Departamento
de Controle do Espaço Aéreo

COURSE ATM047
ATM PERFORMANCE INDICATOR

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INDEX

INTRODUCTION

This discipline aims to explain the fundamentals of ATM performance indicators, their classification and characteristics; to provide the necessary knowledge for the use of tools for the production and interpretation of results of performance indicators, highlighting the importance of the use of indicators in the Operational Doctrine and the communication of these results; and identify KPIs and IDBRs.

"You can't manage what you can't measure."

Peter Drucker

UNIT 1.1: INDICATORS

SUBUNIT 1.1.1: Introduction to Indicators

There is a lot of discussion about indicators in private companies, in the public administration and in federal agencies and units, such as *Departamento de Control del Espacio Aéreo* (DECEA) [1]. Undoubtedly, it is a recurring theme and considered fundamental. But how many organizations consistently apply management supported by indicators?

Performance indicators are a management tool that not only offers the possibility of identifying processes that are not following the desired course, but also their improvement, while at the same time supporting the decisions of senior management when the need arises to opt for a business course with continuous growth prospects.

Indicators are calculated measures of performance made up of a set of different metrics. It is the quantifiable representation of characteristics of services, products and processes, that is, they are parameters for evaluating the efficiency and effectiveness of an organization's processes.

The indicator is also considered a methodological resource to help interpret reality in a synthetic and operational way. It can be used for the diagnosis of a certain condition (environmental, economic, social, educational, etc.), for monitoring and evaluation of Air Traffic Management (ATM) planning, and for research in general.

From the point of view of public policies, indicators are instruments that allow identifying and measuring aspects related to a particular concept, phenomenon, problem or result of an intervention in reality. The main purpose of an indicator is to translate, in a measurable way, a certain aspect of a reality (in the case of this course, an ATM reality) in order to operationalize its observation and evaluation. Literature points out several meanings about the indicators and they all have a certain conceptual similarity. According to Ferreira, Cassiolato and Gonzales (2009), for example:

"*The indicator is a measure, of a quantitative or qualitative order, endowed with a particular meaning and used to organize and capture the relevant information of the elements that make up the object of observation. It is a methodological resource that empirically informs about the evolution of the observed aspect*".

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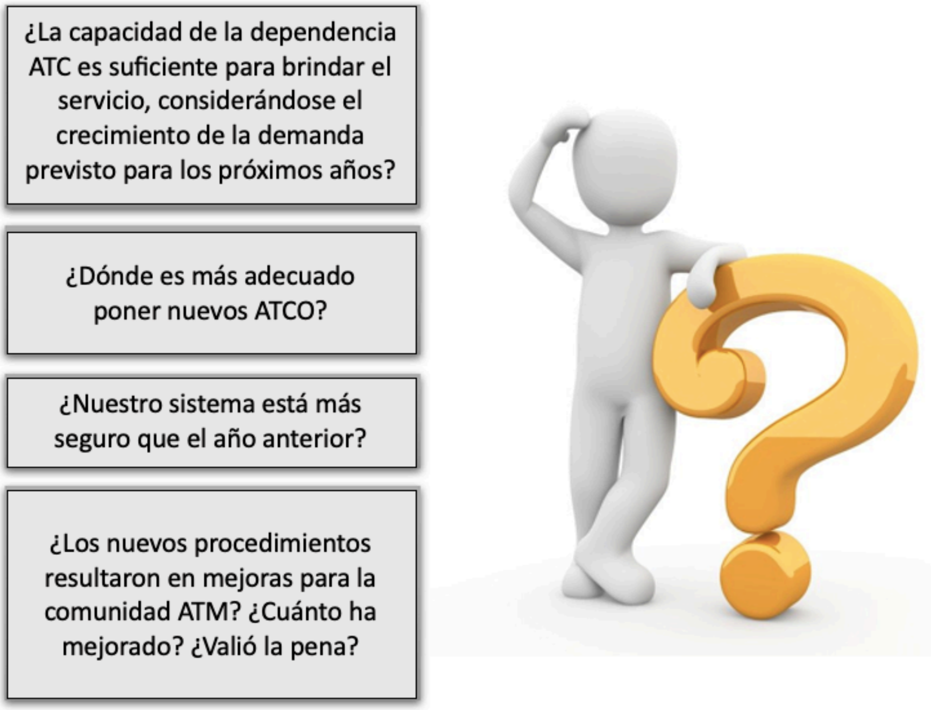
[1] The DECEA performance site can be found at: https://performance.decea.mil.br

Importance of Indicators

Indicators are the instruments that allow the organization's performance to be evaluated. They aim to facilitate the planning and control of the processes of the organization as a whole, establishing quantifiable goals and determining the deviations that occurred, contributing to the continuous improvement of organizational processes.

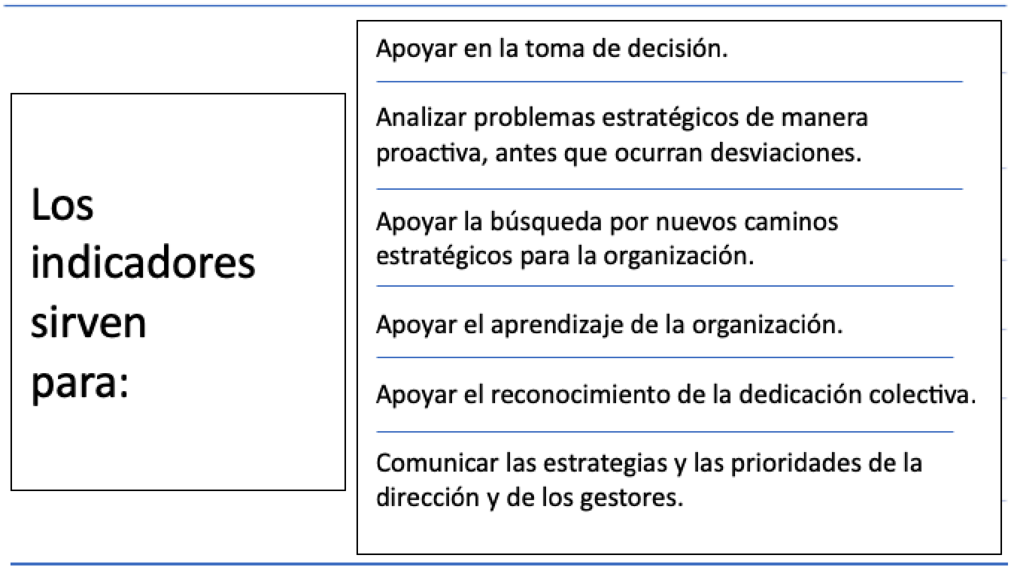
Here are some examples of questions that help translate the importance of indicators:



Picture 1 – To think.

Most people think that an organization needs indicators to verify that the set goals are being achieved. Yes, this is true, but indicators should also be used to support decision-making.

An organization that systematically measures its performance can make interventions quickly as fluctuations occur in the process. Based on the information generated, users can evaluate the performance of teams, activities, processes and management to, at the most appropriate time, make decisions and execute actions that will improve the performance of the organization.



Pictue 2 - What are indicators for?.

Why implement performance indicators?

According to FRANCISCHINI, 2017, the most common benefits provided by a system of indicators are::

• **Control:** The Control function consists of three essential parts:

a) collect data from a previously chosen variable;

b) analyze the data and detect deviations from an ideal or planned value; and

c) take corrective action to reduce the deviation from the ideal value.

• **Communication of objectives.** All minimally organized institutions have a strategic planning with a greater or lesser degree of detail and consistency of content. In order planning can be implemented, it is necessary for all those involved to know what objectives the institution intends to achieve in the coming years, the resources it will use and what is expected of each sector, administration or board of directors.

• **Motivation of professionals.** There is a natural resistance of human beings to leave the "comfort zone" since, in their opinion, it is there where they dedicate the least effort to perform their tasks. To minimize this resistance, it is necessary to show the employee what he /she will gain from the change.

• **Drive improvements in the company.** Detecting user expectations, analyzing the evolution of the organization and comparing with benchmarks and, mainly, knowing where to improve processes to set higher goals, are factors that depend on a system of performance indicators.

As an example of the use of indicators, a possible relationship between the number of flights departing from China and the number of new cases of COVID-19 in the destination countries of these flights can be identified in Figure 1 and Figure 2.

Figure 1–Daily flights / New Covid cases per Origin countries - Destination. (Source: https://data.icao.int/coVID-19/country-pair.htm)

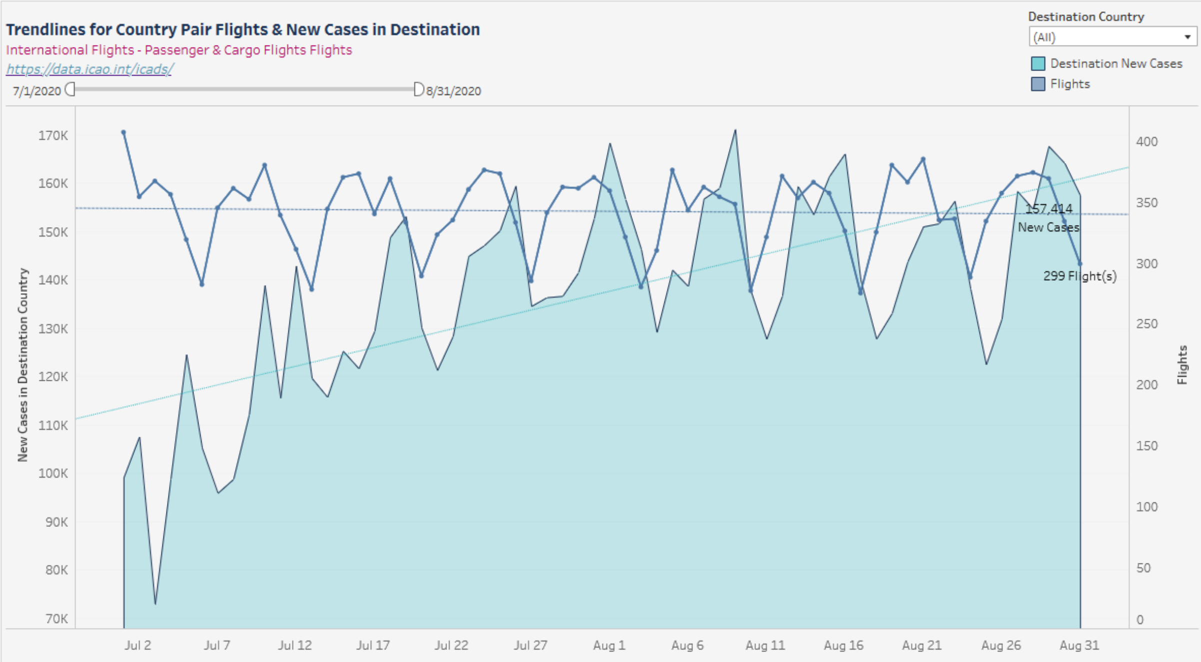


Figure 2 - Trend lines by country pair flights and new cases at destination. (Source: https://data.icao.int/coVID-19/country-pair.htm)

Another example would be the observation regarding the recovery of air traffic demand for the planning of the operational shifts of the ATC units, as shown in Figure 3.

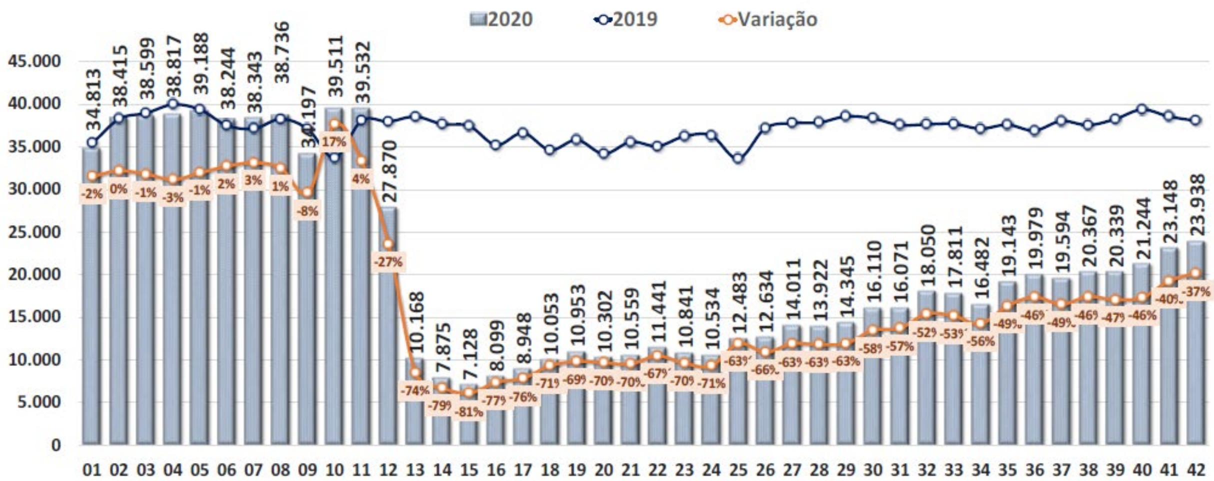


Figure 3 - Recovery of weekly air traffic since COVID. (Source: CGNA)

Difference Between Metric and Indicator

In a few words, a metric is a simple number, which corresponds to some measured result. An **indicator** is what indicates or demonstrates something in a specific situation. Indicators are built based on metrics.

A. Metrics

Metrics are generic measures, of simple composition, such as formats of values and quantities that serve as subsidies to the indicators. They are made up of various types, such as value, quantity, weight, volume or other quantitative format, and are also the basis for the constitution of performance indicators.

As an example of metric, the number of arrivals per hour or the number in minutes of flight delays in a day can be considered.

B. Indicators

Indicators are the measures calculated from metrics and are used to evaluate the performance of the company/organization. They are strategic information that help in trend analysis, continuous improvement, proactive action and give transparency to the company. They are usually expressed clearly by percentages and probabilities.

With deliberate redundancy, it can be said that an indicator is what indicates something or some specific situation and allows verifying the fulfillment of the goals established by an organization.

Thus, indicators are more appropriate for strategic decision-making advice than metrics.

Considering the metric of the number of arrivals per hour, it can be used for the development of indicators, for example, to calculate the utilization of the capacity of an airport.

If the metric of number in minutes of delayed flights in a day is considered, an airport punctuality indicator can be calculated.

It is well known that there is a difference at the managerial level in the two concepts. The indicator is a value generally calculated according to the metrics provided, which has quantitative and significant characteristics for the organizational strategy, being essential for decision-making. It is universally composed of indexes, range of values, frequencies, comparatives, among others.

Performance indicators, in addition to evaluating organizational performance, help with trend analysis, continuous improvement, proactive action, and give transparency to institutions. They also provide information for the analysis of processes and implementation of improvements, and are the elements that guide in the direction established by strategic planning.

However, we must realize that, despite the conceptual differences between each and their different applications, metrics and performance indicators support the organization's strategic-level objectives.

As an example for better understanding, we can consider the percentage of delayed flights. This indicator can be established to verify the extent to which the performance target of "improved arrivals on schedule" is being met. Data on the scheduled time and actual opening time of aircraft doors on arrival should be obtained for its calculation. From this data, the values of the total delay time (metric) can be determined, which, divided by the number of arrivals (metric), will allow the established indicator to be calculated.

Performance Indicators

Indicators are qualitative or quantitative measures that show the status of an operation, process, or system. Performance is the comparison between the result of the operation with respect to the client's expectation or the manager's objective. Therefore, performance indicators are measures that show the comparison of what was achieved in the operation against an expectation or objective.

Indicador clave de rendimiento is the Spanish translation used in the GANP Portal for Key Performance Indicator (KPI). KPIs are considered to be the best indicators for monitoring and analyzing business performance.

Targets

The concept of target is associated with an intention. Targets are the objectives to be achieved after the consolidation of metrics and indicators. They are important for measuring how far (or close) we are from the strategic goal set for the organization.

The target quantifies what is aspired to. It has the function of eliminating subjectivity, reinforcing commitment, encouraging continuous improvement and promoting innovation. In addition, it must answer the following question "How much do we intend to achieve?".

For example, if the quantitative of operational ATCOs is required to be higher than 80%, we are talking about a target. Targets are quantifiable milestones of fixed duration that help in the development of a project.

How to set targets – SMART methodology

Any target or objective can be created through the SMART methodology, which is an acronym that stands for:

- ***Specific***: What are you going to do? When, where, why?
- ***Measurable***: Is it measurable in numbers?
- ***Attainable***: Is it feasible?
- ***Relevant***: Is it important?
- ***Term***: Is there a defined term?

Each letter of the acronym identifies an essential component of effective goal setting, as presented in Figure 4.

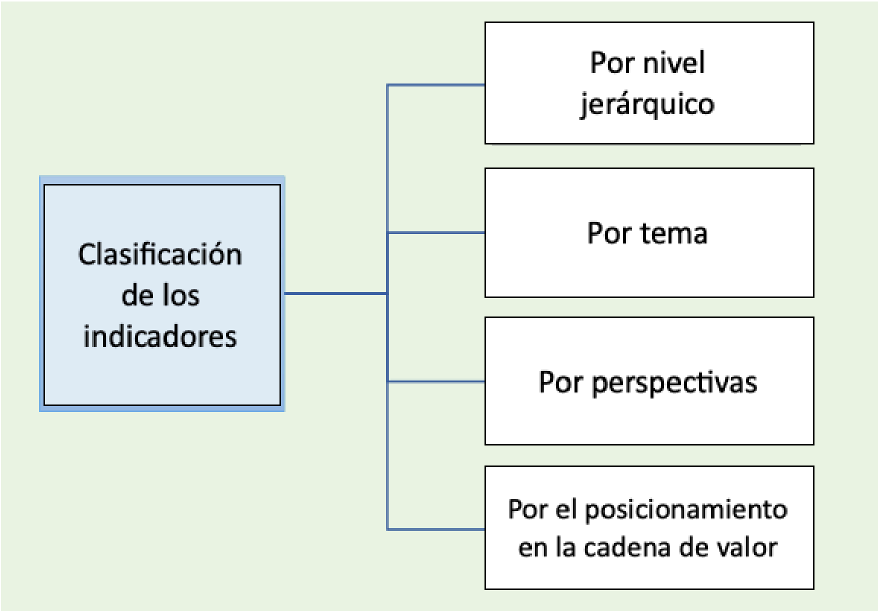
SMART targets refer to an established methodology for defining objectives. This methodology helps to define clear expectations to maximize the chances of achieving them.

