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Correct Delay Code Assignment

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Embry-Riddle Aeronautical University

Aviation Management Program – Class of 2019

EMBRY-RIDDLE
Aeronautical University
CENTRAL & SOUTH AMERICA

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

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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
University in partial fulfillment of the requirements
for the Aviation Management
Certificate Program

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Abstract

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The air transport market requires high investments, has elevated risks, and low financial return. The competition requires airlines to differentiate themselves by offering better services. On-time Performance (OTP) is an essential service; lack of punctuality affects company costs and revenues. An on-time company generates more satisfaction for travelers, retaining them. Flight delays are identified and reported by airlines through delay codes that are standardized by IATA.

A detailed and specific analysis of an airline's processes was performed to verify the quality of delay code allocation information. It also features the complete mapping of this company's delay code allocation processes and the current quality of the delay code allocation information. In the analysis, comparing the same scenarios for the flights, routes, and departure and arrival times, we found process failures, information divergences, code allocation errors, and differences in the reasons for delays between airlines.

This study generated new proposals for improving the current processes of this airline, ensuring data quality and integrity, process improvement. Other airlines can also use this study to identify and improve their delay code allocation processes.

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Chapter I

Introduction

There are several indicators that airlines can use to measure their performance and the quality of services offered to travelers.

One of the key indicators for the Airline Industry is On-Time Performance (OTP) (Asif, 2013). Airlines focus on On-Time Performance (OTP), mainly due to customer satisfaction, the need to honor the airfare contract, and the costs involved for each minute delay (Cook, 2009).

IATA and official aviation regulators worldwide do not have consolidated data on financial impacts due to flight delays and cancellations.

Due to the high costs involved in flight delays or cancellations, airlines need to have the correct reason information for delays and cancellations.

Correctly identifying the reasons for the delays allows the airline to work on the causes of the delays.

The reasons for flight delays are standardized by the IATA (International Air Transport Association) through codes, which are called Delay Codes. Airlines use these codes to assign the delay of a flight.

In Brazil, the ANAC (National Civil Aviation Agency) responsible for regulating and standardizing the procedures of airlines flying in Brazil, follows the standards set by IATA. The ANAC also determines other delay codes that are not on the IATA list.

In Brazil, airlines send to ANAC monthly the list and reasons for all flights that have been canceled or delayed.

In Brazil, the traveler protection law requires airlines to pay travelers compensation for any delay and flight cancellation, even when the situation is beyond the control of the airlines (e.g., bad weather). ANAC Resolution 400/2016, regulates the obligations of airlines with their travelers.

According to Mazareanu (2019), if we consider a delay of 15 minutes, which is still considered as punctual by the consulting company OAG which supports the “Oscar” of airline’s punctuality every year, we are talking of a cost of $ 811,530,000.00 additionally to all airlines. Due to all this, the companies should have a deep understanding of its operation and the reasons for a delay to have a better On-Time Performance (OTP) and reduce costs.

According to IATA data, in 2018, 4.3 billion people were transported around the world, a total of 46.1 million flights. (https://www.iata.org/pressroom/pr/Pages/2019-02-21-01.aspx).

There are no consolidated statistics or studies in the world that measure total delayed or canceled flights.

Project Definition

Several components can comprise the delayed costs of an airline. Cook (2009) defines that the costs involved in flight delays may be hard and soft.

Hard costs are those that can be quantified. Examples include accommodation in hotels, transfers, issuing a new air ticket, food, etc. "Soft" costs are those that are not easily measured. For example, it is when the customer experiences a new service from another airline due to flight delay or cancellation and realizes that the other company offers excellent service. Another example is the passenger posting on social networks.

According to Airlines for America (A4A), in 2018, the average cost of aircraft block (taxi plus airborne) time for U.S. passenger airlines was $74.20 per minute, as demonstrated in table 1.

Calendar Year 2018	**Direct Aircraft Operating Cost per Block Minute**
Fuel	$ 27.01
Crew – Pilots/Flight Attendants	$ 23.35
Maintenance	$ 11.76
Aircraft Ownership	$ 9.28
Other	$ 2.80
Total Direct Operating Costs	$ 74.20

Table 1 - 2018 average cost of aircraft block (taxi plus airborne) time for U.S. passenger airlines.

Note: Adapted from A4A website: http://airlines.org/dataset/per-minute-cost-of-delays-to-u-s-airlines/

Airlines have opportunities to improve the delay cost management, as illustrated in Table 2.

Phase	Description	Example
Strategic	Resources committed at planning stage: advance contingency for delays	Buffers in schedules: large enough to absorb tactical delays, but without over compromising utilization of aircraft/crew

Tactical	Pre-departure	Slot management process. (Also decision point for fuel uplift.)	Re-route: accepting/filing a longer route to bring a departure slot forward
	Airborne	Speed/route adjustment; depends on ATC, weather, fuel uplifted	Change of cost ; request to ATC for change to filed plan
	Post-flight	Aircraft, crew, and passenger delay recovery	Re-booking delayed passengers. (Potential of associated 'soft' costs.)

Table 2 - Delay cost management by phase of flight

Note. Adapted from website

https://www.eurocontrol.int/eec/gallery/content/public/document/other/other_document/200905_D2Y1_Cost_of_delay.pdf

To reduce flight delay, the airlines must know what is causing a delay.

The process starts with reviewing the delay codes that ideally should be assigned properly. This review process permits the company to act on each cause delay situation and take corrective actions.

To work precisely on the leading cause of these delays, airlines use IATA, local regulators codes (such as ANAC), and company delay code. Once identified, the airlines address this internally.

To standardize of delay codes, IATA publishes and recommended the delay codes as a reference for airlines to reference. However, airlines in their processes may add other codes of delay.

ANAC, through publication (ANAC Ordinance 791/2012), follows IATA recommendations and standardizes delay codes following the same recommendations. It also allows the airline to be able to determine more delay codes within the airline's internal process.

The main objective of this study is to analyze whether the current delay code allocation processes of a Brazilian airline are safe, ensuring data quality. There is a suspicion that the allocation of the delay codes is not correct.

If delay codes do not reflect the reality of actual situations, the airline's action plans to mitigate delays will be inefficient.

The relevance of this study is to ensure the high quality of delay data to allow Brazilian airlines building action plans for mitigating the delay genuinely efficient and effective.

The purpose of this study is not to focus on cost savings due to improved on-time performance and customer satisfaction. The target is the quality of delay data analysis that will help the airline build efficient and timely action plans with data collected correctly.

During the review of current processes, a report may be proposed for improvement if faults or insecurity about allocation code information or procedures.

The quality and security of the data you enter will allow this airline to work out the real reasons for flight delays, and work to improve On-Time Performance (OTP).

In table 3, ANAC data from 2013 to 2018 show the number of delayed flights and the reasons for the delays. According to the ANAC 791 Ordinance, ANAC (2012) airlines report the reasons for the delays, using as reference the delay codes published by ANAC.

