



Automated Disruption Assistance

Embry-Riddle Aeronautical University

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AUTOMATED DISRUPTION ASSISTANCE

by

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This Capstone Project was prepared and approved under the direction of the
Group's Capstone Project Chair, Dr. Leila Halawi
It was submitted to Embry-Riddle Aeronautical
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for the Aviation Management
Certificate Program

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Abstract

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During the last decade, commercial aviation in Brazil has grown significantly, overcoming the number of 100 million passengers per year. The intense operation represents a challenge for the air carriers, especially during flight disruptions.

In Brazil, besides the re-accommodation of the passengers into other flights, under certain circumstances, the ANAC 400 resolution requires the airlines to provide a series of material assistance. Meal, transport, and hotel make part of the exigences stated by the ANAC 400.

Our study aims to analyze the current process that is mainly manual and propose to automatize several steps through a self-service solution. The researchers verified the potential adoption of the solution through a survey where the great majority of respondents are favorable for using self-services and avoid lines at the airport.

The researchers also created a financial analysis to demonstrate the benefits of the solution through the reduction of headcount to execute the process.

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Chapter I

Introduction

In Brazil, commercial aviation is a sector where margins are relatively low and highly exposed to externalities. Since the apparition of GOL in 2001 as the first low-cost carrier (LCC), the concern for cost reduction increased. The aviation industry started many initiatives, such as firming agreements between different airlines to ease misconnections solutions or the implementation of a flight slot management model to minimize delays and cancellations. Miranda and Oliveira (2018) created an econometric model to demonstrate how the different strategies of slot management impact the costs of the airlines in case of flight disruptions.

All airlines that operate in Brazil must strictly comply with Resolution 400 of Agência Nacional de Aviação Civil (ANAC). It requires the airlines to provide a certain level of material assistance to customers that varies according to the severity and the duration of the disruption.

Disruptions represent one of the biggest expenses of an airline, and as the handling of these situations is highly regulated, there is only little room for cost reduction. In one of its studies, IT consultancy Travel Technology Research Ltd (T2RL) (2016), revealed that the cost of disruption represents 8% of the global revenue of airlines.

During a disruption, time becomes a critical dimension, and the challenge for the airline is to recover as soon as possible. There is still a high volume of manual processes to execute. This process requires a significant number of employees to deal properly with re-accommodation, voucher issuance for meals and hotels, and the other services stated

by the regulation. For the last years in Brazil, the researchers couldn't see major changes in the way of handling disruption that provides cost reduction.

Project Definition

The purpose of this study is to design a solution that reduces the cost of the headcount of the company. The researchers will provide a self-service solution to customers that allows them to choose their re-accommodated flight and issue their vouchers.

The automated disruption assistance (ADA) concentrates on the integration between the airlines and hotel, transport, and meal providers to facilitate the re-accommodation logistic for the passengers affected by the disruption. The solution aims to provide these services to the passenger through the mobile application (APP) of the company. In other words, the solution intends to bring more efficiency to the operation and savings for the airline from a financial perspective.

Project Goals and Scope

This study will improve disruption handling and demonstrate the unnecessary spending of money in manual processes that are not easily auditable and susceptible to human failures. Of course, there is no guarantee that all passengers will prefer the conveniences of the APP. This means that airport agents will still need to handle the minority of cases or exceptional cases. It also contributes to decrease the customer dissatisfaction in the critical scenario of a disruption.

Even in 2019, flight disruptions are still a problem for airlines. In the next chapter, the researchers will go deeper through the improvements that appeared in the last years regarding the processes related to disruption management.

Definitions of Terms

APP	Software designed and built to run on a mobile device.
	Abbreviation for application
Cloud	Hosting IT solutions as a service
Pax	Passenger

List of Acronyms

ADA	Automated Disruption Assistance
ANAC	Agência Nacional de Aviação Civil
API	Application Programming Interface
BO	Back-Office
DOT	Department of Transport (United-States of America)
IATA	International Air Transport Association
IT	Information Technology
ICAO	International Civil Aviation Organization
LCC	Low-Cost Carrier
NPS	Net Promoter Score
OLAP	Online Analytical Processing
OLTP	Online Transaction Processing
OCC	Operation Control Center
OR	Operation Research

PSS	Passenger Service System
SNEA	Sindicato Nacional das Empresas Aerooviária
T2RL	Travel Technology Research Ltd
UAT	User Acceptance Test
USA	United States of America

Chapter II

Review of the Relevant Literature

In this chapter, the researchers first give an overview of the European and Brazilian regulations regarding passenger material assistance in case of flight delays and cancellations. The researchers focus on these two regions because the local authorities are more exigent in terms of the obligation of the airlines in these situations.

The researchers also report the results of some studies that aimed to reduce the costs of disruptions, suggesting different strategies to manage and recover from flight disruptions efficiently.

Regulations in Brazilian and European Markets

In an industry where cost control is essential to achieve positive financial margins, companies need to keep looking for better processes that reduce consumption of time and, consequently, expenses. The contingency costs in the daily operations of the airline are caused by numerous factors such as adverse weather, unscheduled aircraft maintenance, or airport security, among others.

In Brazil, the airlines are required to provide material assistance to any passenger who is affected by a flight delay or cancellation, and these obligations may vary according to the impact on the passenger. In case of non-compliance with the regulations, the company may receive a fine of a minimum of R\$ 20,000 and a maximum of R\$ 50,000 per passenger affected.

Another market that presents some similarities from the Brazilian is the European market, where terms of material assistance are guaranteed by the European Commission

(EC) document 261/2004. This document specifies in detail the responsibilities of airlines regarding delays, cancellations, and overbooking. There is a significant contrast with the US market, regulated by the Department of Transportation (DOT). In the USA, the airline cannot be held responsible for schedule changes and cancellations and require the airlines to provide material assistance only in case of overbooking.

Resolution 400 of the Brazilian National Civil Aviation Agency (ANAC)

According to resolution 400, material assistance is to meet the needs of the passenger. The airline should provide it free of charge depending on the waiting time even if passengers are on board the aircraft with its doors open as follows:

- I - more than 1 (one) hour: communication assistance;
- II - more than 2 (two) hours: meals, according to the schedule, by providing meals or individual voucher; and
- III - more than 4 (four) hours: overnight accommodation service and round-trip transfer.

The carrier may cease to offer accommodation service to the passenger residing at the local airport of origin, guaranteed the round-trip transfer.

The re-accommodation will be free of charge, will not override the transport contracts already signed. Moreover, it will take precedence over the conclusion of new transport contracts, and should be made, at the choice of the passenger, as follows:

- I - on own or third-party flights to the same destination at the earliest opportunity;
or

II - on the carrier's own flight to be performed on the date and time of the convenience of the passenger.

Interpretative Guidelines on Regulation (EC) No 261/2004 of the European Parliament

The Regulation protects passengers against denied boarding, cancellation, delay, upgrading, and downgrading. These events, as well as the rights granted to passengers when they materialize, are described in the sections below.

Passengers whose flights are canceled should be able either to obtain reimbursement of their tickets or rebooked and adequately cared for while awaiting a later flight.

The Montreal Convention, adopted by the International Civil Aviation Organization (ICAO) in 1999, was ratified by Brazil in 2006. All obligations on operating airlines should be limited or excluded in cases where extraordinary circumstances have caused an event. In other words, cases that could not have been avoided even if airlines take all reasonable measures. Such circumstances may, in particular, occur in cases of political instability, meteorological conditions incompatible

with the operation of the flight concerned, security risks, unexpected flight safety shortcomings and strikes that affect the operation of an operating air carrier.

When an operating air carrier reasonably expects a flight to be delayed beyond its scheduled time of departure:

- (a) for two hours or more in the case of flights of 1 500 kilometers or less it is necessary to provide meals and refreshments in a reasonable relation to the waiting time;
- (b) for three hours or more in the case of all intra-Community flights of more than 1 500 kilometers and all other flights between 1 500 and 3 500 kilometers; it is necessary to provide meals and refreshments in a reasonable relation to the waiting time and hotel accommodation with transport between the airport and hotel.

Impact of Disruptions and Strategies for Recovery

The analysis of the Brazilian and European regulations demonstrates that the cost of disruption is a real offender for the airline's profits. Through our review of the literature, the researchers found some studies that proposed different strategies for disruption recovery.

Jafari and Zegordi (2011) pointed out the impact of a disruption on the aircraft operation, crew, and, of course, passengers. However, other aspects need to be taken into consideration when an airline looks at disruption management. Ground staff, gate, and catering are resources that play an important role in the management of a disruption. Most of the published studies that the researchers cite in this chapter, so far focus on aircraft recovery, schedule recovery, and techniques to mitigate the costs of airline disruption. Clausen et al. (2010) highlighted how aviation is one of the industries that

took advantage of Operation Research (OR) for the past years. They proposed an integrated research method of disruption management by robustness. This method uses a buffer in the airline schedule to make flight and crew schedules as well as aircraft rotation less sensitive to disruption.

Maher (2015) recognizes that passenger recovery is usually the last step of a flight disruption recovery process and that the related costs significantly affect operational efficiency. In his study, he uses OR to create a model that enhances passengers flow and minimize costs, in case of flight cancellation decision.

However, from a passenger perspective, there are a lot of possibilities for the airlines to improve the processes to passenger assistance with accommodation and compensations. Lettovsky (1997) states that passengers may understand that the airline is not responsible for the bad weather and the cancellation of a flight is due to safety reasons. On the other hand, in cases where the passengers cannot see the problem or cancelation reason, they will hardly understand that it would affect the entire network. This situation usually frustrates the passenger, leading to the loss of future revenue for the airline. In terms of flight cancellation costs, Lettovsky (1997) also showed in his study the importance of considering costs of reassigning passengers, hotels, and meals, as well as an estimation of the loss of passenger goodwill. Bratu and Barnhart (2006) developed a model that focused on finding a balance between the cost of operation of an airline and the cost generated by passenger delay. It additionally highlights the

importance of customer satisfaction in the mean that it affects their loyalty and consequently affect the revenue of the airlines.

Cook et al. (2009) developed a decision-support tool for managing flight delay costs in the pre-departure and airborne phases of a flight. They determined that costs related to passengers are comprised of different aspects. Examples include re-accommodation and compensation (hard costs borne), loss of market share due to passenger dissatisfaction (soft costs borne), and cost borne by the passenger like the impact of late arrival at a meeting.

The Current Process

The Brazilian airline's current process is extremely manual and has a low level of governance due to its fragility. The manual steps are presented in figure 1.

Essentially, when there is a delay or a flight change time of more than 2 hours, passengers are called and sorted by airline employees. After this process, the airline provides a new itinerary and the required vouchers to attend the National Civil Aviation Resolution 400. The airport agents of the airline execute this process.

In case of a flight delay greater than 2 hours and lesser than 4 hours, the passengers are qualified to receive meal vouchers. For flight delay greater than 4 hours, additionally, the passengers are entitled to hotel accommodation and transportation from the airport to the hotel.

Based on this scenario, there is a great opportunity for process optimization and governance improvements through automation. According to Kurian (2013), the business process reengineering is performed in 3 phases: (1) process capture and business

modeling, (2) process redesign, and (3) process support. In figure 1 below, the researchers mapped the current process run by the Brazilian airlines.

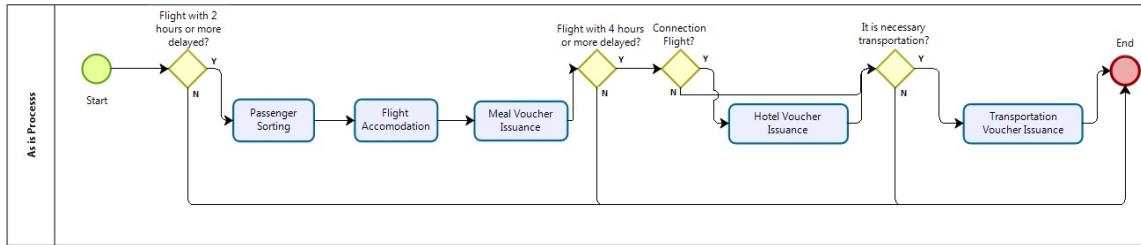


Figure 1. The current process of passenger treatment under ANAC 400 resolution

Self-Service Solutions

The air transport industry globally embraced the creation of self-service solutions for its customers. The International Air Transport Association (IATA) created a program named Fast Travel that concentrates on offering more options to the customers and lowering the cost for the industry. The program focuses on six key areas, and flight rebooking is one of these areas. The IATA estimates that the saving represented by the self-service options in the six areas represents a saving of 2.1 billion US dollars annually for the industry.

Protus and Govender (2016) suggest that even if some self-service solution may impact negatively in comparison to person-to-person interactions, the customers appreciate the reliability and the time saving provided by self-service solutions. Another advantage of a self-service solution is the avoidance of long queues at the airport, especially at peak hours. This item is relevant in the general customer experience with the airlines. However, to maximize customer satisfaction, it is mandatory that these

solution's reliability is high and to provide efficient contingencies in case of problems with the technology. Otherwise, the effect on customer satisfaction can be dramatic.

Summary

Material assistance to passengers and re-accommodation costs represent an important challenge for airlines, especially in Brazil and Europe, where the regulation is more favorable to the passengers than in the United States and other regions of the world. An example that illustrates this situation is the ANAC Resolution 400 that obliges the airline to assist regardless of the reason for delay or cancellation. In other words, airlines are responsible for the passenger's situation even when they have no management over the cause of the incidents, such as weather conditions, air traffic, and security risks.

Many studies propose strategies and models that minimize the impact of disruptions when they raise. Other studies focus on decision making to minimize costs related to passengers and consequently to the overall operations. In the review of the literature, the researchers could not find studies that handle the question of the costs related to the operation of the re-accommodation of the passenger and assisting. In this study, the researchers will propose the use of technology to build a solution that reduces the cost of operation by minimizing the work effort and the time consumption to run these processes. As an additional benefit of this solution, the researchers also see a potential positive impact on customer satisfaction with the airline.

Chapter III

Methodology

In this chapter, the researchers will describe the methodology that the researchers will apply to estimate the costs related to material assistance to passengers by Brazilian airlines. To do so, the researchers will use a quantitative and qualitative methodology. According to Profillidis and Botzoris (2019), a quantitative method uses an interrelated set of variables under certain assumptions and aims to specify the relationship among the variables in terms of magnitudes. It is characterized by a rationale that permits us to analyze, explain, and predict a specific phenomenon that can be reduced to some variables.

Study Design

This study was developed to propose a new material assistance solution for passengers during disruption scenarios. Knowing the potential for process improvement that the tool will cover, it is possible to act more efficiently and optimize labor force in passenger rebooking. This solution aims to reduce headcount costs for airlines, provide better cost control with suppliers, and, additionally, improve customer experience.

Through the quantitative methodology, the researchers will run statistical analyses to understand what the opportunities are found in the current process for material assistance. For this, the researchers will use four data sets extracted during our research.

1. Historical data for delays and cancellations flights

To measure the magnitude of the impact generated to the airlines, the researchers will explore the number of canceled flights, the number of delayed flights, and the delays in minutes.

2. Missed connection rate

Not a disruption for the company, but a disruption in the customer journey, missed connections demand attention for airlines. As the process is essentially manual, the time for rebooking and material assistance is slow. Brazilian airlines run their network planning on the hub-and-spoke method, bringing a huge number of passengers to the hubs and transport them to their final destination.

3. Material assistance cost

These costs are comprised of the amount spent on voucher issuance for meals, hotels, and land transportation. As a consequence of the requirements of ANAC 400 Resolution, the material assistance cost will be used to understand the amount spent by airlines. Automated processes represent opportunities to improve the control efficiency of this expense.

4. Headcount and cost

The labor cost is a predominant variable of the total cost of a disruption situation for an airline. The minimum wage of airport agents is agreed between the Brazilian union, Sindicato Nacional das Empresas Aeroviárias (SNEA), and airlines. The

researchers will collect the corresponding value through the SNEA's website. The hourly rate of wage will constitute a variable of our statistical analysis.

Data Source(s), Collection, and Analysis

The data sources used in this study are primary and secondary. The secondary data obtained to develop this project were extracted from Internet searches on ANAC and SNEA websites, as well as data provided by GOL, LATAM, and Azul airlines, the three major airlines in Brazil. For the primary data, the researchers did descriptive research to understand existing opportunities in disruption scenarios better.

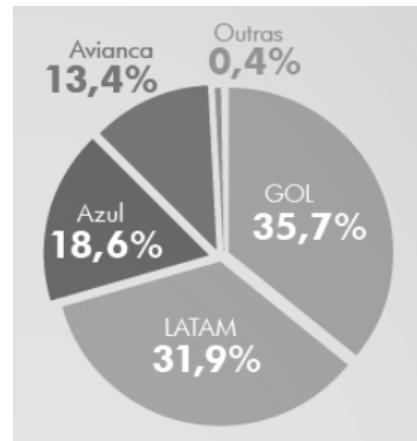


Figure 2. Domestic Market Share – December 2018 (Source: ANAC)

Note: Since May 2019, Avianca is no longer operating due to bankruptcy.