Setting SMART targets creates trajectories toward a certain goal, with clear milestones and an estimate of how to achieve it.

Figure 4 - SMART Methodology.

SUBUNIT 1.1.2: Indicators Classification

Indicators can be classified by their hierarchical level, by theme, by dimensions or perspective, or by their positioning in the value chain.



Picture 3 – Indicators classification.

By hierarchical level

The indicators can be classified by hierarchical levels, as follows:

Strategic: directly linked to strategic planning, such as the mission, purpose and vision established for the organization, usually in the medium or long term;

Management: Metrics are pointed out to determine whether the actions planned by each area are contributing to the achievement of the broader objectives They are linked to managerial and medium-term objectives; and

Operational: they are usually short-term and linked to operational processes.

By topic

This is a classification that has already been widely adopted in private and public organizations, but has been falling into disuse in recent times, especially with the expansion of the Balanced Scorecard (BSC) [2]. (BSC, "Balanced Performance Indicators"). The division by themes is used to ensure the balance of institutional performance among the defined topics.

[2] BSC es una metodología de medición de la gestión de desempeño.

Indicators can be of various topics, such as the following:

- Quality;
- Cost;
- Efficiency;
- Envionment; or
- Safety.

By perspectives

The division of the measurement system into perspectives is necessary to highlight the priority areas and ensure the balance between them.

Indicators can be distinguished according to the perspectives of ATM community members. We could, for example, highlight the perspective:

- From Air Navigation Service Providers (ANSP),
- From regulatory agencies,
- From airlines companies,
- From airports,
- From passengers..

By positioning in the value chain

In 2009, Brazil's Ministry of Planning conducted extensive research on management indicators. Models proposed by renowned consultancies were analyzed, models used by public agencies in the three spheres of government (municipal, departmental and federal) and also by agencies from various countries. The conclusions were similar to those obtained in the meetings of the Performance Measurement Committee of the National Foundation for Quality (FNQ): a very useful classification of management indicators refers to their position at the value chain stage.

As a direct result of this classification, indicators can also be divided into:

- Effort indicators; or
- Results indicators

Several publications adopt this classification, including the Thematic Committee for the Measurement of the Performance of the FNQ, and there are numerous terminologies to designate what in this course we will call effort indicators and results indicators, a term more common in Brazil. It should be noted that in English the terms drivers and *outcomes* are widely used.

This classification is interesting because if an objective was measured with indicators of result and effort, if the expected results have been obtained, it is possible to conclude whether they were achieved as a result of the management practices used. It is a proactive way of monitoring performance, because those that have not been achieved as a result of management practices cannot be considered in fact.

When a measurement system does not have indicators of both types, it can be verified that:

- A measurement system that only has effort indicators reflects a lack of objectivity, with greater concern for the means than for the results; and
- A measurement system that only has performance indicators reflects a lack of connection between strategy, means and results.

Here are some concepts that distinguish them (Table 1):

Table - Difference between effort and result indicators.

EFFORT INDICATORS	RESULT INDICATORS
They measure the cause before the effect occurs.	They measure the effect after a certain time.
They serve to verify whether the plans linked to the critical success factors are being fulfilled.	They serve to verify whether the objectives are being achieved.
Apropiados para medir planes de acción, proyectos e iniciativas.	Appropriate for measuring action plans, projects and initiatives.

Source: *FNQ. Performance Indicators – Structuring of the System of Organizational Indicators.*

SUBUNIT 1.1.3: Indicators Characteristics

Every performance measurement system is made up of a set of previously established indicators that will verify the achievement or not of certain organizational objectives. A good indicator should have the following characteristics:

- **Adaptability** – Responsiveness to changes in customer behavior and requirements;
- **Availability** – Ease of access for collection, being available in time to the right people and without distortions, serving as a basis for decision-making.. It would not be so useful to have outdated information, even if it is correct, or to provide the right information for the wrong people;
- **Cost-effectiveness** – You shouldn't spend too much time looking for data, much less researching or waiting for new methods of collection. The benefits provided by the indicators must be greater than the costs incurred in the measurement;
- **Stability** – Ensure that it is generated in process routines and remains over time, allowing the formation of historical series;
- **Objectivity** – Calculations must consider the magnitudes of the value, without having the possibility of misinterpretations, in addition to ensuring that it really works in practice and allows management decisions to be made;
- **Precision** – The margin of error must be calculated and acceptable, i.e., it must not distort its interpretation;
- **Traceability** – ease of identification of the origin of the data, its records and maintenance. Whenever possible, the results should be transformed into graphs, for more accurate tracking, allowing comparison with previous results;;
- **Pertinence** – The values provided must be essential for controlling, evaluating, making decisions, being accountable and making adjustments;
- **Representativity** – capture of the most important and critical stages of the processes, in the right place, so that it is sufficiently representative, comprehensive and relevant. Unnecessary data should not be collected. On the contrary, important data must be accurate, meet objectives, and be sought from the right source. This attribute deserves some attention, because highly representative indicators can be very difficult to obtain. Therefore, there must be a certain balance between representativeness and availability for collection; and

- **Simplicity** – easy to be understood and applied both by those who handle the indicator and by those who will receive the results. Names and expressions must be known and understood by everyone in a homogeneous way, ensuring broad validity throughout the organization.

Picture 3 – Indicators Characteristics.

It is important to note that when it is identified that indicators may become unnecessary, they should be immediately eliminated or replaced by others of greater use.

In addition to these characteristics, it is important that the indicator selection process considers the following aspects:

- **Advertising** – The indicators must be public, that is, known and accessible to all levels of the institution, as well as to society and other entities of the public administration.

- **Temporality** – The identification of performance indicators must consider some temporal issues: first, the moment at which the measurement should begin; second, the availability of obtaining the data when different outcomes begin to happen; and, finally, the possibility that, through these measures, it will be possible to carry out periodic monitoring of the performance of the Program.
- **Feasibility** – The data necessary for measurements constitute information that is part of the institution's management processes and, therefore, is obtained through collection instruments, either by sample or census, statistics, application of questionnaires, observation, etc., depending on the aspect to be measured. A proposal for the development of indicators should make it possible to have viable measurement indicators at appropriate times and intervals that balance information needs with technical and financial resources.

SUBUNIT 1.1.4: Indicators Development

As already explained, we can classify the indicators into hierarchical levels as follows: strategic, management and operational. With this, each hierarchical level must monitor a different set of indicators, which must be integrated aiming at the organization's ultimate goal. It is notorious that there is a natural tendency to consider all the objectives and plans of the organization as critical to strategy and analysis by senior management, but it should be taken into account that the degree of strategic importance of each indicator is certainly variable.

Figure 5 below presents the measurement technique presented in Doc 9883, Manual on Global Performance of the Air Navigation System (ICAO, 2009).

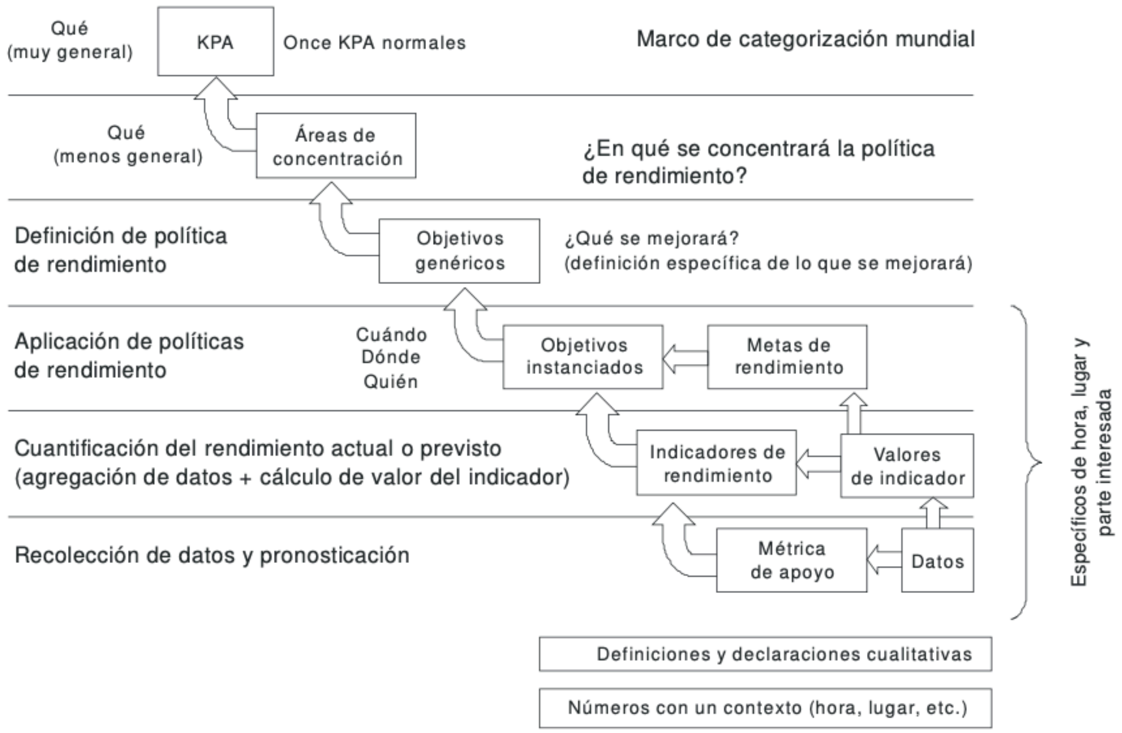


Figure 5 – Measurement taxonomy illustration. (Source: ICAO, 2009)

Step by step for the construction of indicators

Here is a step-by-step guide to build indicators:[3]

1. Select a goal:

The objective may be contained in the strategic map or belong to some other form of institutional strategic planning. It is recommended to start with the objectives most related to the institution's final results, which include the expectations of the ATM community.

2. Identify critical success factors:

A critical success factor is a challenge, obstacle, or constraint that, if not overcome, will prevent the achievement of the goal.

3. Choose indicators that represent the achievement of the objective:

An outcome indicator refers to the effectiveness or impact of achieving the goal. Table 2 has suggested outcome indicators..

4. Assess the quality of indicators:

Evaluate the adherence of the indicator in relation to the attributes of the institutional indicators and their quality. Check, for example, whether the characteristics of the indicators described fit into the suggested indicators.

[3] Another methodology for developing indicators can be found in Doc 9883.

5. Analyse all indicators and select them:

Analyze the consistency of the developed system: verify if the goals of the indicators of the base of the strategic map are achieved. In addition, the number of planning-level indicators to be monitored should be reduced.

6. Establish an action plan to achieve the goal:

An action plan should consist of activities and/or projects that help overcome critical success factors and achieve objectives.

7. Describe the indicator:

Complete the fact sheet for the selected indicator, according to the model in Table 3.

Table 1 - Suggested outcome indicators.

<table>
<tr><th colspan="2">Thinking about outcome indicators</th><th colspan="2">Examples</th></tr>
<tr><th>If the objective...</th><th>If the indicator...</th><th>Objective</th><th>Indicator example</th></tr>
<tr><td>contains terms such as reduce or enlarge</td><td>can be an index</td><td>Increase the number of operational ATCOs</td><td>Operationality Index</td></tr>
<tr><td rowspan="3">refers to quality or may relate to the service provided or customer service</td><td>can be based on a satisfaction survey</td><td>Improve the quality of air traffic control service</td><td>Satisfaction of airmen (based on survey results)</td></tr>
<tr><td>can be based on a percentage of failures</td><td>Promote the improvement of the systems used (SIGMA, SAGITTARIUS, etc.)</td><td>Number of repeated occurrences</td></tr>
<tr><td>can refer to the period of attention</td><td>Promote the improvement of the systems used (SIGMA, SAGITTARIUS, etc.)</td><td>Average time to implement system improvements</td></tr>
<tr><td>refers to something that should be encouraged</td><td>can refer to a percentage increase</td><td>Encourage research</td><td>Percentage increase in the number of investigations carried out</td></tr>
<tr><td rowspan="3">It can only be achieved if a set of objectives, projects or actions is successful</td><td rowspan="3">it can be a percentage measure of the goals achieved</td><td>Improve the performance of SISCEAB</td><td>Percentage of goals achieved by DECEA</td></tr>
<tr><td>Promoting knowledge management</td><td>Percentage of goals achieved in knowledge management</td></tr>
<tr><td>Promoting competency-based management</td><td>Percentage of goals achieved in management by competencies</td></tr>
</table>

Table 2 - Model indicator descriptive sheet.

Indicator	DEPARTURE PUNCTUALITY (KPI01)
Business Area	
Indicator Description	
Objective	
Identification of the variables	
Formula (metric)	
Analysis Parameters	
Guidance for analysis	
Data Source	
Reference	

Follow an example of the step-by-step for developing an ATM indicator:

1. Select a goal:

As expected by the ATM community, the predictability of operations (expectations) must be maintained. One of the objectives is to increase the percentage of flights carried out on their scheduled schedule – Scheduled Off-Block Time (SOBT).

2. Identify critical success factors:

A critical success factor may be the optimization of aircraft output capacity.

3. Choose indicators that represent the achievement of the objective:

The following indicators represent the achievement of the desired objective: departure punctuality, average departure delay and take-off punctuality.

4. Assess the quality of indicators:

The evaluation of the quality of indicators can be carried out for various characteristics. In the example presented in Table 4, three characteristics are analyzed.

Table 3 – Characteristis Analysis.

	Punctuality of departure	Average Departure Delay	Timeliness at take-off
AVAILABILITY	Sí	Sí	No
OBJECTIVITY	Sí	Sí	Sí
PRECISION	Sí	Sí	No

5. Analyse all the indicators and select them:

After the analysis, the chosen indicator is the punctuality of departure (KPI01).

6. stablish an action plan to achieve the goal:

The possibilities of operational improvements must be studied to reduce runway occupancy time and consequent increase in capacity.

7. Describe the indicator:

For the ATM reality of the DECEA, once the indicator has been defined, it is essential to identify the elements presented in Table 5, referring to the indicator of punctuality of departure.

Table 4 - Output punctuality indicator descriptive sheet.

Indicator	**DEPARTURE PUNCTUALITY (KPI01)**
Business area	Predictability
Description of the indicator	Percentage of flights departing from the boarding gate on time with respect to the planned schedule (EOBT, Registro ANAC)
Objective	This indicator points to the predictability played by the airport in its departure operations. It can be calculated in two ways: based on the scheduled departure time of the flight (ANAC Record) or the EOBT (Flight Plan)
Identification of the variabless	1. Filter only scheduled flights (flight plan type). 2. Determine the Time Variance (Delta Outbound). $\Delta T\ 1 = \lvert AOBT - EOBT \rvert$ $\Delta T\ 2 = \lvert AOBT - \text{Departure record} \rvert$ 3. Classify the flight as punctual or not (with the 2 variants of ΔT 1 and 2). - Yes $\Delta T \geq \Delta L \rightarrow$ Flight on time - Yes $\Delta T < \Delta L \rightarrow$ Punctual flight Limit Delta = 5 min, 15 min or 30 min

Indicator	DEPARTURE PUNCTUALITY (KPI01)
	4. Calculate percentage of one-off flights.
Firmula (metric)	$KPI_{01} = \frac{\sum(punctual\ departures)}{\sum(departures)} \times 100$ [% of flights]
Analysis Parameters	Day, month, year, ATC dependency, airline, airport and runway.
Guidance for analysis	Cut-off value (maximum positive or negative deviation expected for a scheduled departure), which defines whether it is considered a one-off flight or not. 5, 15 and 30 minute value Scheduled departures based on regular flight plans
Data Source	AOBT – TATIC FLOW EOBT (Record) – ANAC Flight record EOBT (PLN) – TATIC FLOW
Reference	GANP 6ª ed.

The establishment of good indicators requires perception, objectivity and knowledge of the reality of the organization, highlighting that a minimum of experience in the subject is essential. In addition to strategic planning and defined goals, the KPI should be monitored with the required regularity. It is important to note that the information must be shared with the entire team so that it can be improved and add information that is considered necessary throughout the measurement.

UNIT 1.2 ATM PERFORMANCE INDICATORS

SUBUNIT 1.2.1: GANP Indicators

Historical of ATM Indicators

The International Civil Aviation Organization (ICAO) is a specialized agency of the United Nations (UN) that seeks to develop principles and techniques for international air navigation, promoting the planning and evolution of the transit.

Following the approval of the planning and implementation of Performance Management for Air Navigation at the 11th Air Navigation Conference in 2003, as well as at the 35th Session of the ICAO Assembly in 2004, a relevant guidance document was published in 2009: the Manual on Global Performance of the Air Navigation System (Doc 9883).

In 2009, all Planning and Implementation Regional Groups (PIRGs), adopting a regional performance structure, invited States to implement a national performance structure for air navigation systems, based on ICAO guidance material, in line with regional performance objectives, existing regional air navigation plans and the Global Air Traffic Management Operational Concept (Doc 9854).

The next step required monitoring performance through a well-established measurement strategy. While the PIRGs progressively identify a set of regional performance indicators, States recognize that data collection, processing, storage, and reporting in support of regional performance indicators are critical to the success of performance-based strategies.

The performance structure of the PIRG provides that the reporting, monitoring, analysis, and review activities are conducted in a cyclical manner, annually. The Air Navigation Report[4] will be the basis for monitoring performance related to the implementation of the Aviation System Block Upgrade (ASBU) at the regional and national level.

The results of the report and monitoring will be analyzed by ICAO, which urges States to develop their initial analyses and disseminate their results. The Air Navigation Report will provide the global civil aviation community with an opportunity to compare the evolution of the establishment of Air Navigation infrastructure and performance-based procedures in various ICAO regions.

