arena parameters considering the actual process probability of each line type.

Lastly, regarding the resources allocated we had 4 X-rays available at Goiania airport.

Resource - Basic Process

	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
1	X ray	Fixed Capacity	4	0.0	0.0	0.0		0 rows	☑

Figure 3.5. Arena parameters considering the number of x-rays.

b) Simulation Model

The simulation model considers the same parameters as the actual model with an addiction of a question that divided the passengers into two groups: who has the TSA Pre-check and will use an exclusive line and who does not have and will go to the normal line. In the diagram below it is possible to see how the process was designed. Basically, we divided the passengers into two groups before the current process happens.

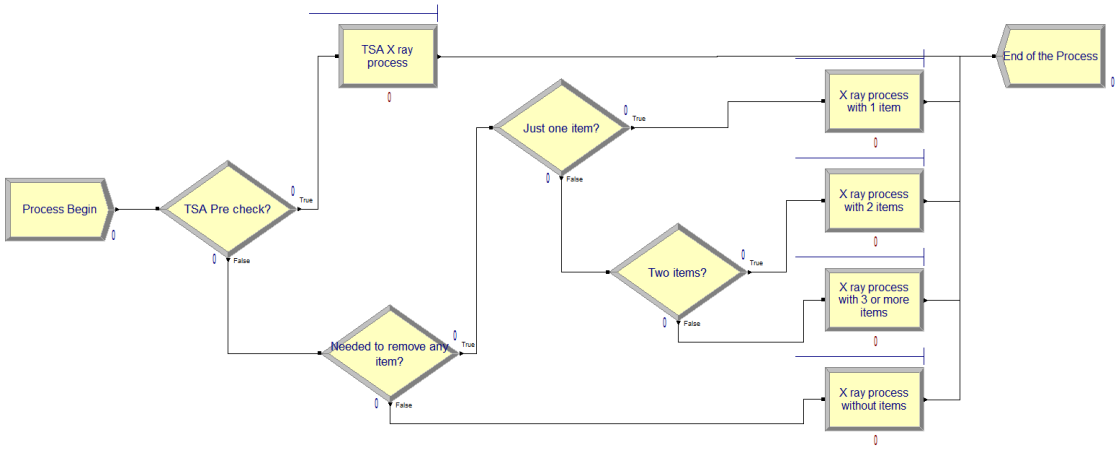

Figure 3.6. Arena Model considering the simulated process.

We still measured the time by the normal delay type which uses the average of each group and its standard deviation. All measurements are considered in seconds. By measuring the sample, it is possible to observe that the more items, the longer the processing time. And passengers that have TSA Pre-check can execute the process with much less time. The following parameters can be seen:

Process - Basic Process

	Name	Type	Action	Priority	Resources	Delay Type	Units	Allocation	Value	Std Dev	Report Statistics
1	X ray process without items	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	47.3	26.2	☑
2	X ray process with 1 item	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	63.2	26.4	☑
3	X ray process with 3 or more items	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	89	34.5	☑
4	X ray process with 2 items	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	69.6	34.3	☑
5	TSA X ray process	Standard	Seize Delay Release	Medium(2)	1 rows	Normal	Seconds	Value Added	16.7	5.1	☑

Figure 3.7. Arena parameters considering the simulated process during times.

The passenger's division in each group was defined by the percentage collected on the sample and the percentage of TSA Pre-check was defined on "TSA data collection" in this same chapter, as shown below:

Decide - Basic Process

	Name	Type	Percent True
1	Needed to remove any item?	2-way by Chance	81.7
2	Just one item?	2-way by Chance	34.3
3	Two items?	2-way by Chance	69.5
4	TSA Pre check?	2-way by Chance	6.8

Figure 3.8. Arena parameters considering the simulated process probability of each line type.

Lastly, for the resources allocated we had 4 X-rays available at Goiania airport which will be used for non-TSA Pre-check clients, and 1 exclusive for TSA Pre-check clients.

Resource - Basic Process

	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
1	X ray	Fixed Capacity	4	0.0	0.0	0.0		0 rows	☑
2	TSA X ray	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑

Figure 3.9. Arena parameters considering the number of x-rays.

Results

The findings of the data collection, measurements, and simulations gave us the necessary material to proceed with the recommendations and conclusions in the following chapters.

