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THE USE OF *AIRPORT COLLABORATIVE DECISION MAKING* AND THE INDICATORS OF VARIATION OF *TARGET OFF-BLOCK TIME, TARGET START-UP APPROVAL TIME AND SEQUENCE START*, IN DECOLAGES AT GUARULHOS INTERNATIONAL AIRPORT

Edna Ghiorzi Varela Parente

Talita Nobre da Silva

Elisete Dahmer Pfitscher

Abstract: *Airport Collaborative Decision Making* (A-CDM) is aimed at collaboration between airport partners on the quality and efficiency of flight information. The implementation of A-CDM at XYZ Airlines in Guarulhos is an advance in airport management, transforming the decision-making environment on the performance of take-off flights on three indicators: *Target Off-Block Time* (TOBT), *Target Start-Up Approval Time* (TSAT) and *Sequence Start* (SS). Thus, the problem of this research is summarized in the following question-problem: How does the A-CDM system, by estimating the TOBT, TSAT and SS metrics, show the efficiency of take-offs at XYZ Airline at Guarulhos International Airport in 2023? From this perspective, the general objective is to analyze the implementation of the A-CDM operational concept and its impact on the operational efficiency of take-offs at XYZ Airline at Guarulhos International Airport in 2023, focusing on take-offs in relation to variations in TOBT, TSAT and SS. The methodology in terms of objectives is considered descriptive. The technical procedures are bibliographical, documentary and case study. With regard to the research problem, the approach was qualitative. The analysis showed variations in the TOBT, TSAT and SS indicators in 2023. The integration of real-time systems standardized communication with operational efficiency, punctuality and flight safety. The result showed that with A-CDM the TOBT indicator varied from 43.8% in May to 80.37% in December, reflecting problems with the season and operations at the end of the year. TSAT ranged from 1.52 in May to 5.85 in February, indicating problems with departure approvals caused by changes in demand and airport coordination. SS varied from 47.1% in January to 42.3% in October, indicating changes in allocation policies and operations.
Keywords: A-CDM. Indicators. Airlines. Guarulhos.

INTRODUCTION

The *Airport Collaborative Decision Making* (A-CDM) concept comes from the *Air Traffic Management* (ATM) operational concept, which aims to improve operational efficiency, predictability and punctuality for the ATM network, the Air Navigation Management Center (CGNA), for airport *partners*, *Airline Operational Control* (AOC*), Aircraft Operator* (AO), *Ground handling* (GH) *and Airport Operations* (ATC). A-CDM aims to activate collaboration between airport partners. By improving the quality and efficient exchange of information, A-CDM implements specific processes to achieve defined goals (EUROCONTROL, 2017).

The implementation of A-CDM at XYZ Linhas Aéreas at Guarulhos Airport represents a significant advance in airport management, technology and operations, aimed at transforming the decision-making environment in relation to flights, according to the *International Civil Aviation Organization* (ICAO, 2014).

This collaborative approach seeks to improve efficiency, punctuality and safety in airport operations through collaboration between the parties involved (LAUDON; LAUDON, 2011).

In the context of the company XYZ Linhas Aéreas in Guarulhos, the implementation of A-CDM involves the integration of information and communication systems to effectively coordinate real-time information on flight departures, runway availability, among other factors (ICAO, 2016). Coordination is key to standardizing, streamlining and improving communication in the airport environment.

A-CDM is a practical approach, with collaboration between partners such as airport operators, airlines and air traffic service providers essential for successful implementation (EUROCONTROL, 2017).

According to Pizolato (2021), in order to constantly increase and optimize operational results at an airport, it is necessary to use management tools. A-CDM, or collaborative decision-making at an airport, has emerged as an ally in the search for bottlenecks in operations between aircraft landings and take-offs

For effective air traffic management, time parameters known as these acronyms, such as *Target Off-Block Time* (TOBT) or *Target* Ramp Departure *Time*, *Target Start-Up Approval Time* (TSAT) or *Target* Departure Approval Time and *Sequence Start* (SS) or *Sequence Start* are used (EUROCONTROL, 2017).

From this context, the implementation of A-CDM at XYZ Linhas Aéreas in Guarulhos involves integrating information and communication systems so that more effective coordination can take place, including real-time sharing of flights, runway availability, among other factors (ICAO, 2016).

The research question is thus: how does the A-CDM system, by estimating the TOBT, TSAT and SS metrics, show the efficiency of take-offs at XYZ Airline at Guarulhos International Airport in 2023?

The general objective of this study is to analyze the implementation of the A-CDM operational concept and its impact on the operational efficiency of XYZ Airline's take-offs at Guarulhos International Airport during the year 2023, focusing on take-offs in relation to TOBT, TSAT and SS variations.