Global Air Navigation Plan – GANP

The Global Air Navigation Plan (GANP)[5] is an important planning tool for setting global priorities that drive the evolution of the global air navigation system and ensure that the vision of an integrated, harmonized, globally interoperable and seamless system is realized. Developed in collaboration with stakeholders for their benefit, the GANP makes a key contribution to the achievement of ICAO's strategic objectives.

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[4] This report is available at: https://www.icao.int/airnavigation/Pages/Air-Navigation-Report.aspx

[5] Since its sixth edition, the GANP has been available at. https://www4.icao.int/ganpportal/

The Global Air Navigation Plan

- Guides States to correlate their national or regional programmes with the harmonised GANP, but provides them with much greater certainty of investment.
- Requires active collaboration among States through the PIRGs, in order to coordinate initiatives within the framework of the applicable regional air navigation plans.
- Provides the tools required for States and regions to produce comprehensive cost-benefit analyses when seeking to make specific operational improvements.
- Provides an insight to the evolution of the global ATM system and the potential requirements for the industry to make the necessary forecasts for its products.

Picture 5 – GANP Overview.

The GANP content is organised in a four-tier structure, each of which is tailored to different audiences. This allows better communication with high-level and technical-level managers, with the aim that no State or stakeholder is left behind. This structure encompasses the global (strategic and technical), regional and national levels, and provides a framework for harmonizing regional, subregional and national plans.. This facilitates decision-making because it provides stable strategic guidance for the evolution of the air navigation system and, at the same time, the relevance of the technical content over time.

The GANP outlines ten key principles of ICAO's civil aviation policy with global, regional and national guidance on air navigation planning, as summarized below:

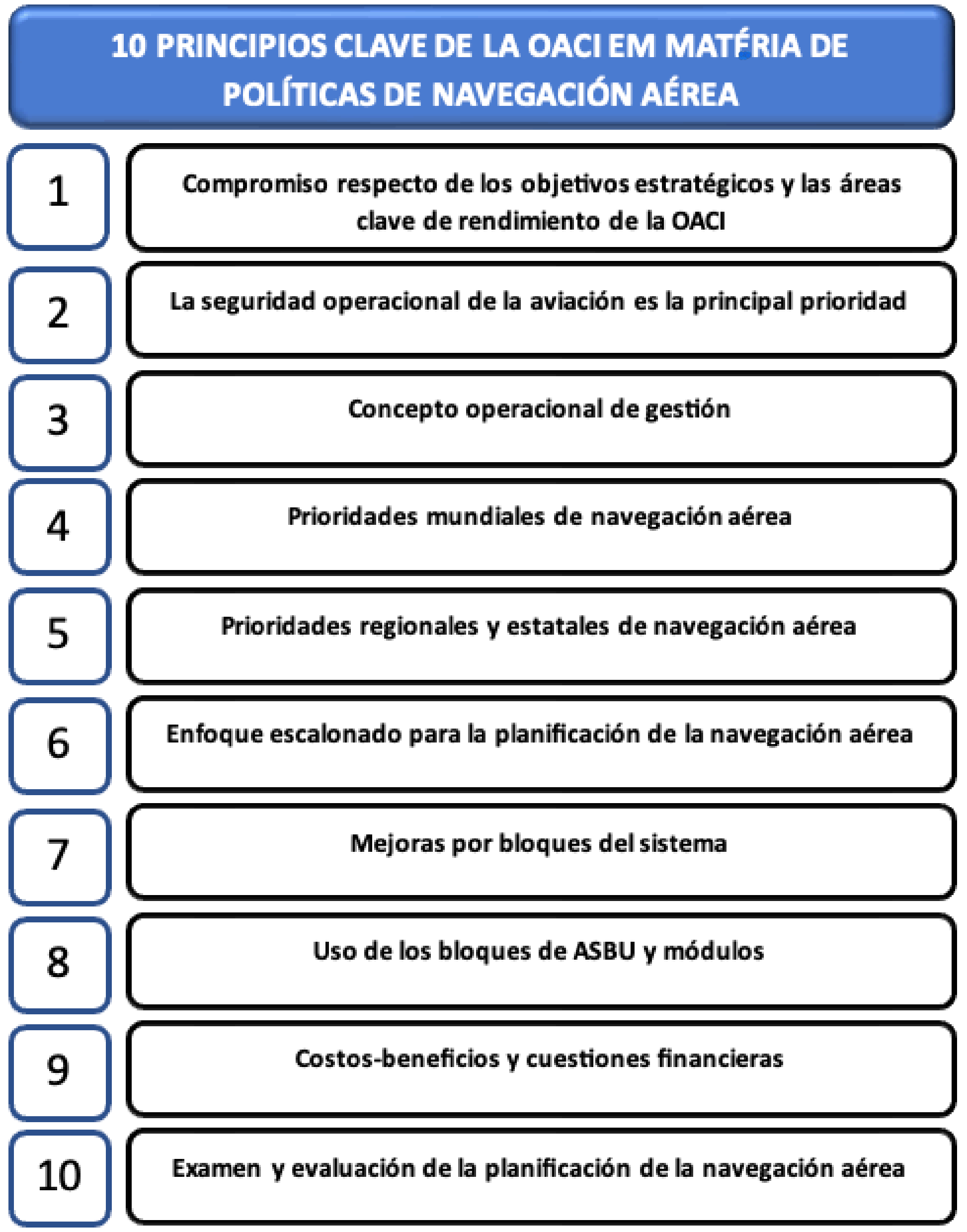


Figure 6 – ICAO Policy Principles.

Management by Performance

Today's aviation system is complex, with its performance determined by a diverse group of stakeholders – including PSNA, airspace users and airports. Each participant's ability to operate is significantly affected by external factors such as weather. To maintain high levels of safety and efficiency, everyone involved must make significant investments in new technologies.

To prioritize future investments and improve system efficiency, the adoption of performance management, as described in Doc 9883, is necessary, using a carefully selected set of indicators, which also allows for the monitoring of current operations.

Performance management is results-focused, with decision-makers collaborating by setting priorities and determining the appropriate balance that supports an optimized allocation of resources, while maintaining an acceptable level of safety performance and promoting transparency and accountability among stakeholders. In promoting performance management, ICAO recommends that nations use a specific set of key performance indicators (KPIs) that provide the means to identify gaps and prioritize investments.

The implementation of KPIs will allow the sharing of performance issues and best practices globally, as well as the measurement and documentation of the performance benefits produced by the implementations of new technologies and concepts.

Performance management will also allow participants to analyse the performance of the air navigation system and to act, if necessary, to fill any gaps between current and expected performance..

Figure 7 presents the performance management cycle, as recommended in Doc 9883.

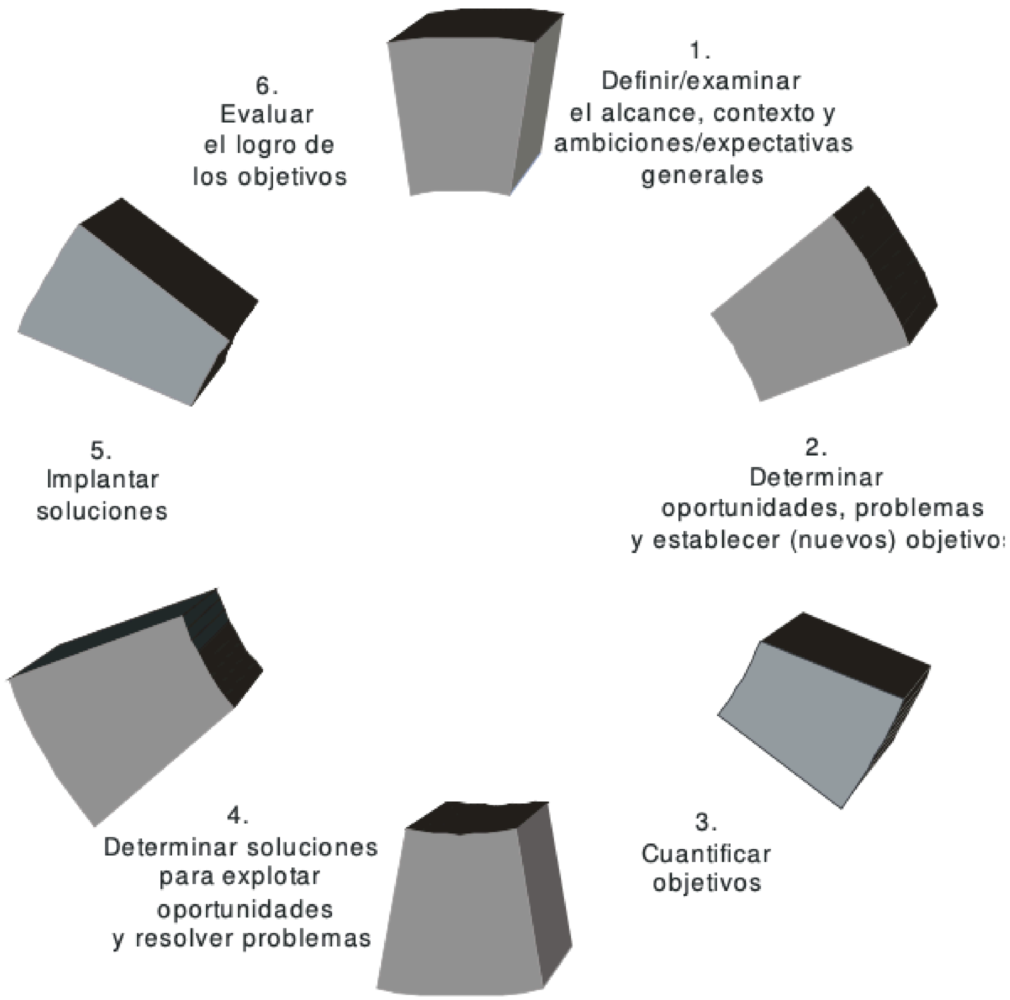


Figure 7 – Overall performance management process. (Source: Doc 9883)

The purpose of Step 1 is to achieve a common agreement on the scope and context (assumption) of the "system" on which the performance management process will be applied, as well as a common understanding of the overall nature of the planned performance improvements. In this regard, it is important to identify overall expectations and ambitions..

The term "expectation" refers to the desired outcomes from an external perspective. The term "ambition" indicates that the desired results refer to an internal initiative. The definition of expectations and objectives allows you to develop a strategic vision of the expected results (performance).

Figure 8 demonstrates the relationship between ATM community expectations, performance areas, and strategic objectives of global air navigation. Performance management will allow States to measure the degree of success of implementations that seek to meet these strategic objectives.

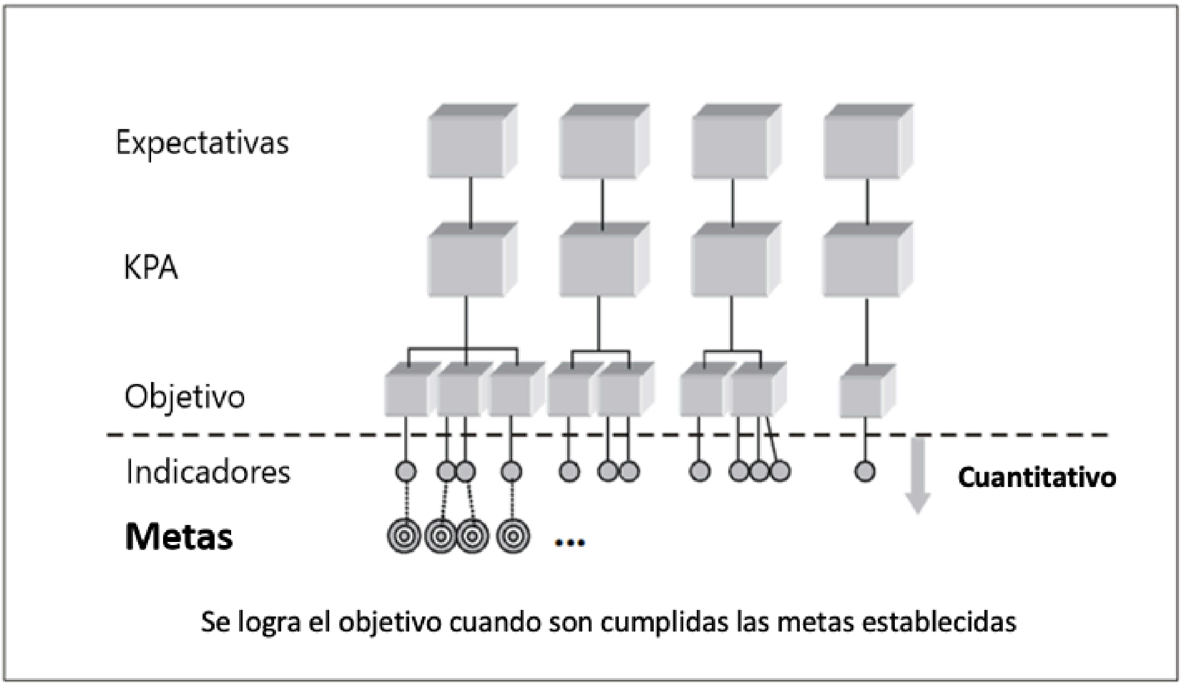


Figure 8 – Structure and relationship between expectations and KPIs.

KPA

Performance areas, also called KPAs (Key Performance Areas), are a way of categorizing performance topics related to high-level ambitions and expectations. ICAO has defined 11 KPAs, which are listed below:

Access and equity: A global air navigation system should provide an operating environment that ensures that all airspace users have the right to access the ATM resources necessary to meet their specific operational requirements and that a safe use of airspace can be achieved by different users. The global air navigation system should ensure fairness for all users who have access to a given part of the airspace or service.

Capacity: The global air navigation system should exploit the inherent capacity to meet the demands of airspace users at times and locations of peak traffic, while minimizing restrictions on traffic flows.

Cost-effectiveness: The air navigation system should be cost-effective, while maintaining a balance between the diverse interests of the ATM community. The cost of services to airspace users should always be considered when evaluating any proposal to improve the quality of service or the performance of the ATM.

Efficiency: Efficiency refers to the operational effectiveness and economic profitability of door-to-door flight operations from a single-flight perspective. In all phases of flight, airspace users want to leave and arrive at the time they have selected and fly on the trajectory they consider optimal.

Environment: The air navigation system should contribute to the protection of the environment, considering noise, gaseous emissions and other environmental issues in the implementation and operation of the global air navigation system.

Flexibility: Flexibility refers to the ability of all airspace users to dynamically modify their flight paths and adjust departure and arrival times with a view to exploiting operational opportunities as they arise.

Interoperability: The air navigation system should be based on global standards and uniform principles to ensure the technical and operational interoperability of air navigation systems and to facilitate homogeneous and non-discriminatory global and regional traffic flows.

ATM community participation: The ATM community should be continuously involved in the planning, implementation, and operation of the system to ensure that the evolution of the global air navigation system meets the expectations of the community**.**

Predictability: Refers to the ability of airspace users and air navigation service providers to provide consistent and reliable levels of performance. The ability to predict is essential for airspace users when preparing and operating their itineraries.

Safety: Safety is the highest priority in aviation, and ATM plays an important role in ensuring the safety and security of aviation as a whole. Uniform safety standards and methods for risk management and safety should be applied systematically for the air navigation system.

Aviation security: Aviation security refers to protection against threats from intentional (e.g., terrorism) or unintentional (e.g., human error, natural disasters) acts affecting aircraft, people, or ground facilities. Proper aviation security is a primary expectation of the ATM community and citizens. The air navigation system should therefore contribute to aviation security and be protected against threats to aviation security.

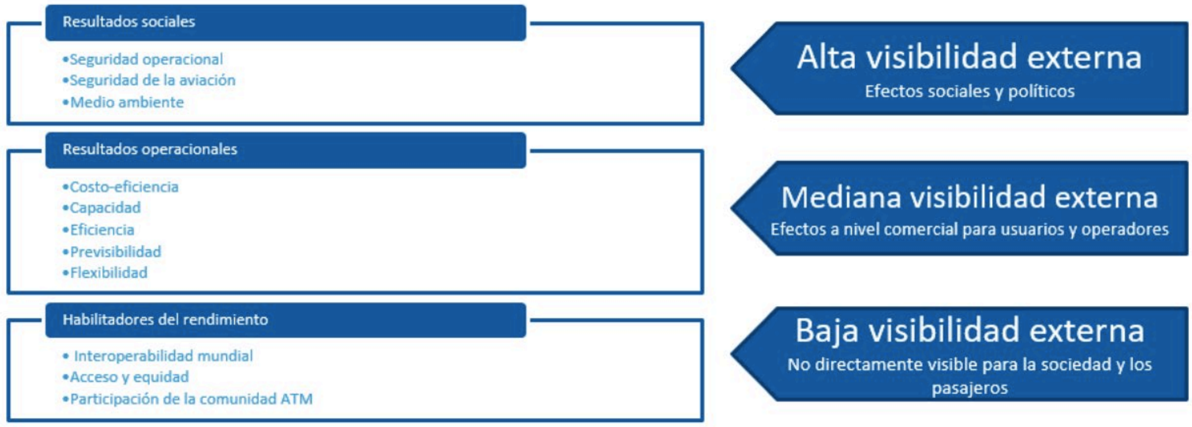
Table 6 below presents the relationship between the ATM community's performance areas and ambitions present in the GANP.

Table 5 – GANP Ambitions.