To identify and analyze the key data for this project, the researchers consider the data below:

- Total number of operated flights per airline
- Total number of delayed and canceled flights
- Total number of passengers transported per airline

- Average flight occupancy per airline
- Percentage of passengers connecting
- Percentage of missed connection
- The average cost of an employee

The number of flights and passengers were collected considering the years 2017 and 2018.

To measure the estimated time spent by Brazilian airlines in rebooking and material assistance processes, the researchers made a table according to the requirements of ANAC resolution 400. The time process was provided by airlines according to the current scenario.

Table 1

Time process per passenger and action

	Time process per passenger			
	40 sec	40 sec	40 sec	3 min
Rebooking	Meals	Transport	Hotel	
Missed Connections	Yes	According to accommodation	According to accommodation	According to accommodation
Canceled Flights	Yes	According to accommodation	According to accommodation	According to accommodation
> 2h Delays	No	Yes	No	No
> 4h Delays	No	Yes	Yes	Yes

On missed connections and canceled flights scenario, the rebooking process can variate according to the next flights available.

Currently, employees responsible for the rebooking process, and for providing material assistance vouchers, work in the back-office (BO) area. The solution aims to

provide a reduction in manual interaction and, consequently, to reduce the number of employees required in this sector. According to Brazilian airlines, back-office employees represent 10% of the total station's headcount. To understand the total cost of employees in Brazil; the researchers considered the formula below:

$$\text{Cost per headcount} = \text{Salary} + \text{taxes}$$

Simulation of the As-Is and To-be process

To demonstrate the feasibility and efficiency of the new process involving the accommodation and voucher issuance, this study also aims to simulate the As-Is process (Fig.1) and To-Be process containing all proposed automation and changes. The following steps for building the simulation should be considered.

1. Model the current process in Rockwell Arena software, which will ensure that all activity sets are thoroughly detailed.
2. Estimate the required resources by the logic already mentioned in the study, such as BO headcount and target customers.
3. After defining the design and features, the system must run several times to collect efficiency data.
4. Design the future process in Rockwell Arena, including all digital solutions proposed by the study as well as process changes.

5. Include all resources defined for the proposed solution, not excluding digital processing capacity as well as the existing manual processes.
6. Repeat the simulation the same number of times as done with the As-Is process, and finally, the output data will be compared to verify the feasibility and efficiency of the new process.

Simulation is an essential step of the process redesign methodology, according to Maruster (2009), this ensures the success of the solutions proposed by the study.

The To-be Process

The new process is designed to automate the current process and provides greater governance and traceability of issued vouchers the to-be process has similar steps to the current process. However, it brings a high level of automation in each of the planned steps that makes it simpler and more agile. It also logs information into a database that helps controlling costs related to legal obligations provided.

This new process proposal consists basically of 8 steps, such as System Input, Passenger Sorting, Flight Re-Accommodation, Meal Voucher, Hotel Voucher, Transportation Voucher, Voucher provision, and Data Storage for future analysis.

1. System input

When a flight is delayed by 2 hours or more, an airline employee must enter this information on Automated Digital Assistance (ADA). Then the tool starts the entire automated management process. The company employee may be assigned to the airport staff or operations control center.

2. Passenger Sorting

Even with the automation of the process, there will be at this stage a sorting of the passengers by destination and prioritization according to the customer's tier level in the airline frequent flyer program.

3. Flight Re-Accommodation

At this stage of the process, the customers will be accommodated to a new flight according to the priority set in the previous step so that the frequent flyer will have priority for the best accommodations.

4. Meal voucher

As per customer rights, he/she will receive a meal voucher, and this voucher will be valid until the departure time of his/her new flight.

5. Hotel voucher

In the fifth phase of the process, only passengers in connection receive a hotel voucher if the delay or change of the flight departure has more than 4 hours of difference from the original departure time. It is noteworthy that for this

voucher issuance, the prioritization defined in step 2 will be considered, providing earlier assistance to frequent passengers.

6. Transportation voucher

The transportation voucher is provided to passengers who have received a hotel voucher. But only when the selected hotel does not offer a shuttle service and also to local passengers who may wish to return home.

7. Voucher provision

This is the final phase of the process that directly involves the passenger. At this moment, a push notification will appear on his/her mobile phone through the airline APP, making available the vouchers that are the obligation of the company and customer rights.

8. Data Storage

The last part of the process is the storage of all affected passenger and voucher data that can be used for future analysis for continuous improvement, cost control, and auditing purposes.

It is important to mention that this whole process assumes that the passenger has installed the airline APP on his/her mobile phone. However, in cases where the passenger does not have installed the APP, he/she can obtain the vouchers from a company employee that can print it through the disruption management module control screen.

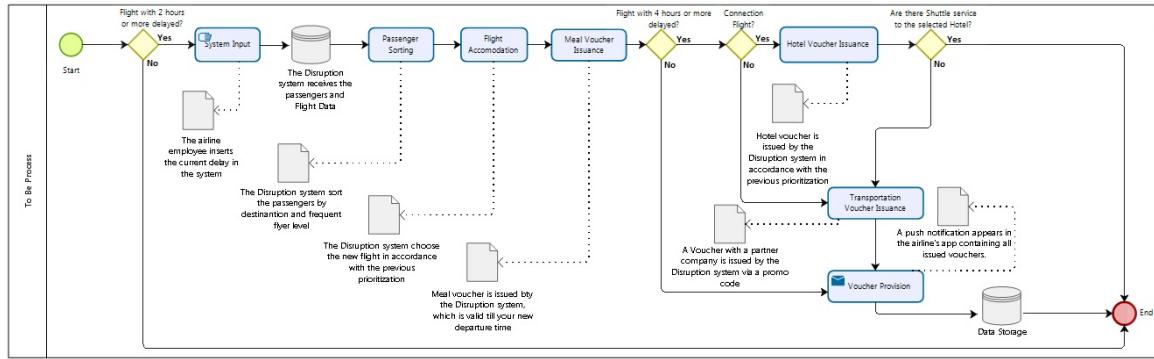


Figure 3. The to-be process of passenger treatment under ANAC 400 resolution

Descriptive Research Design

To better understand the flight disruption process and the impact that this event has on both customers and airport employees, two different surveys were developed to collect information that can support this study.

Based on descriptive research, the researchers saw the opportunity to integrate the qualitative and quantitative methods of data collection. The objective was to gauge public opinion on airline processes and evaluating satisfaction with such processes.

The first survey focused on the airline employees who are involved in the flight disruption process. The objective of this survey is to understand how they feel about executing such processes and check if they see room for improvements in the whole process. The second survey focused on travelers who are familiar with airline processes. The main objectives of this survey are to check if customers already passed through a disruption scenario and understand how the experience was once it has occurred. Both surveys collected some personal information to map the profile of the survey respondent, trying to find relationships between variables.

The surveys were designed in Google Forms platform. Google Forms is a web-based tool used to create forms for data collection and analyze purposes. It allowed us to get instant results as they came in. Once the data was collected, it helped to summarize survey results at a glance with charts and graphs generated in Google Sheets. It also provided the data results in CSV format that the researchers exported from Google Forms and imported it in Microsoft Excel software, where the researchers could analyze the results.

Both surveys were designed using multiple-choice questions, where the survey for travelers contained thirteen questions, and the airport agents survey contained seven questions.

To run some pre-test and validate both exploratory surveys, the researchers sent the questionnaires to a small group of 30 people. Students of Embry-Riddle University and airline employees were invited to be part of the group. Once this group answered the survey, the researchers asked feedback about the clarity and objectivity of the questions. Also, with the preliminary results, the researchers checked the data provided by the platform to see the accuracy of the answers and how this data could be used in this work as an important and useful information to support this study. Based on the results and feedbacks the researchers collected through this pre-test, the researchers adjusted some questions of the survey, and then the researchers sent the final version of the survey to a larger group.

The invitation for the first survey was sent by the Airport Board of Azul, Gol, and Latam, to over 200 employees who are part of the airport ground staff in Brazil. The researchers used email and WhatsApp as channels to reach this group of people. The

invitation for the second survey was sent over 500 airline travelers in Brazil also by email and social media, promoting the survey through our networks.

The researchers used applied research type as the researchers were trying to solve a practical problem. Also, the researchers used primary data as collect directly through the survey link.

Chapter IV

Outcomes

After collecting operational data from the three major airlines in Brazil, it was possible to analyze and work with some disruption scenarios. All results presented in this study were focused on hub airports, which have a large volume of transported connections and flights. In other words, the hub and spoke model. The main scenarios analyzed were:

- Missed connections
- Canceled Flights

At the request of airlines, all data will be presented with the code name A, B, and C, to keep the information available confidential. To begin the study, the researchers consolidated the information on flights and passengers carried in 2017 and 2018.

Table 2

Total of carried passengers in 2017 and 2018

Airline	Carried Passengers	
	2017	2018
A	32.300.413,00	33.394.299,00
B	33.548.185,00	34.114.685,00
C	21.476.344,00	22.557.925,00
Total	87.324.942,00	90.066.909,00
Average	29.108.314,00	30.022.303,00

Table 3

Total of flights operated and canceled flights in 2017 and 2018.

Airline	Flights in 2017		Flights in 2018	
	Operated	Canceled	Operated	Canceled
A	242.720,00	1.362,00	250.924,00	1.593,00

B	232.723,00	2.460,00	245.627,00	2.310,00
C	241.153,00	3.073,00	257.440,00	3.998,00
Total	716.596,00	6.895,00	753.991,00	7.901,00
Average	238.865,33	2.298,33	251.330,33	2.633,67

When the researchers asked airlines about the percentage of connections carried in flights and the percentage of missed connections, data were presented from a macro perspective for strategic market reasons.

- Percentage of connections in hubs: 37%
- Percentage of missed connections in hubs: 2%

Minimum wage

According to SNEA's collective agreement 2018/2019, the minimum wage of an employee who acts as an airport agent is R\$ 1332.83. Assuming that employee's rates in Brazil are approximately 70% of the salary paid, the researchers consider the formula below for cost per headcount.

$$\text{Cost per headcount} = 1332.83 + 70\% \text{ salary} = \text{R\$ } 2265.81$$

Scenarios

Scenario A - Missed Connections

To begin the scenario design, the researchers considered the volume of flights and passengers carried in 2018, due to the continuous growth of the Brazilian aviation market. Analyzing the data collected, the number of operated flights increased by 5% from 2017 to 2018.

To development of scenario A, the researchers consider the following rational:

1. Average passengers carried per year
2. Percentage of passengers with connection per year
3. Percentage of missed connection per year
4. Missed connection per day
5. Missed connection per day in each hub
6. Time spent to provide rebooking and material assistance
7. Required hours to do the process
8. Required agents per hub to do the process
9. Minimum of one agent per shift
10. Total of required agents per hub considering scale factor
11. Total of required agents in the airline
12. Cost per agent
13. Total cost in all hubs per month and year

Table 4

Scenario A rational

Description	Qty	Logic
Average passengers carried per year	30022303	Passenger carried per airline
Passengers with connection per year	11108252	*0.37
Missed connection per year	222165	*0.02
Missed connection per day	609	/365
Missed connection per day in each hub	152	/4 (assuming four hubs per company)
Time spent (minutes)	761	* 5 min - Considering 5 minutes (rebooking and all material assistance service)
Passengers served/hour	12	Affected passengers day hub * 60 / time spent (minutes)

Required hours	13 / 60 (change from minutes to hours)
Required agents (working per hub)	2 / 6h (airport agent workday)
Required agents (minimum of 1 per shift)	4 Four shifts of 6 hours each one
Required agents (total per hub)	5 + 30% scale factor
Required agents in the airline	21 *4 hub
Agent Salary + taxes	R\$ 2.265,81 Cost per Headcount
Total cost in all Hubs per month	R\$ 47.128,87 Required agents in the airline * (Salary + taxes)
Total cost in all Hubs per year	R\$ 565.546,43 Total cost in all Hubs per month * 12

According to the logic presented, an airline that has the operation with the characteristics described in this scenario can save R\$ 565.546,43 per year automating its disruption processes.

Scenario B - Canceled flights

Scenario B was designed based on the number of cancellations and average load factors of 2018 of the three main airlines in the Brazilian market. Scenario B considered that only the provision of meal and transport vouchers was required.

Based on data released by the airlines, about 38% of cancellations are from flights that have its departure from any hub. And it was possible to reach the average number of flights canceled per day on these stations.

Table 5

Average annual load per flight and per airline

Airline	2017	2018
A	133	133
B	144	139
C	88	87

Average	122	120
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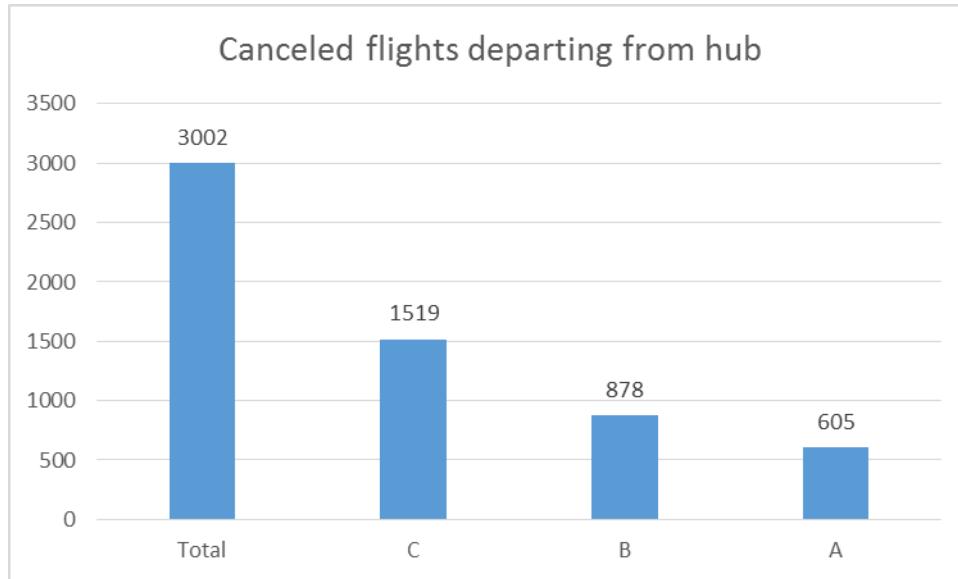


Figure 4. 2018 Canceled Flights departing from hubs

Finally, with this data, it was possible to develop a rational to reach the necessary number of agents for this function. And also, to estimate the potential saving since the process automation will replace this need.

Table 6

Scenario B rational

Description	Qty	Logic
Canceled flight per day in hubs	1,66	According to the database collected
Average Load Factor per flight	120	According to the database collected
Time spent (minutes)	398	* 2min - Considering 2 minutes per pax (rebooking, meal and transport)
Required hours	7	/ 60 (change from minutes to hours)
Required agents (working per hub)	1,11	/ 6h (airport agent workday) or the minimum of 1 agent
Required agents (total per hub)	1,44	+ 30% scale factor
Required agents in the airline	6	* 4 hubs
Agent Salary + taxes	R\$ 2.265,81	Cost per Headcount
Total cost in all Hubs per month	R\$ 13.038,99	Required agents in the airline * (Salary + taxes)
Total cost in all Hubs per year	R\$ 156.467,84	Total cost in all Hubs per month * 12

For this scenario, the researchers selected the lowest daily cancellation rate among the three airlines. However, the researchers will not consider this saving on our study, because agents assigned to other activities could cover the lower number of resources applied.

Savings Scenario A and B

Scenarios A and B happen simultaneously, causing missed connections due to flight delay and flight cancellation, respectively. So, the expected annual maximum potential saving should remain under R\$ 565.546,43.

The potential saving mentioned can be achieved through the reduction of headcount and the new automated process.

As-Is and To-Be Process Efficiency Comparison**1. As-Is process**

The current process with all the manual tasks involved and their specific duration requires at least 17 employees hired to the airline, leading to a high annual cost.

2. To-be Process

The new process brings an important gain in efficiency. The execution time of issuance and delivery of vouchers takes about 2 minutes for all affected passengers of the flight. Considering that the current process can take up to 5 minutes per passenger, the gain is significant. Also, there is no need for dedicated agents for the passenger accommodation process.

This new process will eliminate the headcount profile required for the activity. The only headcount needed in the new process is already present in other company activities, whether at the Operation Control Center (OCC) or the boarding gate.