The specific objectives of this study are:

a) Collect detailed information on the A-CDM system, including the TOBT, TSAT and SS metrics.

b) To gather data on the take-off operations of XYZ Linhas Aéreas at Guarulhos International Airport during the year 2023, focusing on planned departure times (TOBT), start-up approval times (TSAT), and actual departure times (SS), as well as other relevant data.

c) Identify performance standards and operational efficiency of Airline XYZ in relation to planned and actual take--off times.

In terms of justification, A-CDM involves not only sharing information, but also making decisions based on accurate information with common meanings for everyone involved. The lack of a system like A-CDM can result in incorrect decisions and a lack of adequate information for partners (EUROCONTROL, 2017).

However, it is worth noting that the emphasis in this study on A-CDM will be on TOBT, TSAT and SS. TOBT represents the estimated time of departure of the aircraft, TSAT is the target time for the departure authorization granted by ATC, and SS indicates the scheduled time of departure (SAIPHER, 2021).

The relevance of these three parameters lies in their ability to effectively synchronize operations between aircraft and air traffic control, promoting greater punctuality and predictability.

This study is justified because they constitute fundamental commitments such as improving coordination and operational efficiency, which are essential for a dynamic and safe airport environment.

According to Silva (2021), Guarulhos International Airport has implemented A-CDM or Airport Collaborative Decision Making, and this action generates the need for studies that address the scenarios of this transition and its results, thus showing the relevance and justifying this article as well.

The limits of the study are related to the context of the research on the A-CDM, in relation to TOBT, TSAT and SS and operational performance in the year 2023, not exploring its content in its entirety.

Another limitation is that it was based on information provided by one of the three largest commercial aviation companies in Brazil, as it was not possible to obtain access to data from other companies due to their unwillingness to cooperate.

THEORETICAL FRAMEWORK

This section presents the essential elements that make up the theoretical framework of this research. It begins with a history, the application of A-CDM in the world and in Brazil, the choice of Guarulhos airport and its performance before and after, TOBT, TSAT and SS.

A BRIEF HISTORY OF A-CDM

Before it became A-CDM, *Collaborative Decision Making* (CDM) was defined as a concept applied to support activities ranging from strategic planning to the operation itself. As such, CDM cannot be considered a goal, but rather a means by which goals can be achieved by observing the performance of the processes managed (VAIL, 2015).

According to Pizolato *et al*, 2021, when this concept is implemented at airports, the acronym A-CDM is changed to A-CDM, which guides the application to airport activities, with the aim of, through the participation of the parties entering the information, enabling better planning of passenger boarding, use of the airport and traffic planning, achieving a cycle of continuous optimization of operations.

A-CDM, or Airport Collaborative Decision Making, is an operational concept stemming from ATM, or Air Traffic Management. Its main objective is to optimize operational efficiency, increase the predictability of operations and ensure punctuality, both for the Air Traffic Control (ATM) network and for the partners involved at airports, such as airlines, airport operators, ground resource managers and air traffic control (EUROCONTROL, 2017).

In order to meet the growing global need for safe and efficient air navigation services, the *International Civil Aviation Organization* (ICAO) has drawn up a plan to modernize Airspace Control Systems, based on the A-CDM system. This plan aims to improve efficiency and safety in the management of airport operations through the integration of operational processes and information technology (A-CDM, 2020).

A-CDM aims to improve the way airports and stakeholders collaborate in order to achieve more efficient use of available resources, make flight operations more predictable and ensure that flights are carried out according to scheduled times, resulting in more effective operational performance and a more satisfying experience for all involved (EUROCONTROL, 2017).

The concept of A-CDM began in the United States in 1998, due to capacity problems in both airports and air routes, as there were serious problems with very significant flight delays. To address this issue, A-CDM was introduced, and during a period of testing, managed to reduce delays by 15% (fifteen percent) (EUROCONTROL, 2017).

In 2000, EUROCONTROL, a European air traffic control organization, observed the American concept and began adapting it for Europe. Tests were carried out at some of Europe's largest airports to study and improve the concept. In addition, the "*Airport* A-CDM *Task Force*" was formed with the aim of developing the A-CDM concept in Europe (A-CDM, 2020).

The work resulted in the definition of six basic elements of the concept, which are *Collaborative Management of Flight Updates* (CMFU), *Variable Taxi Time* (VTT), *Predeparture Sequence* (PDS), CDM *in Adverse Conditions, Milestone Approach* and A-CDM *Information Sharing* and, in turn, culminated in the creation of a manual in 2004, called the

"European A-CDM Implementation Manual". This manual has been successful in guiding the implementation and application of A-CDM at various airports around the world (EUROCONTROL, 2017).