SUMMARY OF THE EFFICIENCY AMBITIONS OF THE GANP	
KPA	**AMBITION**
ACCESS AND EQUITY	No member of the aviation community will be excluded or treated unfairly
CAPACITY	Nominal capacity easily adjustable to demand
	Disruptive events do not disrupt service delivery or significantly affect system performance
PROFITABILITY	No increase in the direct total cost of air navigation services while maintaining operational safety and quality of services
	Significant increase in air navigation service productivity regardless of demand
EFFICIENCY	Reducing the gap between the flight efficiency achieved and the optimal trajectory desired by airspace users
ENVIRONMENT	Phasing out inefficiencies caused by air navigation services in support of ICAO's global CO2 emissions targets
	Benefits due to improvements in flight efficiency
FLEXIBILITY	Absorbing required changes from different business trajectories and operations
INTEROPERABILITY	System compatibility at operational and technical level
ATM COMMUNITY ENGAGEMENT	Pre-agreed level of participation to share air navigation resources as much as possible
PREVISIBILIDAD	No increase in variability in the supply of air navigation services, including asset availability
SEGURIDAD OPERACIONAL	No incident related to the air navigation service and significant reduction (50%) in related major incidents
AVIATION SECURITY	No major disruption due to cyber incidents

Source: (ICAO, 2020a)

Areas of performance can be classified according to the perspective of ATM community members. Although all these areas are equally important, since they are interrelated and cannot be considered in isolation, some of them are more visible to society than others, as presented in the GANP and described below:



Picture 4 - Division of the KPA by perspective

KPI

Key Performance Indicators, also called KPIs, quantitatively express past and current performance based on the organization's goals. To be relevant, indicators must faithfully express the intent of the specific associated objective. Indicators, in general, are not measured directly, but are calculated from support metrics according to well-defined formulas.

Table 7 presents the identification code of the indicator, its nomenclature and a brief definition, according to the GANP. For more details on KPIs and their methodologies, please refer to the GANP Portal: https://www4.icao.int/ganpportal/ASBU/KPI.

Table 6 – Indicators Description

NUMBER	KPI	DESCRIPTION
KPI01	Punctuality of departure	Percentage of flights departing from the gate on-time (EOBT/ Horario de Registro).
KPI02	Taxi-out additional time	Actual taxi-out time compared to an unimpeded/reference taxi-out time.
KPI03	ATFM slot adherence	Percentage of flights taking off within their assigned ATFM slot (Calculated Take-Off Time Compliance).
KPI04	Filed flight plan en-route extension	Flight planned en-route distance compared to a reference ideal trajectory distance.
KPI05	Actual en-route extension	Actual en-route distance flown compared to a reference ideal distance.
KPI06	En-route airspace capacity	The maximum volume of traffic an airspace volume will safely accept under normal conditions in a given time period.
KPI07	En-route ATFM delay	ATFM delay attributed to flow restrictions in a given en-route airspace volume Mesurement Units Minutes/flight.
KPI08	Additional time in terminal airspace	Actual terminal airspace transit time compared to an unimpeded time.
KPI09	Airport peak capacity	The highest number of operations an airport can accept in a one-hour time frame (also called declared capacity).
KPI10	Airport peak throughput	The 95th percentile of the hourly number of operations recorded at an airport, in the “rolling” hours sorted from the least busy to the busiest hour.
KPI11	Airport throughput efficiency	Airport throughput (accommodated demand) compared to capacity or demand, whichever is lower.
KPI12	Airport/Terminal ATFM delay	ATFM delay attributed to arrival flow restrictions at a given airport and/or associated terminal airspace volume.
KPI13	Taxi-in additional time	Actual taxi-in time compared to an unimpeded/reference taxi-in time.
KPI14	Arrival punctuality	Percentage of flights arriving at the gate on-time (EIBT).
KPI15	Flight time variability	Distribution of the flight (phase) duration around the average value.
KPI16	Additional fuel burn	Additional flight time/distance and vertical flight inefficiency converted to estimated additional fuel burn attributable to ATM.
KPI17	Level-off during climb	Distance and time flown in level flight before Top of Climb.
KPI18	Level capping during cruise	Flight Level difference between maximum Flight Levels on a measured airport pair and maximum Flight Levels on similar unconstrained airport pairs.

NUMBER	KPI	DESCRIPTION
KPI19	Level-off during descent	Distance and time flown in level flight after Top of Descent.

KPI 01 – DEPARTURE PUNCTUALITY

This KPI points to the predictability of an airport's departure operations, considering the Actual off-block time (AOBT)

and is calculated in two ways: based on the scheduled flight departure time (ANAC Record - SOBT) and based on the Estimated off-block time (EOBT) reported on the flight plan. The indicator has two variants for each diversion parameter (5, 15, or 30 minutes) with respect to the reference time, that is, the flight can be early or delayed.

KPI 02 – TAXI-OUT ADDITIONAL TIME

This KPI provides an indication of the efficiency of taxi-out at the airport. That includes possible waits for take-off, non-optimised taxiing routes and intermediate interruptions during the departure taxi. The KPI is designed to filter the effect of the airport design, while focusing on the ATM's responsibility to improve the flow between gate departure and take-off.

KPI 03 – ATFM SLOT ADHERENCE

The objective of this KPI is to verify the percentage of flights that take off within the assigned ATFM slot, that is, compliance with the Calculated Take Off Time (CTOT). The assignment of CTOT is used by the CGNA in very specific scenarios.

KPI 04 – FILED FLIGHT PLAN EN-ROUTE EXTENSION

This KPI measures the en-route horizontal flight (in)efficiency contained in a set of filed flight plans crossing an airspace volume. Its value is influenced by route network design, route & airspace availability, airspace user choice (e.g. to ensure safety, to minimize cost and to take into account wind and weather) and airspace user constraints (e.g. overflight permits, aircraft limitations).

KPI 05 – ACTUAL EN-ROUTE EXTENSION

This KPI measures the en-route horizontal flight (in)efficiency as actually flown, of a set of IFR flights crossing an airspace volume. S Its value is influenced by route network design, route & airspace availability, airspace user choice (e.g. to ensure safety, to minimize cost and to take into account wind and weather) and airspace user constraints (e.g. overflight permits, aircraft limitations), and tactical ATC interventions modifying the trajectory (e.g. reroutings and 'direct to' clearances).

KPI 06 – EN-ROUTE AIRSPACE CAPACITY

This indicator does not propose to standardize the capacity calculation methodology, indicating only that the maximum number of movements in an ATC sector should be established, either per hour (sector hourly capacity – CHS), or in terms of the number of aircraft simultaneously under its control. To learn about capacity calculation methodologies, you can consult, in addition to the references mentioned by the GANP, the Manual for the Calculation of Runway and ATC Sector Capacity, developed within the scope of GESEA and approved by the South American Implementation Group (SAM/IG).

KPI 07 – EN-ROUTE ATFM DELAY

This KPI is a time aggregation of the ATFM delay generated by flow restrictions which are established to protect a given volume of en-route airspace against demand/capacity imbalances. These flow restrictions (also called ATFM regulations) normally have a delay cause associated with them. This allows the KPI to be disaggregated by cause, which allows better diagnosis of the reasons for demand/capacity imbalances. Typically, the KPI is used to check whether ANSPs provide the capacity needed to cope with demand.

KPI 08 – ADDITIONAL TIME IN TERMINAL AIRSPACE

The objective of this KPI is to monitor the additional time of flights during the arrival phase in the terminal airspace, which is normally a result of speed reductions, waits in flight, among other factors.

KPI 09 – AIRPORT PEAK CAPACITY

This indicator does not propose to standardize the methodology for calculating arrival capacity, but refers to the largest number of operations that an airport can accept, using the most favorable runway configuration in optimal operating conditions. To learn about capacity calculation methodologies, you can consult, in addition to the references mentioned by the GANP, the Manual for the Calculation of Runway and ATC Sector Capacity, developed within the scope of GESEA and approved by the South American Implementation Group (SAM/IG).

KPI 10 – AIRPORT PEAK THROUGHPUT

The methodology for this indicator is already well defined and is known as the "Busy-Hour Rate" (BHR) in the literature (Ashford, Coutu & Beasley, 2013), generally applied to the context of airport terminals, but here introduced for runway operation.

This is a baseline maximum arrival demand, which is given by the 95th percentile of hourly arrival demands recorded at the airport, ranked from lowest to highest in terms of congestion.

KPI 11 – AIRPORT THROUGHPUT EFFICIENCY

This KPI aims to indicate how efficient capacity utilization is. It is a measure to accommodate demand, compared to the available capacity of the airport, regardless of the delay suffered by incoming traffic.

KPI 12 – AIRPORT/TERMINAL ATFM DELAY

This KPI aims to manage the temporary capacity deficit at destination airports and surrounding areas due to high demand and/or reduced capacity for various reasons, resulting in the allocation of ATFM slots.

KPI 13 – TAXI-IN ADDITIONAL TIME

This KPI aims to provide an indication of the efficiency of taxi-in at the airport. . also used to estimate excess fuel consumption and associated emissions. The KPI is designed to filter the effect of the airport's design, while focusing on the ATM's responsibility to optimize the flow of traffic from the runway to the gate.

KPI 14 – ARRIVAL PUNCTUALITY

This KPI aims to target the predictability made by the airport in its landing operations, being calculated in two ways: based on the scheduled time of arrival of the flight (ANAC Record – SIBT, *Scheduled In Block Time*) and based on the Actual in-block time (AIBT) of the Flight Plan.

The indicator also has three variants for the 5, 15, or 30 minute discrepancy parameters of the reference time, which can be flight anticipation or delay.

KPI 15 – FLIGHT TIME VARIABILITY

This KPI aims to determine the level of predictability for users. In this way, it has an impact on the airlines' schedule, focusing on the variation in time associated with the phases of the flight.

The greater the variability, the greater the distribution of actual travel times and the cost of this buffer time required in airline scheduling to maintain a satisfactory level of punctuality.

KPI 16 – ADDITIONAL FUEL BURNS

This KPI represents the inefficiency in terms of fuel consumption attributed to t ATM, through the estimated conversion of other indicators:

- KPI 02 – Taxi-out additional time
- KPI 05 – Actual en-route extension
- KPI 08 – Additional time in terminal airspace
- KPI 13 – Taxi-in additional time
- KPI 17 – Level-off during climb
- KPI 18 – Level capping during cruise
- KPI 19 – Level-off during descent

KPI 17 – LEVEL-OFF DURING CLIMB

This KPI aims to point out inefficiencies due to leveling during the climb phase. That is, it captures inefficiency due to the lack of CCO (Continuous Climb Operations) procedures. Ideally, the climb should not have any flight stages leveled because flight leveling at this stage causes higher fuel consumption and higher noise.

KPI 18 – LEVEL CAPPING DURING CRUISE

This KPI shows the flight level difference between the maximum flight level for a measured pair of airports and the maximum flight level for an unrestricted pair of reference airports.

Its objective is to indicate the amount of vertical inefficiency related to the level of cruise flight, proposing to measure the difference between the maximum ideal reference level for the flight and the one performed.

KPI 19 – LEVEL-DURING DESCENT

This KPI aims to point out inefficiencies due to leveling during the descent phase. That is, it captures inefficiency due to the lack of CDO (Continuous Descent Operations) procedures. Ideally, the descent should not have any flight legs leveled because flight leveling at this stage causes higher fuel consumption and higher noise.

KPIs and the flight phases

To relate KPIs to the phases of a flight, we consider the *gate-to-gate* concept, which refers to the moment of the flight in which a variable calculated from the departure of the aircraft from the departure of the aircraft from the gate of origin (from the airport where the aircraft was before) to the gate of destination (from the airport where the aircraft arrived) is considered.

Based on this structure, it is noted in Figure 9 with the KPIs related to the flight phases.

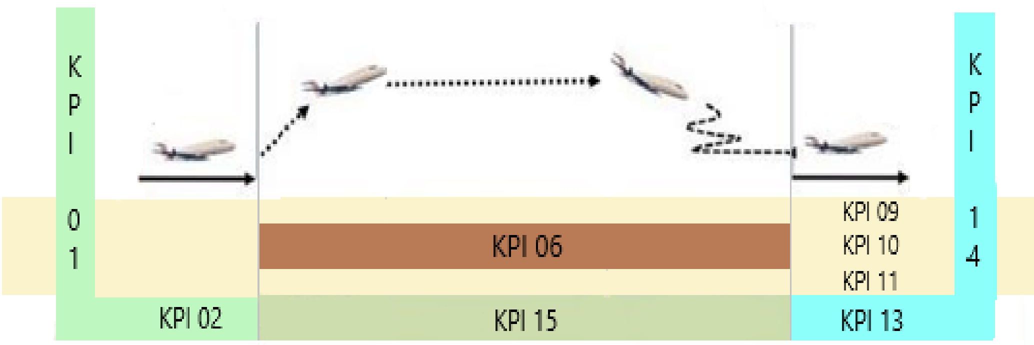


Figure 9 - KPI and the flight phases

SUBUNIT 1.2.2: Other Indicators

In addition to the ATM performance indicators presented by the GANP, DECEA considered it important to develop other indicators adhering to the operational reality of SISCEAB.

IDBR

The IDBR are indicators created in Brazil, developed by the Indicators Working Group, according to the demand verified throughout operational activities, and in continuous expansion. Table 8 presents the identification code, the nomenclature and a brief definition of the indicator.

Table 7 – IDBR Description

IDBR	NAME	DESCRIPTION
ID BR 01	Ratio of demand per runway capacity	Relationship between the movement (landing, take-off and TGL) performed and the runway capacity.
ID BR 02	Arrival time at the TMA	It is a comparison of the unobstructed arrival time at TMA with the actual flight time in the terminal.
ID BR 03	TMA Departure Time	It is a comparison of the unobstructed departure time of the TMA with the actual flight time leaving the terminal.
ID BR 04	Hours of flights that occurred in the unit by ATC personnel	Sum of flight hours in the airspace of an ATC unit by number of personnel.
ID BR 05	Hours of flights that occurred in the unit by number of hours of ATC personnel	Sum of flight hours in the airspace of an ATC unit on: - sum of ATCO hours on the shift list; and - sum of ATCO connected hours.
ID BR 06	Ratio of LOGIN hours to ATCO hours	Ratio of ATCO time hours recorded to operational stopover time.
ID BR 07	Relationship between demand for capacity in the sector	Relationship between demand and declared capacity

ID BR 01 – RATIO OF DEMAND PER RUNWAY CAPACITY

This IDBR aims to measure runway capacity utilization by means of data obtained from available systems, and relates the total aerodrome movement (ARR, DEP and TGL), in the interval of one hour, to the declared runway capacity.

ID BR 02 – TIEMPO DE LLEGADA EN LA TERMINAL

Este IDBR es útil para verificar la eficiencia de la estructura del espacio aéreo y la gestión del flujo de los sectores del espacio aéreo responsables de secuenciar las llegadas en un área de control de terminal determinada, con miras a maximizar el uso de las pistas disponibles. Cuanto más corto sea el tiempo adicional, más optimizada será la operación y menor será el consumo de combustible y su impacto en el medio ambiente.

ID BR 03 – TERMINAL DEPARTURE TIME

This IDBR is useful for verifying the efficiency of the airspace structure in exit procedures. The shorter the additional time, the more optimized and direct the operation will be and the lower the fuel consumption and its impact on the environment, especially at this stage of the flight when the aircraft is heavier and requires higher fuel consumption.

ID BR 04 – FLIGHT HOURS OCCURRED IN THE UNIT BY ATC PERSONNEL

This IDBR seeks to observe the calculation of movements considering the amount of time used for each movement in relation to the number of personnel.

It should be noted that, according to ICA 63-33, the amount of ATCO made available by SISCEAB to meet the traffic demand of an ATS organ depends on the number of annual movements.

IDBR 05 – HOURS OF FLIGHTS THAT OCCURRED IN THE UNIT BY NUMBER OF HOURS OF ATC PERSONNEL

This IDBR seeks to refine the calculation of movements by considering the amount of time used for each movement, the amount of labor made available by SISCEAB, and the efficiency with which this effective cash was used to meet demand.

ID BR 06 – RELATIONSHIP BETWEEN LOGIN HOURS BY ATCO HOURS

This IDBR focuses on measuring the relationship between the workload of scheduled operational personnel (Schedule Hour) and the workload actually employed in the group of operational positions (Logged-in Hour).

ID BR 07 – RELATIONSHIP BETWEEN DEMAND BY CAPACITY IN THE SECTOR

This IDBR aims to assess the employment rate in the sector. It allows us to infer if the real demand is accommodating, if the sector is correctly sized or needs to be reevaluated, in addition to evidencing the level of complexity of this sector, either at the level of specialized personnel or available equipment.

Below, we can verify the relationship between the performance areas and the indicators (KPIs and IDBRs) in Table 9.

Table 8 – Indicators List and KPA

KPA	INDICATORS
EFFICIENCY	KPI02 – Taxi-out additional time KPI04 – Filed flight plan en-route extension KPI05 – Actual en-route extension KPI08 – Additional time in terminal airspace KPI13 – Taxi-in additional time KPI16 – Additional fuel burn KPI17 – Level-off during climb KPI19 – Level-off during descent IDBR02 – Arrival time at the TMA IDBR03 – Terminal Departure Time
CAPACITY	KPI06 – En-route airspace capacity KPI07 – En-route ATFM delay KPI09 – Airport peak capacity KPI10 – Airport peak throughput KPI11 – Airport throughput efficiency KPI12 – Airport/Terminal ATFM delay IDBR01 – Ratio Of Demand Per Runway Capacity IDBR07 – Relationship between Demand by Capacity in the Sector
PREDICTABILITY	KPI01 - Departure punctuality Puntualidad de salida KPI03 – ATFM slot adherence KPI14 – Arrival punctuality KPI15 – Flight time variability
COST-BENEFIT	IDBR04 – Flight Hours Occurred in the Unit by ATC Personnel IDBR05 – Hours of Flights that Occurred in the Unit by Number of Hours of ATC Personnel IDBR06 – Relationship between Login Hours by ATCO Hours

SUBUNIT 1.2.3: Data Sources

The available data sources are those from the SISCEAB systems and agencies and partner institutions in order to present information closer to reality, portraying behaviors and/or trends for research, studies, decision-making in the field of strategic planning and operational actions, as well as storage of a database history.

It should be noted that some data sources are used for both TMA/CTR movements and FIR movements, such as SAGITTARIUS and CAT62. The same goes for SETA MILENIUM, which is used for aerodrome movements, TMA/CTR and FIR.

Table 10 below describes the main data sources used by DECEA, with the respective information available.

Table 9 – Characteristics of data sources.