From the sample analyzed, it was possible to observe some behaviors of the public analyzed, as shown:

- 82.8% of the passengers need to remove any item to pass the x-ray as shown in graph 1.
- 6.5% of the passengers need to go to a random inspection as shown in graph 2.
- The most frequent items between the passengers are:
    - Notebook: 61.2% of the passengers have a notebook in the sample analyzed

- Cell Phone: 26.4% of the passengers needed to get out their cell phones from their pockets.
- Belt: 21.6% of the passengers were using a belt and were obligated to take it off to pass into the x-ray.
- Other items were observed, but with less representation, such as shoes, watches, pocket items (wallet, keys, and coins), liquids, coats, and jewelry.

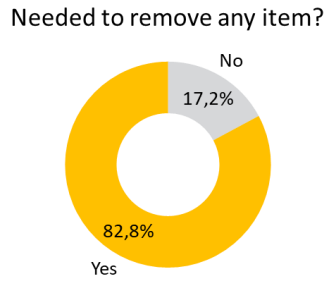

Figure 3.10. Division of passengers who had the need to remove an item.

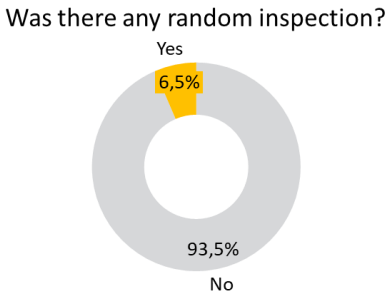

Figure 3.11. Division of passengers who had the random inspection.

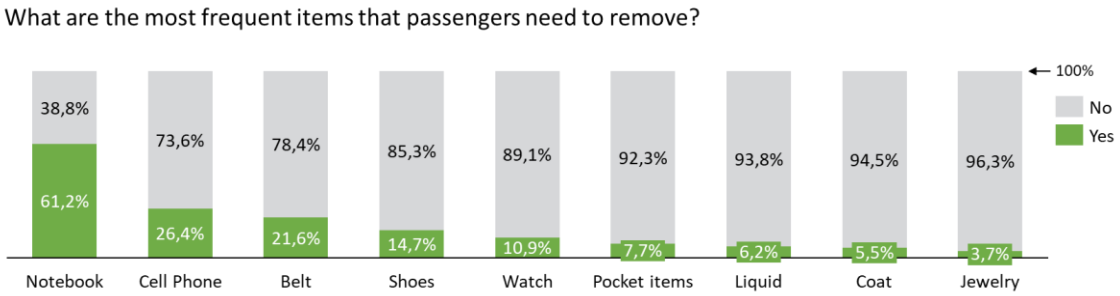

Figure 3.12. Items that are removed most often during the x-ray process.

Analyzing the time results of this sample, we have the following numbers (in seconds), considering all scenarios:

Table 3.2 – Time measures of the actual process

Measure	Time (seconds)
Average	79
Q1	43
Median	64
Q3	92
Max	517
Standard Deviation	64

Note. (analysis from samples collected in loco)

Observing that the maximum number is far from the results obtained, a normalization of the sampling was necessary to remove the outliers that could bias our result. The interquartile range (IQR) method was used.

According to Towards data science, the interquartile range (IQR) method is:

1. Find the first quartile, Q1.
2. Find the third quartile, Q3.
3. Calculate the IQR. IQR= Q3-Q1.

4. Define the normal data range with a lower limit as Q1–1.5*IQR and an upper limit as Q3+1.5*IQR.
5. Any data point outside this range is considered an outlier and should be removed for further analysis.

We applied the IQR method and obtained the following results which mean that we need to remove any result that is upper than 165.5 seconds.

Table 3.3 - Statistical study to define outliers

IQR	49
Lower Limit	-30,5
Upper Limit	165,5

Note. (analysis from samples collected in loco)

With the removal of outliers, we have a more homogeneous database, obtaining the following result when analyzing the complete sample:

Table 3.4 - Time measures of the actual process without outliers

	Time (seconds)
Average	66,9
Q1	41,3
Median	62,0
Q3	87,0
Max	165,0
Standard Deviation	33,2

Note. (analysis from samples collected in loco)

Considering the distribution by the number of items that the passenger had to take:

Table 3.5 - Time measures of the actual process without outliers per number of items

Time (seconds)	0	1	2	3+
Average	47,3	63,2	69,6	89,0
Q1	32,0	43,0	47,0	57,3
Median	40,0	61,0	71,0	90,5
Q3	53,0	73,8	88,0	109,0
Max	156,0	157,0	165,0	154,0
Standard Deviation	26,2	26,4	34,3	34,5

Note. (analysis from samples collected in loco)

With the graph below, it is possible to observe that most passengers carry at least two items that need to be removed at the time of passing through the x-ray.