APPLICATIONS OF A-CDM

In this context, the *Airport Collaborative Decision Making* (A-CDM) concept is perceived on a global scale, with special attention to the European protagonism, ongoing developments in the Caribbean and South America region (CAR-SAM) and a distinct approach in the United States called "*Surface Collaborative Decision Making*" (S-CDM).

Application of A-CDM around the world

The implementation of A-CDM began after the manual was published in 2004, with Europe leading the way. By March 2020, 29 European airports had adopted A-CDM, with 28 of them successfully completing the deployment. However, Gatwick Airport faced challenges due to unsatisfactory performance in exchanging data with the *Network Manager Operations Center* (NMOC).

As a result, Gatwick Airport began implementing A-CDM in its local operations without sharing information on flight arrivals with other airports and EUROCONTROL (EUROCONTROL, 2020).

Munich Airport was the first European airport to adopt A-CDM in 2007, and since then, several other European airports have followed suit. In addition to Europe, more than 40 airports in Asia have implemented it in an effort to improve the efficiency of related procedures.

In Australia, four implementations are underway. In the Caribbean and South America region (CAR-SAM), several implementations are underway (EUROCONTROL, 2020).

In the United States, the concept is known as "*Surface Collaborative Decision Making*" (S-CDM), with an emphasis on managing departing flights and a different approach to managing parking areas, where the yards are owned by the airlines and movement within the yard is their responsibility (EUROCONTROL, 2020).

This global expansion of the A-CDM concept demonstrates its success in improving operational efficiency, predictability and punctuality at airports around the world.

Application in Brazil

The introduction of the A-CDM concept in Brazil resulted from an agreement between the Department of Airspace Control (DECEA) and EUROCONTROL in 2015 (DECEA, 2017).

Initially concentrated at Guarulhos International Airport, implementation was led by the Commission for the Implementation of the Airspace Control System (CISCEA), with support from the Commission for Studies Relating to International Air Navigation (CERNAI) (DECEA, 2020).

The current phase, called "*Endurance*", is underway with exhaustive testing of the systems and operational processes at Guarulhos International Airport, São Paulo, with the active participation of the airlines (DECEA, 2020).

The strategic choice of Guarulhos as a starting point highlights its importance as the busiest airport and a significant *hub* in Latin America (DECEA, 2020).

A-CDM, managed by CISCEA, aims to optimize operational efficiency, predictability and punctuality of flights, focusing on the exchange of information and operational data between South America and Europe, especially in the context of *Air* Traffic *Flow Management* (ATFM) (DECEA, 2020).

The integration of A-CDM in Brazil reflects DECEA's commitment to improving efficiency and safety in the control of national airspace, and is expected to go live in November of the same year (DECEA, 2020).

The collective agreement signed between CISCEA on November 24, 2017 in Guarulhos and the airlines of São Paulo International Airport in Guarulhos highlights the joint commitment to optimize operations and promote efficiency in the Brazilian airport sector (DECEA, 2017).

GUARULHOS INTERNATIONAL AIRPORT BEFORE AND AFTER THE A-CDM

The strategic decision to choose Guarulhos as the pioneer in implementing A-CDM was based on a partnership between DECEA, GRU *Airport*, INFRAERO and Saipher ATC. Performance following implementation focuses on operational management, demonstrating significant improvements (DECEA, 2020).

Guarulhos Airport's Performance Before A-CDM

The official launch of Operation A-CDM at Guarulhos airport was marked by an internal ceremony on November 18, 2020, which underscored the commitment to improve collaboration between partners, aiming for an efficient and standardized exchange of information (DECEA, 2020).

Guarulhos airport was selected as a pioneer in Brazil for the implementation of the A-CDM concept, considering its position as the largest airport complex in South America and its great importance for cargo transportation in Brazil (DECEA, 2020).

This initiative, resulting from a collaboration between DECEA, GRU *Airport*, INFRAERO and Saipher ATC, led to the development of the ACISP (Airport Collaborative Information Sharing Platform) and PDS (Pre-Departure Sequencer) tools by Saipher ATC, designed to improve communication between participants and promote efficiency in airport operations (A-CDM, 2020).

It is worth noting that Pizolato *et al.* (2021, *apud* Saipher ATC,2021) presented the configuration used at the airport in relation to traffic planning, highlighting the direction of information.