SOURCE OF ORIGIN	SOURCE	INFORMATION	RESPONSIBLE
AERODROME	BIMTRA	DATE / CODE / ACFT_TYPE / FLIGHT TYPE / ORIGEN / DESTINATION / OPR_TYPE / OPR_ FH /PISTA	DECEA (ATAN)
	HSTVOO / QUESTIONNAIRES	DATE / CODE / ACFT_TYPE / ORIGIN / DESTINATION/ OPR_TYPE / OPR_ FH / EOBT_FH (ANAC RECORD) / AOBT_FH / EIBT_FH / AIBT_FH	INFRAERO / CONCESSIONAIRES
	SETA MILENIUM - AERODROME MODULE	DATE / CODE / ACFT_TYPE / FLIGHT TYPE / ORIGIN / DESTINATION / OPR_TYPE / FH_OPR / RWY	CGNA
	SIROS	DATE / CALL CODE / ACFT_TYPE / ORIGIN / DESTINATION / SOBT_ FH / SIBT_ FH_ / AOBT_ FH_ / AIBT_ FH	ANAC
	STDMA	DATE / CODE / ACFT_TYPE / FLIGHT TYPE / ORIGIN / DESTINATION / OPR_TYPE / OPR_FH / RWY	CGNA
	TATIC FLOW	DATE / CODE / ACFT_TYPE / FLIGHT TYPE / ORIGIN / DESTINATION / OPR_TYPE / OPR_FH / RWY / EOBT_ FH / AOBT_ FH_ / AIBT_ FH_	CGNA
TMA/CTR	CAT62	GEORREFERENCIACIÓN EN FRECUENCIA DE 4 SEGUNDOS DE CADA VUELO (LATITUD, LONGITUD Y ALTITUD)	ICEA/ PAME
	SAGITARIO	FECHA / CÓDIGO / TIPO_ACFT / TIPO DE VUELO / ORIGEN / DESTINO / PLAN DE VUELO / FH_OPR / SECTOR / OPERADOR	SALA TÉCNICA (REGIONAL)
	SETA MILLENNIUM - MÓDULO TMA	FECHA / CÓDIGO / TIPO_ACFT / ORIGEN / DESTINO / TIPO DE VUELO / FH_ENTRADA_FIJO / FH_SALIDA_FIJO	CGNA
ABETO	CAT62	GEOREFERENCING IN FREQUENCY OF 4 SECONDS OF EACH AIRCRAFT (LATITUDE, LONGITUDE AND ALTITUDE)	TIOP (REGIONAL)

SOURCE OF ORIGIN	SOURCE	INFORMATION	RESPONSIBLE
	SAGITARIO	DATE / CODE / ACFT_TYPE / FLIGHT TYPE / ORIGIN / DESTINATION / FLIGHT PLAN / OPS_FH / SECTOR / FIXED_ARRIVAL_FH / FIXED_DEPARTURE_FH / OPERATOR	TIOP (REGIONAL)
	SETA MILLENNIUM - MÓDULO FIR	DATE / CODE / ACFT_TYPE / ORIGIN / DESTINATION / FLIGHT TYPE / FIXED_ARRIAL_FH / FIXED_DEPARTURE_FH	CGNA
OTHER	BDC	OVERVIEW OF WEATHER STATION COLLECTIONS	ICEA
	CGNA	GENERAL INFORMATION ON RUNWAY AND AIRSPACE CAPACITY	
	PUBLICACIONES AERONÁUTICAS	GENERAL INFORMATION ON THE PARAMETERS USED IN AIR TRAFFIC	ICA
	RMS (SAGITARIO)	SUMMARY TABLES OF SAGITTARIUS FLIGHT HISTORY	TIOP (REGIONAL)
	SGPO	MONITORING OF EFFECTIVENESS IN OPERATIONAL BODIES	DECEA

BIMTRA

The Air Traffic Movement Information Bank – *Banco de Información sobre el Movimiento del Tráfico Aéreo* (BIMTRA) is the database used for the collection of Air Navigation Fees, being formed with the data on aircraft movements collected in the more than 180 aerodromes registered in the database. This DECEA database makes its information available to some links of the Civil Aviation system, such as ANAC and SAC, among others, allowing the exchange of information to update records, inspections, statistics, indicators, etc.

On a daily basis, this collected data is monitored, analysed and prepared for the invoicing of air navigation fares. The system provides information on aerodrome movements, such as landing (ARR), take-off (DEP), take-off and take-off (TGL) and crossings.

BDC

The Climatological Database – *Base de Datos Climatológica* (BDC) is a set of data referring to the records of meteorological observations made in the Surface and Altitude Meteorological Stations (EMS and EMA), operated in the SISCEAB.

CAT62

Database created with flight information captured by radar synthesis, with all the georeference information (latitude, longitude and level) of a flight every four seconds.

CGNA

It is the organization responsible for Air Traffic Flow Management (ATFM), having as attributions, among others, the measurements of runway and airspace capacity.

HSTVOOS (INFRAERO) / CONCESSIONAIRES

The aerodrome data are related to movements on the ground, of aircraft in chocks and out of chocks.

The information provided by institutions such as INFRAERO (HSTVOOS), Guarulhos Airport (GRU), RIO GALEÃO, among other concessionaires, offers the possibility of carrying out analyses such as punctuality and arrival and departure taxiing time.

AERONAUTICAL PUBLICATIONS

Airspace structure data, including IAC, SID, STAR, area charts and route charts, published as aeronautical information (AIP BR) and published on DECEA's AIS portal (AISWEB).

SAGITARIO

The Advanced Air Traffic Information Management and Operational Interest Report - *Sistema Avanzado de Gestión de Información de Tráfico Aéreo e Informe de Interés Operacional* (SAGITARIO) System, developed by the company Atech, part of the EMBRAER group, is capable of processing data from various capture sources, such as radars and satellites, and consolidating them into a single visual presentation for the flight controller.

For historical data analysis, it is possible to consult the Reported Managed System (RMS), which is the database available for post-operation analysis. This dataset contains information used for traffic control, such as the date and time of the controller's message exchanges with the aircraft, the time the operator logged into the console, the flight plans that passed through the system during the control period, all within more than 100 relational tables.

SETA MILLENNIUM

The Air Traffic Statistical System - *Sistema Estadístico de Tráfico Aéreo* (SETA MILLENNIUM) provides statistics on air traffic movements on an hourly, daily, monthly and annual basis. The AERODROME, TMA/CTR and FIR modules contemplated by the system are available to users with data from more than 180 aerodromes, 42 terminals and 5 FIRs, under the management of CGNA.

SGPO

El propósito del Sistema de Gestión de Personal Operacional (SGPO) es sistematizar la gestión del personal operativo de ATCO, incluyendo los procesos de chequeo médico anual de los Controladores de Tránsito Aéreo, así como automatizar los procesos de otorgamiento de calificación técnica y realización de turnos operativos.

SIROS

The Operations Registration System is carried out by IATA season (summer and winter), following a previously published calendar of activities. Airlines must agree with airport operators and CGNA on the reservation of the airport and aeronautical infrastructure necessary to carry out air services.

STDMA

The Aerodrome Movement Data Processing System - *Sistema de Procesamiento de Datos de Movimiento de Aeródromo* (STDMA) is a tool created for the use of CGNA in order to process data extracted from the Control Tower and Management System - *Sistema de Gestión y Torre de Control* (SGTC) or the Total Air Traffic Information Control TWR (TATIC TWR) and sent to the CGNA by the control towers.

TATIC FLOW

Total Air Traffic Information Control FLOW (TATIC FLOW) is a software dedicated to support CGNA monitor traffic developments at aerodromes, as well as assist in coordination between ATC units. This system offers benefits such as:

- real-time monitoring of traffic in control towers and AFIS (Aerodrome Flight Information Service) stations; and
- Operation at the tactical level and storage of database with information for the strategic level.

SUBUNIT 1.2.4: Indicators in Operational Doctrine

The Operational Doctrine aims at the constant search for excellence in the quality of the provision of operational activities in the SISCEAB, through the research, registration and application of the best applicable practices, observed empirically or by indicators. The analyses, in search of best practices, look at the main pillars:

- Standards and legislation that guide operational activity;

- Systems, equipment, and technologies used in the unit providing operational activities; and
- Operational performance doctrine.

The development of the Operational Doctrine occurs in a cyclical manner in which the best local practices are observed or researched, they are recorded in a Doctrinal Action Proposal (PAD) for study and, finally, they are standardized at the national level through the Doctrinal Action (ADT) issued by the Operations Subdepartment (SDOP) of DECEA, according to Figure 10.

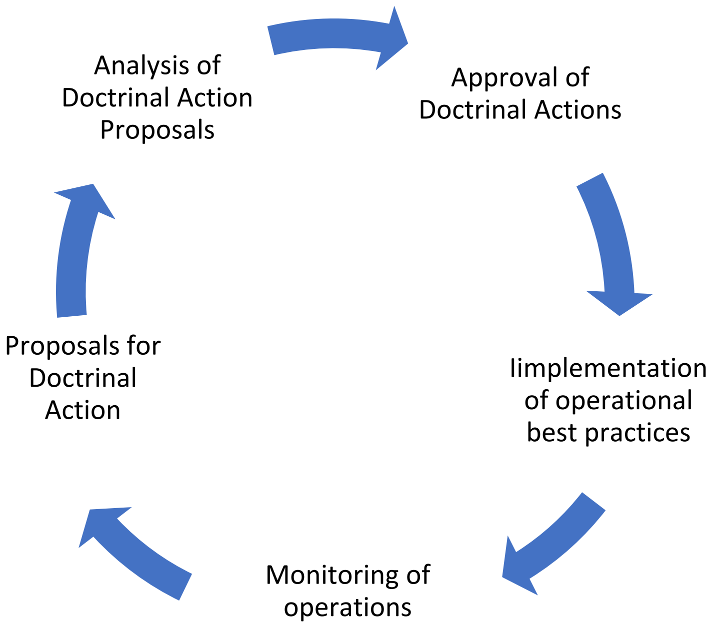


Figure 10 - Operational Doctrine Cycle.

The monitoring of the Operational Doctrine through the monitoring of the operational activities of DECEA (ATM, COM, MET and AIS) is carried out through the following mechanisms presented in Figure 11.

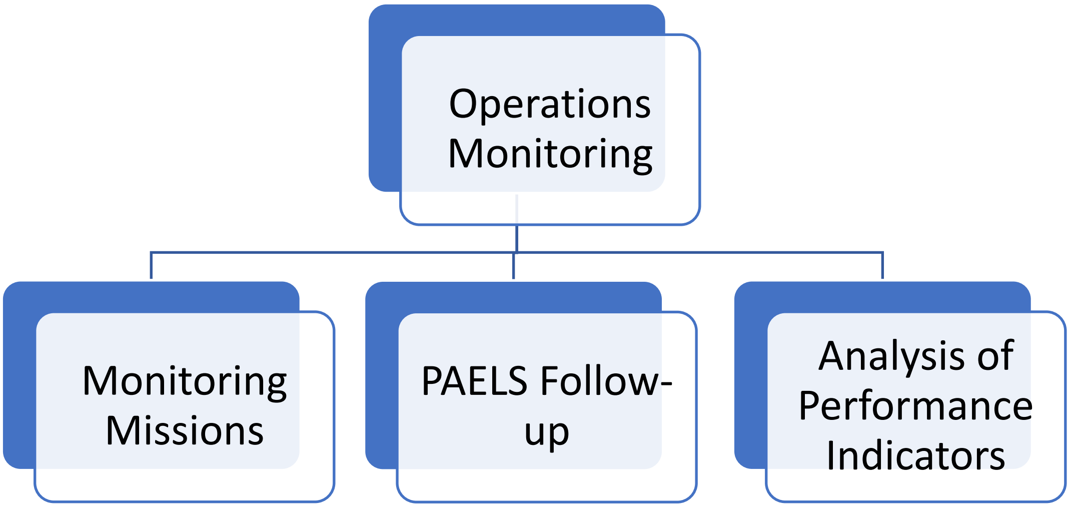


Figure 11 – Follow-up mechanisms

In order to advise DECEA, the Operational Doctrine carries out analyses of the ATM Performance Indicators in order to:

- measure the quality of the ATM service;
- identify best practices; and
- propose actions to improve the performance of the ATM.

Analysis of ATM performance indicators by Operational Doctrine

There is a dynamism in air activities due to constant updates and innovations. In this continuous evolution of scenarios, it is in the operation of air traffic where knowledge, solutions and best practices are developed to meet the demands of SISCEAB, which can be observed by the PSNA, users and other stakeholders. These observations can be recorded and analyzed through performance indicators. At the local level, best practices can be defined through analysis of ATC unit operations.

Responsibility of the Operational Doctrine in the quality of the produced data

To ensure greater uniformity and validity among the data obtained from various PSNA, the elements of local[6] operational doctrine must ensure that the operation is the most aligned with that applied throughout the SISCEAB.

[6] The elements of the Operational Doctrine are the professionals who work in the Operating Doctrine Section, the immediate head of each PSNA, and any representatives designated as an element of the Operating Doctrine.

Standardization in data entry and human-machine interaction is one of the challenges of the Operational Doctrine. However, changing the modus operandi to improve data quality should not always prevail in cases of excess workload, associated costs, etc.

UNIT 1.3: DATA ANALYSIS

SUBUNIT 1.3.1: Data Visualization

Data visualization consists of the presentation of information through visual elements, usually through tables and graphs. In this way, it is easier to analyze the results, helping the process of identifying trends and making decisions.

An example of data visualization is dashboard charts, which are visual dashboards that centrally present a set of information and are made up of important performance indicators and metrics. The main purpose of the dashboard as an information panel is to facilitate the efficient monitoring of a company's operations.

To create a good data visualization, you should start with clean, well-documented, and complete data, and from there, when the data is ready to be visualized, choose the right chart.

Charts are used to indicate patterns and trends, as well as to compare certain circumstances over a period of time, in order to facilitate and make analysis and/or interpretation faster and more objective.

Graphic representation must meet primary requirements such as:

Simplicity, which is the need to lead to a quick understanding of the overall meaning of the data presented;

Clarity, which is the possibility of a correct interpretation of the values presented in the study; and

Veracity, because, if it does not present a reality, the graph loses its purpose.

Types of graphs

There are many varieties of graphical representation, and the choice depends on the types of data that exist, as well as the information that is intended to be transmitted.

The main types of charts that allow simplifying, clarifying and highlighting a set of information for decision-making are: columns, bars, line, sectors, thread, histogram, combination, area, scatter, bubbles, surface and radar. Here are the graphs illustrated in Figure 12.

Figure 12 – Types of graphs

Column charts

Column charts are useful for showing data changes over a period of time or for illustrating comparisons between items. In these column charts, categories are arranged along the horizontal axis and values along the vertical axis.

Figure 13 is an example of a column chart that represents the average daily movement by day of the week at Santos Dumont Airport (SBRJ). It is very clear that Thursday is the busiest day, with 305 movements, and that Sunday is the day with the least movement, with 269 movements.

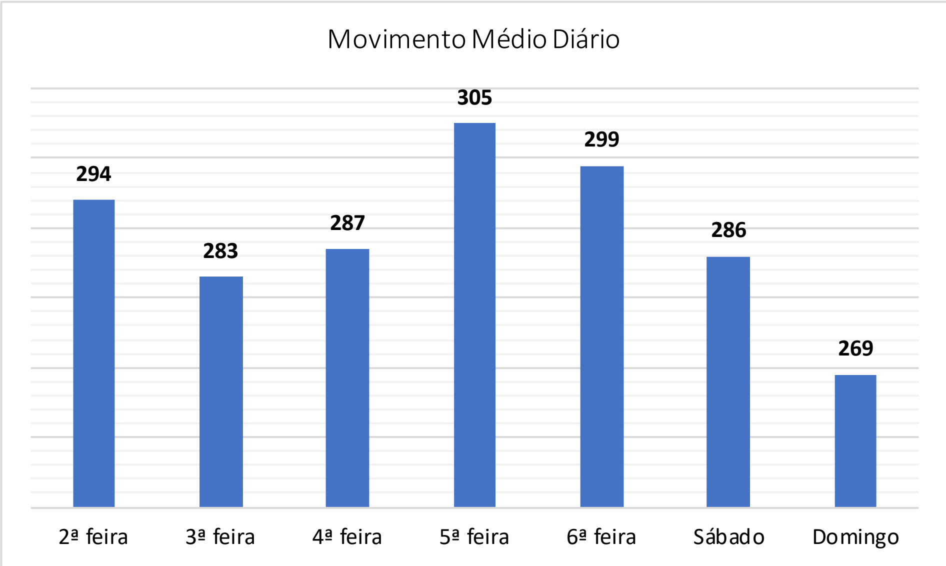


Figure 13 - Column chart example.

Bars Graphs

Data that is organized into columns or rows in a spreadsheet can be plotted in a bar chart, which illustrates comparisons between individual items, commonly used to present *rankings*.

Figure 14 is an example of a bar graph that represents the classification of the main flows, by pairs of cities.

Figure 14 - Bar chart example.

Line charts

Line charts can display continuous data over time, defined relative to a common scale, and are therefore ideal for showing trends in data at equal intervals. Category data is evenly distributed along the horizontal axis, and value data is distributed along the vertical axis.

Figure 15 is an example of a line graph that represents the evolution of the number of flights, starting in 2017.

Figure 15 - Line Chart Example.

Pie Charts

Data organized into columns or rows in a spreadsheet can be plotted in a pie chart, which shows the size of items in a data series, proportional to the sum of those items. This chart is considered best use when:

- there is only one set of data;
- none of the values in the data are negative;
- there are few categories with values equal to zero; and
- No more than seven categories.

Figure 16 is an example of a pie chart that represents the percentage of the participation of movements of the FIR Curitiba.