Arena Simulation

Arena is a simulation software developed by Rockwell Automation that helps to understand the potential impact of a specific business process decisions before they are implemented. The simulation of the current and new processes through Arena models allowed us to change and test alternatives to determine the best in terms of efficiency. The researchers considered elements as a contribution to the mitigation of the risk of failures, identification of possible bottlenecks, and reduction of idle time.

Simulation Process As-Is

Considering the data of scenarios A and B previously mentioned in the study, the researchers simulated the current process for 30 days at one Hub.

During the simulations, the researchers made several changes trying to concentrate the assistance in two or three shifts. But the researchers realized that the maximum waiting time for rebooking and issuing vouchers of each passenger correspond to the moment where no agent is working at the customer service.

After replicating the simulation, the researchers identified that the result pointed out that at least one employee must permanently be available. It also showed that a shift reduction caused a waiting time of 6 hours.

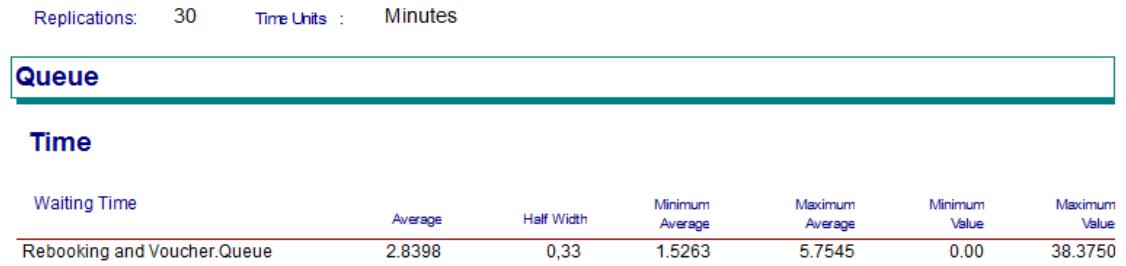


Figure 5. Simulation including four shifts

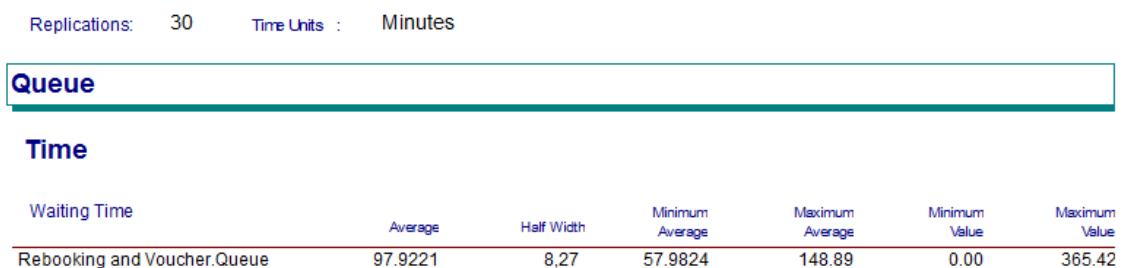


Figure 6. Simulation including three shifts

To-be process simulation

With the simulation of the to-be process, it became clear that there is still a need for human intervention to start the automated process. However, this process only takes a few seconds to execute and can be assigned to an employee located at the company's OCC, which is already responsible for monitoring passengers who have connecting flights. Thus, it ensures the gain by reducing the number of people involved in the manual process of issuing and delivering vouchers.

On the new solution, the waiting time became insignificant because it only relies on the action of the passenger in the APP. The process full process is executed by the passengers and can be executed simultaneously by all the impacted passengers.

Descriptive Research Design

After running the survey questionnaire focused on frequent travelers, the researchers received 281 answers about 13 questions of multiple choice.

The first three questions were raised to understand the respondent profile. The following three questions were raised to understand the traveler behavior and relationship with the airlines. Through questions 7 to 9, the researchers tried to check if the respondent already had a flight delay or disruption experience. Through questions 10 to 12, the researchers tried to understand how bad (or good) was the experience with the airline in case of flight delay or disruption. Finally, through the last question, the researchers tried to understand from the traveler, and based on his/her experience, what would be the best way for the airline to assist the travelers in case of flight delay or cancellation happened and hotel, meal, and transportation assistance is needed.

In the charts below, the researchers can find the results obtained throughout this research:

63,3% of respondents in this research were male:

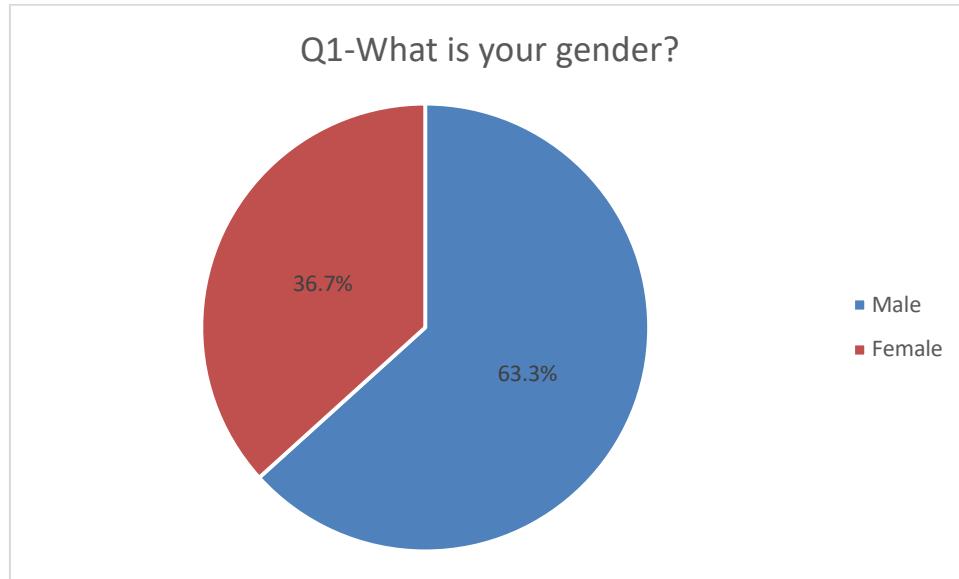


Figure 7. Traveler Research Question 1 (What is your gender?)

43% of the respondents were between 31 and 40 years old:

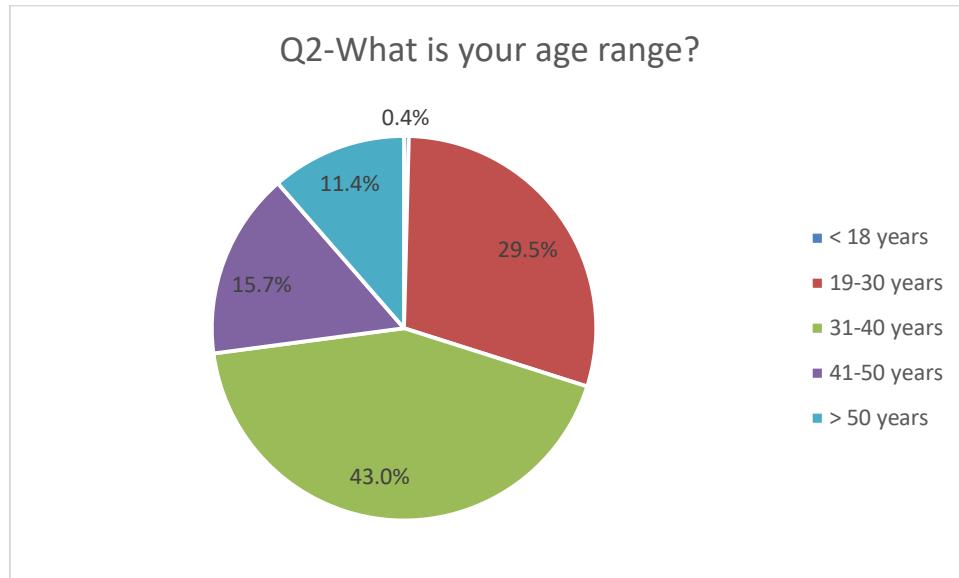


Figure 8. Traveler Research Question 2 (What is your age range?)

Regarding the occupation of the respondents, 74% were employed in a private company:

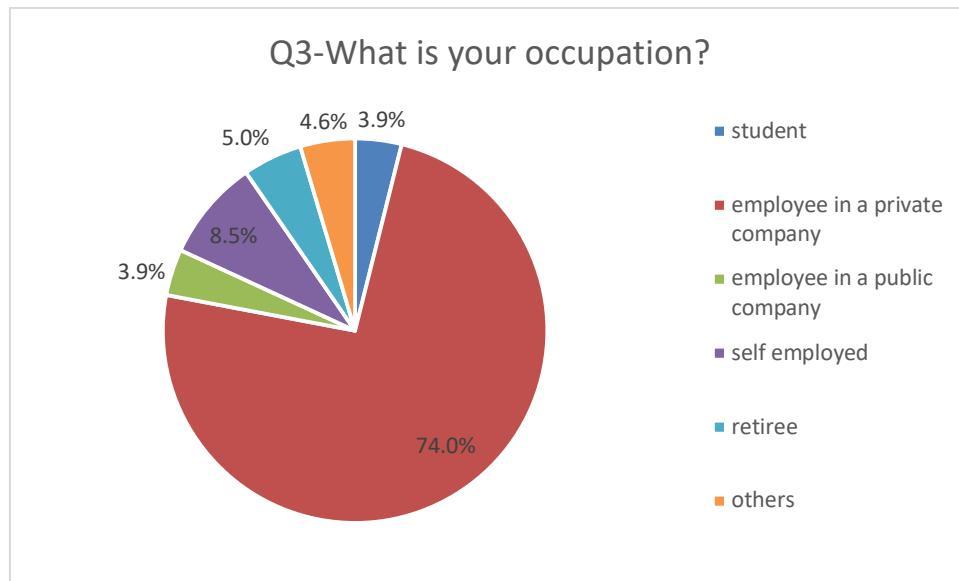


Figure 9. Traveler Research Question 3 (What is your occupation?)

From what we could see, 63,7% of the respondent were already part of any loyalty program:

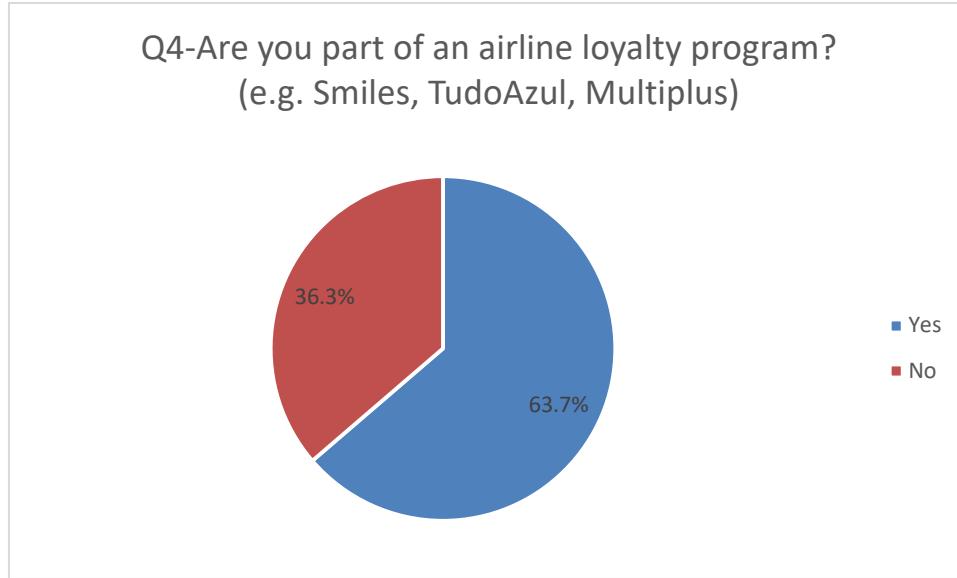


Figure 10. Traveler Research Question 4 (Are you part of an airline loyalty program?)

73% of the respondents fly more than once a year:

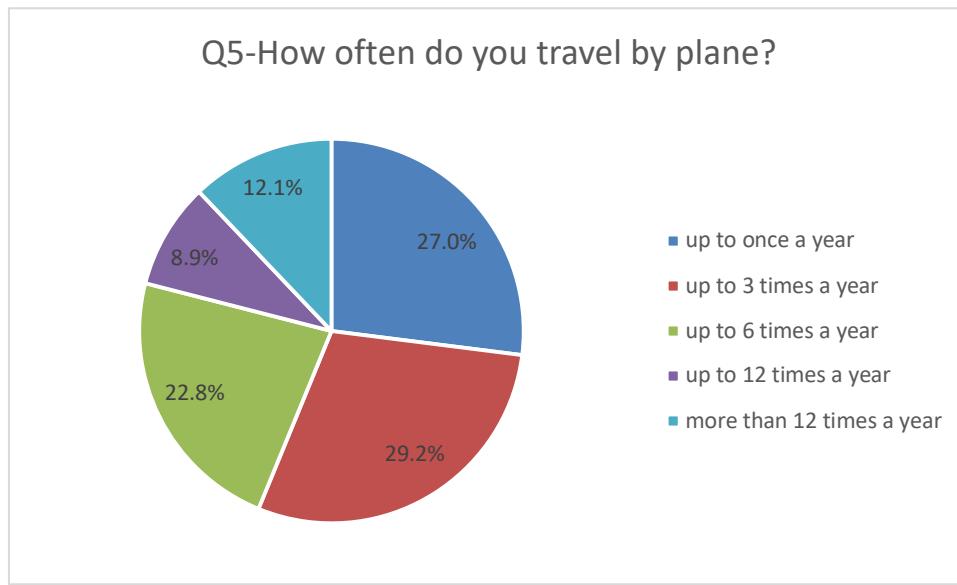


Figure 11. Traveler Research Question 5 (How often do you travel by plane?)

Leisure is the main reason for most of the respondents:

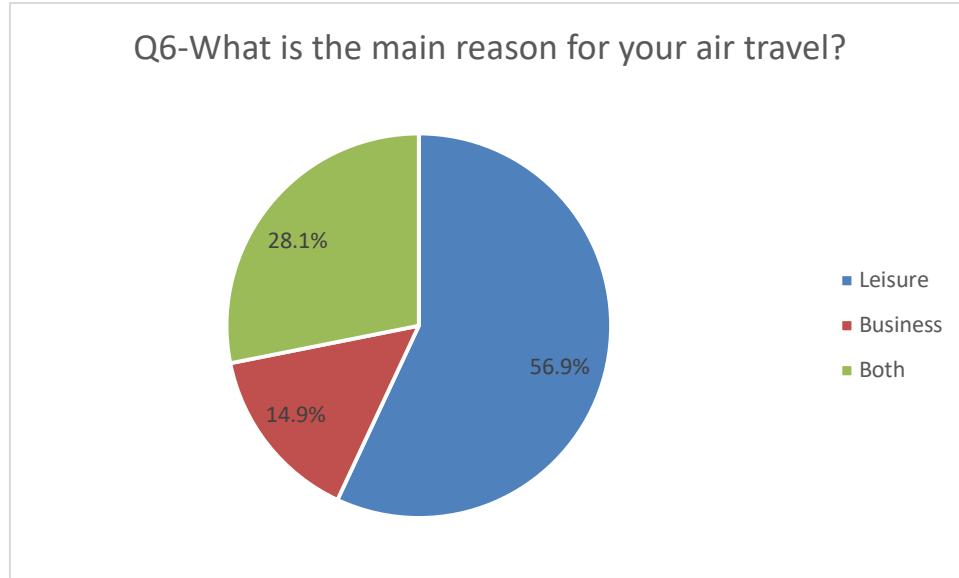


Figure 12. Traveler Research Question 6 (What is the main reason for your air travel?)

59,4% of the respondents already experienced a flight delay of more than two hours:

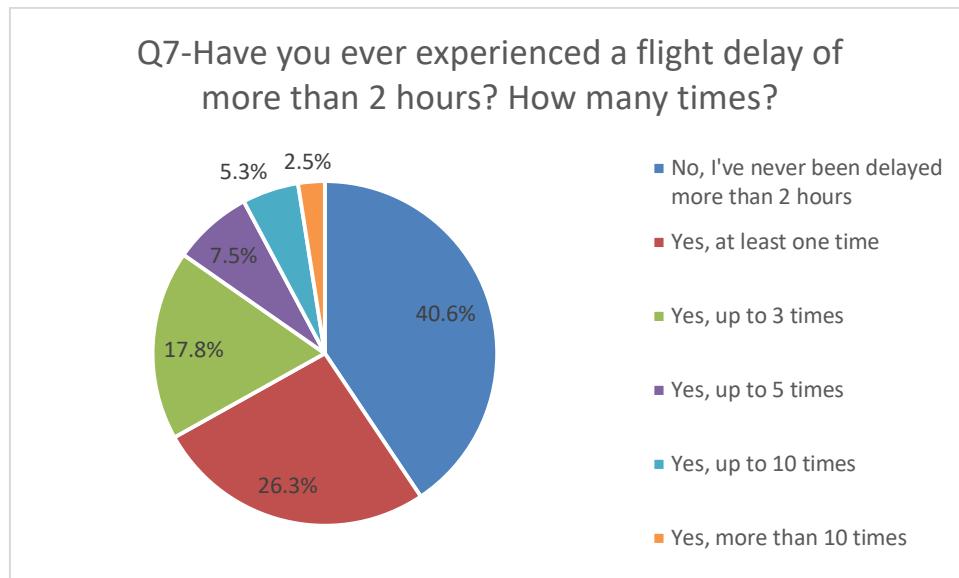


Figure 13. Traveler Research Question 7 (Have you ever experienced a flight delay of more than 2 hours? How many times?)