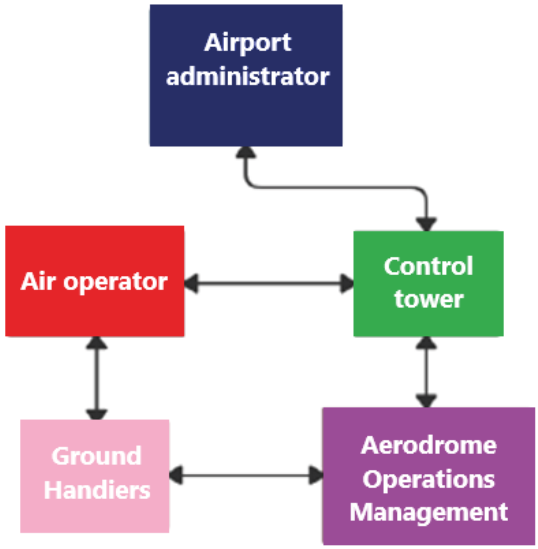


Figure 1 - Information management before the implementation of A-CDM

Source: Pizolato *et al.* (2021, p. 07, *apud* SAIPHER ATC, 2021).

In the structure shown, there are five members, and according to Pizolato (2021) this system used at the airport did not allow everyone to share, include or view information about operations, and was restricted according to the type of operation. As can be seen in Figure 1, the information provided by each participant was not available to all the other participants, which made it difficult to improve operations and make them better. The participants were assigned specific roles, as they comprised the airport administration, the Control Tower, the Air Operator and the *Ground Handlers*.

For the administrator, Ordinance No. 090/GM5 OF 11 JAN 80 of the General Staff of the Air Force in its Article 5 says that he is responsible for adopting and implementing measures aimed at states that he is responsible for adopting and implementing measures aimed at: a) the general security of the airport; b) the unimpeded movement of aircraft on the ground and their rapid clearance for flight; c) the rapid clearance of passengers and their luggage with the minimum of inconvenience for passengers; d) the controlled handling of air cargo in movement and in storage; e) the protection and comfort of all those who use the airport; and f) the preservation of order, discipline and the good presentation of the airport.

The Control Tower, according to DECEA (2024), is an operational air traffic control body housed in a tower located at the busiest airports and designed to provide the services required by aircraft only during the take-off and landing phases.

The A-CDM concept depends on the aircraft operators (AO). They insert TOBT into the ACISP platform to make departures more predictable and facilitate the work of ATC and ATFM. AOs use mobile devices to access information such as TOBT and TSAT, which allows for practical editing. The commitment to call at the suggested target time improves the punctuality and efficiency of operations. In addition, the platform facilitates benchmarking and performance analysis, which helps promote continuous improvement of operations (SAIPHER, 2021).

The *Ground Handler* (GH) is responsible for ensuring that all ground operations related to the aircraft are carried out effectively and on time. This includes including TOBT in the ACISP platform, which allows for precise coordination with other partners such as NO, ATC, AO and AOC. GH uses a flexible and user-friendly interface to access and manage important data such as TOBT and TSAT (Target Start Approval Time), facilitating communication and data sharing between participants. Ground operations are synchronized, which improves the punctuality and predictability of airport operations, and the GH can view and edit this information (SAIPHER, 2021).

The A-CDM, by promoting joint decisions on air traffic flow and flight operations, holds bi-weekly meetings to evaluate implementation, using indicators to identify opportunities to improve predictability (DECEA, 2023). This collaborative approach, along with the implementation of specialized tools, reflects a significant effort to raise operational performance standards at São Paulo International Airport in Guarulhos (DECEA, 2023).

Prior to implementation, representatives from DECEA, CGNA, CISCEA and Saipher ATC presented the benefits of the A-CDM concept, highlighting the importance of collaboration for the success of the project (DECEA, 2023). The event was attended by GRU *Airport* employees, airlines and *ground handling* companies. The head of DECEA's Operations Sub-Department emphasized the need for everyone to participate in order to ensure efficiency, predictability and sustainability, resulting in better user service (DECEA, 2023).

Guarulhos Airport's Performance After A-CDM

Before the implementation of the A-CDM concept at São Paulo International *Airport* in Guarulhos (GRU *Airport*), under the management of the Department of Airspace Control (DECEA), several adversities affected air traffic management, influencing predictability, punctuality and operational efficiency in the airport chain (DECEA, 2020).

São Paulo International Airport (SBGR), located in Guarulhos, has implemented the A-CDM concept, fostering collaboration between airport sectors through the ACISP platform (A-CDM, 2020).

This initiative has replaced the reactive approach with proactive pre-departure management, based on target times (TOBT) reported by Aircraft Operators (AO) or *Ground Handlers* (GH). Developed by EUROCONTROL, A-CDM aims to improve operational efficiency and punctuality.

Under the leadership of DECEA, the project went through phases of validation, implementation of modules and analysis of indicators.

The ACISP platform integrates data from various sources, promoting situational awareness and collaboration between airport partners.