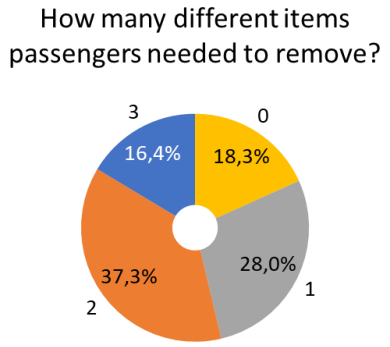

Figure 3.13. How many different items, on average, does each passenger need to remove from their belongings.

In the following graphs, it is possible to observe that the mean and median increase with the increase of items to be removed from their luggage/pockets.

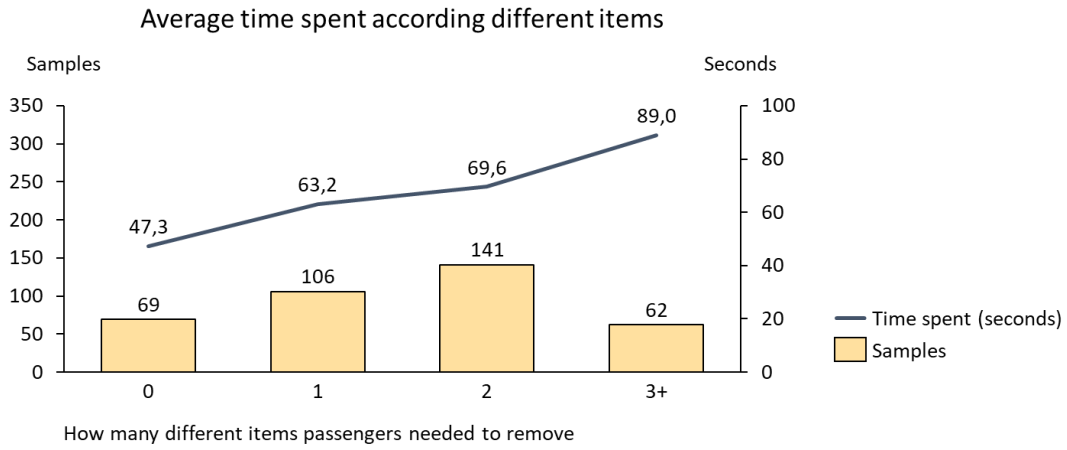

Figure 3.14. Average time spent according to the number of different items carried.

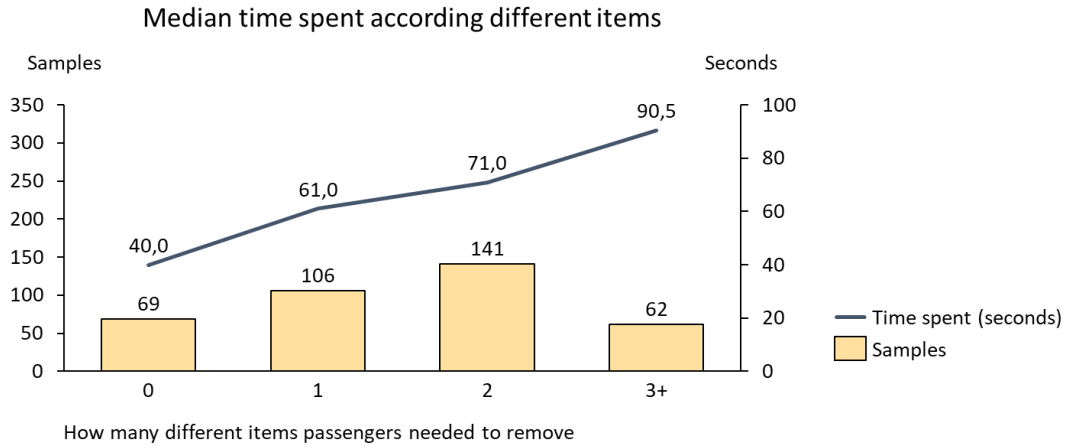

Figure 3.15. The median time spent according to the number of different items carried.

On the simulation results, we had 988 passengers at the beginning of the process and concluded with 872 passengers, leaving 116 passengers still in line at the end of the 4.5-hour simulation.