63,9% of the respondents were rebooked on flights greater than two hours from the original flight:

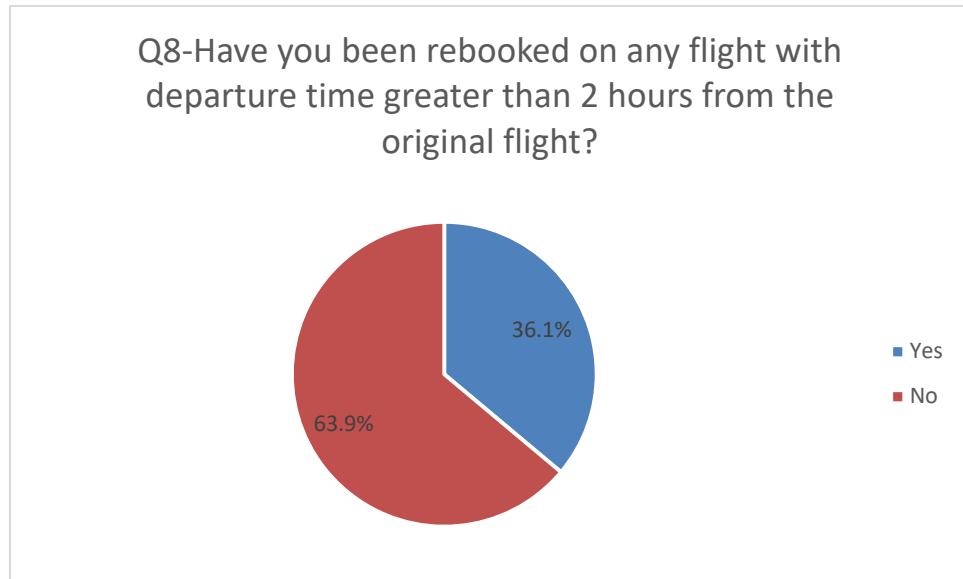


Figure 14. Traveler Research Question 8 (Have you been rebooked on any flight with departure time greater than 2 hours from the original flight?)

Now, talking about flight cancellation, we can see that 38,2% of the respondents already had experienced this kind of event:

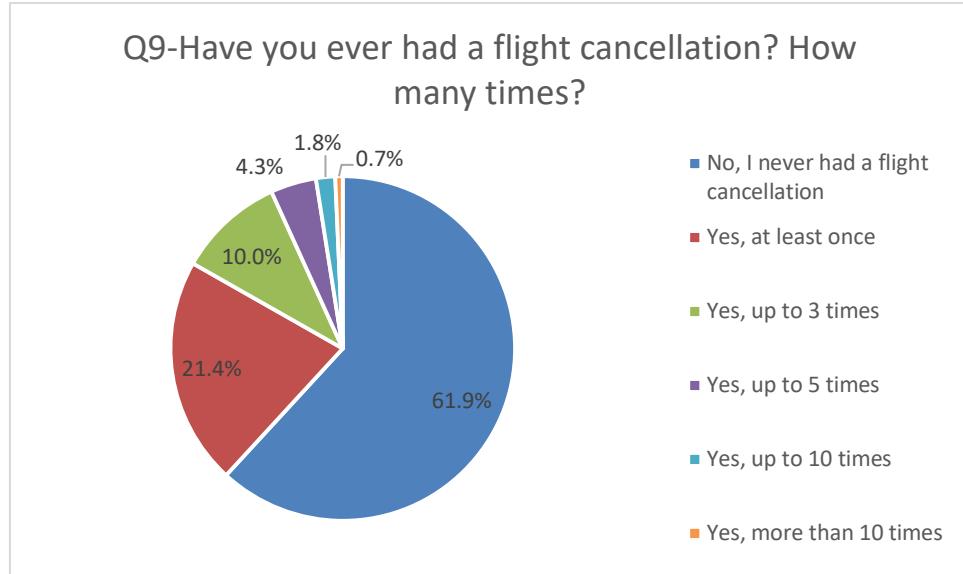


Figure 15. Traveler Research Question 9 (Have you ever had a flight cancellation? How many times?)

Regarding the assistance provided by the airline in the event of flight cancellation, 37% of the respondents said that they did receive assistance:

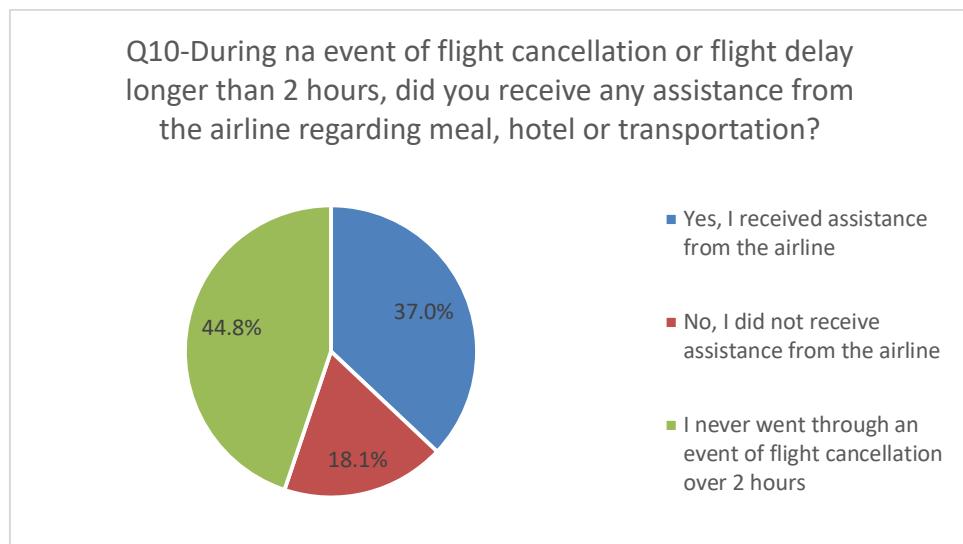


Figure 16. Traveler Research Question 10 (During an event of flight cancellation or flight delay longer than 2 hours, did you receive any assistance from the airline regarding meal, hotel, or transportation?)

34,5% of the respondent reported that the process of receiving assistance from the airline was not smooth.

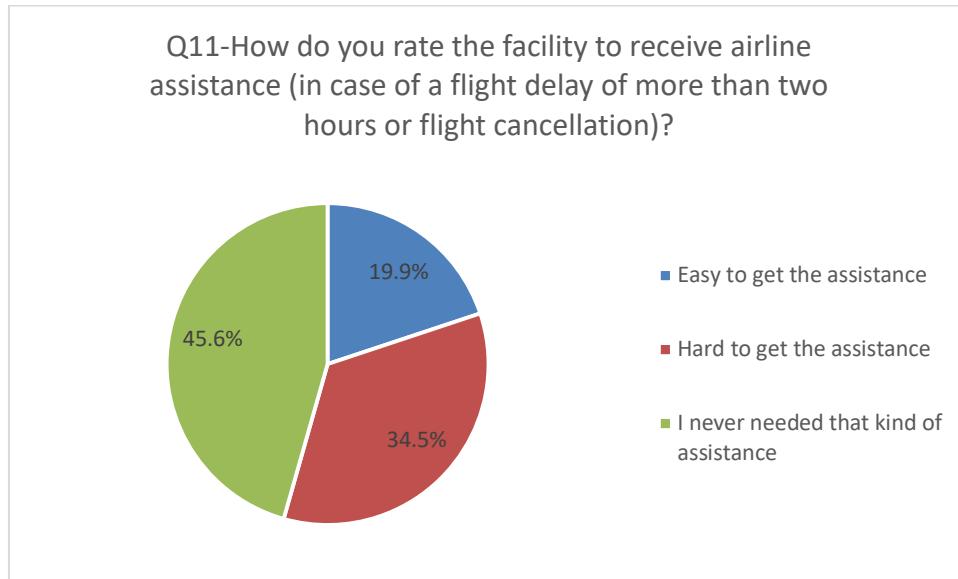


Figure 17. Traveler Research Question 11 (How do you rate the facility to receive airline assistance?)

Now, 40,2% of the respondents think that the agility of the airline in assisting is considered slow:

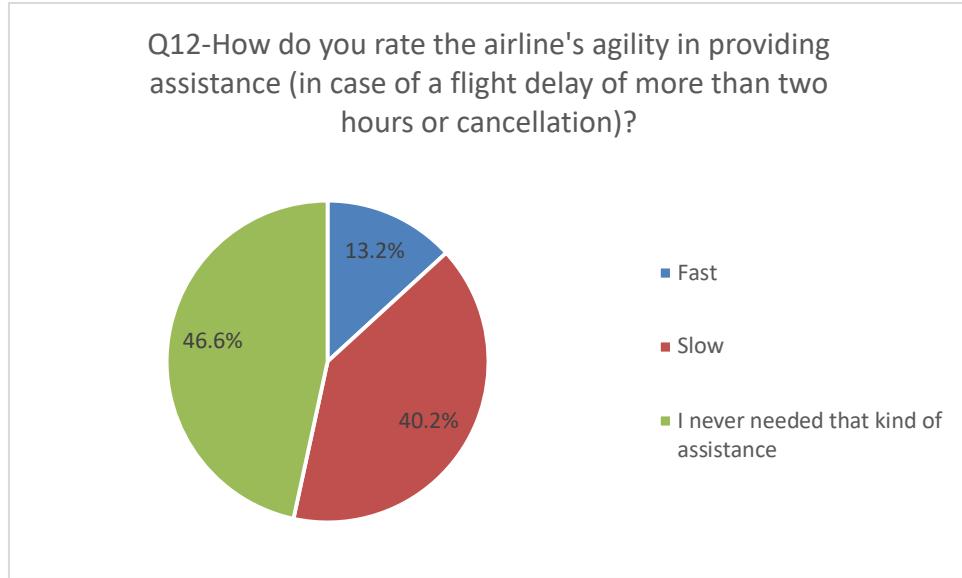


Figure 18. Traveler Research Question 12 (How do you rate the airline's agility in providing assistance?)

Finally, we could see that the large majority of respondents (i.e., 91,5%) prefer to receive hotel, transportation, and meal vouchers digitally in the airline app instead of waiting for an airport agent assistant.

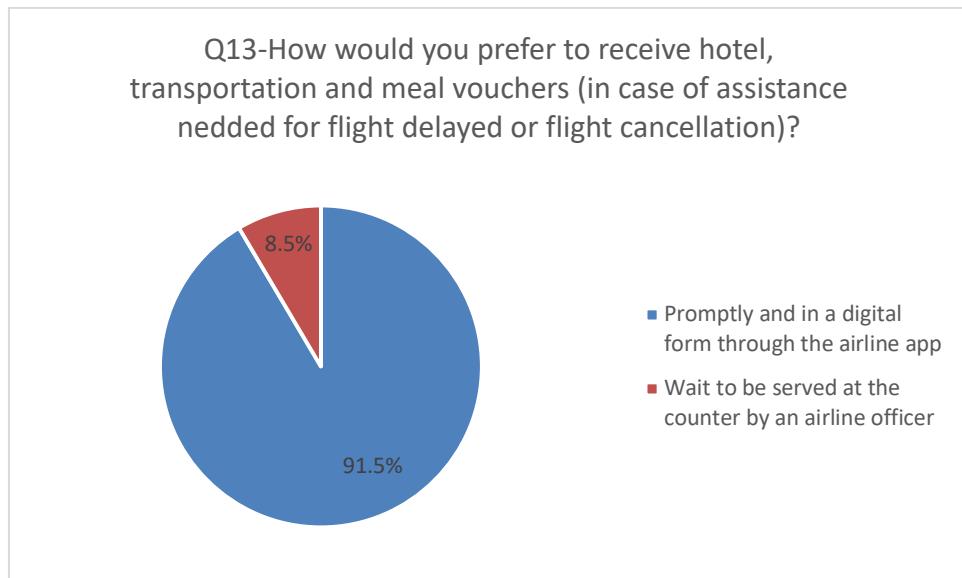


Figure 19. Traveler Research Question 13 (How would you prefer to receive hotel transportation and meal vouchers?)

Now, after running the second survey focused on airline employees who are involved in the disruption process, the researchers received 38 answers regarding seven questions of multiple choice.

The first two questions were designed to understand the respondent profile. The third question defines the airport agent location. The following two questions were raised to check whether or not the respondent is somehow involved in the disruption process. In question 6, the researchers tried to measure the efficiency of the current process from the respondent perspective. Finally, in the last question, the researchers wanted to see if the automated disruption solution would be helpful for the airport's operation, from the employee perspective.

In the charts below, we can find the results obtained throughout this research

52,6% of respondents in this research were male:

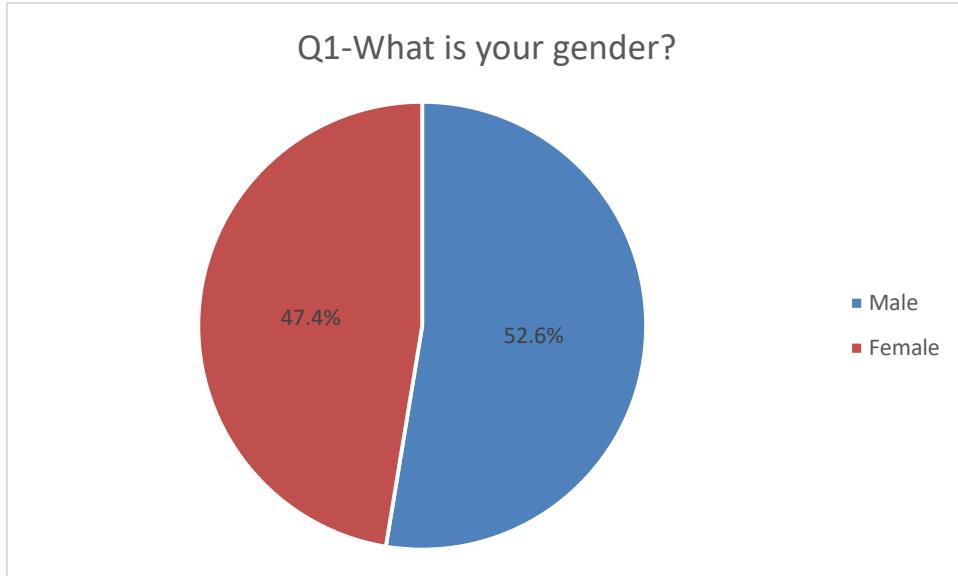


Figure 20. Employees Research Question 1 (What is your gender?)

63,2% of respondents in this research were between 19 to 30 years old:

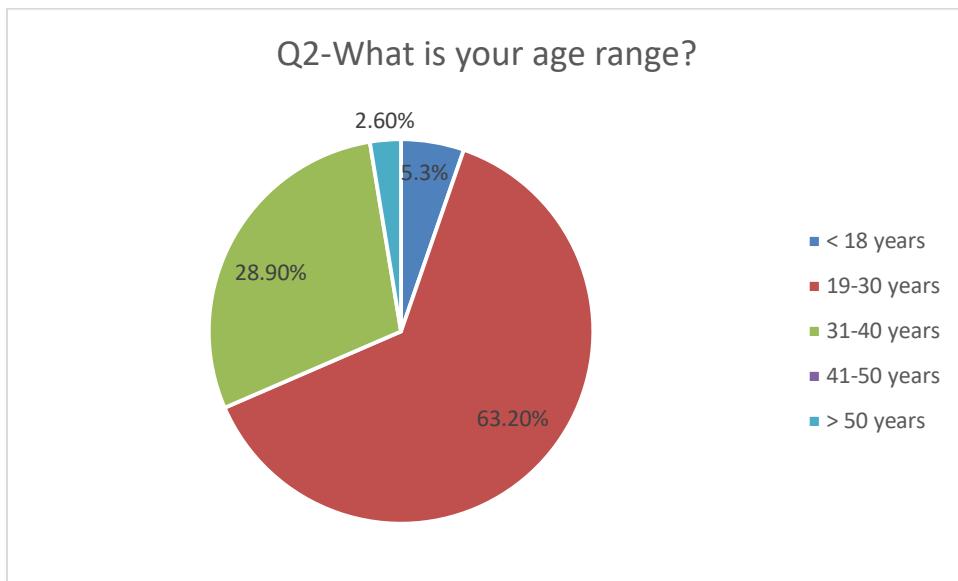


Figure 21. Employees Research Question 2 (What is your age range?)