The benefits include better predictability, on-time performance and optimization of airport resources. A-CDM represents a significant change in management, boosting efficiency and coordination in all operational phases (A-CDM, 2020).

Pizolato *et al.* (2021, *apud* SAIPHER ATC, 2021) figuratively show the operational improvement of information.

Figure 2 - Direction of information after the implementation of A-CDM - PDS Module.

Source: Pizolato *et al.* (2021, *apud* SAIPHER ATC, 2021).

As you can see, with the implementation of A-CDM the *layout of* the information now converges on the ACISP platform, it is an addition to the infrastructure to manage the information, which is coordinated by the GRU *Airport* Operational Control Center, causing improvements and includes predictability, punctuality and optimization of the airport infrastructure (A-CDM, 2020).

The ACISP platform aims to organize and optimize airport operations. It allows the TOBT to be entered and validated and consults the PDS module to issue the TSAT, all of which improves the predictability and punctuality of operations. ACISP divides arrivals and departures information into specific tabs, allowing users to track details such as turnaround times, estimated and actual landing and take-off times and more. In addition, it includes performance metrics (KPIs) to evaluate performance and adjust operational rules. The platform ensures that all businesses have consistent data and processes, which facilitates intelligent decision-making (SAIPHER, 2021).

Representatives from DECEA, CGNA, CISCEA and Saipher highlighted the improvements resulting from the implementation of the A-CDM concept at Guarulhos Airport. The project aims to promote collaboration between different organizational levels to improve airport predictability. Joint participation is considered fundamental to ensuring efficiency, predictability and sustainability, benefiting user service. A-CDM aims to improve operational efficiency, predictability and punctuality, with fortnightly meetings to monitor implementation and identify opportunities for improvement (DECEA, 2023).

THE TARGET TIME OF DEPARTURE FROM THE RAMP (TOBT), THE TARGET TIME OF APPROVAL FOR DEPARTURE (TSAT) AND THE START OF THE SEQUENCE (SS)

Target Time of Departure from Ramp (TOBT), Target Time of Approval for Departure (TSAT) and Start of Sequence (SS) are the three essential concepts of air traffic flow management. While TSAT indicates the expected time of departure clearance, TOBT indicates the estimated time when the aircraft will be ready to leave the gate. SS, on the other hand, includes the moment when the aircraft begins its movement sequence to the runway, according to the schedule.

These concepts are essential for maintaining efficient and punctual airport operations (TATIC, 2021).

Target Off-Block Time (TOBT)

The moment at which an Aircraft Operator or Ground Service Provider anticipates that an aircraft will be completely ready to commence departure is known as TOBT. This includes the aircraft ready, with all doors closed, the boarding bridge removed and the return vehicle available, which is only awaiting authorization from the Aerodrome Control Tower (TWR) to start or turn back (EUROCONTROL, 2017).

Operators (AO's) add the TOBT to the ACISP platform. Users can see the TSAT corresponding to the TOBT on the platform 30 minutes before the specified time (TATIC, 2021).

Estimated Off Block Time (EOBT) lost importance after the introduction of the A-CDM concept, while TOBT gained more importance. The information has become more useful and modern. A flexible and pleasant interface allows the NO, ATC, AO, GH and AOC partners, seen in Figure 2, to accept the data and view the same organized information. The integrated PDS module is consulted to issue a TSAT when the TOBT is entered into the ACISP platform and validated by specific rules (TATIC, 2021).

The *Target Start-Up Approval Time* (TSAT)

The time estimated by Air Traffic Control (ATC) takes into account the target time for the aircraft to move away from the parking position (TOBT), the calculated time for take-off (CTOT) and/or the traffic conditions in which an aircraft can wait for clearance to start departure or turn back.

It is important to note that the actual approval to start operations (ASAT) can be granted before the target time to start operations (TSAT) (EUROCONTROL, 2017). Once the TOBT has been entered into the ACISP platform and validated by specific rules, the integrated PDS module is consulted to issue a TSAT (Target Start Approval Time). The date on which the aircraft must receive approval to start the engines is the TSAT. This forecast is provided in advance by the ATC control body based on the number of take-off slots available and the capacity of the airport's runway system at that time. When the TSAT is issued, the aircraft and the control body make a commitment. The aircraft must be ready for take-off at the time of the TOBT informed and validated, and the control body must authorize the start of the engines in accordance with the TSAT provided (TATIC, 2021).

EUROCONTROL suggests that full consolidation of the A-CDM data and concept could take around eight years. Despite the disruptions caused by the COVID-19 pandemic, the first complete data was released in 2023 from Airline XYZ alone. Currently, the data available mainly includes the TOBT, TSAT and SS parameters.