Code	**Description**	**Type**	**Laram**	**Gol**	**Azul**	**Total**

AR	Operational Restrictions at the Airport	External	112.444	48.830	1.144	162.418
AT	ATC restriction en-route or capacity	External	86.264	9.631	49.404	145.299
RA	Aircraft rotation, late arrival of aircraft from another flight or previous sector	Internal	21.192	45.537	17.103	83.832
RI	Aircraft Rotation/Return - Non-Penalized outbound flight due to interdicted airport	External	283	41.661	24.079	66.023
TD	Aircraft defects	Internal	14.623	7.162	35.478	57.263
RM	Aircraft Rotation/Return - Non-Penalized outbound flight due to metheorological conditions	External	17.802	19.598	19.705	57.105
MX	Non specific delay – Others	Internal	-	28.005	19.450	47.455
MA	Automotive and Pax Service Failure	Internal	6.538	24.857	5.404	36.799
AS	Mandatory security	Internal	16.132	9.055	4.281	29.468
WO	Departure station – Weather	External	10.076	9.813	5.444	25.333
AJ	Interdicted Destination Airport	External	2.328	22.457	-	24.785
WT	Destination station - Weather	External	8.644	6.265	4.455	19.364
AF	Airport Facilities, parking stands, ramp congestion, buildings, gate limitations, ...	External	784	9.960	2.955	13.699
TC	Aircraft Change	Internal	2.792	2.459	7.845	13.096
VR	Special test flights - Returning to origin	Internal	-	1.196	8.534	9.730
WA	Alternate airport bellow meteorological minimums	External	9.702	-	-	9.702

FP	Flight plan, late completion or change of flight documentation	External	2.148	1.349	243	3.740
AI	Interdicted Origin Airport	External	2.731	527	115	3.373
GF	Fuelling, Defuelling, fuel supplier	Internal	2.201	597	361	3.159
No Info	No Info	No Info	2.809	-	-	2.809
AO	Authorized Delay	Internal	2.333	7	32	2.372
WR	En route or Alternate – Weather	External	6	-	2.234	2.240
HI	Authorized Antecipation Time Change - Only International Flights	Internal	-	1.495	-	1.495
AA	Delay on alternate airport - Technical Demand	External	461	866	-	1.327
AG	Immigration/Customs/Health	External	380	385	477	1.242
DF	Failure during flight operations	Internal	107	203	554	864
VE	Specific for special test flights	Internal	-	1	621	622
WS	Removal of snow/ice/water/sand from airport/runway	External	347	4	7	358
DG	Failure during ground operations	Internal	-	144	42	186
WI	De-Icing of aircraft, removal of ice/snow, frost prevention	Internal	43	19	90	152
HÁ	Authorized Time Change	Internal	-	1	62	63
AM	Delay on alternate airport - Metheorological Conditions	External	-	45	-	45
IR	Addition of flight leg due to returning special flight	Internal	-	8	18	26

WP	Return of flight due to technical order	Internal	-	1	-	1
			323.170	292.138	210.137	825.445

Table 3 - Major Brazilian Airlines Delay Codes (2013-2018)

Note. Adapted from ANAC, period 2013-2018, website https://www.anac.gov.br/assuntos/dados-e-estatisticas/historico-de-voos

Table 3 above indicates that most of the delay codes used by Brazilian Airlines are related to external facts. The AT code is under the responsibility of a third-party agent and does not allow the airline to act directly on the cause. In Brazil, DECEA – Air Traffic Control Department, which is a subdivision of the Brazilian Air Force, controls the air traffic.

Even flying at the same airports, and having flight departures at equal times, there is a significant divergence between the reasons for the delay.

Considering the divergence of the delay codes allocated by the airlines in Brazil, the researchers will compare the airline network and find domestic flights in the main airports operated by the three airlines.

Although IATA and ANAC have standardized delay codes, each airline can use the codes differently.

We will challenge the misuse of the codes and the impacts, and present the actions needed to mitigate future delayed flights.

Due to the complexities in the identification and measurement of delays, it is essential to carry out a careful review of the delay code allocation.

An increasingly accurate and high-quality data must be available to management for decision-making purposes. Reliable data on the reasons for the delay are essential to analyze the facts and factors and to define an operational improvement strategy.

Project Goals and Scope

The purpose of this study is to streamline and re-engineer the process to ensure the right use of the delay codes.

Uncertainty about whether the delay codes are correct will leave the company vulnerable and will not be able to act on the cause of the delays, which severely affect airline profitability. The correct assignment of the delay codes, as well as ensuring the correct operation of the system, allow airlines to act on the exact causes of the delays. This would result in a significant saving in resources and costs of the delay to the airline, crew, fuel, maintenance and fleet costs (Cook, 2009).

Definitions of Terms

Air carrier	means a regular Brazilian or Foreign air transport companies with a valid operating license.
Block time	the total time between the aircraft engines starts work and stops work.
Cancellation	the non-operation flight which was previously programmed.
Delay	an operation flight which the departure time occurs after the previously programmed.
Delay Code	means the identification code to determine the reason for the delay.
Disruption	means an interruption in the airport process that could cause flight cancellation or flight delay.
External	responsibility identification of the delay, it is outside the company control.
Turnaround time	means the time between the time the aircraft arrives and the time the aircraft departs on the next flight.
Flight	a journey using an aircraft to connect two cities to transport passenger.
Internal	responsibility identification of the delay, it is inside the company control.
Taxi in	means the period between the aircraft engines stars work and the takeoff.
Taxi out	the period between the landing and the aircraft engines stops of work.

List of Acronyms

A0	means an operation flight that arrives on time.
A15	an operation flight that arrives delayed no more than fifteen minutes from previously arrive programmed.
A30	an operation flight that arrives delayed at least thirty minutes from previously arrive programmed. This code is used to identify the arrives delayed after sixteen minutes once A15 identifies the arrives delayed until fifteen minutes.
ABEAR	Brazilian Association of Air Carriers.
ACARS	Aircraft Communication Addressing and Reporting System.
AHM	Airport Handling Manual
ANAC	Brazilian National Civil Aviation Agency
D0	means an operation flight that departs on time.
D15	an operation flight that departs delayed no more than fifteen minutes from previously departs programmed.
D30	an operation flight that departures delayed at least thirty minutes from previously departs programmed. This code is used to identify the departures delayed after sixteen minutes once D15 identifies the departures delay until fifteen minutes.
DECEA	Airspace Control Department in Brazil
FAA	Federal Aviation Administration.
IATA	International Air Transport Association.
Nextor	Consulting Company
OAG	Consulting Company
OCC	Operations Control Center

OTP	On-Time Performance.
U.S.	United State of America

Chapter II

Review of the Relevant Literature

For airlines, flight delays are one of the significant challenges to be mitigated on the operation due to several factors, such as identifying the actual cause of the delay, the impacts of the delay on the airline networking, and the consequences of the delays for the passengers (Sarseshiki et al., 2010).

Conceptually, a flight delay occurs when an airline flight takes off and lands later than its scheduled time. According to the Federal Aviation Administration (FAA), the delay occurs when it is 15 minutes later than its scheduled time. A cancellation occurs when the airline does not operate the flight for a precise reason.

Delays occur at any stage of the airline operations, as illustrated in Fig. 1.

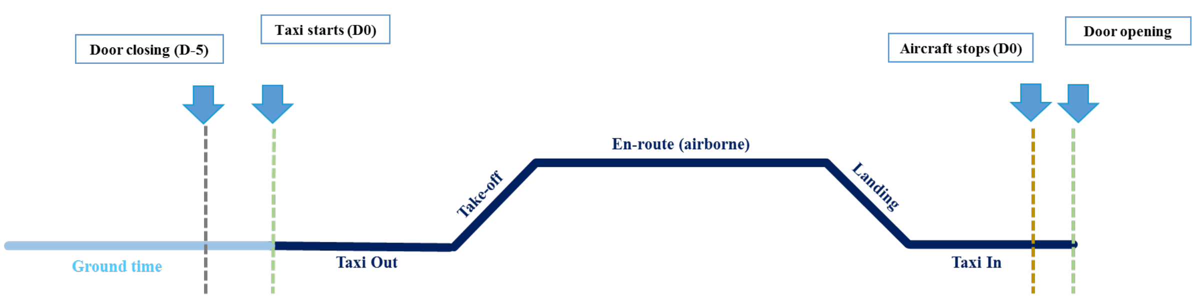

Figure 1 - Flight main stages

Most airlines follow the IATA coding system for meeting the requirements of delay data reporting to aviation authorities in different counties. High-quality delay data are essential in post-operation analysis to guide future operational and scheduling improvements. For airlines, this data is used mostly for schedule improvements to reduce operating costs (Truong and Wu, 2014).