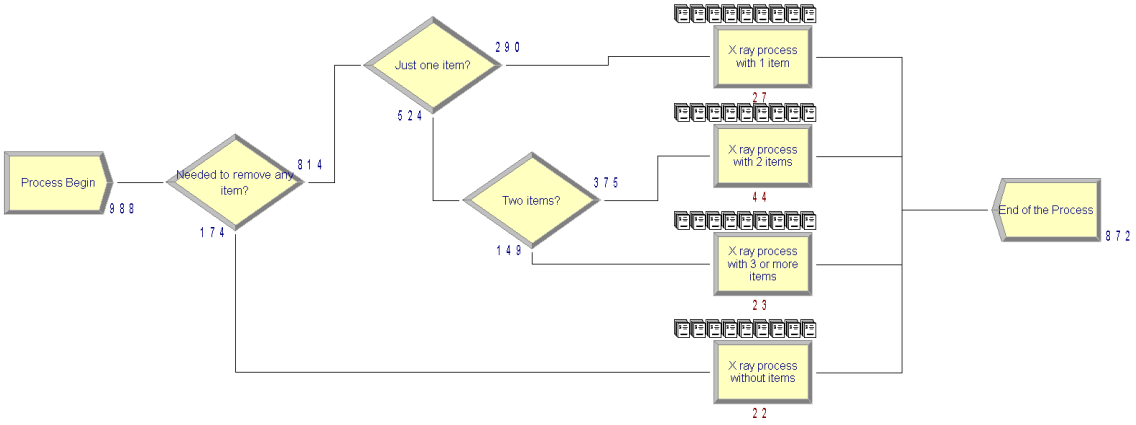

Figure 3.16. Arena model after the run with the actual process

From the simulation results, it's possible to see that the average wait time is 10.8595 minutes on the actual model - as can be seen in the report below.

21:46:04 **Category Overview** outubro 4, 2022

Actual Model

Replications: 1 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Value	Maximum Value
Pax	1.1005	0,026840014	0.00	2.8203

NVA Time	Average	Half Width	Minimum Value	Maximum Value
Pax	0.00	0,000000000	0.00	0.00

Wait Time	Average	Half Width	Minimum Value	Maximum Value
Pax	10.8595	(Correlated)	0.00	25.1416

Total Time	Average	Half Width	Minimum Value	Maximum Value
Pax	11.9600	(Correlated)	0.00	27.4531

Other

Number In	Value
Pax	988.00

Number Out	Value
Pax	872.00

WIP	Average	Half Width	Minimum Value	Maximum Value
Pax	43.7778	(Correlated)	0.00	123.00

Figure 3.17. Arena model times results with the actual process

Another important piece of information is that the 4 x-rays are used 89.11% of the time, as can be seen in the report below.

21:46:04 **Category Overview** outubro 4, 2022

Actual Model

Replications: 1 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
X ray process with 1 item.Queue	10.5511	(Insufficient)	0.00	25.1416
X ray process with 2 items.Queue	11.0862	(Correlated)	0.00	25.0523
X ray process with 3 or more items.Queue	10.5226	(Insufficient)	0.00	25.0634
X ray process without items.Queue	11.4509	(Insufficient)	0.00	25.0857

Other

Number Waiting	Average	Half Width	Minimum Value	Maximum Value
X ray process with 1 item.Queue	11.4907	(Correlated)	0.00	31.0000
X ray process with 2 items.Queue	15.3180	(Correlated)	0.00	44.0000
X ray process with 3 or more items.Queue	6.0829	(Insufficient)	0.00	26.0000
X ray process without items.Queue	7.3219	(Insufficient)	0.00	26.0000

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Value	Maximum Value
X ray	0.8911	(Insufficient)	0.00	1.0000

Number Busy	Average	Half Width	Minimum Value	Maximum Value
X ray	3.5643	(Insufficient)	0.00	4.0000

Number Scheduled	Average	Half Width	Minimum Value	Maximum Value
X ray	4.0000	(Insufficient)	4.0000	4.0000

Scheduled Utilization	Value
X ray	0.8911

Total Number Seized	Value
X ray	876.00

Figure 3.18. Arena model queue times result in the actual process

On the other side, we have the simulation model with the inclusion of TSA Pre-check.

Analyzing the time results of this sample, we have the following numbers (in seconds), considering the simulation scenarios:

Table 3.6 – Time measures of the actual process

	Time (seconds)
Average	16.7
Q1	13,3
Median	16,5
Q3	18,8
Max	39,0
Standard Deviation	5,1

Note. (analysis from samples collected in loco)

On the simulation results, we had 981 passengers at the beginning of the process and concluded with 909 passengers, leaving 72 passengers still in line at the end of the 4.5-hour simulation.