METHODOLOGICAL PROCEDURES

This chapter presents the methodology applied in terms of nature, approach to the problem, objective, procedures, data collection techniques and data analysis.

The nature of the article qualifies as applied, as it is characterized when the objective is to generate knowledge for practical application aimed at solving specific problems and is submerged in local truths and interests (SILVA; MENEZES, 2003). The A-CDM system and the TOBT, TSAT and SS indicators were studied in depth in this study.

The approach to the problem is qualitative. Qualitative research investigates or seeks interpretation, which according to Gil (2002). The TOBT, TSAT and SS parameters were treated qualitatively and organized in tables created manually by computer. This allowed for an in-depth analysis of the data and the precise factors necessary for airport operations.

As far as the article's objectives are concerned is descriptive. According to Gil (2002), descriptive research occurs when the intention is to describe the characteristics of a particular population, event or to establish relationships between variables. Gil (2002) concludes that in descriptive research there are numerous studies that can be classified. In other words, descriptive research is not limited to a single type of study, but includes various types of investigation that seek to describe characteristics or relationships in different contexts.

The data collection procedures are characterized by a bibliographical study and a case study, with an interview with a coordinator who provided specific company data. The biographical study is indispensable to any scientific research.

The bibliography was collected from sources such as periodicals like newspapers and magazines, electronic documents and various printed materials (GIL, 2002). According to Yin (2005), a case study is an empirical investigation of a contemporary event within a real-life context, where the boundaries between the fact and the context are not clearly defined.

Data analysis is the process of evaluating information. This process involves inspecting, investigating, storing and monitoring information in data format in order to obtain new knowledge. The data analysis process involves various procedures such as data tabulation and/or statistical calculations (GIL, 2002).

The data for this study was collected through an interview with the coordinator responsible for the TOBT, TSAT and SS indicators. To improve the visualization of the results and facilitate the interpretation of the data collected, tables and graphs were created. This information was essential in order to understand the performance of A-CDM in the Operational Control Center (OCC) at GRU Airport, in collaboration with XYZ Airline.

These visualization tools helped to find patterns and trends in the TOBT, TSAT and SS parameters, providing essential information for improving airport operations. A deeper understanding of A-CDM's performance and efficiency was achieved through comprehensive analysis.

Next, we present the results and discussion as a way of answering the research question.

RESULTS AND DISCUSSION

This chapter presents and discusses the conclusions of the analysis of Airline XYZ's operations at Guarulhos International Airport.

Planned departure times (TOBT), start-up approval times (TSAT) and actual departure times (SS) are the focus of the data, which allows for a better understanding of operational performance and its efficiency in relation to take-off flights.

INFORMATION ON XYZ AIRLINE'S OPERATIONS AT GUARULHOS INTERNATIONAL AIRPORT RELATED TO TAKE-OFF FLIGHTS:

PLANNED DEPARTURE TIMES (TOBT), START-UP APPROVAL TIMES (TSAT), AND ACTUAL DEPARTURE TIMES GROUND SUCCESS (SS)

To better understand the results of the study, we present the parameters[1] of percentages for TOBT analysis:

a. From 10% to 25% - Good

b. From 26% to 50% - Good

c. From 51% to 75% - Fair

d. From 76% to 100% - Insufficient

It is worth noting that the limit acceptable to the company, due to the magnitude of the use of A-CDM, whose objective is to improve efficiency, and here in this study is focused on take-off, the maximum acceptable percentage is 40%. The lower the better.

For TSAT, the parameters are presented as percentages for analysis, the lower the better:

a. From 0% to 1.95% - Good

b. From 1.96% to 2% - Good

c. From 2.1% to 4% - Fair

d. From 4.1% to 10% - Insufficient

To make it easier to understand the results of the study, the percentage parameters for the SS analysis are presented, the lower the better:

a. From 10% to 25% - Good

b. From 26% to 50% - Good

c. From 51% to 75% - Fair

d. From 76% to 100% - Insufficient

Table 1 shows the monthly variations of the parameters TOBT (Target Unblocking Time), TSAT (Target Authorization Time) and SS (Sequence Start Time) at XYZ Airline and Guarulhos International Airport in 2023.

This table shows the data that, over a twelve-month period, there was increasing difficulty in meeting the established schedules in relation to the increasing percentages.