In Brazil, as required by IAC 1504, airlines use the delay codes defined by ANAC (Resolution 218).

There is no recommendation or guidance from IATA or ANAC, indicating the situations and which codes the airlines must consider defining the reason for a flight delay.

The absence of guidance gives airlines the freedom to assign the delay code. There is no rule or enforcement over the reasons for the delay, not even a charge from the regulatory authorities requiring airlines to act effectively on the reasons for the delay, reducing its occurrence.

In Brazil, as ANAC defines the compensation should be offered to passengers in case of flight delay or cancellation, as follows.

Flight delay, cancellation and refused boarding - ANAC Resolution 400/2016

According to ANAC Resolution 400/2016, in cases of flight delays, flight cancellations, or refused to board, passengers who attend the boarding are entitled to receive assistance by airlines.

Assistance is gradually offered, according to the waiting time, counted from the moment of the delay, cancellation or refused boarding, as follows:

- one hour: communications (e.g., internet, phone calls);
- two hours: catering (e.g., voucher, snacks, water);
- four hours: accommodation/lodging and transportation to and from local accommodation facilities.

If the passengers are in their domicile, the airline may only offer transportation to their residence and from there to the airport again.

If a flight delay exceeds 4 hours (or if the airline is already aware that the flight will be delayed for more than 4 hours) or in cases of cancellation or refused boarding, the airline must also offer the passenger options of rerouting or refund.

Passenger rights in case of more than 4 hours of delay.

If passengers are at the airport of origin:

- Receiving a full refund, including airport tax. In this case, the airline may suspend assistance;
- Rebooking the flight to any date of your convenience, without any cost. In this case, the airline may suspend assistance;
- Boarding on the next flight, offered by the same airline, to the same destination, if there are seats available. The airline must offer assistance.

If passengers are at stopover or connection airports:

- Receiving a full refund and returning to the airport of origin without any cost. The airline must offer assistance.
- Staying at the location where the interruption occurred and receiving a refund of the unused portion. In this case, the airline may suspend assistance.
- Boarding on the next flight, offered by the same airline or by another one, to the same destination, if there are seats available. The airline must offer assistance.
- Concluding your travel by other means of transportation (bus, van, taxi, etc.). The airline must offer assistance.
- Rebooking the flight at no cost for date and time of your convenience. In this case, the airline may suspend assistance.

Flight delays are costly for airlines. The cost impact varies depending on the reason and stage at which delays occur. However, compensation for passengers for delays is not always caused by the airline (e.g., weather) increases these costs.

Operation without delay will help to honor the contract between the traveler and the airline, avoiding additional costs in case of flight delay.

To keep operations running without delay, companies must have flight delay information entered correctly. Confidence of information will allow for solutions to the real causes of delays.

Current delay code assignment practice of one Brazilian Airline

The ground handling department typically performs delay recording. The air traffic control authorities and airports may also record their data for airspace/airport capacity for monitoring purposes (IAC 1504).

For this study, we analyzed the delay code assignment process of one airline in Brazil, as published in its internal policy (B-COV-001/2017).

The policy provides a set of information to explain the importance of the correct assignment of the delay code. The purpose of this policy is mainly to inform the process for the continuous improvement of On-Time Performance (OTP).

The policy emphasizes that there is an opportunity for a better evaluation of the causes of flight delays by obtaining more details and better targeting the action plan of each area. A different matter that the document also deals with is transparency for the operation.

As a standard for the delay code assignment, the airline opted to allocate a maximum of three delay codes per flight: two delay codes related to direct delays and one related to a consequent delay.

The direct delay means that the delay occurred during the flight stages and was not affected by the previous flight.

The consequent delay means that the flight was affected by the last reason flight why the flight departed late (e.g., the previous flight arrived late).

To calculate the direct delay of delayed flight, the airport agent needs to know the minimum turnaround time of each aircraft. The airline used as an example in this study considers the minimum turnaround time, as demonstrated in Table 4:

:

Minimum Turnaround Time - Domestic Flights				
Aircraft Type	ATR	E90/E95	A320	A330
Turnaround time	00:30	00:30	00:40	01:35

Minimum Turnaround Time - International Flights				
Aircraft Type	ATR	E90/E95	A320	A330
Turnaround Time	00:35	00:30	00:40	02:00

Table 4 - Minimum turnaround time per aircraft model defined by one Brazilian airline

Note: retrieved from the delay code assignment policy of one Brazilian Airline (F-CCO-002/2019).

According to the airline general airport manual, the airline works with push back time for on-time performance purposes and also considered when the aircraft doors closing.

The airline classifies the delay code as follows:

D0 - Delays from 1 minute, for company control only.

D15 - Delays from 15 minutes for company control and ANAC (Brazilian National Civil Aviation Agency).

D30 - Delays from 30 minutes to control the company, airport managers, and INFRAERO.

Fig. 2 illustrates the process to assign the proper delay code:

Delay Reason	Analyze	Code	Disclosure
			Update McWeb Sabre system
Aircraft ARR delay	Yes?	No?	
	Assign RA code	Without RA CODE	
First Direct Delay	Investigate the reason and delay time	Assign direct delay code	
Second Direct Delay	Investigate the reason and delay time	Assign direct delay code	

Figure 2 - Summary of delay code assignment process

Note: adapted from the delay code assignment policy of one Brazilian Airline (F-CCO-002/2019)

In the airline analyzed, the airport department is responsible for the delay codes assignment. Airport agents are responsible for identifying the cause of the delay and defining the appropriate delay code. Airport agent assigns the delay codes manually in the aircraft control system only after a consensus among the various operational departments, (B-COV-002/2017).

Part of the process aims to ensure code assignments for all delayed flights. Identification must occur on all flights.

After 30 minutes of flight take-off, if no delay or divergence code is assigned, an alert shall be issued by the radio station to the flight captain, who shall indicate the code. (POP-CCO- 001/2018).

If there is no agreement on the delays between the departments, the disagreeing operational department shall contest the delay by e-mail to the airport manager involved in the delay. The manager evaluates the assigned delay code by changing or confirming what was previously assigned.

Flight coordination has no action in the assignment of delays and cannot change any assigned delay code previously entered into the system by the airport agent.