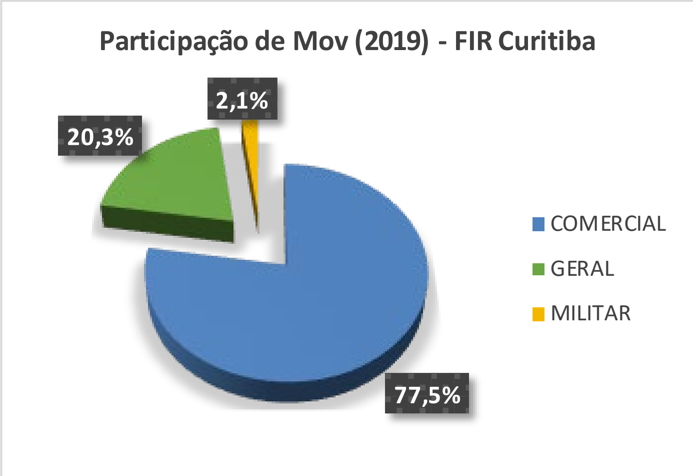


Figure 16 – Example of pie chart

Donut graph

Data that is organized into columns or rows can be plotted on a donut chart. Like a pie chart, a donut chart shows the relationship of parts to a whole and can contain more than one set of data.

Figure 17 is an example of a doughnut chart, with two data series, representing the mix of aircraft categories that operated at an airport in 2018 and 2019. It can be seen that there was a reduction in medium and heavy aircraft operations, while there was a reduction in light aircraft operations.

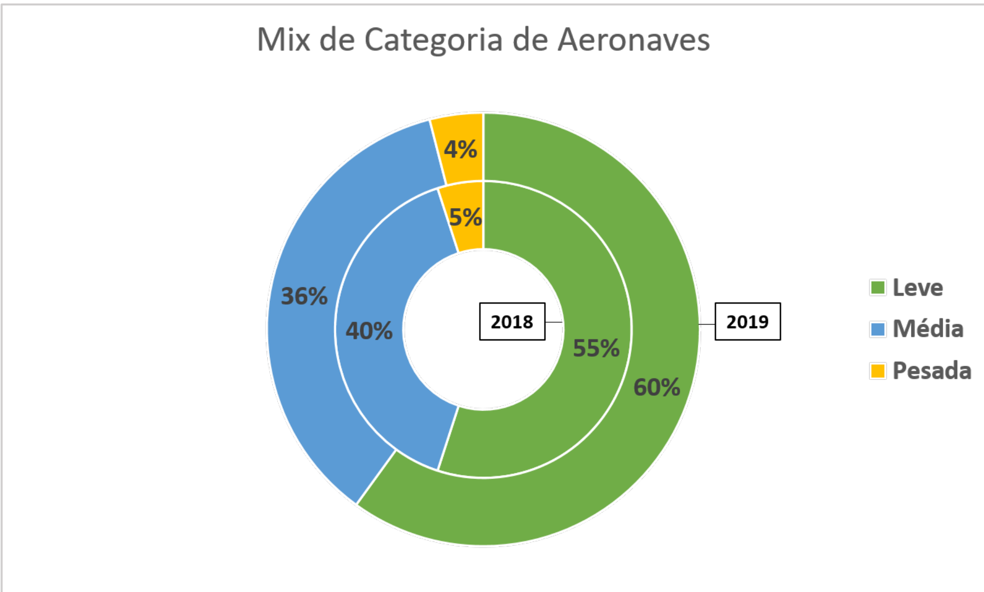


Figura 17 - Ejemplo de gráfico de rosquillas.

Histogram charts

The data plotted on a histogram diagram shows the frequencies within a distribution. Each column in the chart is called a container.

Figure 18 is an example of a histogram of the distribution of movements per minute of punctuality at Brasília airport (SBBR). It is possible to observe that the airport has little delay above 15 min, considering that the decrease in the number of movements in this range is observed.

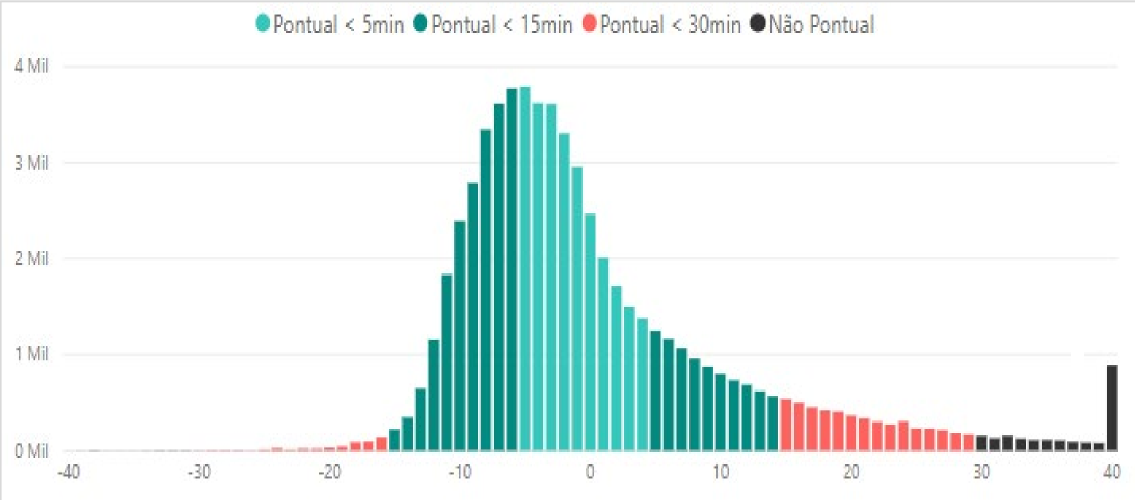


Figure 18 - Histogram Example

Combined graphs

Data organized into columns and rows can be plotted in a combo chart. This chart combines two or more types of charts to make it easier to interpret the data, especially when there are data series with very different scales.

Figure 19 is an example of a combined graph that represents the information of the average daily movements and their percentages of punctuality, by time slot.

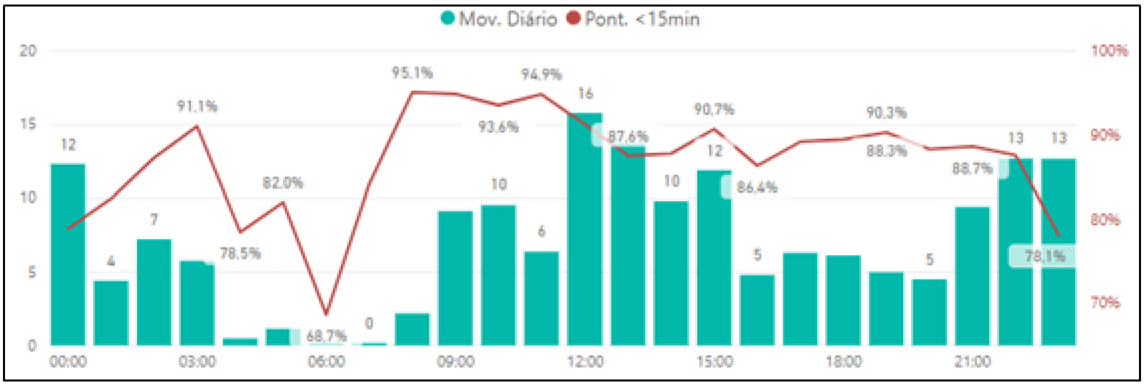


Figura 19 - Ejemplo de gráfico combinado.

Area Charts

Data organized into columns or rows in a spreadsheet can be plotted in an area chart. These charts emphasize the magnitude of change over time and can be used to draw attention to the total value over a trend.

Figure 20 is an example of an area graph that represents the predictability of the gradual increase in traffic in the Brasília FIR from 2012 to 2019, as well as the forecasts for low, medium, and high demand from 2020 to 2025. It is clear that movement has slowed down a lot in 2020 and that, in the best-case scenario, the forecast return of the movement recorded in 2019 will occur in 2025 (light blue band).

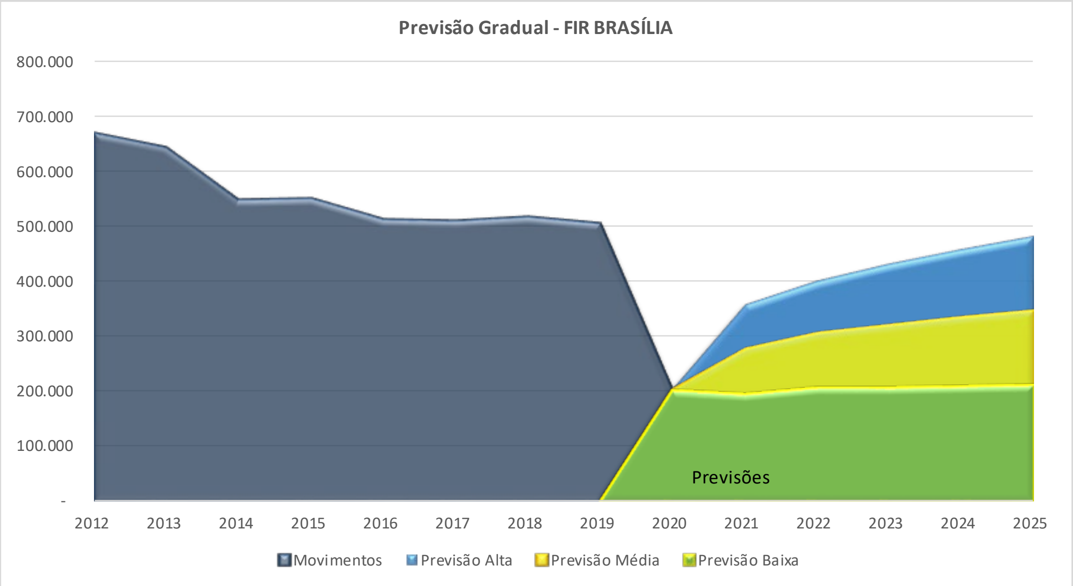


Figure 20 - Example of an area chart.

Dispersion Diagram

Data organized into columns or rows in a spreadsheet can be represented in a scatter plot (XY). These graphs show the relationships between two groups of numbers as a sequence of XY coordinates.

A dispersion diagram has two value axes, which show one set of numerical data along the horizontal axis (X-axis) and another along the vertical axis (Y-axis). It combines these values into single data points and displays them at irregular intervals. These graphs are often used to display and compare numerical values, such as scientific, statistical, and engineering data. In other words, it is used with the intention of showing how much one variable affects the other.

Figure 21 is an example of a dispersion diagram depicting the relationship between total commercial aviation movements (vertical axis) and total general aviation movements (horizontal axis) for the year 2019. It can be inferred that SBGR is the one with the highest movement in commercial aviation, while SBMT and SBJR have practically no operations of this type of aviation, compared to the number of movements of general aviation.

Figure 21 – Dispersion diagram example

Bubble graphs

Data that is organized into columns in a spreadsheet can be plotted in a bubble chart so that X-values are listed in the first column, while corresponding Y-values and bubble size values are listed in adjacent columns.

This chart is a variation of a dispersion diagram in which the dots are replaced by bubbles, and an additional dimension of the data is represented in the size of the bubbles.

Figure 22 is an example of a bubble chart that represents the movement statistics at some aerodromes, presenting the total movements of commercial aviation (vertical axis) and the total movements of general aviation (horizontal axis), for the year 2019. In this type of chart, the size of each bubble is proportional to the total number of moves. It can be inferred that SBGR is the one with the highest movement in commercial aviation, while SBMT and SBJR have practically no operations of this type of aviation, compared to the number of movements of general aviation.

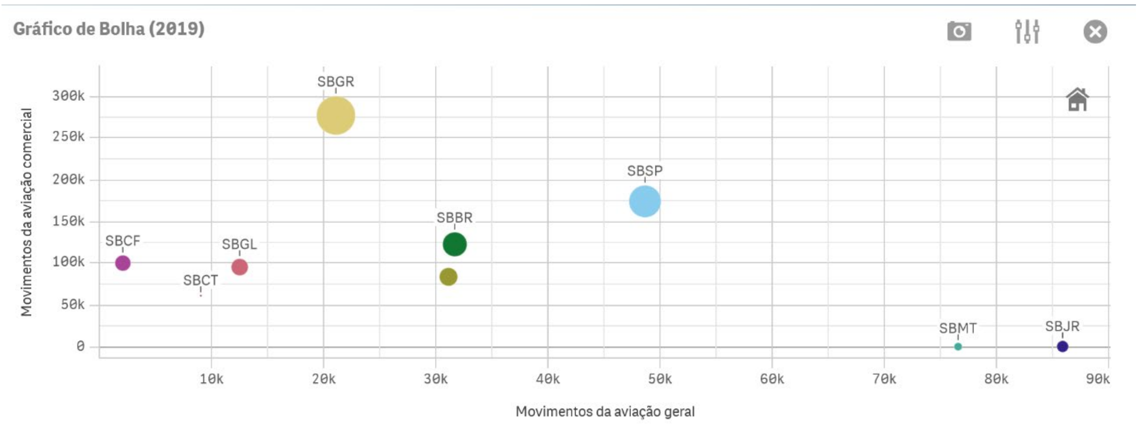


Figure 22 – Bubble graph example

Radar graph

Data organized in columns or rows in a spreadsheet can be plotted on a radar chart, which compares the aggregate values of various data series, providing the presentation of several dimensions at the same time, because it has easy visualization and uniformity of units of measurement.

This type of chart is suitable for showing values outside the data series or showing a large distance from the others, as well as a possible inconsistent value. On the other hand, you can still show the similarities of groups or categories, describing which variables stand out when compared.

Figure 23 is an example of a radar graph that represents the hourly movement in the Amazon FIR. It is clear that in the period between dawn and 9 am, the movement is very low, and traffic is heaviest in the period between 13 and 20 hours.

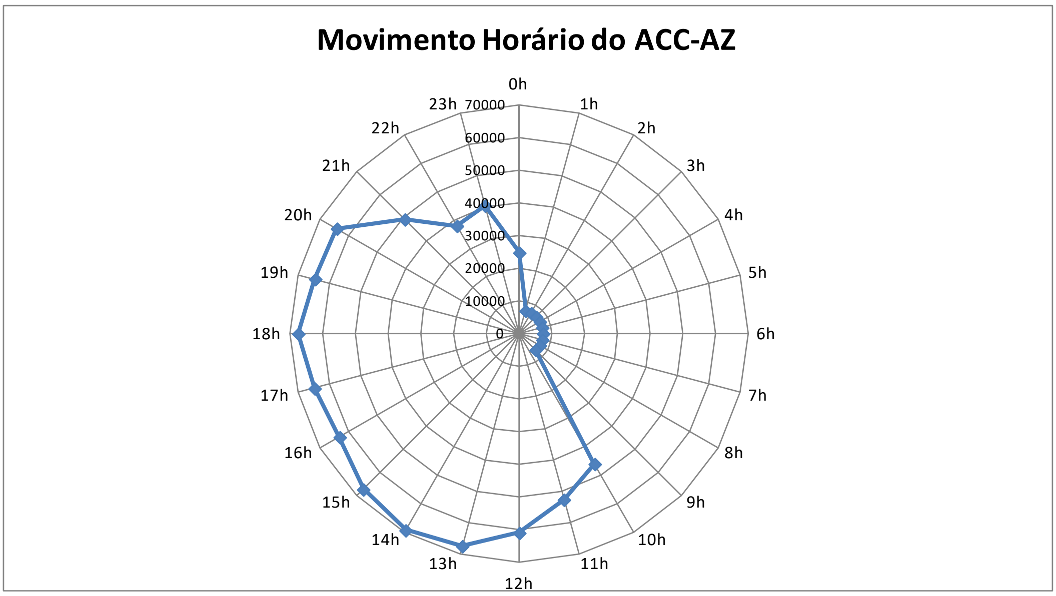


Figure 23 – Radar graph example.

SUBUNIT 1.3.2: Indicators Results

A Necessidade de Gestores com Habilidades de Análise de Dados

A empresa de consultoria McKinsey and Company estima que "haverá uma escassez do talento necessário para as empresas obterem vantagem em big data. Em 2018, os Estados Unidos sozinho poderá enfrentar uma escassez de 140.000 a 190.000 pessoas com habilidades analíticas profundas, bem como 1,5 milhão de gestores e analistas com conhecimento para usar a análise de big data para tomar decisões eficazes." (Manyika, 2011). Por que o número de gerentes e analistas necessários será 10 vezes maior que aqueles com habilidades analíticas profundas? Certamente, os cientistas de dados não são tão difíceis de administrar ao ponto de precisarem de 10 gerentes! O motivo é que uma empresa pode obter aproveitamento a partir de uma equipe de data science para tomar melhores decisões em diversas áreas do negócio. No entanto, conforme McKinsey aponta, os gestores dessas áreas precisam entender os princípios de data science para obter esse aproveitamento de forma eficaz.

Framework 5 - Need for data analysts. Source: (Provost & Fawcett, 2016)

After understanding the different forms of data visualization, it is essential to have knowledge of the most tangible and important step for the decision-maker, which is **data analysis**.

Gathering information is essential for business growth. Data collection is part of the job of developing a successful strategy. However, it is not enough to maintain a giant store of information. It is necessary to extract knowledge that provides a basis for decision-making.

For this reason, companies are investing in Big Data and Analytics, in powerful *software* capable of processing this data to transform it into useful information for organizations.

The four main types of *Big Data* analytics are:

a) Descriptive analysis

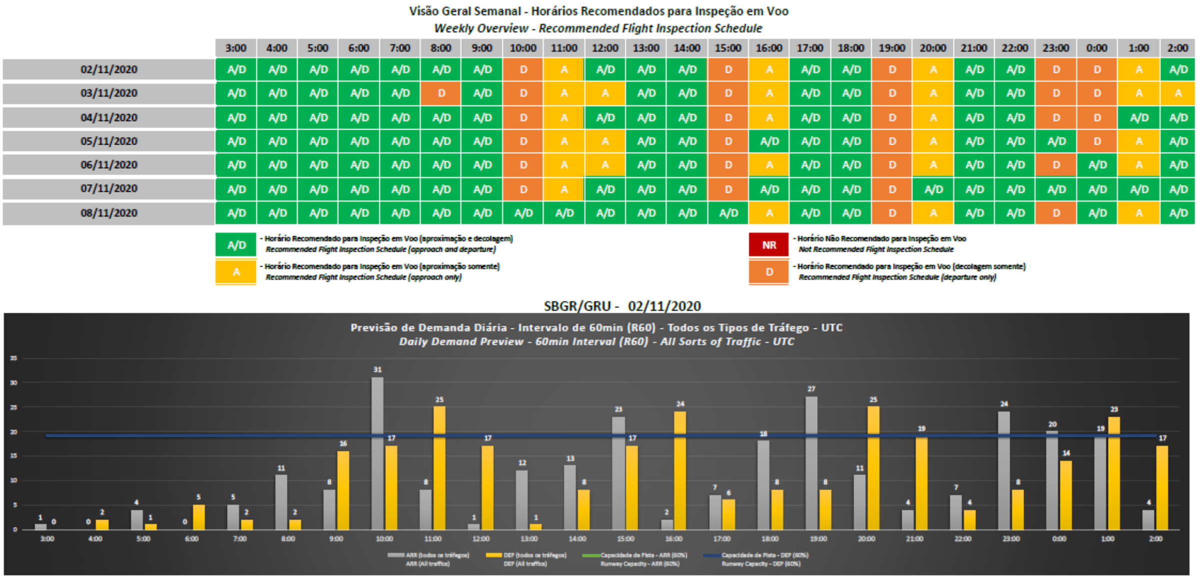
The purpose of this analysis is to understand events, helping to make immediate decisions (in real time) with calm and security.