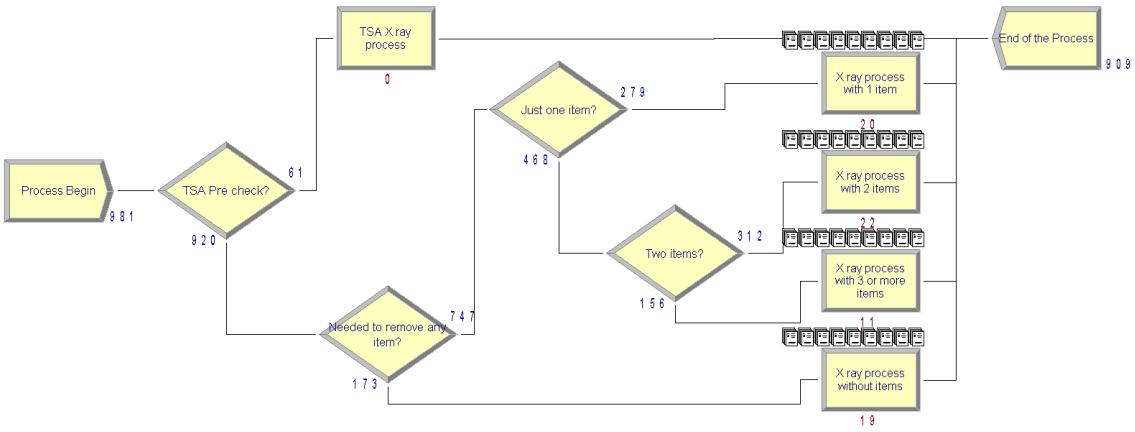

Figure 3.19. Arena model after the run with simulated process

From the simulation results, it's possible to see that the average wait time is 9.1641 minutes on the simulation model - as can be seen in the report below.

22:36:04 **Category Overview** outubro 4, 2022

Simulation Model

Replications: 1 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Value	Maximum Value
Pax	1.0463	0,041552766	0.00	3.1062

NVA Time	Average	Half Width	Minimum Value	Maximum Value
Pax	0.00	0,000000000	0.00	0.00

Wait Time	Average	Half Width	Minimum Value	Maximum Value
Pax	9.1641	(Correlated)	0.00	24.7117

Total Time	Average	Half Width	Minimum Value	Maximum Value
Pax	10.2104	(Correlated)	0.00	26.5277

Other

Number In	Value
Pax	981.00

Number Out	Value
Pax	909.00

WIP	Average	Half Width	Minimum Value	Maximum Value
Pax	36.1548	(Correlated)	0.00	86.0000

Figure 3.20. Arena model times results with simulated process

22:36:04 **Category Overview** outubro 4, 2022

Simulation Model

Replications: 1 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Value	Maximum Value
TSA X ray process.Queue	0.00361634	(Insufficient)	0.00	0.1271
X ray process with 1 item.Queue	9.7948	(Insufficient)	0.00	24.5813
X ray process with 2 items.Queue	10.0656	(Insufficient)	0.00	24.7117
X ray process with 3 or more items.Queue	9.6003	(Insufficient)	0.00	24.1383
X ray process without items.Queue	9.7320	(Insufficient)	0.00	24.3662

Other

Number Waiting	Average	Half Width	Minimum Value	Maximum Value
TSA X ray process.Queue	0.00081702	(Insufficient)	0.00	1.0000
X ray process with 1 item.Queue	9.8580	(Correlated)	0.00	30.0000
X ray process with 2 items.Queue	11.3664	(Correlated)	0.00	31.0000
X ray process with 3 or more items.Queue	5.4162	(Insufficient)	0.00	16.0000
X ray process without items.Queue	5.9807	(Insufficient)	0.00	18.0000

Figure 3.21. Arena model queue times results with simulated process

Another important piece of information is that the 4 x-rays are used 86.69% of the time, and the exclusive TSA Pre-check is used 0.06% of the time, as can be seen in the report below.

22:36:04 **Category Overview** outubro 4, 2022

Simulation Model

Replications: 1 Time Units: Minutes

Resource

Usage

Instantaneous Utilization	Average	Half Width	Minimum Value	Maximum Value
TSA X ray	0.06499929	(Insufficient)	0.00	1.0000
X ray	0.8669	(Insufficient)	0.00	1.0000

Number Busy	Average	Half Width	Minimum Value	Maximum Value
TSA X ray	0.06499929	(Insufficient)	0.00	1.0000
X ray	3.4676	(Insufficient)	0.00	4.0000

Number Scheduled	Average	Half Width	Minimum Value	Maximum Value
TSA X ray	1.0000	(Insufficient)	1.0000	1.0000
X ray	4.0000	(Insufficient)	4.0000	4.0000