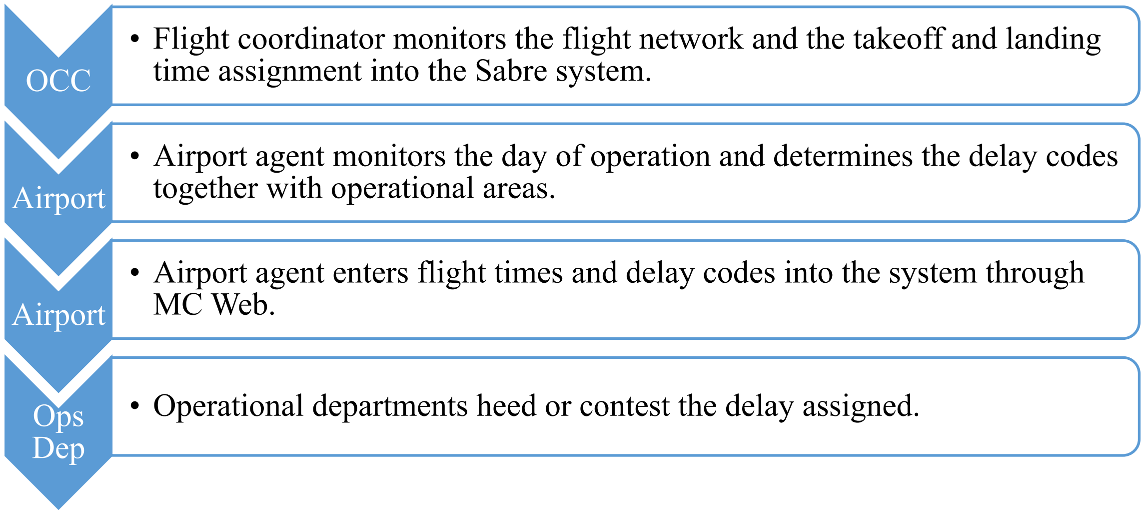

Figure 3 - Actual delay code assignment of one Brazilian Airline

Note: retrieved from the airline policy (B-COV-002/2017)

During the turnaround time, many activities take place between landing and takeoff. Passengers who need to disembark from the aircraft, aircraft cleaning, scheduled maintenance, documentation, crew change, refueling, load, and unload luggage, are few examples of the multiple activities that that coincide. It is well-known that low-cost carriers strongly focus on short turnaround times and an absence of turnaround buffers (Wu, 2010).

The airline expects to operate on-time, as scheduled, except when uncontrollable conditions and adverse weather result in delayed operations. In the case of a flight that does not run on time, it is the responsibility of the company airport agent designee to code it.

The aircraft arrived on time, no consequent delay of the previous flight code is assigned. If there is a delay due to a prior flight delay, the delay code assigned is the same as the last flight.

If the aircraft arrives late, and there is a new takeoff delay, the flight will receive more one code. Under these conditions, there will be two codes, one from the previous trip and one from the current flight.

According to the General Airport Manual (MGA) M-APT-001/2019, the airline's airport agent is responsible for identifying the cause of these delays and assigning the two delay codes in the system.

Defining the cause of the delay depends on the interpretation of the airport agent. This process is not automatic. The delay code allocation policy does not guarantee that the allocated delay code accurately represents the event that caused the delay.

Another policy has been published by the Flight Ops to ensure pilots enter the delay code in the logbook, which is called divergence in the delay codes assignment. According to document RT-OPS-49/17, when there are differences in the attribution of the delay code between the captain and company airport agent, the captain shall report the divergence in the logbook.

According to the internal airline policy, the captain, can assign in the logbook the delay code without debate or discuss it with airports. In this case, the delay code allocated by both (captain and airports) may differ. It shows evidence of possible incorrect allocation of delay codes.

Another evidence of weakness in the process is the possibility of the airline works with push back time or doors closing for on-time performance purposes. In this case, the interpretation of the company airport agent is free.

The other evidence of weakness in the document RT-OPS-49/17 is the captain has the prerogative to assign the code he considers most appropriate in logbooks. In this case, for the same delayed flight, two variables are considered.

The purpose of this study was to investigate delay code allocation to propose a robust delay code assignment policy.

We also consider automating the entire process to provide data automatically.

The departments will only develop action plans to mitigate the delays if they receive accurate information on the reasons for the delay**.**

This practice is costly and time-consuming and brings the opportunity for process improvement.

This company allowed field research to study the perception of its employees in the areas directly involved with On-Time Performance (OTP).

Culture

Another objective of the study is to understand if there is a culture of guilt hidden.

Some studies looked at people's behavior when the culture of guilt impacted them.

"A New Perspective on Culture of Guilt: An Experimental Study" (Gorini, 2012), "Creating a Culture Without Guilt through Medical Education: A UK Perspective" (Elmqvist, 2016) and "Nature of Culpa in Incident Reports Patient Safety: Mixed Methods Analysis of a National Database "(Cooper, 2017).

In these studies, there is evidence that, although aware, most people have attitudes to remove the cult about themselves. It is more defensive behavior.

Malone (2019), Mohammed (2014) and Dekker (2016) performed a work "Just Culture," the opposite of "Blame Culture."

The goal of these researchers to understand the benefit to organizations of implementing a culture is not to blame. Mistakes should not focus on people but on situations.

Companies should understand that attitudes that lead to process errors or failures are the result of unresolved issues.

Examples could be process errors, lack of proper tools, lack of training, lack of synergy between areas, reward plan for quantitative and non-qualitative results only.

Chapter III
Methodology

This chapter presents the methodology applied to demonstrate the divergences that occur in delay code allocation and to propose a solution to mitigate or solve problems.

Current processes are detailed, and flow is presented to demonstrate divergences in allocated codes between airlines.

Airlines can be more efficient if they are confident and confident in the quality of the information presented, demonstrating the real reasons for the delays.

As Cook, Tanner, and Enaud (2010) stated, the costs of delayed flights severely affect the profitability of the airline.

According (Ishikawa, 1989), companies should be aware of the causes that have negative impacts on their business. For airlines, correct delay code allocation allows you to focus on solving the problems that cause and hinder On-Time Performance (OTP).

The study focused on developing and analyzing available support information and demonstrating possible divergences in delay code allocation.

In our study, we demonstrated the need to establish new secure delay code allocation processes to address the possible reasons that affect On-Time Performance (OTP).

In the analysis of ANAC data, it is possible to notice significant differences in delay code allocation. An airline flying the same day, route, and time have different delay codes.

In our study, we will present the following methodologies:

• Research of academic literature in an airline conducted with the teams of Airports, Maintenance, OCC - Operational Control Center, and Pilots.

• ANAC provides data showing the total number of domestic scheduled flights of all airlines in Brazil, which gave the reasons for the delays.

• The above data is issued by ANAC and also contains relevant information such as route flown, date, and time.

Survey

The survey we made was looking to have more evidence about the feeling of the usage of delay codes by the people who work directly to the flight. The intention was to understand if we are in front of a broken system in terms of confidence from users.

We conducted a field survey for one of Brazil's airlines, which flies to over 100 destinations. Approval for the survey was from the airline president.

The internal communication area guided the entire research process to ensure compliance with compliance rules and policies.

The research was allowed for teams that are directly part of the delay codes allocation process, which are Airports, Maintenance, OCC, and Pilots.

The survey was anonymous, could not exceed eight questions, and the answers to the questions were multiple choice. It was also requested seven days from the beginning of the research for completion.

The platform used for the search was from Google company. Independent forms were created for each team to identify the outcome of each unit. The Study Group prepared the questions and approved by the airline's communications department.

Search results were automatically generated by the Google platform that allows extraction into the Google Sheets tool, and graphical or tabular displays the results of each question for each area.

The survey had eight questions, seven with yes or no answers, and one with an answer: Not important; It is important; Very important.

Directors from each of the four areas held meetings with the group. The group presented the organization Embry-Riddle, the summary content of our course, the purpose of the work (Capstone).

Following guidance from the communication area, the survey was sent from the area director's email to the group of people eligible to respond.