There were respondents from five different locations:

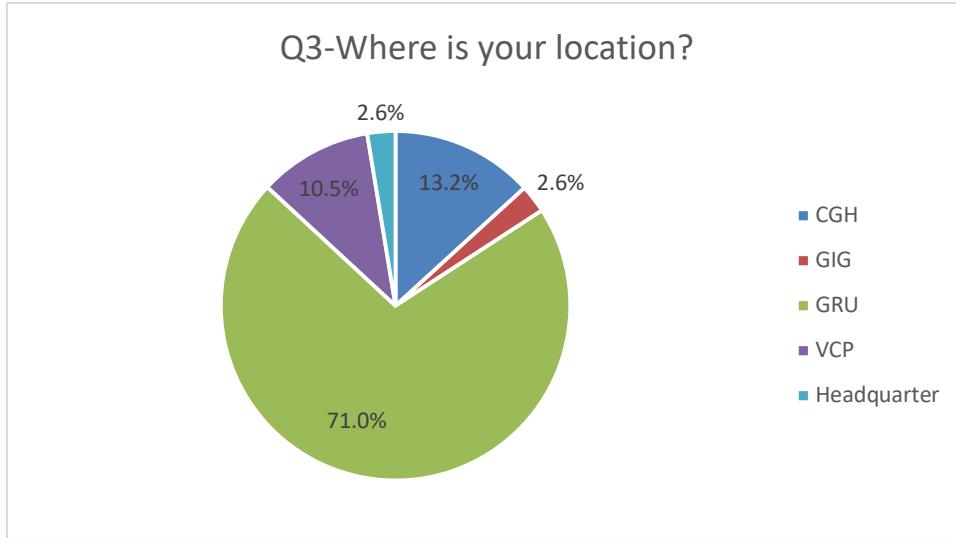


Figure 22. Employees Research Question 3 (What is your location?)

Regarding the involvement in the disruption/re-accommodation process, 92,1% of the respondents said they were involved in this process:

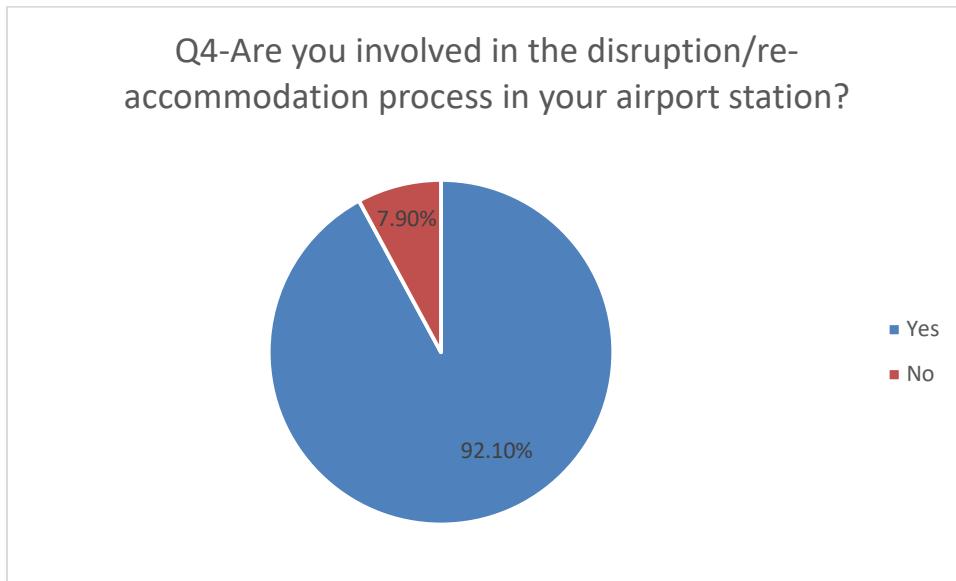


Figure 23. Employees Research Question 4 (Are you involved in the disruption/re-accommodation process?)

71,1% of the respondents are involved in the voucher issuing process:

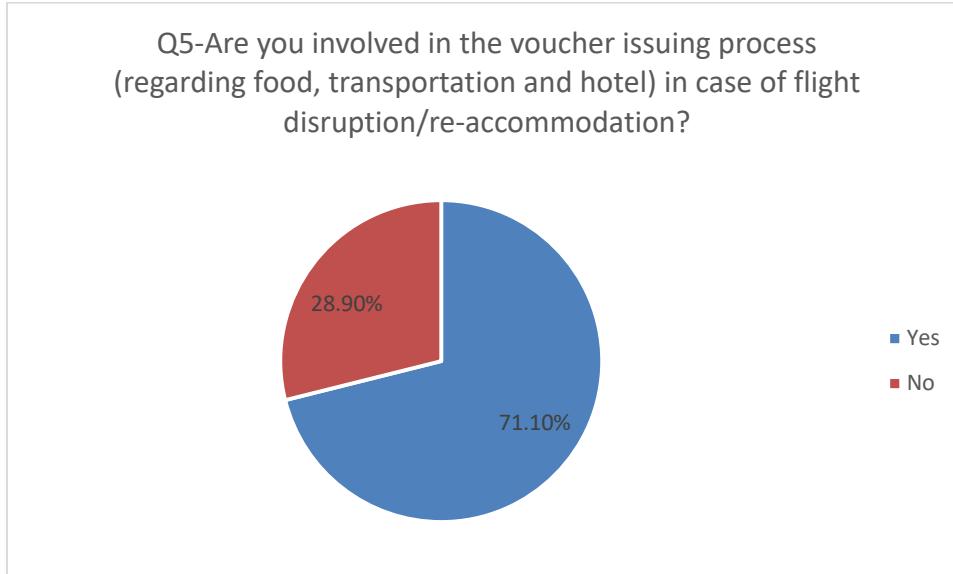


Figure 24. Employees Research Question 5 (Are you involved in the voucher issuing process?)

Regarding the efficiency of the voucher issuance process, 52,6% of the respondents consider it as inefficient.

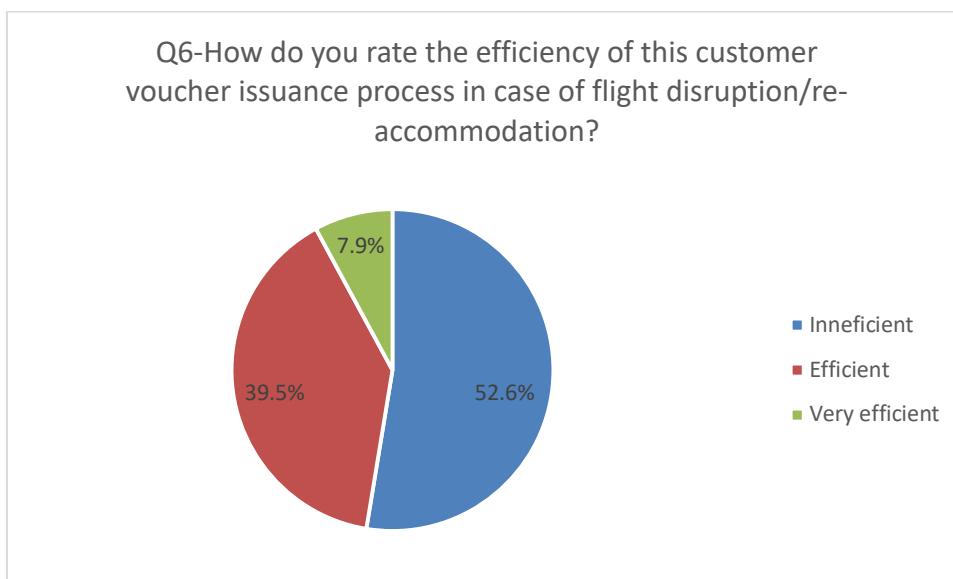


Figure 25. Employees Research Question 6 (How do you rate the efficiency of this customer voucher issuance process?)

Finally, 92,1% of the respondents believe that an automated solution for vouchers issuance would help and make the disruption/recommendation process easier for them:

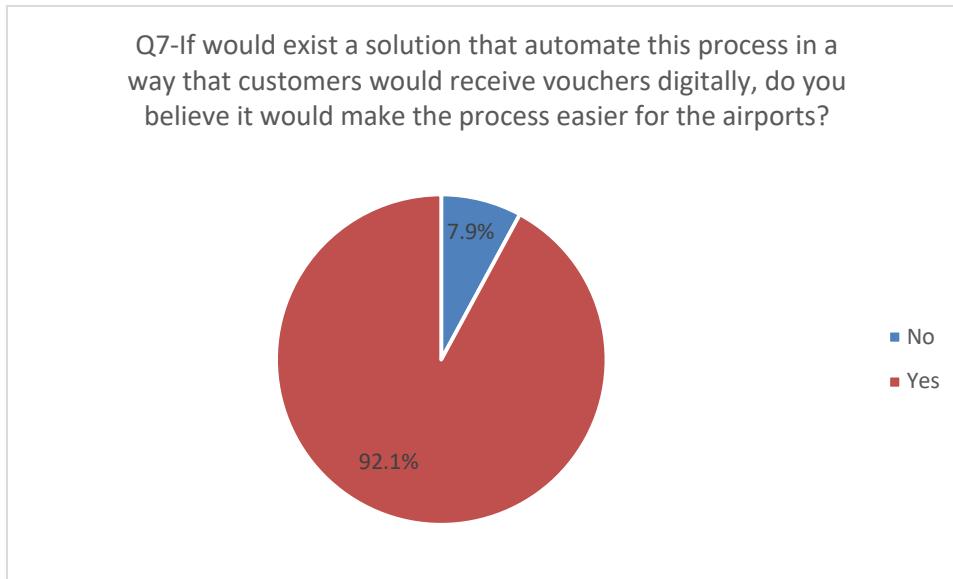


Figure 26. Employees Research Question 7 (If a solution that automates this process in a way that customers would receive vouchers digitally do you believe it would make the process easier for the airports?)

Technical Solution Design

The automation of the process requires the construction of an IT solution, integrated with the Passenger Service System (PSS) of the airline, and implemented in the airline's APP. A PSS is the main system of an airline. It allows the company to manage the network, the pricing, the inventory, and sales. It also allows the airline to execute the check-in and boarding processes of the passengers.

The integration with the PSS is necessary to get the information of the available flights in case of re-accommodation and move the passengers from a flight to another flight. The integration will be made through an Application Programming Interface (API), available in the PSS used in Brazil: Sabre Sonic, Amadeus Altea and Navitaire NewSkies.

The core of the solution is comprised of:

- a set of business services,
- a configuration module that allows the parameterization of business rules to apply,
- a reporting interface to generate a relevant report regarding vouchers issuance,
- an Online Transaction Processing (OLTP) database to store all the transactions executed by the solution,
- an Online Analytical Processing database to store information for reporting,
- a configuration database to store all the parameters values set through the configuration user interface,
- an API to allow the APP consuming the business services,
- a service that generates data feed for the revenue accounting system.

Besides the integration with the PSS API, the solution will integrate with Uber's API to issue a transport voucher. For hotel voucher issuance, the solution will also need to integrate with partners API. The partners can be different from one airline to another, so the number of integrations can vary by the number of partners.

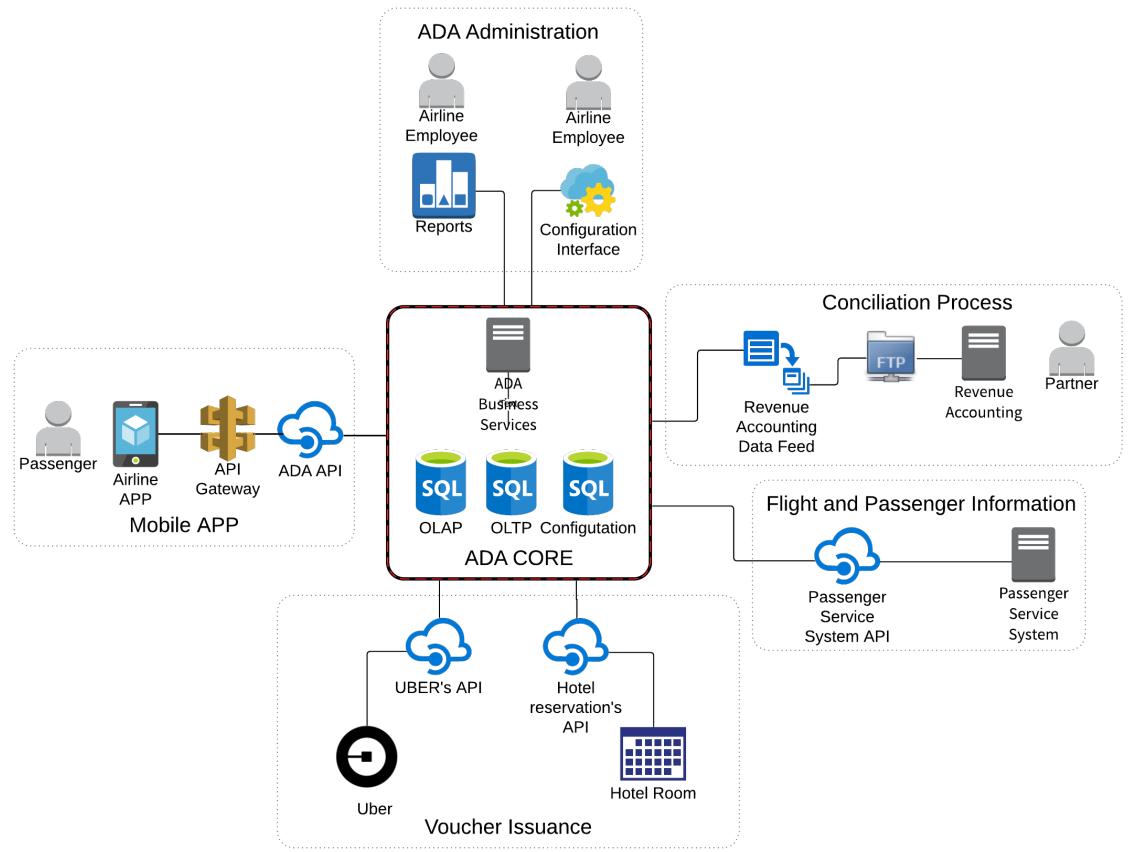


Figure 27. Architecture of the IT solution

Technical Solution Cost

To estimate the cost of the solution, the researchers separated the costs of implementation from the running costs of the solution.

Solution Building Costs

The researchers chose to develop the solution using Microsoft .NET C# for the code. It is one of the most popular modern technology to build applications. And it is what Azul and GOL use to build the majority of its applications integrated into their PSS. For the database, the researchers chose to use Microsoft SQL Server because it is easy to integrate with the Microsoft .NET applications.

Table 7

Breakdown of the cost to build the solution

Category	Item	Unit	Volume	Unit Cost	Total Cost
IT	Administration				R\$
Development	Module	Men Hours	200	R\$ 120	24.000
IT	Business Rules				R\$
Development	Engine	Men Hours	240	R\$ 120	28.800
IT					
Development	Report Module	Men Hours	80	R\$ 120	R\$ 9.600
	Revenue				
IT	Accounting Data				R\$
Development	Feed	Men Hours	320	R\$ 120	38.400
IT	OLAP				
Development	Synchronization	Men Hours	40	R\$ 120	R\$ 4.800

IT	PSS API		R\$
Development	Integration	Men Hours	240 R\$ 120 28.800
IT	Uber API		R\$
Development	Integration	Men Hours	200 R\$ 120 24.000
IT	Hotels API		R\$
Development	Integration	Men Hours	240 R\$ 120 28.800
IT	Meal Voucher		
Development	Issuance	Men Hours	80 R\$ 120 R\$ 9.600
IT			R\$
Development	API for APP	Men Hours	160 R\$ 120 19.200
IT	Front-End of		
Development	APP	Men Hours	80 R\$ 120 R\$ 9.600
	Revenue		
IT	Accounting		R\$
Development	Conciliation	Men Hours	120 R\$ 120 14.400
IT	Personnel		
Development	Training	Men Hours	20 R\$ 120 R\$ 2.400
			R\$
TOTAL			242.400

Running Costs

For the running costs related to the infrastructure, the researchers only take into account the new assets that should be acquired. Some of the marginal costs, such as links or API gateway, are not considered in this study. The current infrastructure of the Brazilian airlines is dimensioned to sustain irrelevant increments that the solution will add.