Scheduled Utilization	Value
TSA X ray	0.06499929
X ray	0.8669

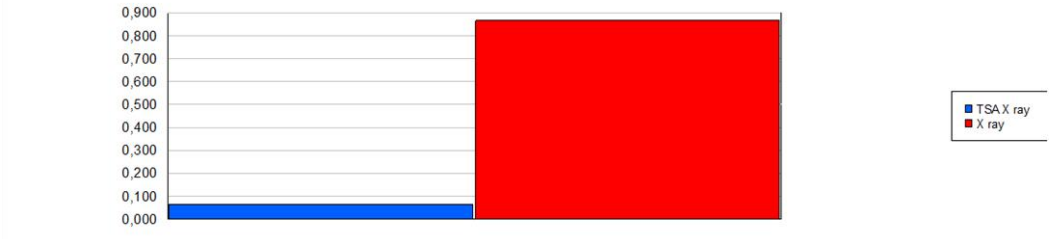

Figure 3.22. Arena model usage results with simulated process

When we compare the average time spent in the queue, we have a 15.6% reduction compared to the time spent currently, as we can see in the graph below.

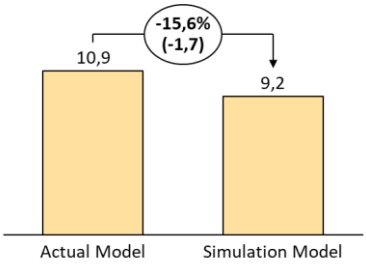

Figure 3.23. Queue time difference between both scenarios

Airports with a higher volume of passengers will be able to obtain even more significant gains. Recommendation for airports with more than 5 million passengers per year.

Chapter IV

Conclusion

To promote sustainable growth and meet the growing demand for air travel, our research study sought to identify the feasibility of using a security system, like TSA Pre-Check, at airports in Brazil. The focus was on enhancing safety, reducing the potential for risk, and improving efficiency through faster processes for passengers.

The research study's Conclusions are as follows:

- **Conclusion One: Improved Customer Experience at Brazilian Airports**
  - Data Gathering: We have collected samples of the passenger processes inspection channel at *Goiania Airport* and *Congonhas Airport*, based on the methodology described in Chapter 3. For this sample collection, we measured the time each passenger took to as soon as they arrived at the X-ray and until they got back everything (such as jackets, belts, shoes, etc.) and left the area.
  - Results: From the results of this collection, we noticed that most of the passengers take more than 67 seconds to go through the inspection channel. Depending on what they had to remove or if there was a manual inspection, the whole process can take up to 517 seconds. Taking into consideration the peak times for busy airports – like *Congonhas*, in São Paulo – it causes massive queues, A considerable queue can occur resulting in customer dissatisfaction with the whole process.

- Conclusion: As mentioned in Chapter Two, the x-ray inspection model adopted in Brazil causes long queues, especially at peak times is mostly responsible for the need for passengers to arrive at the airport well in advance of their flights. As per the results of the model proposed, acquiring a service that will optimize the time for the security inspection will have an impact not only on the passengers who use the service but also on the passengers who stay at the traditional inspection.
- **See Recommendation One in Chapter V.**

- **Conclusion Two: Improvement Security Screening of Passengers**
  - Data Gathering: It will allow law enforcement to know in greater depth the airport passengers who are part of the trusted traveler program. The third conclusion of this study was that the analyzed service implementation is going to allow the Brazilian security authorities to know travelers' criminal records.
  - Results: In Brazil, there is no current control of passenger identification on domestic flights, unlike international flights. When buying a domestic ticket, the passenger document is informed, but there is no prior verification. As there is a chance to have homonyms people, the security process may be endangered because it is not possible to say if the passenger trying to board is actually the right one.
  - Conclusion: As for the implementation of this study’s proposed service, a registration step should previously happen. The passenger would need to

register themselves and a criminal records analysis and investigation of other aspects should be done to mitigate the risk to airport security. It is understood that there will be a security improvement because the responsible authority will know in advance the lower-risk passengers passing through the airports. This will help them to save time and focus their attention on unevaluated passengers.

- **See recommendation two in Chapter V.**

- **Conclusion Three: Staffing Gains for the Airport Management Concessionaire: Compliance with the minimum queue time standards established by the Concession Agreement with ANAC and the possibility of savings in OPEX.**

  - Data Gathering: Based on the simulation carried out at Goiania airport already mentioned in the first conclusion, with the implementation of a service like the TSA Pre-Check, there will be a reduction in the passenger inspection time in the x-ray by 50.2 seconds.