In the director's message to the team, there was a text summarizing the reason for the survey and the direct link to the answers. *Hello Crew, all right? I want to share with you a very cool initiative led by some Crew who are finishing a course promoted by Embry-Riddle Aeronautical University, the largest aviation university in the world. In the concluding study, this group had the idea of conducting research among some areas of our company to know a little better the level of knowledge and perception about the delay codes used here at Azul, as well as their impacts on our operations. With this, I share here the link of this survey and invite you to participate and help us in this data collection. There are eight multiple-choice questions, quick to answer. The survey is anonymous and will be available until 09/13/2019. The exemplo of link https://docs.google.com/forms/d/e/1FAIpQLSeUGgthzZQWzXq4EpHCySr5F09F2LY1EqF_htcw59J8L34PnA/viewform.*

The group surveyed from September 6 to 13, 2019.

Because it is a large group of people, it was decided to use the stratified sampling technique.

Three departments were sent to the leadership group because they are the professionals who work in the allocation of the delay code.

The airport director sent the survey to the managers. A total of 106 managers received the survey, and 67 answered.

The maintenance director has sent to regional managers, base managers, and base coordinators. A total of 205 managers and coordinators received the survey, and 175 answered.

The pilot director referred them to commanders with more than five years in the company, and instructors with any company time. Altogether 658 pilots received the survey, and 275 responded. The most significant number of people and with the lowest proportion in the answers because they are professionals who are performing their function in flight without access to the questionnaire.

The director of the OCC forwarded it to the entire department team as people interact directly with the other three departments in the allocation of delay codes. In all, 255 people received the survey, and 167 responded.

The total number of people who participated in the survey were 1274 people, and 684 answered the questions, a total of 53.69% of the sample.

Experimental Design

The data released by ANAC, related to the delay codes of the three airlines operating in Brazil, were consolidated and analyzed. Analysis of these data aims to demonstrate whether there are logical reasons for code delays.

Data refer to the years 2013 to 2018 with 8,482,781 flights. In all, in this period, 5,580,134 had no delays, i.e., 71.65% operated at the scheduled time. More details on the analysis of these data are in chapter IV.

We identified discrepancies regarding the reason for airline delay codes. Two people in the group analyzed this study.

The other suggestion and option for the aviation market is the hiring of new technologies to support the entire system comprising the processes that can influence On-Time Performance (OTP).

The analyzed airline requested a study, and the objective is to investigate whether there is a need to revise the entire current delay code allocation process. The airline's interest is to ensure the integrity of the delay code information so that the reasons for the delay are correct. The company intends to develop new projects to improve the ideas that present the highest delay rate.

The research allowed us to study the perception of its employees in the areas directly involved with On-Time Performance (OTP).

The airline wants to understand through research

The drug developed the studies to understand the culture of guilt. We cite some readings on the subject, "A New Perspective on a Culture of Guilt: An Experimental Study" (Gorini, 2012), "Creating a Culture Without Guilt through a Medical Education: A UK Perspective" (Elmqvist, 2016), and " Nature of Guilt in Patient Safety Incident Reports: Mixed Methods Analysis of a National Database "(Cooper, 2017).

In these studies, there is evidence that, although aware, most people have attitudes to remove the cult about themselves. It is more defensive behavior.

Malone (2019), Mohammed (2014) and Dekker (2016) performed a work "Just Culture," the opposite of "Blame Culture."

The goal of these researchers to understand the benefit to organizations of implementing a culture is not to blame. Mistakes should not focus on people but on situations.

Companies should understand that attitudes that lead to process errors or failures are the result of unresolved issues.

Examples could be process errors, lack of proper tools, lack of training, lack of synergy between areas, reward plan for quantitative and non-qualitative results only.

Three types of data were collected, data from the Brazilian aviation market, and two from a Brazilian airline.

ANAC data is information from the three airlines, which are reported monthly to ANAC. This data is publicly available.

Information is available on the ANAC website.

Data source, collection, and analysis

This study analyzed data from Airlines; Delays; Reasons for the delays identified by the delay codes; Airports of origin and destination; Flight departure time. Data are from 2013 to 2018.

With this information, it is possible to identify whether there is consistency in the use of delay codes between airlines. By comparing company flights on the same route and similar departure time, you can analyze whether the reasons for the delays are equivalent or divergent.

Chapter IV

Data Analysis

To start our analysis, proving the misallocation of delay codes, we analyzed ANAC data among the three main airlines in Brazil: Azul, Gol, and Latam.

This data series began in 2013 when airlines had nearly the same number of aircraft, and their network overlap is consistent to ensure they are operating at the same airports, with a similar fleet and similar system.

We observed the same operating conditions, and they allocated a vast and different code configuration.

Based on internal research on ANAC data, the actual fleet of three major airlines in Brazil are:

AIRCRAFT	GOL	LATAM	AZUL	TOTAL
737-400F	0	0	2	2
737-700	22	0	0	22
737-800	95	0	0	95
737-8MAX	7	0	0	7
767-300W	0	13	0	13
777-300ER	0	10	0	10
A319	0	22	0	22
A320	0	69	1	70
A320NEO	0	4	36	40
A321	0	31	0	31
A330-200	0	0	8	8
A330-900	0	0	1	1
A350-900	0	7	0	7
ATR72-600	0	0	33	33
E190	0	0	6	6
E195	0	0	50	50
E195E2	0	0	1	1
TOTAL	**124**	**156**	**138**	**418**
NARROW-BODY	**124**	**126**	**129**	**379**
WIDE-BODY	**0**	**30**	**9**	**39**

Table 5 - The fleet of the three major airlines in Brazil in September/2019.

Source: ANAC – RAB ONLINE

Note: For Latam, we do not consider all aircraft registered in Brazil only

As we can see, the number of the narrow-body fleet is similar to the three airlines. In 2013 our internal research found the following numbers:

AIRCRAFT	GOL	LATAM	AZUL	TOTAL
737-700	37	0	0	37
737-800	91	0	0	91
767-300W	0	4	0	4
777-300ER	0	8	0	8
A319	0	26	0	26
A320	0	89	0	89
A321	0	10	0	10
A330-200	0	20	0	20
A340-500	0	2	0	2
E175	0	0	5	5
ATR42	0	0	9	9
ATR72-600	0	0	40	40
E190	0	0	22	22
E195	0	0	45	45
TOTAL	**128**	**159**	**121**	**408**
NARROW-BODY	**128**	**125**	**121**	**374**
WIDE-BODY	**0**	**34**	**0**	**34**

Table 6 - The fleet of the three major airlines in Brazil in January/2013.

Source: ANAC – RAB ONLINE

Note: For Latam, we do not consider all aircraft registered in Brazil only

The three airlines have almost the same number of aircraft and Narrow-Body. In our analysis, we consider the Turbo-Prop ATR as a Narrow Body. They are smaller aircraft compared to other planes, but for routes that we will analyze, they are not operating.

Network

The top five routes in Brazil in the number of flights were used to compare the delay codes each is allocating.

ROUTE	SUM OF FLIGHTS
CGHBSB	116,754
CGHCNF	103,035
CGHSDU	283,444
GRUPOA	99,064
GRUSSA	93,302
GRAND TOTAL	**695,599**

Table 7 - Top 5 routes with the most significant biggest number of operations in Brazil's domestic network (both ways) between January/2013 thru September/2019.

Source: SRS Analyzer – Cirium Group

SUM OF OPS/WEEK				
ROUTES	Azul	Gol	Latam	Grand Total
SDUCGH	206	334	333	873
GRUPOA	90	104	147	341
CNFCGH	82	102	123	307
BSBCGH		136	162	298
GRUSSA	56	60	150	266
TOTAL	**434**	**736**	**915**	**2,085**

Table 8 - Top five routes with the most significant number of operations in Brazil's domestic network (both ways) October/2019.