All data is summarized, organized, and described through statistical metrics. Once the most important aspects have been defined, the data is related between two or more sets.

This type of analysis provides a solid knowledge base that can support further analysis. In other words, it helps to define a more reliable diagnosis to follow in the predictive and prescriptive steps, for example.

In general, the tools used in a descriptive study are tables and graphs, or percentages, averages, and indices.

Figure 24 shows the result of a descriptive analysis on the definition of the slots to be used for in-flight inspection, considering the operation in SBGR. The solution presented by the analysis was the top table that uses a color scheme of the demand forecast described in the chart below. The green color represents the times when the inspection can be carried out without affecting the operation of the airport.


Visão Geral Semanal - Horários Recomendados para Inspeção em Voo
Weekly Overview - Recommended Flight Inspection Schedule

	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00
02/11/2020	A/D	A/D	A/D	A/D	A/D	A/D	A/D	D	A	A/D	A/D	A/D	D	A	A/D	A/D	D	A	A/D	A/D	D	D	A	A/D
03/11/2020	A/D	A/D	A/D	A/D	A/D	D	A/D	D	A	A	A/D	A/D	D	A	A/D	A/D	D	A	A/D	A/D	D	D	A	A
04/11/2020	A/D	A/D	A/D	A/D	A/D	A/D	A/D	D	A	A/D	A/D	A/D	D	A	A/D	A/D	D	A	A/D	A/D	D	D	A/D	A/D
05/11/2020	A/D	A/D	A/D	A/D	A/D	A/D	A/D	D	A	A	A/D	A/D	D	A/D	A/D	A/D	D	A	A/D	A/D	A/D	D	A	A/D
06/11/2020	A/D	A/D	A/D	A/D	A/D	A/D	A/D	D	A	A	A/D	A/D	D	A	A/D	A/D	D	A	A/D	A/D	D	A/D	A	A/D
07/11/2020	A/D	A/D	A/D	A/D	A/D	A/D	A/D	D	A	A/D	A/D	A/D	D	A/D	A/D	A/D	D	A/D	A/D	A/D	A/D	A/D	A/D	A/D
08/11/2020	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A/D	A	A/D	A/D	D	A	A/D	A/D	D	A/D	A	A/D

Figure 24 - SBGR Flight Forecast. (Source: CGNA Operatonal Portal)

b) Predictive analytics

This is the most well-known model as it helps predict future scenarios based on database pattern analysis. Therefore, it is possible to make more accurate decisions.

The predictive analytics methodology uses statistical and historical data, as well as data mining and artificial intelligence. It is indicated to project future air traffic demand behaviors, as well as to evaluate fluctuations in operational personnel, among others.

Many organizations already apply the predictive model and can gain valuable *information* to drive their business, solve problems, and uncover new opportunities. Airlines, for example, use the model to set ticket prices, while hotels try to anticipate the number of guests per night to maximize their occupancy.

Here's an example in Figure 25 of predictive analytics that generated the post-pandemic demand forecast graph as a result, with three scenarios: high forecast (optimistic), medium forecast, and low forecast (pessimistic).

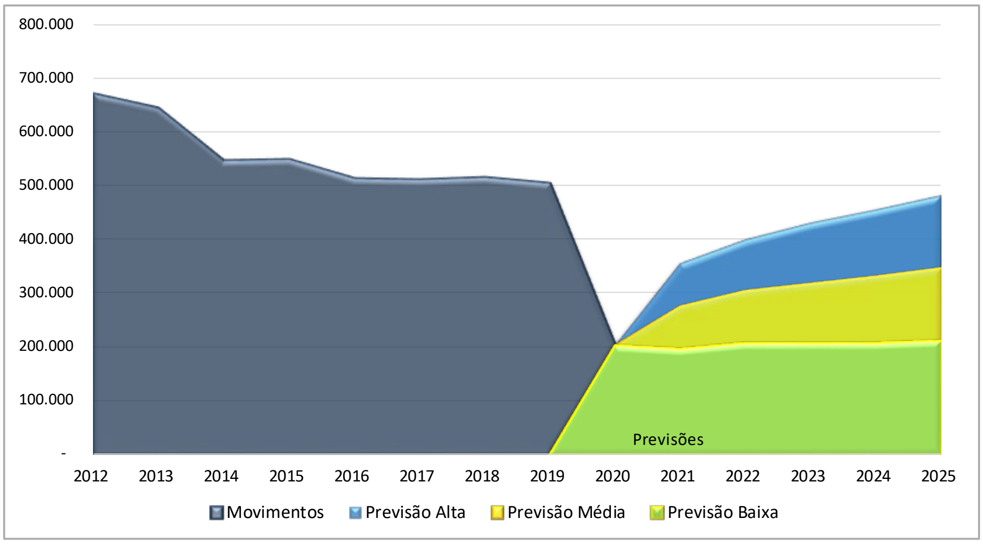


Figure 25 - Post-COVID demand forecast.

c) Prescriptive analysis

The objective of this analysis is to verify the consequences of the actions taken, which allows us to know what should happen when certain attitudes are chosen. This layer is the one that has the most value, because it needs the human element to materialize. In addition, it is relevant because it defines the path that must be taken for the action to occur as expected.

In other words, a goal is established and, from there, the paths that must be taken to achieve it are indicated. This analysis can be done by listing patterns and applying filters by specificities, which allows us to have a real context of the situation and the effects of the actions.

By illustration, this analysis could be applied to solve a capacity problem observed at a given airport. In this example, it was observed that a high percentage of aircraft did not use the fast exit from the runway, since the airline's orientation was to save the use of brakes during landing.

This procedure impacted the runway occupancy time, generating negative effects on the airport's capacity. As a result, there was a concentration of aircraft at the standby point and low on-time rates at peak times. At other airports with similar runway systems, the percentage of aircraft using express departures was higher and the respective runway capacity values were higher than the capacity of the airport under analysis.

The prescriptive analysis pointed out as one of the possible corrective actions the awareness of users to use, preferably, the fast exit after landing, which could generate an increase of up to 10% in capacity, better punctuality rates and less concentration of traffic at the waiting point.

Note: In this type of analysis, a common question is "are there any relevant events that may interfere with the indicators?"

When there is knowledge of a relevant event that may affect the operational scenario, it is very important to have a plan to identify such situations and prepare for it.

Events, such as the World Cup, Military World Games, and World Youth Day, or specific dates, such as Carnival, Christmas, and New Year's, are subject to analysis during ATM planning, as they generate changes in the operational scenario that usually impact performance.

d) Diagnostic analysis:

The purpose of this analysis is to understand the causes of an event, i.e., to answer the following questions:

- Who?
- When?
- Where?
- How?
- Why?

The ideal case is to analyze the impact and scope of an action taken. From there, strategies can be drawn up to improve results. This is a model that must be complemented with predictive analysis to reinforce the projection of the data.

Figure 26 presents the result of a diagnostic analysis of the operations planned and carried out by Gol.

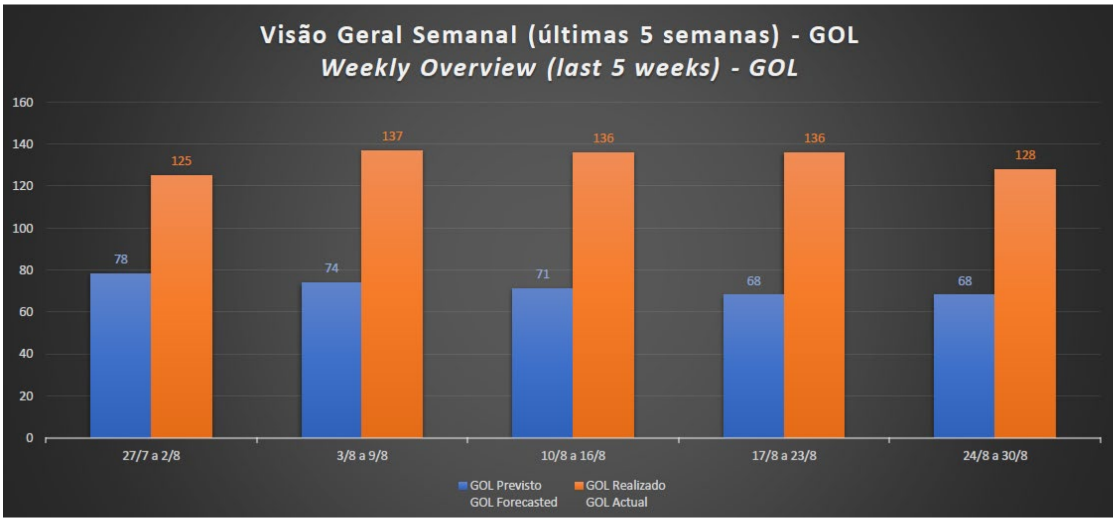


Figure 26 – Flights planned and carried out by Gol. (Source: CGNA Operational Portal)

Thus, questions are anwered as follows:

- GOL airline (Who?);
- In the period from 27/07 to 30/08 of 2020 (When?);
- In the SBSV airport (where?);
- Had difficulties with its planning with respect to operations in SBSV, given the difference between what was planned and what was carried out, according to data extracted from the airport base and TATIC FLOW, respectively (How?); and
- Due to the consequences caused by the limitation on the movement of people due to the COVID-19 pandemic (Why?)

Note: In this type of analysis, a common question is "what is the reason that led the indicators to change?"

It is possible to reach conclusions simply by checking the data, but it is important to look at the scenario that influenced the result obtained. In this way, it is essential to understand what is happening in the operational scenario.

The following situations, among others, can interfere with the indicators:

- Adverse weather conditions;
- The aircraft may have arrived late at the gate and, no matter how efficiently it takes off, it will continue to be delayed;
- Problems related to passengers (e.g., the passenger became ill during the taxi forcing the aircraft to return to the *boarding gate*);

- Aircraft maintenance issues;
- ATM issues (congested airspace, ATFM measures);
- Problems at HUB locations in the country (such as Guarulhos, Campinas, and Brasilia) interfering in other places (because they need to wait for passengers coming from these cities); and
- The lack of efficiency of the unit (observed in comparison with similar units).

What are data analysis types for?

Each of the types of data analytics has a specific purpose. Predictive analytics allows organizations to understand some of the metrics they are working with. Prescriptive analysis is useful for verifying the efficiency of processes. Descriptive analyses are performed all the time and are so accurate that they offer instant answers. Diagnostic analytics, in turn, assess the dimension of an action taken by the business, helping to compare metrics to understand its effects.

To perform these types of data analysis, it is necessary to go through the following process:

a) Exploratory phase

It is performed when the data has not yet been integrated or may be incomplete. This phase is not fully automated because it is necessary to check the points outside the curve for this data to be entered into the systems.

b) Data modelling

During the choice of modeling, automation features are used. This is where practitioners determine what the best approach is, i.e., what type of analysis is optimal for a task. Moving on to the modeling itself, the rules for predictive, descriptive, diagnostic, and prescriptive analytics are created.

c) Reports

A summary of the data should be generated, after the type of analysis performed, to guide decisions. This summary takes into account the clarity of the data used and the accuracy of the analysis performed. All types of analysis have a role within organizations, meeting a particular need, guiding managers in a direction and applying themselves to a particular context. The reports generated after the analyses help in the communication and documentation of the results.

Additional examples of ATM analysis

Many examples have been shown, with simple and straightforward interpretations and analyses. It should be noted that, when considering the results of the indicators, several direct and indirect factors can be related to the values obtained, so it is important to highlight that their interpretations are not limited and can always be explored from different points of view.

Example 1: When landing occurs on SBGL runway 33, it is identified that there are higher rates of delays.

This happens due to the specific characteristics of the operation on runway 33, because the trajectories of the aircraft arriving for the SBGL interfere with the trajectories of the aircraft taking off from the SBRJ. Therefore, the ATC unit makes separations between the aircraft at the two airports, which, of course, leads to an increase in delay rates.

Example 2: Each time an aircraft approaches through a certain ATC sector, there is a higher rate of delay.

This can be associated with specific headers that have lower inbound throughput. A proposed solution in this case would be to suggest to the administration measures to improve airport infrastructure (e.g. by focusing on express departures, in order to reduce runway occupancy time, consequently taxi time, and perhaps other indicators).

It is important to seek to improve the indicator. There won't always be a specific scenario that leads to a bad outcome. Eventually the operation may be inefficient and the analysis of the indicator may result in some adjustment that brings the improvements that are sought..

Framework 6 – Outstanding.

Example 3:

In a hypothetical situation, involving Galeão Airport, eight steps will be presented simulating an ATM performance analysis (the proposed steps are illustrative, as each type of analysis may require other different steps).

a) The airport studied is SBGL, which is located in the same terminal area as the SBRJ;

b) SBGL was with runway 10 closed for maintenance at times of high demand, and its landing capacity was close to the limit;

c) SBRJ was carrying out works on the runway throughout the month of December, making it impossible for the aircraft to land in the town; and

d) In the month of December, there was an abnormal volume of rainfall, which caused SBGL to be closed for at least 1 hour, twice a week, at peak arrival times.

Step 1:

Identify SBGL annual punctuality (2019) and compare it to other airports.

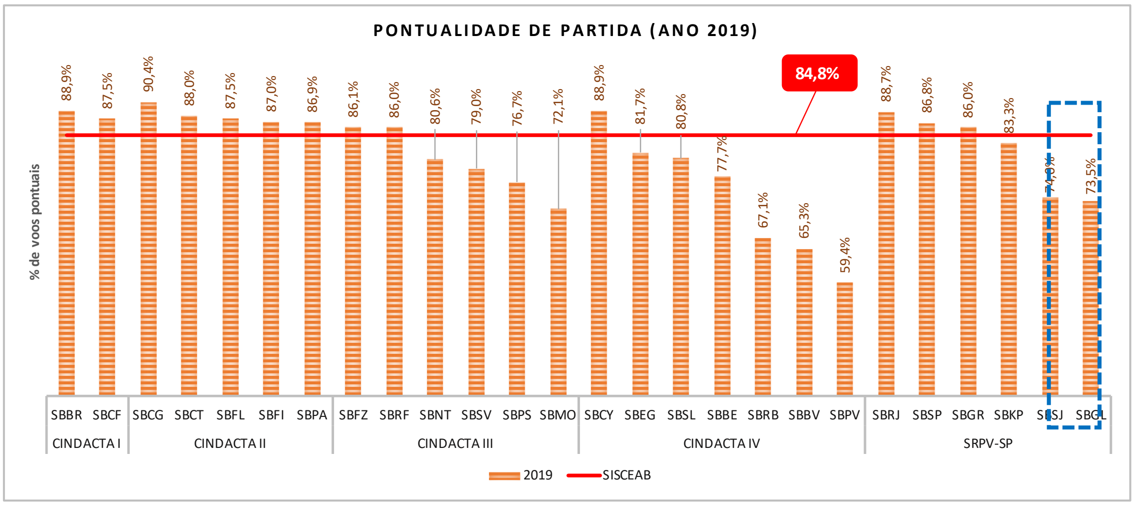


Figure 27 - Punctuality of departure in SISCEAB in 2019.

Figure 27 identified that the punctuality of the SBGL (73.5%) was below the national average.

Step 2:

Identify whether the drop in punctuality affected other indicators. It may have affected taxi time due to the accumulation of delayed planes.

It was identified that taxi time was not affected by the event under analysis, since the result of this indicator was similar to the result of the same month of the previous year.

Step 3:

Due to the work on the runway in its peak demand period (item b), identify if the runway capacity was changed and if this may have contributed to the increase in the delay rate.

Step 4:

Due to the works at Santos Dumont Airport in December, please identify if this will in any way affect SBGL operations.

A large amount of traffic was identified flying into SBGL, exceeding the landing capacity of runway 15, at times when runway 10 was not available. In this way, there was an accumulation of aircraft at the waiting point, which led TWR-GL to regulate the retrogression authorizations, impacting punctuality rates.

Step 5:

Identify the consequences of the climatic conditions reported in item d.

It was identified that these adverse weather conditions increased the complexity of the TMA-RJ airspace, resulting in the application of ATFM measurements by CGNA: minimum take-off intervals were applied, due to the adjustment of demands. Therefore, some planes canceled their flights, moving them the next day.

Step 6:

Identify if the SBGL's timeliness was below average in December due to the above events or if there were any problems in the other months.