    In addition, the Concession Contract signed by the airport administrator of Goiania (CCR Aeroportos) is observed and ANAC provides minimum parameters for airport sizing. As mentioned in chapter 2, the minimum parameter for the security inspection queue time at the airport of Goiania established in the concession contract (citation) is 10 minutes for domestic flights and 15 minutes for international flights. Currently, the Goiania Airport operates the security inspection channel with 4 Scanners and 3

Metal Detector Portals available at peak hours. Considering that one of them would be available exclusively for the pre-check TSA service and the other would be exclusively for priorities, and all of them are used at peak hours, at GYN we would need an extra module for Pre-Check implementation. Therefore, we wouldn't have savings at GYN.

Figure 4.1. Security Inspection Area at GYN Airport

- Results: Considering all the measurements and simulation, GYN has the potential to further reduce the queue time and the inspection time, however, having an exclusive Pre-check module would result in increasing staff and equipment.
- Conclusion: Therefore, the implementation of the pre-check TSA at the airport of Goiania has the potential to (i) reduce the queue time and inspection, there is no significant impact and the cost increase. On the other hand, Airports with more than 5 million passengers per year have different infrastructure and more equipment than GYN and the other AP-2 airports. They don't use all the modules, some of them, not even at peak

hours. Therefore, it is viable to implement the Pre-check in those airports and have OPEX savings. Considering that the minimum required staff at each inspection module is 3 Protection Agents and that the Pre-check passengers' inspection is less complex, we could use only 2 Agents, which will save R$ 28.000 per month, per airport.

- **See Recommendation Three in Chapter V.**

Conclusion Supporting Material

- **Conclusion One:** The passengers utilizing the Pre-Check method will shorten the traditional lines. For this reason, it is believed that there will be an increase in passenger satisfaction with the travel experience, by facilitating the process and bringing faster access to the aircraft.
- **Conclusion Two:** For the Pre-Check registration system the passenger would need to register themselves and a criminal records analysis and investigation of other aspects should be done to mitigate the risk to airport security. It is understood that there will be a security improvement because the responsible authority will know in advance the lower-risk passengers passing through the airports. This will help them to save time and focus their attention on unevaluated passengers.
- **Conclusion Three**: In addition, the Concession Contract signed by the airport administrator of Goiania (CCR Aeroportos) is observed and ANAC provides minimum parameters for airport sizing. As mentioned in chapter 2, the minimum parameter for the security inspection at the airport of Goiania established in the

concession contract (citation) is 10 minutes for domestic flights and 15 minutes for international flights. Currently, Goiania Airport operates the security inspection channel with 4 Scanners and 3 Metal Detector Portals available at peak hours. Considering that one of them would be available exclusively for the TSA pre-check service and the other would be exclusively a priority, at Goiânia airport, although there was an operational gain with the reduction of the queue, it would not be possible to demobilize one of the x-rays, which is why from which it is concluded that there would be no economy. However, as mentioned, there would be a gain for airports that transport more than 5 million passengers a year, classified as AP-3.

Chapter V

Recommendations

As demonstrated in the above study, the implementation of a service like the TSA pre-check, which already exists in the US, would bring benefits to several players involved in the dynamics of civil aviation in Brazil.

In view of the study carried out and the Conclusions presented in Chapter IV, the following are recommendations for the possible implementation of a service like the TSA pre-check in Brazil.

- **Recommendation 1: Customer satisfaction improvements by proving a faster inspection process by implementing a TSA Pre-Check style security system at all Brazilian airports.**
- **Recommendation 2: Using technology, implement a passenger data collection system to improve airport security.**
- **Recommendation 3: Staffing Gains for the Airport Management Concessionaire. For airports classified as AP-3, which transport more than 5 million passengers per year, the gain would be approximately R$ 28,000.00 per month or R$ 336,000.00 per year.**

Recommendations Supporting Material

Recommendation 1

An increase in NPS and other quantitative satisfaction statistics at the airport facility. According to the mentioned in conclusion one, the current method of inspection applied at Brazilian airports results in customer dissatisfaction. With that said, it is

noticeable that providing a faster and improved inspection methodology will result in a better customer experience. From the conclusion one standpoint, we make the following recommendations:

1. It is recommended that the pre-check service is implemented at airports AP3, that is, only for airports that transport more than 5 million passengers per year.
2. It is recommended to apply a qualitative survey to measure periodically customer perception after the service is in place.
3. It is recommended to continuously analyze the security parameters to ensure that the service is aligned with international standards.
4. Constant meetings with the police authorities in Brazil to fine-tune the type of service being provided

Recommendation 2

Brazil does not have a program that allows for the prior registration of passengers on domestic flights yet. This system will enable Brazilian security authorities to access information and know the profile of airport passengers. Following the example of the USA, which already has the TSA Precheck, the proposed system can bring more efficiency in security control, since it will dedicate an exclusive queue to passengers in the program and will also allow the Federal Police to have prior access to the information and communicate with the airlines in case of any need.