Source: SRS Analyzer – Cirium Group

Note: During September/2019, Santos Dumont airport (SDU) passed through a major runway novation, and in that period, the flights from Congonhas (CGH) were moved to Galeão (GIG), so because of that we chose October as the reference to compare the network.

Delay code allocation

Considering the fact of the narrow-body fleet is equivalent, 4 out of 5 top routes in Brazil are operated by the three airlines. We analyzed the allocation of delay codes informed to ANAC to understand if there is a discrepancy.

We analyzed route by route the Top 5 allocated delay codes for each airline:

CGH-Congonhas and SDU-Santos Dumont (both directions)

DELAY CODE	GOL	LATAM	AZUL	TOTAL
AR	6,633	11,359		17,992
RI	12,604	25	5	12,634
AJ	7,900	131		8,031
AT	1,696	5,637	4	7,337
RA	4,558	1,532	2	6,092

Table 9 - Number of times each code was allocated for the route CGH-Congonhas to SDU-Santos Dumont and SDU-Santos Dumont to CGH-Congonhas between 2013 and 2018.

Source ANAC.

Note: Before August/2019 Azul just had weekly flights in this route

As we can see, equivalent equipment, number of flights, networks, and airlines are allocating different delay code settings for the same route. We may observe a discrepancy regarding the RI code when the aircraft cannot land at the destination airport and returns to the departure airport. In our data series, Latam allocated this code only 25 times, while Gol allocated 12,604 times, which represents a difference of 50,416.00%.

CGH-Congonhas and CNF-Confins (both directions)

DELAY CODE	GOL	LATAM	AZUL	TOTAL
AR	2,922	7,167	13	10,102
HD	340		7,284	7,624
RI	3,246	15	211	3,472
AJ	2,993	79		3,072
AT	632	1,868	513	3,013

Table 10 - Code allocation amount for the routes CGH-Congonhas airport to CNF-Confins airport and SDU-Santos Dumont airport to CNF-Confins airport, between 2013 and 2018.

Source ANAC

In this route, the most interesting difference we can see is the usage of the code HD, which is the anticipation of the authorized departure time. Latam never used this code, but Azul, by far, informs this anticipation for ANAC. The code AR, which is operational restrictions at the airport, is also impressive because it is the biggest one, but Azul just allocated 13 times while Latam and Gol allocated 10089 times. Also, the difference between Gol and Latam is 245%.

CGH-Congonhas and BSB-Brasília (both directions)

DELAY CODE	LATAM	GOL	AZUL	GRAND TOTAL
AR	113,96	3,605		15,001
AJ	65	3,190		3,255
RI	9	3,188		3,197
RA	972	1,868		2,840
AT	1,991	731		2,722

Table 11 - Code allocation amount for the routes CGH-Congonhas airport to BSB-Brasília airport and BSB-Brasília airport to CGH-Congonhas airport, between 2013 and 2018. Source ANAC

Note: Azul does not fly in the route CGH-Congonhas to BSB-Brasília airport

In this case, the major difference is in the allocation of the code RI; 35,422.00% of difference between Latam and Gol.

GRU-Guarulhos and POA-Porto Alegre (both directions)

DELAY CODE	LATAM	GOL	AZUL	GRAND TOTAL
AR	6,258	1,870	19	8,147
HD		379	6,972	7,351
AT	1,787	345	763	2,895
RI	1	2201	393	2,595
RA	692	1,531	138	2,361

Table 12 - Code allocation amount for the routes GRU-Guarulhos airport to POA-Porto Alegre airport, and POA-Porto Alegre airport to GRU-Guarulhos airport, between 2013 and 2018. Source ANAC

Here we have another proof of discrepancy, but we would like to bring attention to the number of allocations on AT (Air Traffic Services – ATC). In this example, the difference in the allocation of AT for Latam and Gol is 517%, and Latam and Azul are 234%. Considering the similarity of fleet and network is possible to conclude all three airlines are subjected to the same impacts of delay on ATC because they are flying in the same environment with equivalent fleet and network but, Latam has much more impact on their flights than the others.'

GRU-Guarulhos and SSA-Salvador (both direction)

DELAY CODES	LATAM	GOL	AZUL	GRAND TOTAL
AR	7,913	2,239	1	10,153
RI	2	2,732	180	2,914
RA	775	1,982	96	2,853
AT	1,606	504	247	2,357
AS	*1,263*	*474*	*16*	*1,753*

Table 13 - Code allocation amount for the routes GRU-Guarulhos airport to SSA-Salvador airport, and SSA-Salvador airport to GRU-Guarulhos airport, between 2013 and 2018. Source ANAC

In this case, we have Azul allocating just one time the code AR (restrictions at the airport) and Latam assigning only two times the code RI (which is when the flight is penalized due to restrictions the on destination airport due to the rotation of the aircraft delaying the subsequent flight)

Delay Code analysis

In this initial analysis, it was not sufficient to prove the incorrect allocation of delay codes of these three airlines.

We do not have all the information necessary to understand whether the assignment was correct or not. The purpose of the analysis was to show that there are significant differences in the allocation of delay codes by airlines in a similar situation.

There are situations where reduction occurs when there is no allocation of a specific airline code. In other cases, it happens the opposite condition, the growth of the assignment of a specific code. We can observe the HD code on the route CGH-Congonhas Airport to CNF-Confins airport. Notably, there is something related to the strategies on understanding the delays for each airline, and maybe they are different, resulting in an information discrepant delay codes for the authority.

Inside the airlines, as we already described, is very important to the have the information about the delay codes to act as a condition to improve the operation quality and to save money due to the impacts of not being on-time on the operation (lost passengers connections, extra fuel, diversions, and others).

To have more pieces of evidence of this situation, we did a survey that will be explained in the next part.

Survey Analysis

Of all questions, question number 4 is the most important for our thesis, for almost 75% of the participants of this survey does not think the allocation of codes is correct. This a representative number because it supports our initial thought about the wrong assignment of delay codes. The same percentage considers the allocation of something essential or significant for the process of understanding the delay of a flight (question 5).

Also, research has shown that people who work directly for the operation know the delay coding process, but at the same time, 42% do not know the meaning of codes (question 2).

Some survey respondents know the codes, but recognize that they are unfamiliar with the meaning of the codes. Almost 93% feel responsible for On-Time Performance (OTP) (question 3), which is a good thing. The most significant part of them understand their roles in the operation and the impact they cause because of a delay due to their process. Questions 6 and 7 showed us the airline is trying to work on the cause of delays. 57% of the respondents already work in a project or something to improve the On-Time Performance (OTP). But the airline is not 100% transparent because almost 95% does not have any information about the costs for the airline because of a delay.

This kind of behavior could repel the engagement of all actors on the operation side masking problems because of a flat knowledge of all impacts in terms of cost, stress, lost connections, extra hours, and mainly the passenger satisfaction.

Question number 8 has almost a tie on the opinion of the usage of the codification to act on the delay. More than half of the respondents does not believe the airline is using the codification to act on the flights' delay. This is a big number considering the importance of them to realize where is the cause of delays.

An interesting point here is to notice we are probably talking about a broken system with old concepts. IATA process of coding delays is not the best solution nowadays with all technology, which could lead us to have big data to understand each operation of flights and the causes of delay. Reduce all the complexity of a flight to a single code is not the best option. They do not have the desirable reliability forcing the airline to use other sources to act on the causes of delay. This could let the airline to use unreliable data to take decisions not acting precisely on the cause.

This situation could cause a poor choice of alternatives to have a better On-Time Performance (OTP). An example would include enlarging the planned block time to the aircraft arrived earlier than the expected or having a longer turnaround time to support the delays eventually from the lasts flights. All of this reduces the utilization of the main asset of the airline: the aircraft.