The researchers also considered some hours spent by the IT teams to maintain the solution and some hours of business analysts to administrate the solution. The researchers obtain the costs of both kinds of professionals from the Azul, GOL, and LATAM.

The researchers chose to host the solution in the cloud, using Microsoft Azure as a provider. Microsoft Azure is one of the leaders in cloud services. The researchers obtain the cost through the Microsoft Azure pricing tool on the corresponding website.

Table 8

Breakdown of the running costs of the solution

Category	Item	Unit	Volume	Unit Cost	Total Cost (Annual)
	Application	Fixed Yearly			R\$
Infrastructure	Servers (2)	rate	1	R\$ 120	13.864,14
		Fixed Yearly			R\$
Infrastructure	Database Server	rate	1	R\$ 120	56.931,22
Human Resources	Maintenance IT				
	Team	Men Hours	96	R\$ 90	R\$ 8.640
Human Resources	Administration				
	Team	Men Hours	192	R\$ 50	R\$ 9.600
					R\$
	TOTAL				89.315,35

Payback of the Solution

The term of the project until the go-live of the project is estimated in 6 months. To run a high-level analysis of the payback of the project, the researchers compared the cost of headcount without the solution, to the total cost of the solution, including the initial cost to build the solution as well as the infrastructure and headcount costs to run the

solution. The researchers executed the calculation annually, considering that the cost of building the solution will be paid in the first year and that the cost of headcount will stop right after the 6th month.

As a result, we see that the impact on the cash flow is negative in the first year, generating a difference of R\$ 127.176. But at the end of the second year, we see that the saving is R\$ 349.055. The payback of the project is less than two years.

Table 9

Cost without the Automated Digital Assistance

Item	Cost Year 1	Cost Year 2
Headcount		
Scenario A	R\$ 565.546,43	R\$ 565.546,43
Headcount		
Scenario B	R\$ 0	R\$ 0
TOTAL	R\$ 565.546,43	R\$ 565.546,43

Table 10

Cost with the Automated Digital Assistance

Item	Cost Year 1	Cost Year 2
Headcount		
Scenario A	R\$ 282.773,22	R\$ 0
Headcount		
Scenario B	R\$ 0	R\$ 0
Building the		
Solution	R\$ 242.400,00	R\$ 0

Maintaining the Solution	R\$ 89.315,35	R\$ 89.315,35
TOTAL	R\$ 614.488,57	R\$ 89.315,35

Table 11

Cost difference

Year	Cost Difference
Year 1	R\$ (48.942,14)
Year 2	R\$ 427.288,95

Implementation

The researchers estimated the timeframe of the solution's implementation in six months. It encompasses the effort of development of the core solution, all the integrations with third parties and the development on the airline's APP.

The training of the carrier's personnel can happen before the final version is ready, using the version available for User Acceptance Test (UAT). As the solution is integrated with the airline's APP and the interaction with the passenger is triggered by a disruption event, there is no need for a particular previous communication with the passengers that already installed the APP on their mobile. Therefore, the availability of such self-service functionality represents a certain competitive advantage for the airlines, so the researchers recommend that the airline mention the service in their current or future marketing campaigns related to their APP to incentive its usage.

Prototype:

A prototype was designed to simulate how the solution works from both airline and customer perspectives. The screens detailed here represent the scenario where the airline canceled a flight and the airline agent needs to propose a new flight option to the customer, so that the customer can reach his/her final destination. The second flow represents the customer affected by this event who received a push notification in his mobile app alerting about the flight cancel. After that, the customer proceed with the flight change process and get the vouchers (material assistance) according to the ANAC 400 Resolution.

Airport Disruption Back-Office Portal

The screenshot shows a web-based application titled "My Airlines | Airport Disruption". The top navigation bar includes links for "Arrivals", "Departures", "Pending" (which is currently selected), and "Done". There is also a search bar labeled "Search flight" and a user profile icon for "User".

FLIGHT	FROM	GATE	DATE	HOTRAN	ETA	PREFIX	PASSENGERS	SSR
! 5	4190	BEL	A5	31/10	12:40 AM	01:14 AM	AQO	38
! 11	1234	CPV	-	31/10	12:40 AM	02:19 AM	AXO	85
! 5	2891	REC	-	31/10	02:25 AM	05:23 AM	YYD	160
! 3	2789	BEL	-	31/10	01:50 AM	05:42 AM	YYA	167
! 1	4309	RAO	-	31/10	06:05 AM	06:55 AM	TKJ	66
! 1	5131	JTC	-	31/10	06:00 AM	07:08 AM	AQI	68
! 1	2829	PVH	-	31/10	05:40 AM	07:10 AM	AXB	103
! 1	5798	SDU	-	31/10	06:10 AM	07:16 AM	AZE	77

Figure 28. Airline back-office portal prototype – list of flights canceled or delayed with the number of passengers affected who need to be assisted

The screenshot shows a web-based application interface for managing flight disruptions. At the top, there's a header bar with a logo, a search bar, and navigation links for 'GRU' and 'User'. Below the header, the main content area has a title 'My Airlines | Airport Disruption' and a subtitle 'Flight 4190 BEL + STM'. On the left, there are two flight summary boxes: one for 'MAO' with 5 passengers and 1 bag, and another for 'TBT' with 2 passengers and 3 bags. To the right is a table listing passengers affected by the disruption:

PASSENGER	TYPE	BOOKING	PRIORITY	BAGS
<input checked="" type="checkbox"/> JOHN SMITH	ADT	ZLV6PH	BLACK	1
<input checked="" type="checkbox"/> SIMONE AIRES	ADT	ZLV6PH	PLATINUM	0
<input type="checkbox"/> JOELMA APARECIDA SOUZA	ADT	SFW3PJ	GOLD	1
<input type="checkbox"/> VINICIUS ZONTA	ADT	WF3FJM	SILVER	0
<input type="checkbox"/> FELIPE AMARAL	ADT	JHT5WQ	-	0

At the bottom of the table area, it says '2 passenger(s) selected'. There are also 'New flight' and 'Save changes' buttons.

Figure 29. Airline back-office portal prototype – customers list affected by the flight disruption event

This screenshot shows a modal window titled 'Flight Options' over a background of the previous page. The modal contains information about the current flight and options to choose a new flight or vouchers. The current flight is '4190 BEL - STM' with passengers 'JOHN SMITH' and 'SIMONE AIRES'. Under 'CHOOSE NEW FLIGHT', there are three options: '5724 STM - BEL - MAO' (selected), '2892 STM - MAO', and '5724 STM - BEL - MAO'. Under 'CHOOSE VOUCHERS', there are checkboxes for 'MEAL VOUCHER' (checked), 'TRANSPORTATION VOUCHER' (checked), and 'HOTEL VOUCHER' (unchecked). At the bottom of the modal are 'Discard changes', 'Save changes', and 'New flight' buttons.

Figure 30. Airline back-office portal prototype – flight options available for the flight change and the vouchers options to be issued

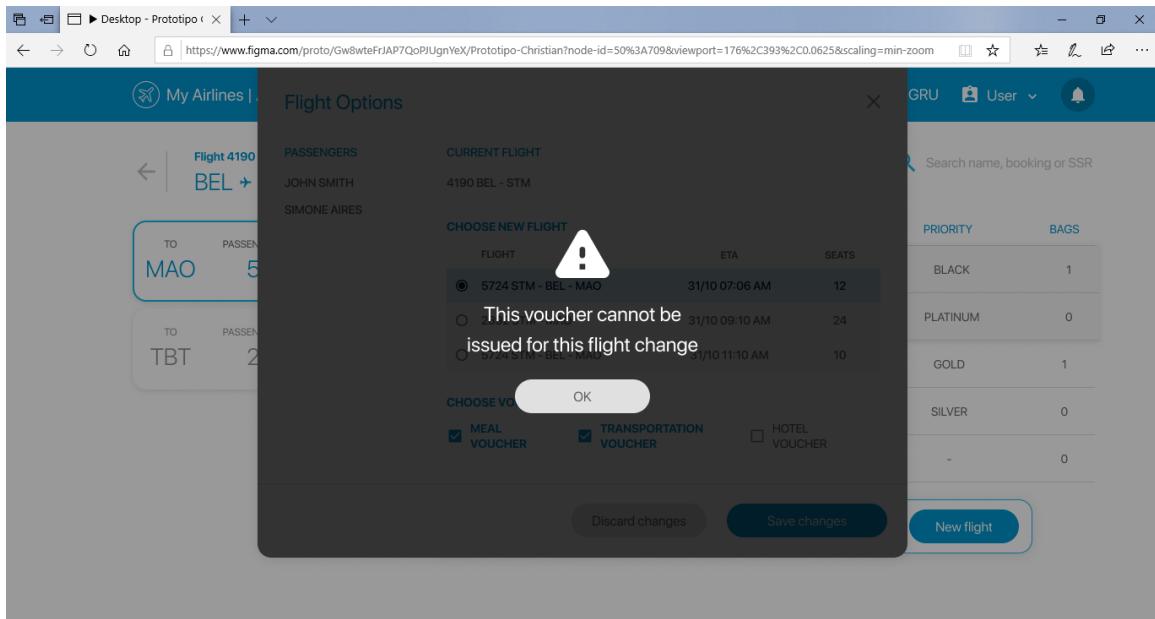


Figure 31. Airline back-office portal prototype – system validation for the vouchers issuance

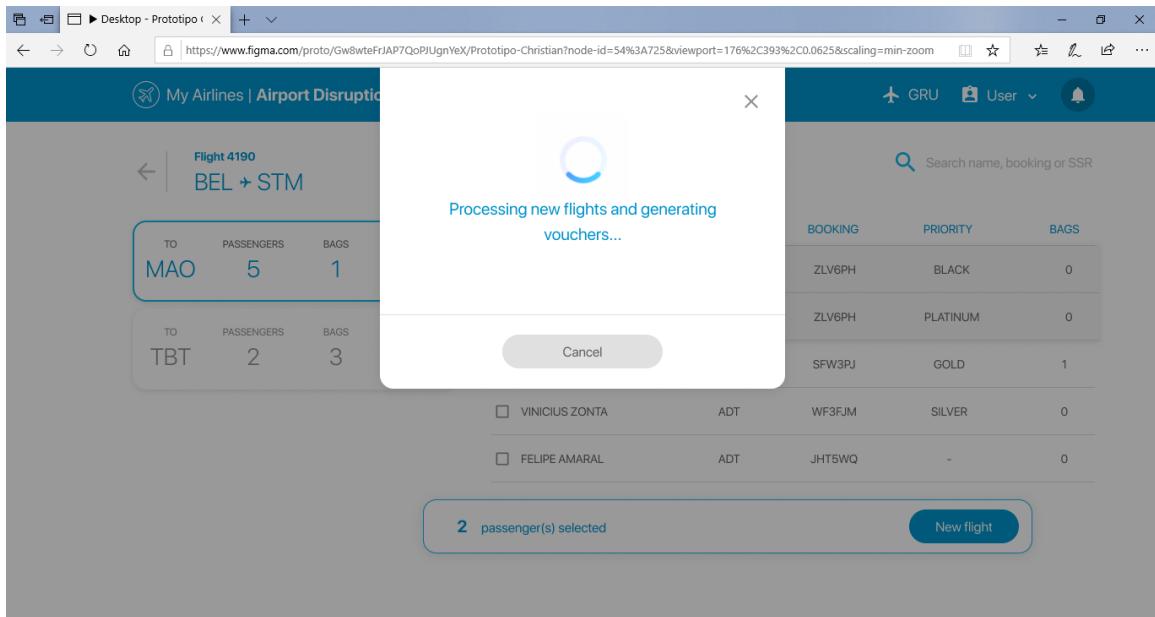


Figure 32. Airline back-office portal prototype – flight change and voucher issuance processing screen

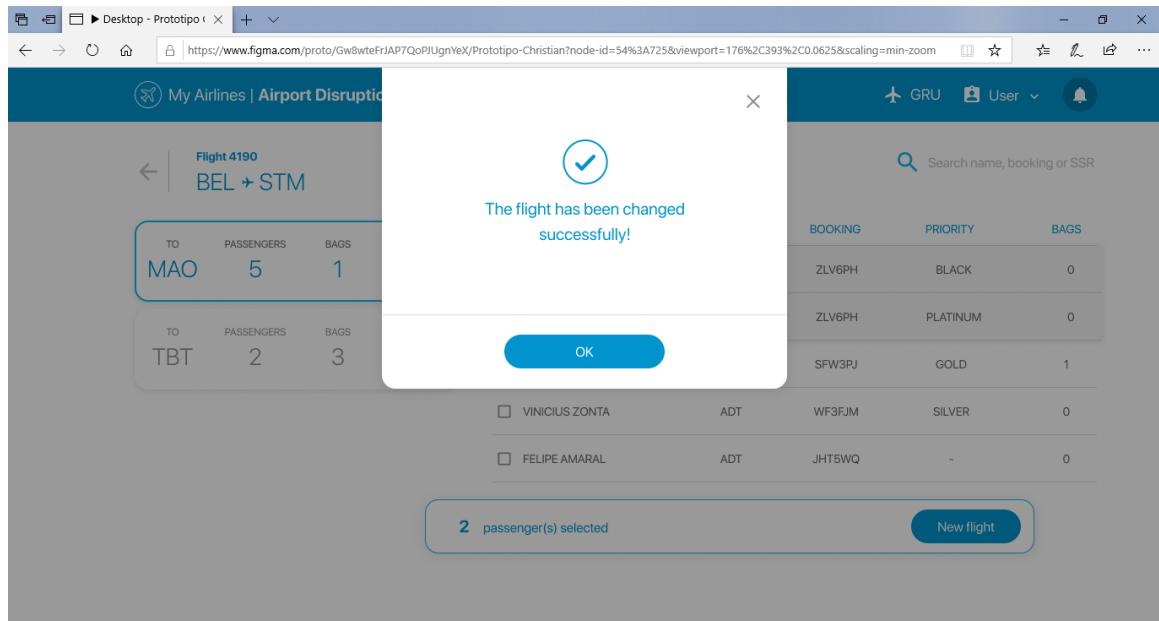


Figure 33. Airline back-office portal prototype – flight change and voucher issuance confirmation screen

Airline app:

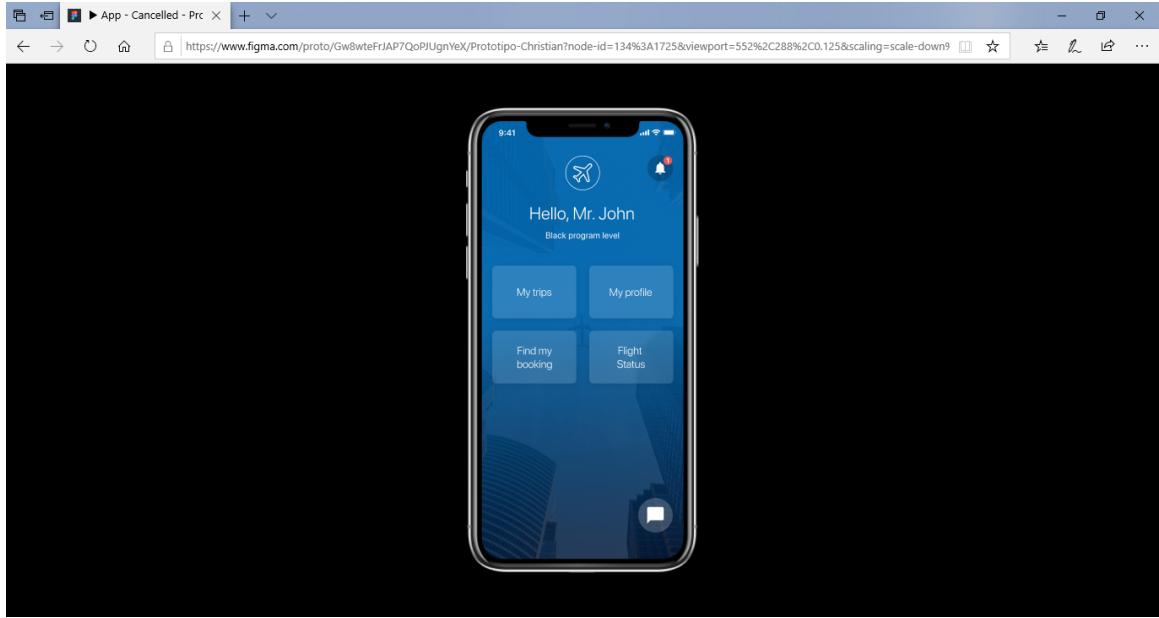


Figure 34. Airline app prototype – airline app screen

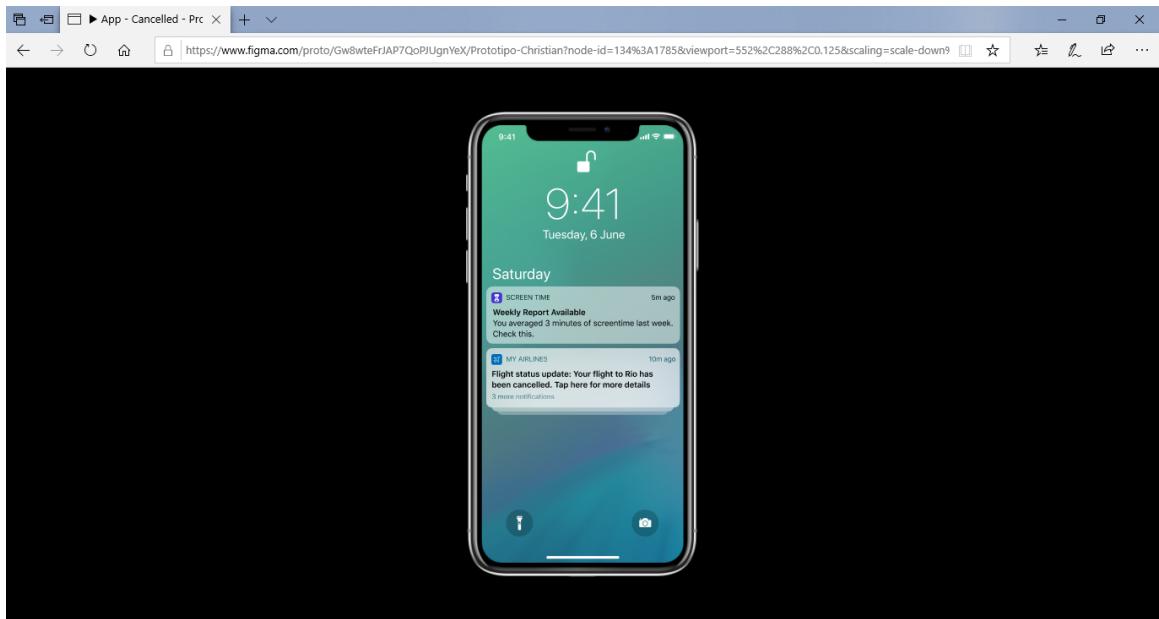


Figure 35. Airline app prototype – push notification with the flight change alert screen