Recommendation 3

Considering that Pre-Check inspection is less complex than the standard, we recommend that ANAC's Supplementary Instruction 107 should be changed to consider 2 Protection Agents at the Pre-Check channel. It would represent R$ 28.000 savings per month, per airport. Compliance with the minimum staffing standards established by the Concession Agreement with ANAC and the possibility of savings in OPEX.

As mentioned in Conclusion 3, the operational gains in the inspection channel with the implementation of a service like the pre-check TSA would allow greater adherence to the parameters established in the Concession Agreement for maximum queue times, as well as a reduction in cost with staffing as it would be possible to provide a smaller number of inspection channels. In view of Conclusion 3, the following recommendations are:

- It is recommended to implement the service at Airports AP3, that is, only for airports that transport more than 5 mm passengers per year, considering the size of the airport security inspection infrastructure.
- It is recommended to continue the study to analyze the costs involved and potential revenue to enable the implementation.

Through the data collected and considering the need for an exclusive inspection channel for passengers who join the new service, the first recommendation of this conclusion is that this service would not be viable in smaller airports, that is, classified as AP-1 and AP-2. This is because AP-1 and AP-2 passengers carry up to 1MM passengers per year and normally have up to 4 x-ray equipment, it is not worth highlighting equipment exclusively for the pre-check TSA.

This service would only benefit larger airports, classified from AP2 onwards, considering they have a greater number of passengers transported per year and a greater amount of equipment for processing passengers in the inspection channel. In other words, airports that have a greater amount of x-ray equipment could benefit from this service, given the possibility of excluding some of this equipment, since there would be an operational gain in the procedure.

In addition, another conclusion refers to the continuity of the study, to deepen the cost savings gains with the implementation of the service. This is because the data collected in this study does not allow a conclusion regarding the effective economy. Therefore, further in-depth studies are recommended to study all the costs involved with this operation.

Limitations of Study

In the US TSA Precheck is a government program (FAA) and follows the same model, in Brazil, it could be a Federal Police program. However, due to the complexity of implementing this public agency, the research suggested that the most feasible way is to implement the program with the airport administrators.

There is a limitation in the Arena student version, which is a maximum of 150 entities being treated at once in the model. Therefore, this study needed to be conducted with this constraint in mind. In a real-life example, more than 150 people could be at the airport at the same time, and, for modeling that, we would need a more powerful license or software to help. One of the main suggestions for future studies is to acquire a new

version or software in order to build a more realistic model before implementing the solution in real life.

Another limitation of the present study was the small amount of literature available for development at work. This is a new study here in Brazil, with little material available for development.

Future Research

As a matter of keep developing the customer experience at larger airports, it is feasible to continuously analyze the customer behavior changes over the inspection process and how the security standards evolve over the years.

It is important to maintain the adherence of the methodology to the current customer behavior and service needs. The improved methodology proposed must be constantly updated in other to adequately address the security needs.

With the data in hand, it is interesting to research in the future to bring new members to the program to increase the level of security in the country and at the airport. This communication can be via marketing encouraging the benefits of being pre-checked at certain airports.

According to Recommendation 1, it is important to study how to implement the program with the government authorities, so that it can be valid for all Brazilian airports.

According to what was exposed in Recommendation 3, to analyze the economic feasibility of implementing the TSA pre-check service in Brazil, it would be necessary to continue this study, to deepen the possible costs and possible savings generated.

This is because, given the need for an exclusive security channel, it could generate costs for the airport administrator (need to include one more piece of equipment). On the other hand, operational optimization of the inspection channel would make it possible to deactivate some equipment, generating a reduction in the costs of hiring employees from outsourced companies that provide this inspection service in the x-ray channel.

In addition to the study on operational costs, a more in-depth study would be needed on which body or company would be responsible for charging a service like the TSA pre-check. This is because, here in Brazil, the company that performs the security inspection is the airport itself and, in the USA, it is the Government Agency responsible for airport security (TSA). After this analysis, it would be possible to study the pricing of this service and charge it to passengers, enabling new revenue for the Airport Concessionaire.

Lessons Learned

Even in the US where passengers make 3.6 trips a year, only 6.8% of travelers have a TSA Precheck. Here in Brazil, despite the gains in safety and passenger satisfaction, the study showed that in airports that carry less than 5 mm of passengers per year, the time saved in the inspection process is not so great. The civil aviation market is a sector of the economy that is of relevant importance for Brazilian development and the implementation of the service proposed in the study will certainly help in the growth of the sector and in the improvement of user satisfaction.

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