It increases the cost of taxes for the usage of the airport due to the extended turnaround time waiting for the next flight. This could also create a problem of the rotation of planes on the airport gates creating other potential situations that could lead to another delay in different flights.

Chapter V

Recommendation of a General Policy

The airline expects to operate on time, as scheduled, except when uncontrollable conditions and adverse weather result in delayed operations. Nevertheless, one controllable process provides poor data quality regarding delay code assignment. 74,7% of the population interviewed do not believe the delay codes are being allocated correctly based on their perception. The way Company "A" manages the delay code allocation is by dividing all the processes into three departments. These are responsible for publishing the processes assigned to the delay code allocation. The departments involved are flight operations, airports, and CCO - operational control centers.

The General Airport Manual (MGA) M-APT-001/2019, which is the policy used by airport agents of the airline, allows the interpretation of the agent to identify if the delay occurs during the pushback or aircraft door closing. This management model creates conflict in the conceptual identification of delays. On the other hand, the RT-OPS-49/17 flight ops procedure allows the flight captain to allocate the delay code he/she considers most appropriate in his logbook. This is also an official policy used by the company. The Operational Control Center that coordinates the operation and needs real-time information is responsible for publishing the delay code allocation policy as well.

To prevent further system breakdown and create more robust processes, the first recommendation is to set up an independent department to handle all issues related to delay identification, delay time, and reasons for each delayed flight. This department needs to be responsible for publishing processes containing a general policy, philosophy, culture, and automation to investigate and allocating delay codes correctly.

The independent department that the company chooses to handle the delay code process needs to be responsible for identifying the correct causes transparently and reliably. This department must also act independently to generate reliable data for all areas involved with delays and rescue the reliance on the process.

The management of the delay code allocation process should be handled by only one department and followed by all staff involved in the process. It should be published following the airline manuals publication process. It is also recommended that the other manuals of departments involved in delay code allocation activities refer to the general policy.

Recommendation to create a new and independent department

As suggested in this study, there are currently three departments involved in the delay code allocation process, being a recommendation to leave only one department.

Centralization of the delayed code allocation process requires the creation of a new, independent department capable of managing the entire allocation code process and control.

This new department will be managed and will be under the leadership of VP Operational Technical, with decision-making autonomy, without interference from other departments.

Below, describing the organizational chart of the Operational Technical VP.

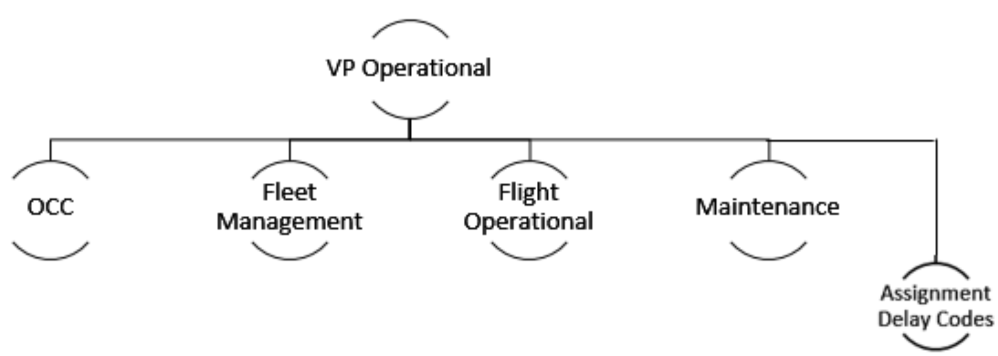

Figure 4 – New Organogram of VP Operacional and Technical

This new department will consist of one manager and coordinator, one senior analyst, three Pleno analyst, and sixteen junior analysts.

The scope of activities of this new department comes down to:

- Ensure the correct allocation of delay codes considering the actual reason for the delay;
- Monitor ground and flight activities that may reflect delays;
- Issue management reports regarding delays and causes;
- Work full time (24x7);
- The commercial workload for Manager, Senior Analyst and Full;
- The workload for Junior Analyst that allows on-call duty and full-time operation monitoring.

Job Description

Manager: Lead the team that will take care of the allocation of delay codes; work with operational area teams to identify potential process improvements to improve operational performance; report the actual reasons for delays to company leadership

Senior Analyst: Generate strategic information about delays; promote technicians to identify the causes of delays.

Pleno Analysts: Track operations to ensure codes are correct; generate reports to the aeronautical authorities; broker potential conflicts of the operational areas when one of the departments disputes the delay code allocation.

Junior Analysts: Enter the delay codes on the flights in operation, report any abnormalities in service.

Although other departments perform the delay code insertion activity, the professionals who perform this delay are also responsible for other activities.

Even if this activity becomes centralized in one department, it is not possible to transfer people to this new department, requiring the hiring of a new team.

We propose a team below to work on this activity and to ensure that operations monitored and codes allocated online at all times. A part of the team will attend full time and on duty.

	Salary	People	Total	Taxes and Benefits	Total Investment
Manager	$3,000	1	$3,000	$2,580	$72,54
Coordinator	$2,425	1	$2,425	$2,086	$58,64
Senior	$1,950	1	$1,950	$1,677	$47,15
Pleno	$1,375	3	$4,125	$3,548	$99,74
Junior	$0,950	16	$15,200	$13,072	$367,54
Total	**$7,275**	**22**	**$26,700**	**$22,962**	**$645,61**

Table 144 – Total investment to create a new department.

A study by the FAA-sponsored Nexton consultancy 2010 describes that, on average, for every 1 pp loss in OTP – On-Time Performance can cost up to $ 10,000 annually for aircraft with up to 170 seats.

According to Ishikawa, 2009, the simplest and fastest way to find the root of a problem is the concentration of activities and processes. On average, centralization allows you to find quick solutions that can initially generate up to 15% gains by applying these solutions.

The airline analyzed, achieved in 2018 a punctuality of 85%, and has more than 100 aircraft. Considering a total of up to 100 aircraft, and up to 15% punctuality gains, the centralization of delay code allocation activity would enable the company to achieve almost 86.28% punctuality in one year.

Considering Nexton's study, 1.28 pp in gain on time would result in a savings of $ 1,270 million.

Considering a conservative scenario, the payback time of this new department would be two years.

Recommendation to reduce the number of delay code allocation per flight leg

During turnaround time, the airline's airport agent needs to make sure that all activities are going as planned. When the aircraft engages on the bridge, the agent needs to know if the aircraft arrived at the scheduled time and was docked at the scheduled time or if the ground staff had the stairs ready for the disembarkation of the passengers and if the airport buses are available in the case of aircraft parked off the bridge. The most common activities during solo time are as follows.

- Coupling of the aircraft to the bridge.
- Door opening.
- Unloading of luggage.
- Disembarkation of passengers.
- Crew change if needed.
- Aircraft cleaning.
- Fuel supply.
- Catering for passengers and crewmembers.
- Loading of luggage and cargo.
- Boarding of passengers.
- Passenger accommodation in their seats.
- Passengers count.
- Maintenance.
- Door closing.

The airline works with two conceptions of delay code types, direct delay and consequent delay. The direct delay occurs when the aircraft lands on the scheduled time and delays the takeoff. The consequent delay occurs when the aircraft lands delayed and delays the takeoff without any other direct delay during the turnaround time. But, on the same delayed flight, the airline allows assigning the maximum 3 (three) delay code per flight, one consequent and two direct delays.

In this recommendation, the company needs to consider the maximum of two delay codes per flight. The actual process allows three delays code per flight, and two directs and one consequent.