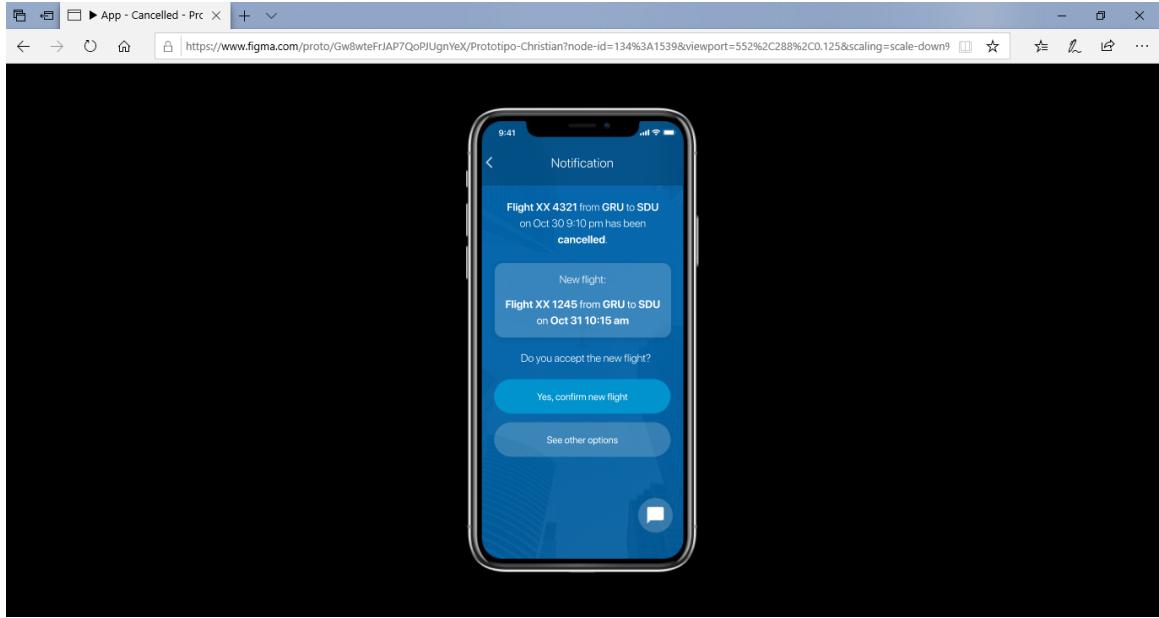


Figure 36. Airline app prototype – new flight proposal screen

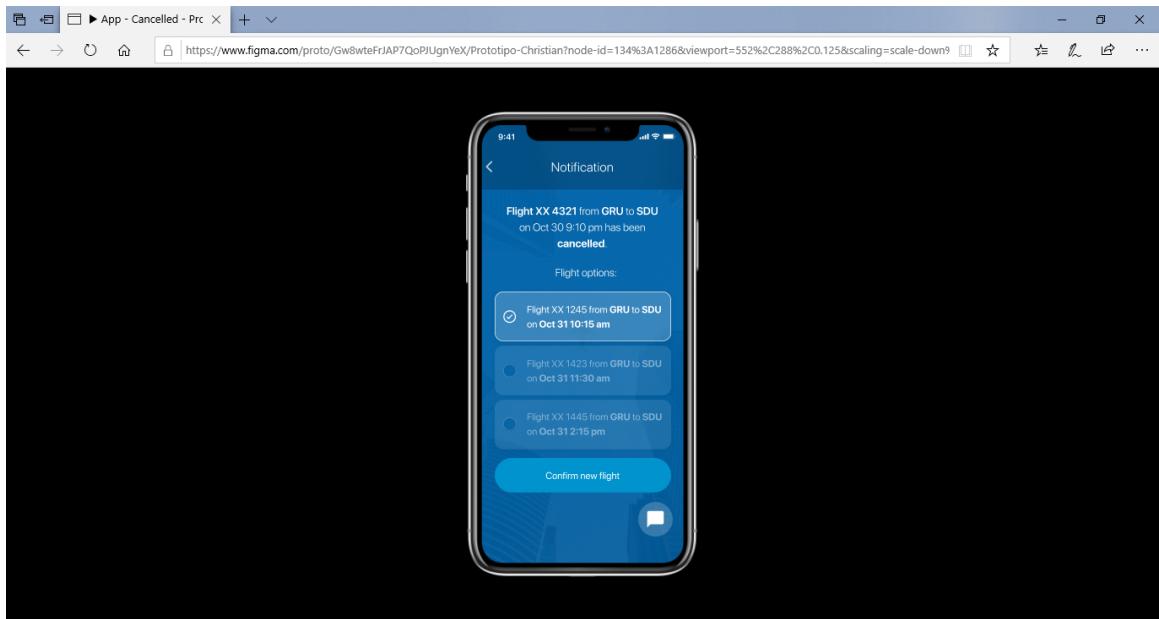


Figure 37. Airline app prototype – other options flights screen

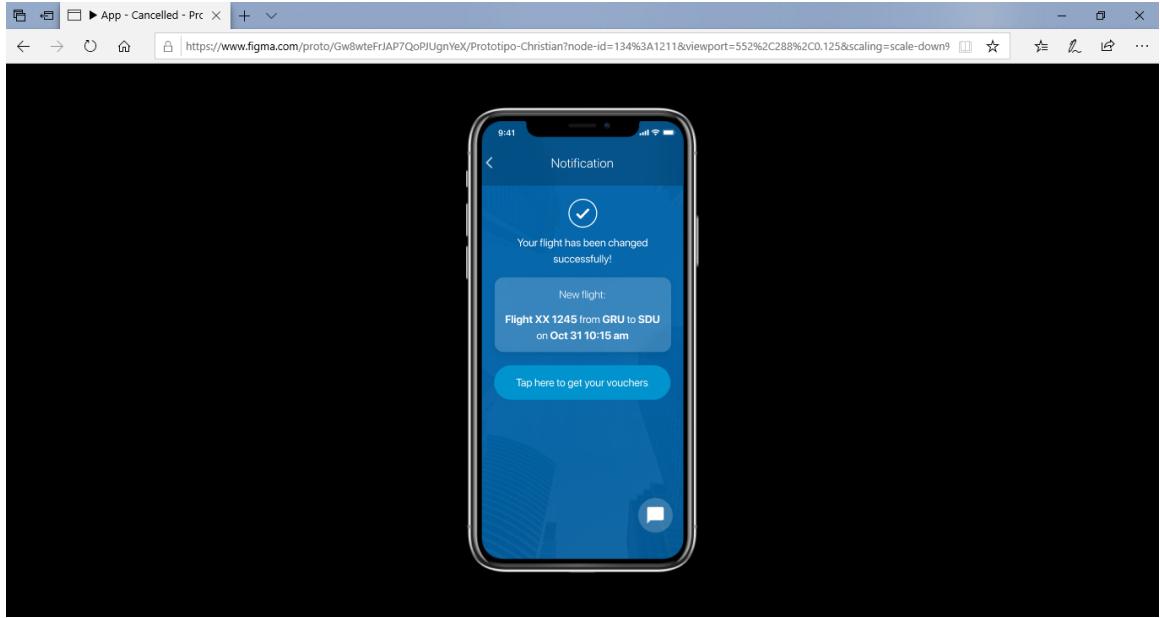


Figure 38. Airline app prototype: flight change confirmation screen

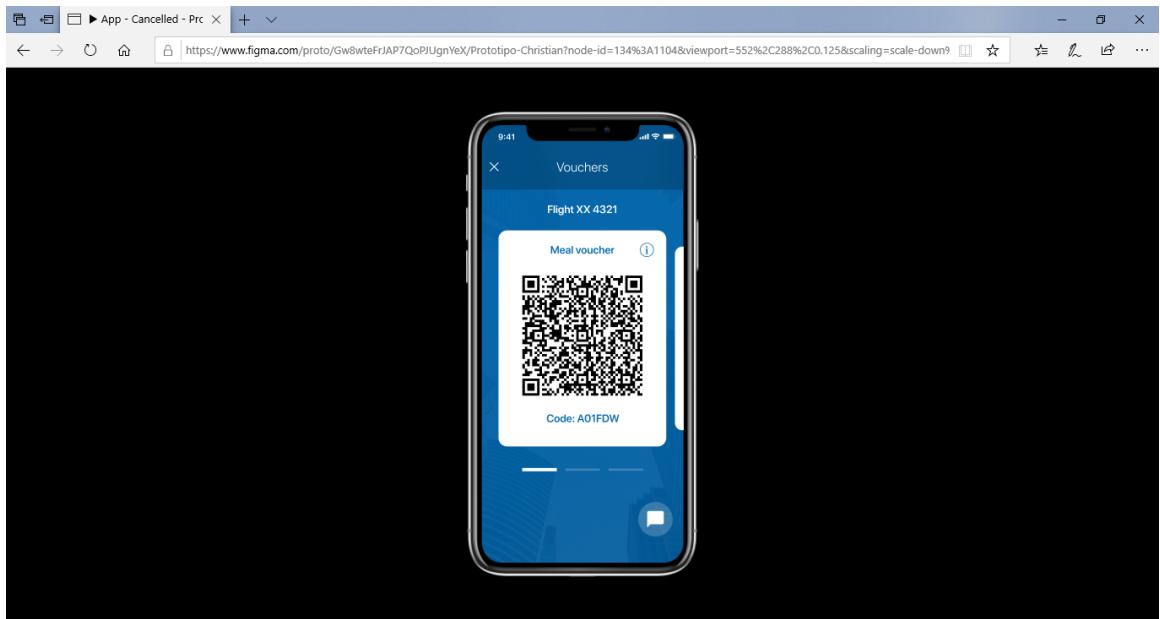


Figure 39. Airline app prototype – meal voucher QR code

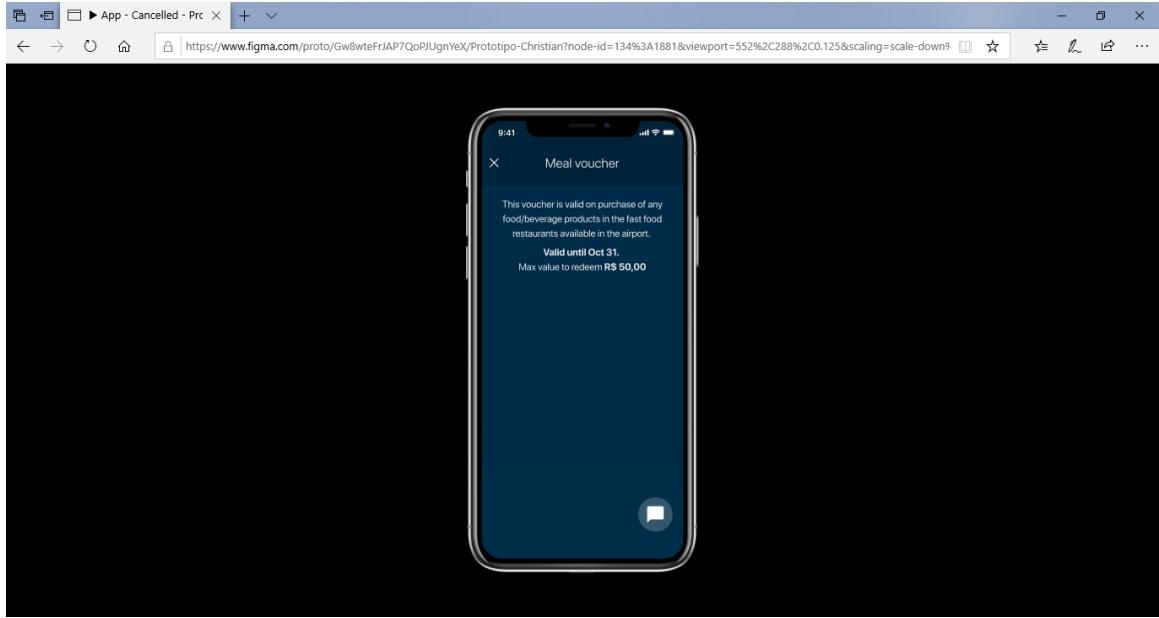


Figure 40. Airline app prototype – meal voucher terms and conditions screen

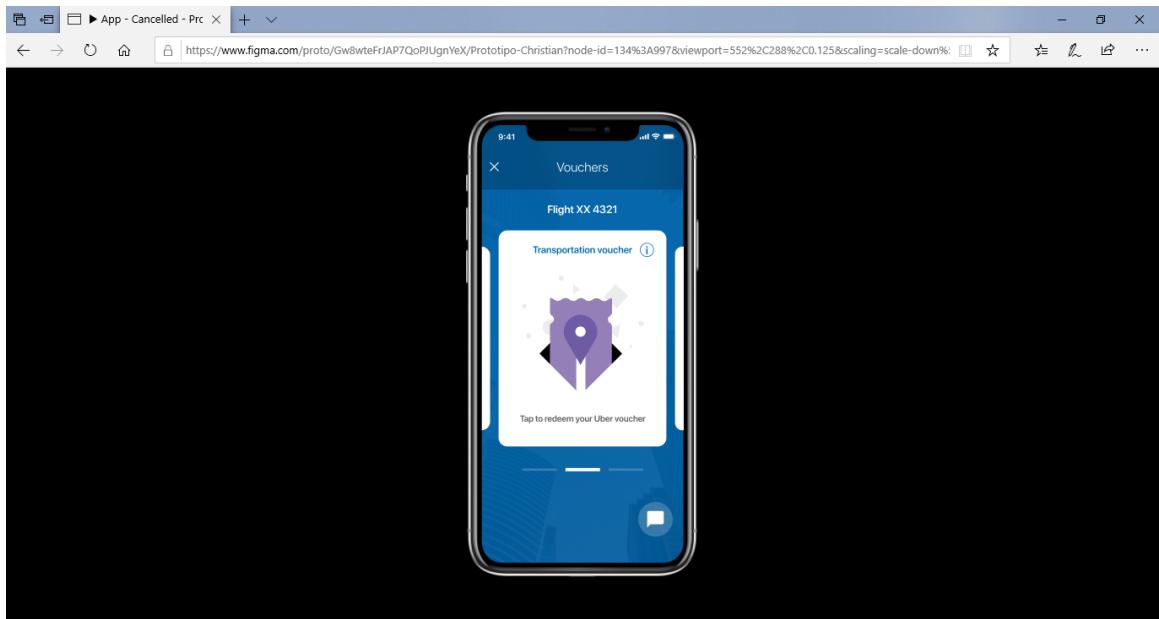


Figure 41. Airline app prototype – transportation voucher screen

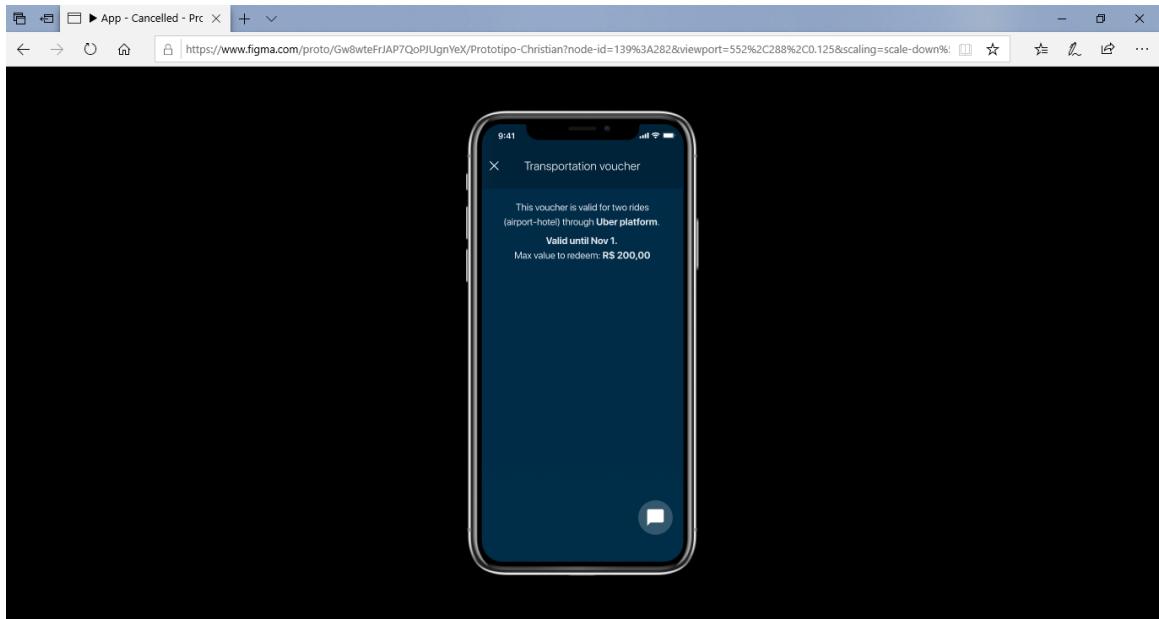


Figure 42. Airline app prototype - transportation voucher terms and conditions screen

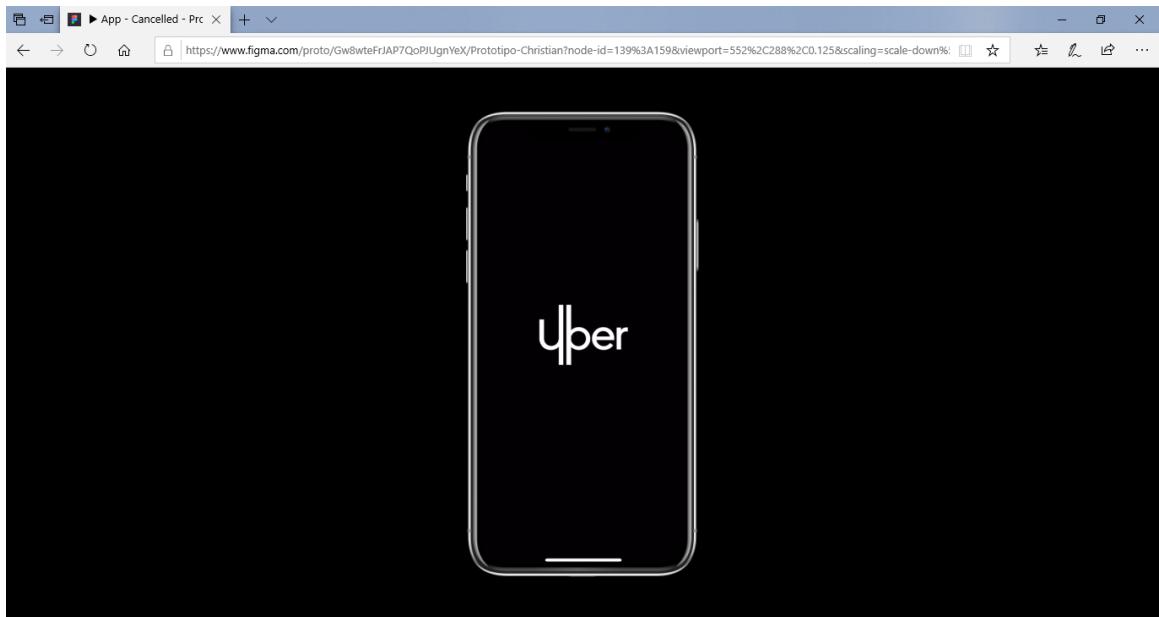


Figure 43. Airline app prototype – link to Uber platform

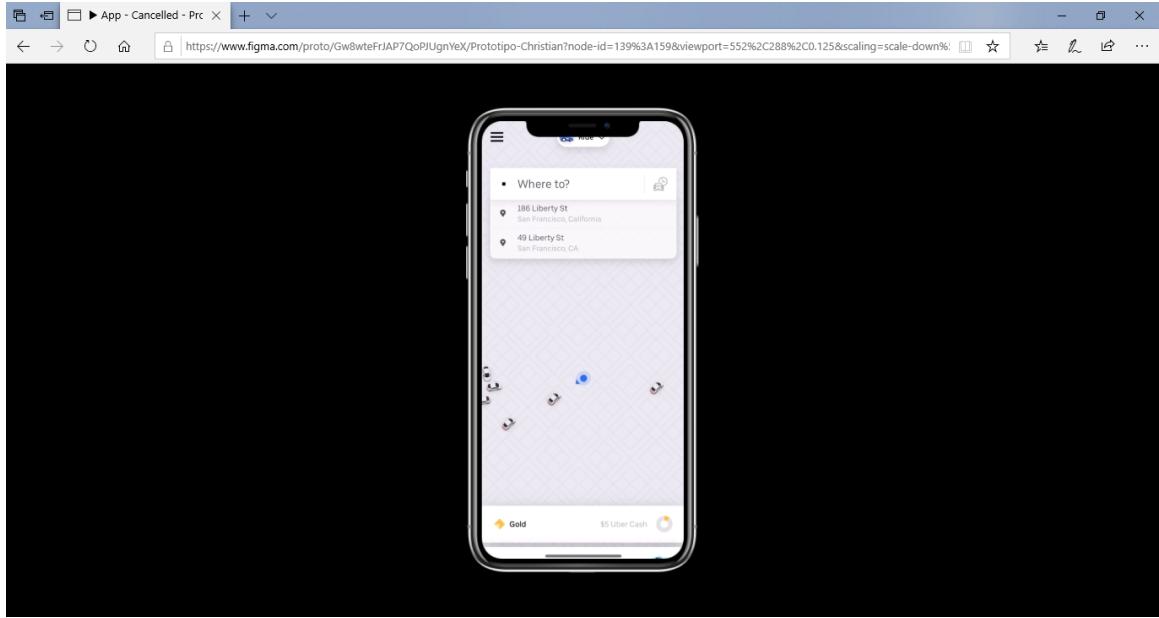


Figure 44. Airline app prototype – integration with Uber platform

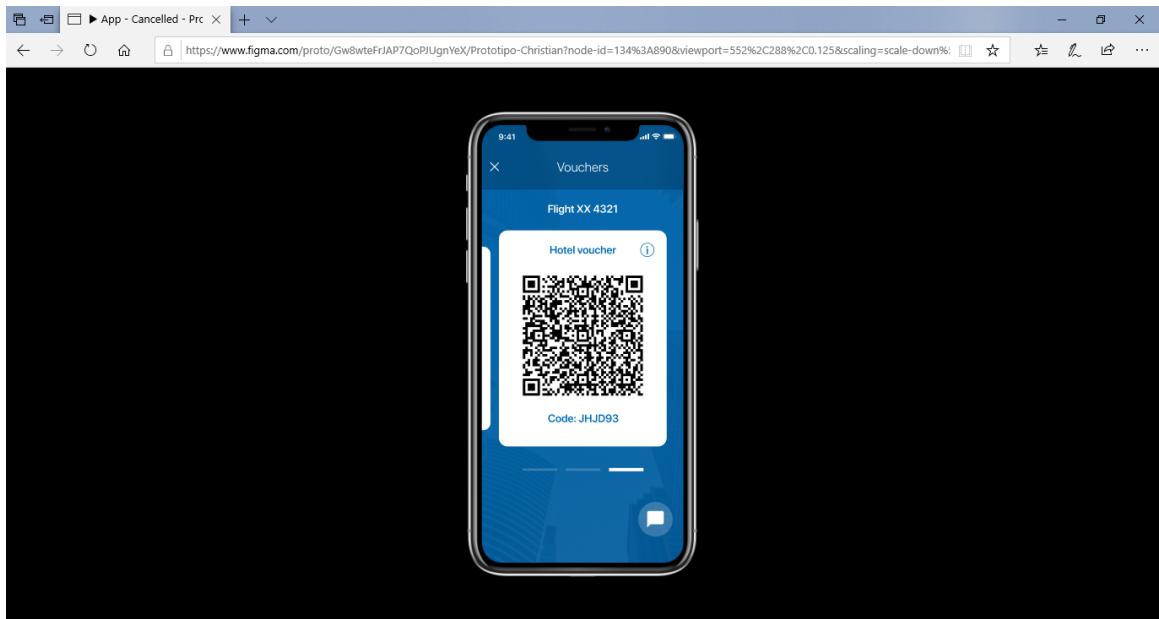


Figure 45. Airline app prototype – hotel voucher QR code

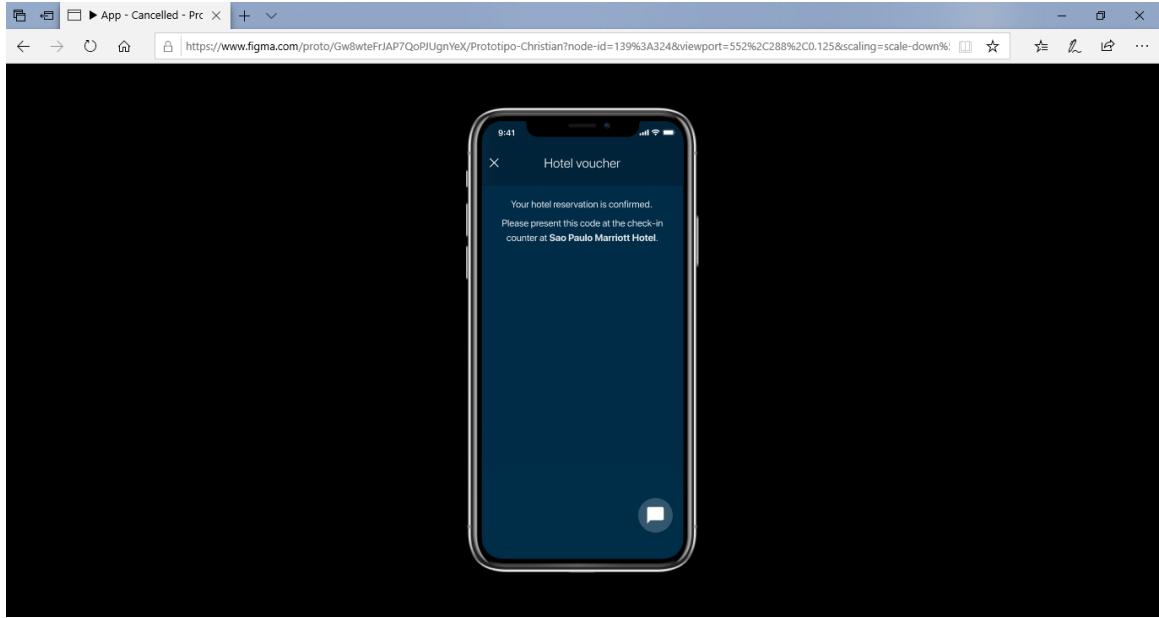


Figure 46. Airline app prototype - hotel voucher terms and conditions screen

Chapter V

Conclusions and Recommendations

Surely, ANAC resolution 400 in Brazil represents an additional operational challenge for Brazilian airlines. Delays or cancellations bring consequences for airline operations. Also, companies need to be agile to minimize impacts on passenger experience, especially when it comes to material assistance, such as meals, transport, and hotel. However, within this challenge, the researchers identified that there are opportunities to turn the process more efficient.

Mobility is one of the key points in this process. The use of devices in customer service drives productivity through interaction with agility, allowing customers to move on their journey without employee's interference or facing long queues at the airport.

Conclusions

By automating processes, airlines will have the opportunity to optimize the ground staff headcount, enabling customers to obtain material assistance according to resolution 400. The purpose of this study was to develop a solution that brings cost savings to airlines as well as to provide passengers with a seamless and smooth experience.

According to our analysis, the ADA project brings R\$ 427.288,95 of saving in two years and an annual saving of R\$ 476.231,08 after the first year. The developing cost is estimated at R\$ 242.400, which means that the payback will be lesser than 24 months. Besides the project being paid, ADA will bring more reliability to the process and will generate a complete database for disruption cases.

The survey showed us that the event of flight cancellation or flight delays greater than two hours is not something that affects the majority of travelers. However, once it happened, most of the people consider the process of getting compensation hard and slow. It showed that the current process is not efficient enough, and there is room for improvement. Also, the survey showed that the vast majority of people prefer to use digital devices rather than waiting for airport agents to support them with hotels, transportation, and meal. Now, from the airport agent's perspective, the researchers could see through the survey that 50% consider the current process not efficient. It also indicates that there is room for improvement, and the automatization of the process is something that the respondents believe will help them with the execution of the tasks. Of course, every change in the operational process takes time to be implemented, requires the engagement of the employees and training. Also, the solution proposed here depends on the existence and utilization of the airline mobile app. The researchers believe this could contribute to the enhancement of the tool and reinforces the importance of it for both carriers and travelers.