	TOBT	TSAT	SS
JAN	**48,31**	**4,55**	**47,1**
FEB	**44,58**	**5,85**	**51,3**
MAR	**48,65**	**2,71**	**54,4**
APR	**46,13**	**2,37**	**60**
MAY	**43,8**	**1,52**	**65,2**
JUN	**57,38**	**1,85**	**56,7**
JUL	**58,99**	**1,74**	**54,1**
AUG	**61,56**	**1,75**	**50,5**
SEP	**59,7**	**1,42**	**57,7**
OCT	**77,96**	**3,82**	**42,3**
NOV	**72,78**	**2,13**	**50,7**
DEC	**80,37**	**2,03**	**55,2**

Table 1 - Monthly percentage changes in TOBT, TSAT and SS parameters Cia XYZ in 2023

Source: Prepared by the authors (2024).

Table 1 shows that, over a twelve-month period, there is a growing difficulty in meeting the established schedules in relation to the percentages.

1. The parameters were provided by Company XYZ.

TARGET TIME OF DEPARTURE (TBOT)

The variation of the Target Time of Departure from the Ramp (TOBT), which is the estimated time of departure of the aircraft, throughout the year is shown in Table 1. The variation in percentages over the period January/2023 to May/2023 showed a good performance. In the period in question, no month was characterized by optimal performance. The lowest percentages were recorded in May (43.8%) and February (44.58%), showing an improvement in efficiency. From June/2023 to September/2023, performance worsened to a level of regular efficiency between approximately 57% and 62%. The last three months of 2023 were marked by an increase in inefficiency, reaching a level considered insufficient at over 75% and 77.96%. Efficiency recovered to regular in November, but recorded its highest level of inefficiency during 2023 in December (80.37%).

These variations suggest that the monthly results are considered low, as the percentages are above the 40% acceptable limit. Seasonal demand and airport operating conditions can affect variations in the efficiency of initial operations. It can be seen that TOBT plays a crucial role, as it allows for more accurate forecasting and coordination of departure times, resulting in greater operational efficiency.

Company XYZ considers TOBT to be an indicator that helps to optimize resources, improve passenger service and guarantee punctual flights. In order to deal with operational problems, especially during busy periods, it needs to be done correctly and used.

TARGET DEPARTURE TIME (TSAT)

Graph 2 shows the TSAT, or Target Start Approval Time, also varied significantly. The lowest value was 1.52 in May, while the peak was 5.85 in February. According to this data, there was greater complication in organizing departure approvals in specific months.

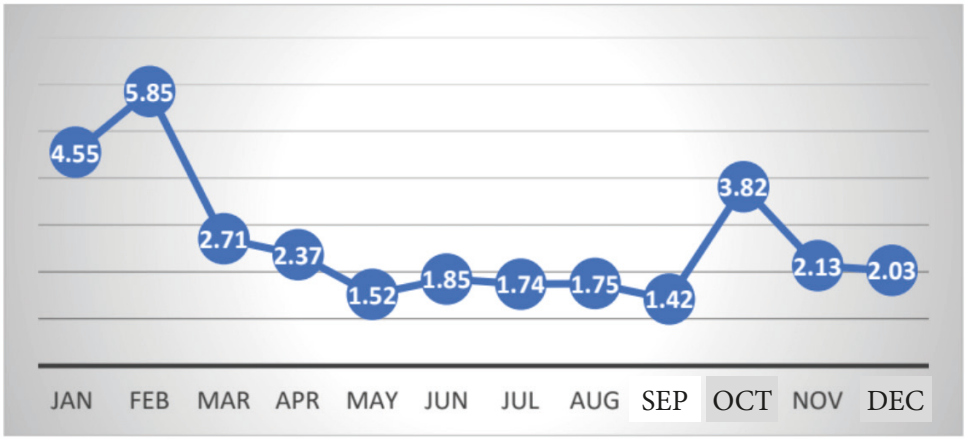
TSAT is the target time for the departure clearance granted by ATC. Its function is to ensure that the aircraft and air traffic control operate correctly, reducing delays and maximizing runway utilization. TSAT is considered an essential element for the operational efficiency and punctuality of Company XYZ's flights, increasing service quality and passenger satisfaction.

The TSAT varied significantly throughout the year, as shown in Graph 2. The lowest value recorded was 1.52 in May, while the peak reached 5.85 in February, indicating that there were more challenges in organizing departure approvals in specific months. TSAT helps reduce delays and maximize runway utilization, ensuring efficient aircraft operations and air traffic control.

The data shows that January, February, March, April, October and November showed less satisfactory results, with levels of insufficient and regular. From May to September, performance was excellent, with low TSAT values. The variation can be attributed to factors such as the time of year, the airport's specific operating conditions and possibly the effectiveness with which the A-CDM concept is implemented throughout the year. The final analysis highlights that TSAT works best from May to September. This may be due to lower seasonal demand or better coordination between the partners. On the other hand, the months with high values, particularly January and February, show problems in organizing departure approvals. This may be due to increased demand or operational problems during these months.