The delay management process the company has adopted allows assigning three delays code per flight, two direct delays that occur during the turnaround time and one consequent delay of the previous flight.

In guidance should be assigned only two delays code per flight leg, only one direct delay that occurs during the turnaround time and only one consequent delay of the previous flight. In the case of two different delays or more during the turnaround time, the responsible department of the last process that releases the aircraft to start the flight operation delayed needs to be responsible for the total direct delay. And only one delay code needs to be assigned.

Some airlines use more than one delay code to identify the causes of the delay. Multiple codes help to broaden and detail the various reasons for delays, and to build broad action plans to mitigate problems.

According to Wu, the practice of using multiple delay codes increases the complexity of processes, the chances of errors, the difficulty of identifying the biggest reasons for delays and increases the time it takes to elaborate and execute actions in search of solutions. (Wu, 2016).

The relevance of this paper is to generate delay data with accurate and reliable information. The airline will make the supported and scenario-based decisions presented as part of the recommendations to identify all opportunities to reduce flight delay code assignment.

Scenario 1

Only one delay code assignment for two different reasons, the previous flight landing on time, and two direct delays occur during the turnaround time, the first delay of 6 (six) minutes due to and another delay with 10 (ten) minutes due to boarding passenger. In this case, the boarding passenger takes more time than maintenance. The delay code allocation must be 10 (ten) minutes due to boarding passengers.

Turnaround Time Activities	Landing delay - Min	Take off new delay-Min
Coupling of the aircraft to the bridge.	0	0
Door opening.	0	0
Unloading of luggage and cargo.	0	0
Disembarkation of passengers.	0	0
Crew change.	0	0
Aircraft cleaning.	0	0
Fuel supply.	0	0
Catering.	0	0
Loading of luggage.	0	0
Boarding of passengers.	0	10
Guest accommodation in their seats.	0	0
Passengers count.	0	0
Maintenance	0	6
Door closing.	0	0
Push back	0	0

Table 15 - Delay code identification to allow only one delay code assignment for different reasons.

Scenario 2

It is considering up to two delay codes assignment for three different reasons, the previous flight landing with a delay of 10 (ten) minutes due to crew change, and a new delay of 10 (ten) minutes due to maintenance. In this case, the delay code allocation should be 10 minutes due to the crew change, and 10 (ten) minutes due to maintenance. Although the loading time of the luggage was 6 (six) minutes handling staff releases the aircraft first than the mechanic. The delay code allocation should be 10 minutes of crew change due to the previous flight and 10 minutes of maintenance.

Turnaround Time Activities	Landing delay minutes	Take off new delay minutes
Coupling of the aircraft to the bridge.	0	0
Door opening.	0	0
Unloading of luggage and cargo.	0	0
Disembarkation of passengers.	0	0
Crew change.	10	0
Aircraft cleaning.	0	0
Fuel supply.	0	0
Catering.	0	0
Loading of luggage.	0	6
Boarding of passengers.	0	0
Guest accommodation in their seats.	0	0
Passengers count.	0	0
Maintenance	0	10
Door closing.	0	0
Push back	0	0

Table 156 - delay code identification to allow two delays code assignment for three different reasons.

Scenario 3

It is considering up to one delay code assignment for two different reasons, but in this scenario, one consequent delay and one direct delay are the same reasons. The previous flight landing delay with 10 (ten) minutes due to maintenance, another immediate delay of 10 (ten) due to maintenance occurs. In this case, the delay code allocation should be 20 minutes due to maintenance. It does not matter the 6 (six) minutes delay of Loading the luggage because the handling staff completes their task before the maintenance staff.

Turnaround Time Activities	Landing delay minutes	Take off new delay minutes
Coupling of the aircraft to the bridge.	0	0
Door opening.	0	0
Unloading of luggage and cargo.	0	0
Disembarkation of passengers.	0	0
Crew change.	0	0
Aircraft cleaning.	0	0
Fuel supply.	0	0
Catering.	0	0
Loading of luggage.	0	6
Boarding of passengers.	0	0
Guest accommodation in their seats.	0	0
Passengers count.	0	0
Maintenance	10	10
Door closing.	0	0
Push back	0	0

Table 17 - delay code identification to allow one delay code assignment for two different reasons.

Scenario 4

Only one delay code assignment for two different reasons, but in this scenario, the airport agent of the airline needs to focus on the real reason for the delay. The previous flight landing on time, and two direct delays occur during the turnaround time. The first delay with 10 (ten) minutes due to crew change and another delay with 5 (five) minutes that seems to be due to air traffic control. The air traffic control agent needs to rearrange the slots to approve the takeoff because the flight was no more on time. In other words, this 5 (five) minutes delay also needs to be allocated for a crew change. So, 15 (fifteen) minutes for a crew change.

Turnaround Time Activities	Landing delay minutes	Take off new delay minutes
Coupling of the aircraft to the bridge.	0	0
Door opening.	0	0
Unloading of luggage and cargo.	0	0
Disembarkation of passengers.	0	0
Crew change.	0	10
Aircraft cleaning.	0	0
Fuel supply.	0	0
Catering.	0	0
Loading of luggage.	0	0
Boarding of passengers.	0	0
Guest accommodation in their seats.	0	0
Passengers count.	0	0
Maintenance	0	0
Door closing.	0	0
Push back	0	5

Table 168 - delay code identification to allow one delay code assignment for two different reasons.

Recommendation of a turnaround system

"It is well-known that low-cost carriers strongly focus on short turnaround times and an absence of turnaround buffers" (Wu, 2010). Automating turnaround time processes can reduce the chances of human error and conflict in identifying a delay. There are in the market software companies offering systems to help manage the ground handling process effectively and efficiently.

Honeywell has released an intuitive and user-friendly system, with simple-to-use screens and graphical prompts. The service gives ground handlers a powerful mobile application to manage every aspect of the turnaround process. The system can assist the ground handler in managing the aircraft turnaround process while providing accurate, real-time information to operations.

AIM company designed a similar system that allows the user to be analytics. Built-in calculation services focusing on statistics, operational performance, process performance, delay analysis. Out of the box graphical reports with drill-down capabilities. Measure performance in real-time with, benchmark against goals, and essential information.

The focus of this recommendation is not to show the suppliers but to present systemic opportunities for turnaround time management and correct delay code identification. The airline decides to select and choose suppliers that best meet their expectations. What is wanted is for delays to be allocated correctly and for the data to translate exactly the event causing the delay.

APPENDIX

Survey

Question 1: Do you know the delay codes used by the company?

Yes	650	95.0%
No	34	5.0%
Total	684	

Question 2: Do you have a deep knowledge of the meaning of each delay code?

Yes	397	58.0%
No	287	42.0%
Total	684	

Question 3: Do you feel responsible for your airline's On-Time Performance (OTP)?

Yes	631	92.3%
No	53	7.7%
Total	684	

Question 4: In your perception, the delay codes are being allocated correctly?

Yes	173	25.3%
No	511	74.7%
Total	684	

Question 5: In your perception how is the importance for the airline of the right code allocation?

Not Important	166	24.3%
Important	317	46.3%
Very Important	201	29.4%
Total	684	

Question 6: Does the airline already showed or informed you of the cost of a delay in a flight?

Yes	39	5.7%
No	645	94.3%
Total	684	

Question 7: Do you ever participate in an action plan or project intending to increase On-Time Performance (OTP)?

Yes	391	57.2%
No	293	42.8%
Total	684	

Question 8: Does the airline uses the delay code to act on the causes of delays?

Yes	321	46.9%
No	363	53.1%
Total	684	

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