ADA brings an innovative solution that aims to identify and bring agility in solving the problems that can occur, generating intelligent solutions for rebooking and material assistance. The tool focuses on allowing customers to choose the services according to their preferences.

Recommendations

Besides the scenarios explored in this study, there are other scenarios with opportunities to be explored in future research. Due to information limitations provided

by airlines, the researchers recommend further studies be conducted to reinforce the tool's gains. There is a huge number of customers with connections flights that are affected by short delays from ten minutes to one hour. Depending on the rebooked flight, material assistance may be required. For this study, the researchers considered the tool being used through smartphones or tablets. Other scenarios could also be explored through kiosks.

Investments in creating customer-centric oriented by digital experiences can facilitate the engagement of current and new costumers. It also can contribute to increasing long-term brand loyalty. Airlines need to find solutions to strengthen ties and keep costumers engaged using technology as a part of the process. Regardless of the mode and how the interaction with customers happens, the customer journey needs to be consistent and positive.

The solution proposed here gives the airline the possibility of tracking all the costs associated with the material assistance with customers. It also brings the benefit of auditing control. However, it is recommended to define an entity in the airline's organization that will be responsible for extracting, analyzing and managing all information provided by the platform. The continuous improvement of the processes depends on the engagement of the team and the focus the airline will give to the subject.

The customer satisfaction evaluation can be widely used to indicate and measure whether the services provided by airlines to its customers are in line with their expectations or are behind. Besides that, airlines can use NPS as a tool to measure the loyalty of company-customer relationships. It is different from traditional customer satisfaction research in that it measures a customer's overall sentiment about a brand, versus their perception of a singular touch-point or transaction. All three major Brazilian

airlines use NPS and believe that there is a positive correlation between NPS and revenue growth. This item may add data regarding the passenger perception regarding the current service. Fodness and Murray (2007) found that the passenger expectations on efficiency and service quality at the airport are growing and impact overall satisfaction.

Finally, the researchers recommend studying the variation in the cost of voucher issuance. As the redemption of vouchers is easier with the self-service solution, the number of redeemed vouchers might increase after the implementation of the solution. Therefore, the corresponding cost increase might be compensated with a cost reduction due to a lower number of passengers suing airlines due to the absence of material assistance.

Key Lesson Learned

The limitation of information regarding the airline's rebooking reports was a barrier to measuring other potential gains. ANAC should request this data from airlines to ensure compliance with 400 resolution, in addition to having a centralized database. Also, airlines would ensure resolution compliance by reports, according to the rebooking and material assistance provided.

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