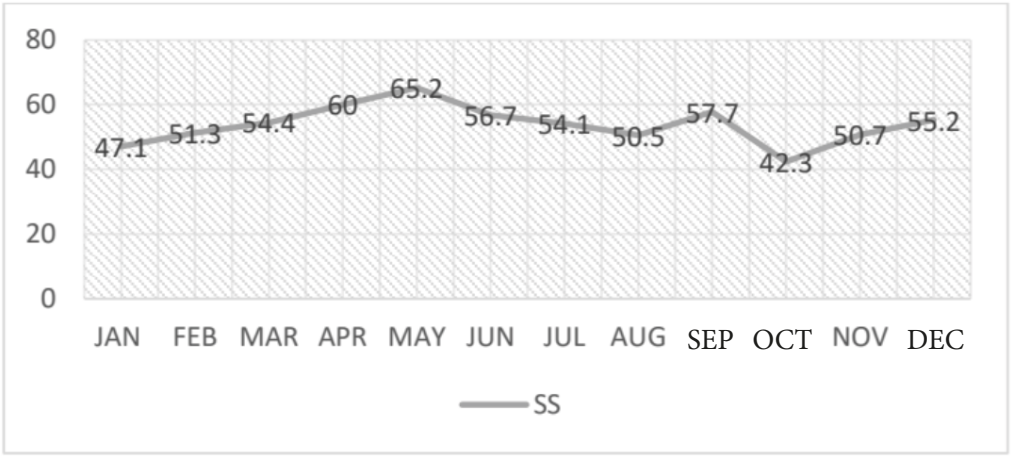
Graph 1 - Target Off Ramp Time (TOBT)

Source: Own elaboration (2024).



Graph 2 - Target Departure Approval Time

Source: Prepared by the authors (2024).



Graph 3 - Start of Sequence (SS)

Source: Prepared by the authors (2024).

START OF SEQUENCE (SS)

Graph 3 shows the Start of Sequence, or SS, showed an upward trend from January (47.1) to May (65.2), indicating an increase in the sequence of take-offs. However, there was a 42.3% drop in October. This can be attributed to adjustments in operations or variations in air traffic demand.

Its importance for Company XYZ is to guarantee a fluid and coordinated operation, reducing delays and avoiding air traffic conflicts. Company XYZ needs SS to improve the use of runways and the overall efficiency of airport operations.

In short, the consequences are in line with the knowledge derived from the theoretical basis. The A-CDM, on the TOBT, TSAT and SS (SAIPHER, 2021).

The performance indicators (TOBT, TSAT and SS) show that months with excellent TOBT generally have adequate TSAT, while periods with insufficient TOBT generally have regular TSAT. TSAT and SS have a moderate correlation; most of the time, optimal TSAT coincides with regular SS, except in April, when regular TSAT is associated with insufficient SS. The relationship between SS and TOBT is less clear, which means that the appropriate time is not always used efficiently. The joint analyses help to understand operational performance throughout the year.

The importance of these three parameters lies in their ability to effectively synchronize operations between aircraft and air traffic control, promoting greater punctuality and predictability. They constitute fundamental commitments that improve coordination and operational efficiency, which are essential for a dynamic and safe airport environment (SAIPHER, 2021).

To this end, the final considerations of this study are presented below, with suggestions for future work.

FINAL CONSIDERATIONS

For effective air traffic management, important time parameters such as TOBT (Target Lock Time/Ramp Out Time), TSAT (Target Start Approval Time/Start Approval Time) and SS (Sequence Start Time/Sequence Start) are essential.

The analysis carried out showed significant monthly changes in the TOBT, TSAT and SS parameters in 2023. This indicates that meeting schedules is becoming more difficult. The percentages remained relatively stable in January 2023, but reached their highest peaks in December. This study focused mainly on take-off flight data, specifically examining Airline XYZ's operations at Guarulhos International Airport.

The TOBT variation was positive, with 43.8% in May and 44.58% in February. However, 80.37% in December and 77.96% in October were not enough. TSAT values ranged from 1.52 in May, which is considered excellent, to 5.85 in February, indicating a variation in the organization of start-up approvals. The SS rose from 47.1 in January, which was considered reasonable, to 65.2, which was reasonable. However, it fell to 42.3% in October, which was also reasonable, indicating adjustments in operations. Finally, with the 40% TOBT parameter in mind, problems arose with operational efficiency. The SS value is 26% to 50%, while the TSAT is zero to ten percent.

For future work, we suggest

- Carry out a similar study with other airports and companies.
- Carry out a comparative study with international airports.
- Create a structured work plan to serve as a basis, with time tracking in other airlines.

The bibliographies used to develop the study are presented below.

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