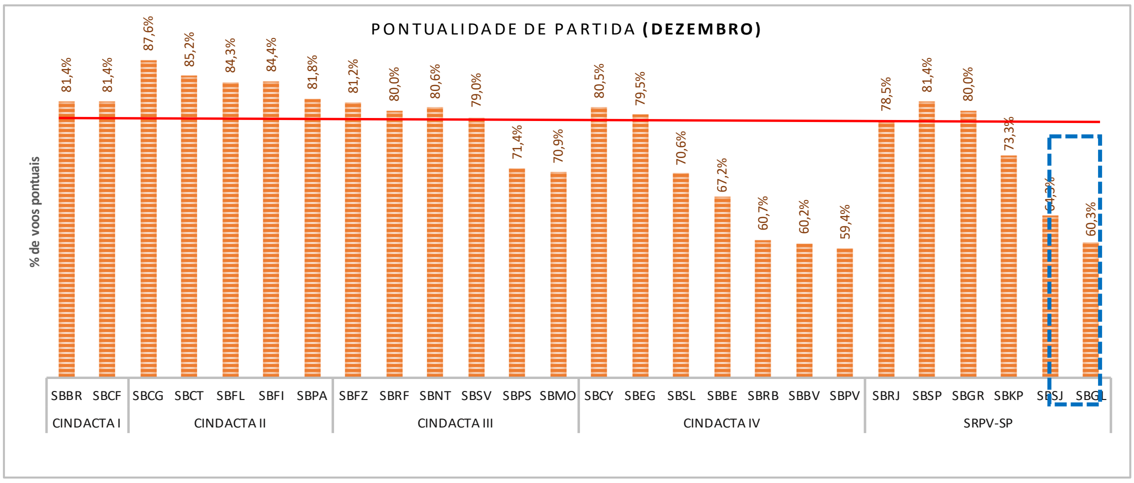


Figure 28 - Punctuality of departure in SISCEAB in December 2019.

When analyzing Figure 28, it can be seen that Galeão was much lower than the other localities, with a punctuality index equal to 60.3%.

Step 7:

To analyse the punctuality of the SBGL in the months of January to November.

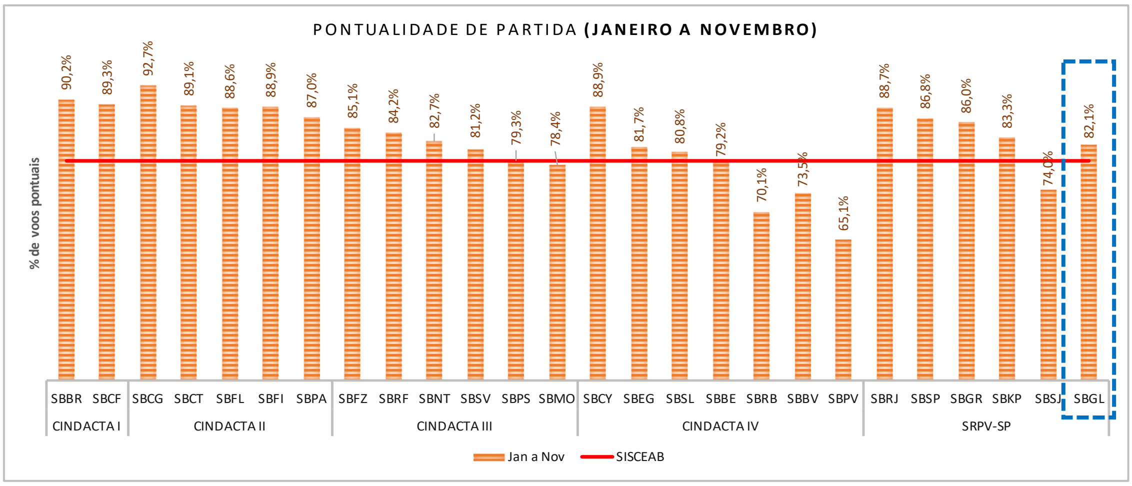


Figure 29 - Departure punctuality in SISCEAB from January to November 2019.

It can be seen in Figure 29 that, in the months of January to November, Galeão Airport obtained a punctuality index above the national average, but, due to the events of December, this index was considerably reduced.

Step 8: Some conclusions

In this way, it is possible to interpret that Galeão's efficiency is high and that, specifically in December, extraordinary events contributed decisively to the drop in its performance.

The Influence of Data Sources on ATM Analysis

It should also be noted that the interpretation of the data, knowledge of the data sources and how the indicators were obtained are essential for the work of disseminating the indicators.

As an example, it will be indicated how punctuality is calculated by four different institutions:

Agency A calculates from the TATIC FLOW information, using the pushback time (cPUSH) and the estimated shim-off time (EOBT).

Agency B calculates from the information of the scheduled time for the flight, in coordination with the airport (also called Registration). This value is not changed in the tactical in case of changes in the flight plan.

Agency C does not take into account all flights because, for its reality, CARGO aircraft are not relevant (unlike what happens in Agencies A and B); and

Agency D calculates a delay rate rather than punctuality, taking into account only flights that arrived after the deadline**.**

It can be concluded that, for the same indicator, the four Agencies have their own methodology for obtaining the data, that is, it is important to understand how the numbers are generated so as not to make erroneous interpretations. Because of this, sometimes different numbers are observed for the same indicator published by different institutions.

In addition, the seasonality of the samples must be considered, due to the peculiar characteristics of each region and each period. For example, in the months of December, January, February, and July, there is a clear increase in demand for air traffic due to the period of school holidays and holidays. Therefore, it is not appropriate to make a comparison of air traffic movement between January and May (which is a month characterized by lower demand than January). It is recommended that comparisons with respect to demand behavior be made between the same periods of different years (e.g., January 2019 to January 2018; first week of March 2019 to first week of March 2018).

Communication

For the results of the PIs to be achieved, communication is essential. It is extremely important that the entire organization is aware of the current performance indicators and their respective results. To this end, it is interesting to promote clear and effective communication.

The goal is to make people understand the goals and importance of each topic in the pursuit of better results.

A first communication should be made immediately after the definition of the institutional indicators, in order to disseminate the strategies and priorities. To do this, it is necessary to learn to contextualize. Effective data visualization can mean the difference between success and failure when it comes to communicating, presenting information, or simply showing ideas to the public.

Below are practical guidelines for communicating visually with data.

- Understand the context: Before you go to visualize the data path, there are two questions to answer succinctly: Who is your audience? What do I need to know or do?
- Choose an appropriate visual presentation: what is the best way to display the data to be communicated? Avoid 3D graphics.
- Eliminate saturation: each element added to the presentation absorbs the cognitive load from the audience. That is, one must evaluate what is being added, objectively. It is recommended to use a few slides and only insert elements that help reinforce what will be said.
- Focus attention where you want it: Emphasize the importance of size, color, and position attributes on the page. This type of element helps direct your audience to where you want them to focus and create a visual hierarchy of components to direct the audience to the information you want to communicate and the way you want it to be processed. Color is a great strategic tool
- Think like a designer: When it comes to the form and function of data visualizations, you should first think about what you want the audience to be able to do with the data (function) and create a visualization (form) that allows you to do so with ease
- Create a narrative: the flow of the narrative is important, the logical chaining and the use of data in a way that collaborates for what it has to communicate.

After understanding this step, another important part of communication is the dissemination of strategies and priorities. To this end, the following means are recommended:

- event with the participation of senior management;
- meeting of senior management with the main managers of the agency reunión de la alta dirección con los principales gerentes de la agencia;
- sectoral meetings;
- Institutional website;
- disclosure tables; and
- Institutional reports.

Information must be disseminated visually and contextually. The following are some "before and after" examples to give you an idea of this process.

Example 1 (before): It is perceived as the placement of the data on the graph, as per Figure 30, is making it difficult to see. The graph is in a simple form, simply presenting the data. That doesn't get the public's attention**.**

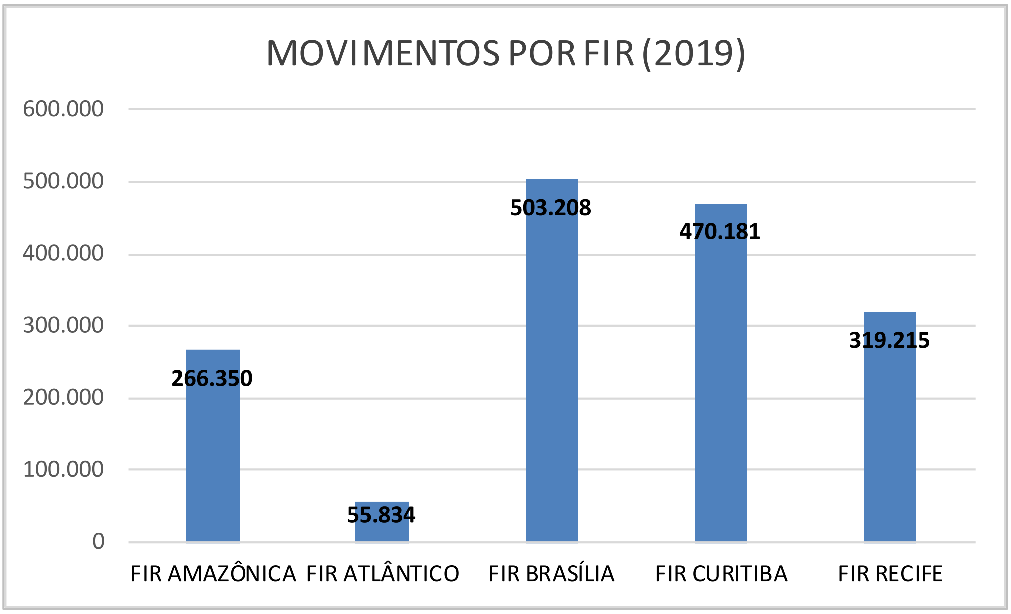


FigurE 29 - FIR movements in 2019.

Example 1 (after): Already in the Figure 31 graphic, a title, a subtitle, and a highlight are shown. The graph itself is not as simple as in the example above. You can see how more attention is drawn to its visualization and how it is easier and more complete to interpret.

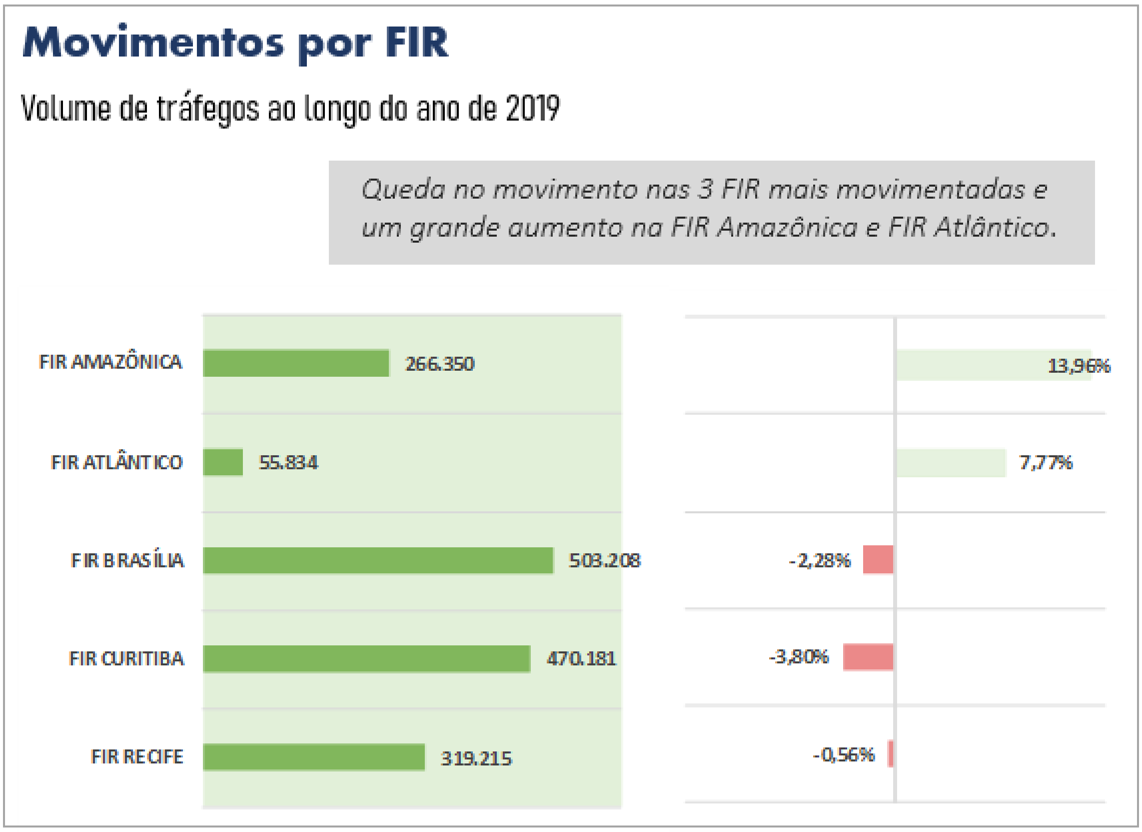


Figure 30 - FIR movements in 2019 (option 2).

Example 2 (before): In this example, the graph in Figure 32 is presented without the label information, placing only the percentage on the side of the graph and there are no grid lines to understand what the initial percentage of punctuality of CINDACTA IV is, for example. In addition to being an unremarkable graph, it's more difficult to analyz.

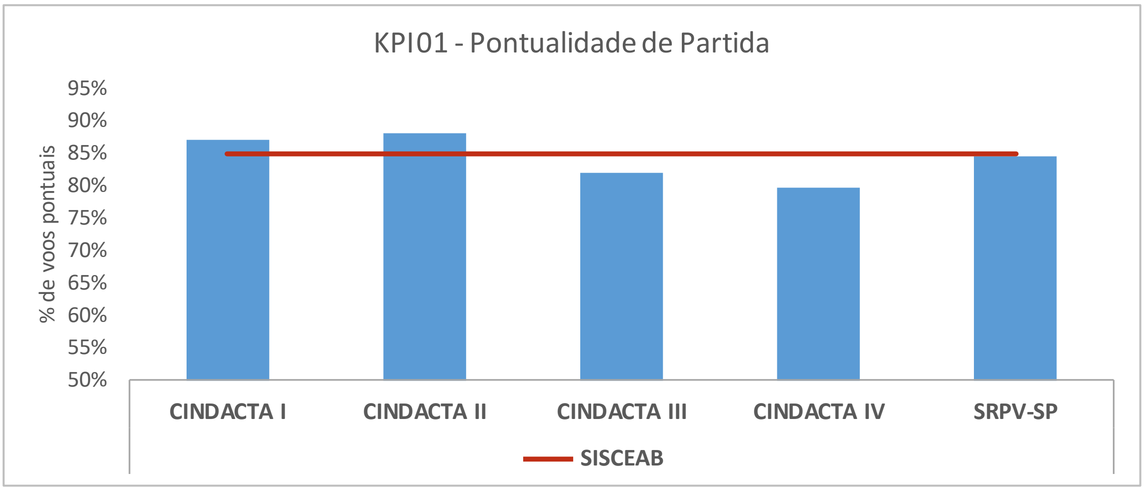


Figure 31 - Departure punctuality by regional in 2019.

Example 2 (after): In the graph in Figure 33, a title is presented with a different color, a more prominent subtitle, and a question, which makes the audience interested in interpreting the graph. In addition, the graph brings information from the previous year for possible comparison and also the well-detailed average of the departure punctuality. You can see how the performance is more understandable and much more visually presentable.

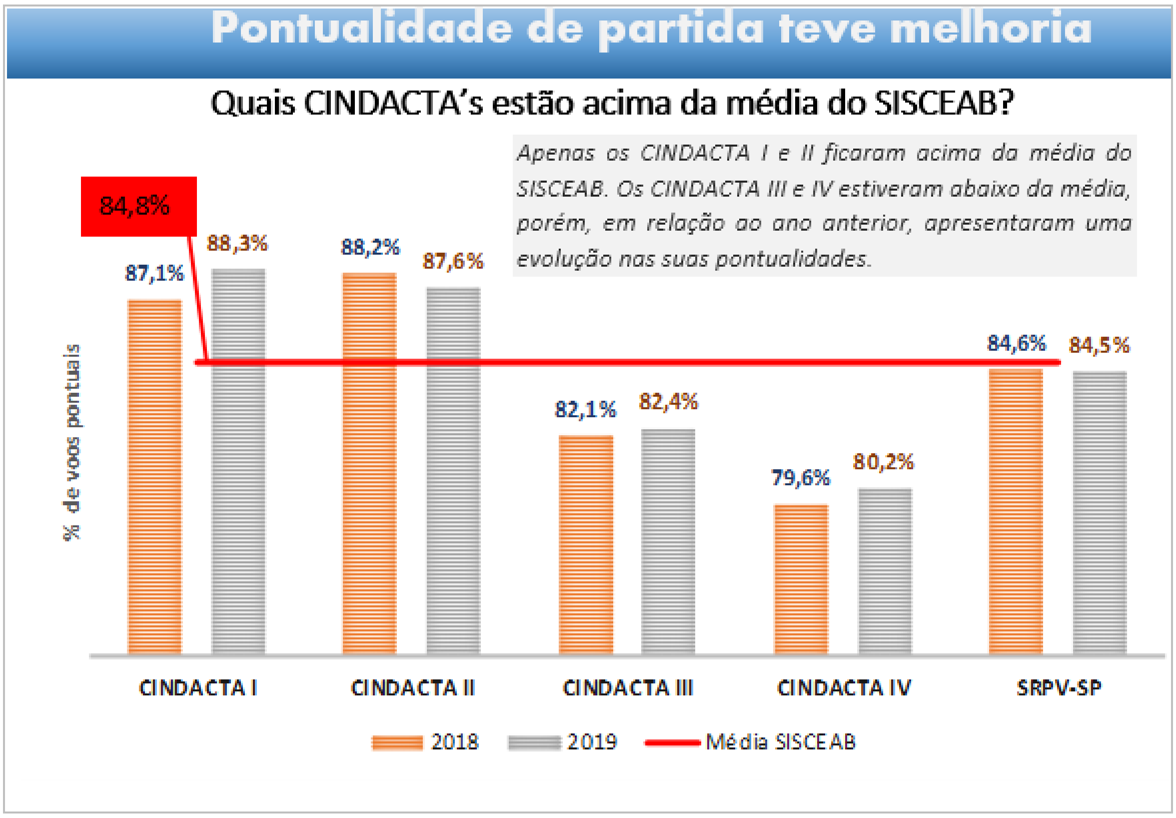


Figure 32 - Puntuality by regional in 2019 (option 2).

It should also be noted that another way to present the data is through a performance ranking among the PSNAs, which have similar characteristics and, therefore, can be compared.

Figure 34 below is an example of a performance ranking in terms of the busiest airports in the country.

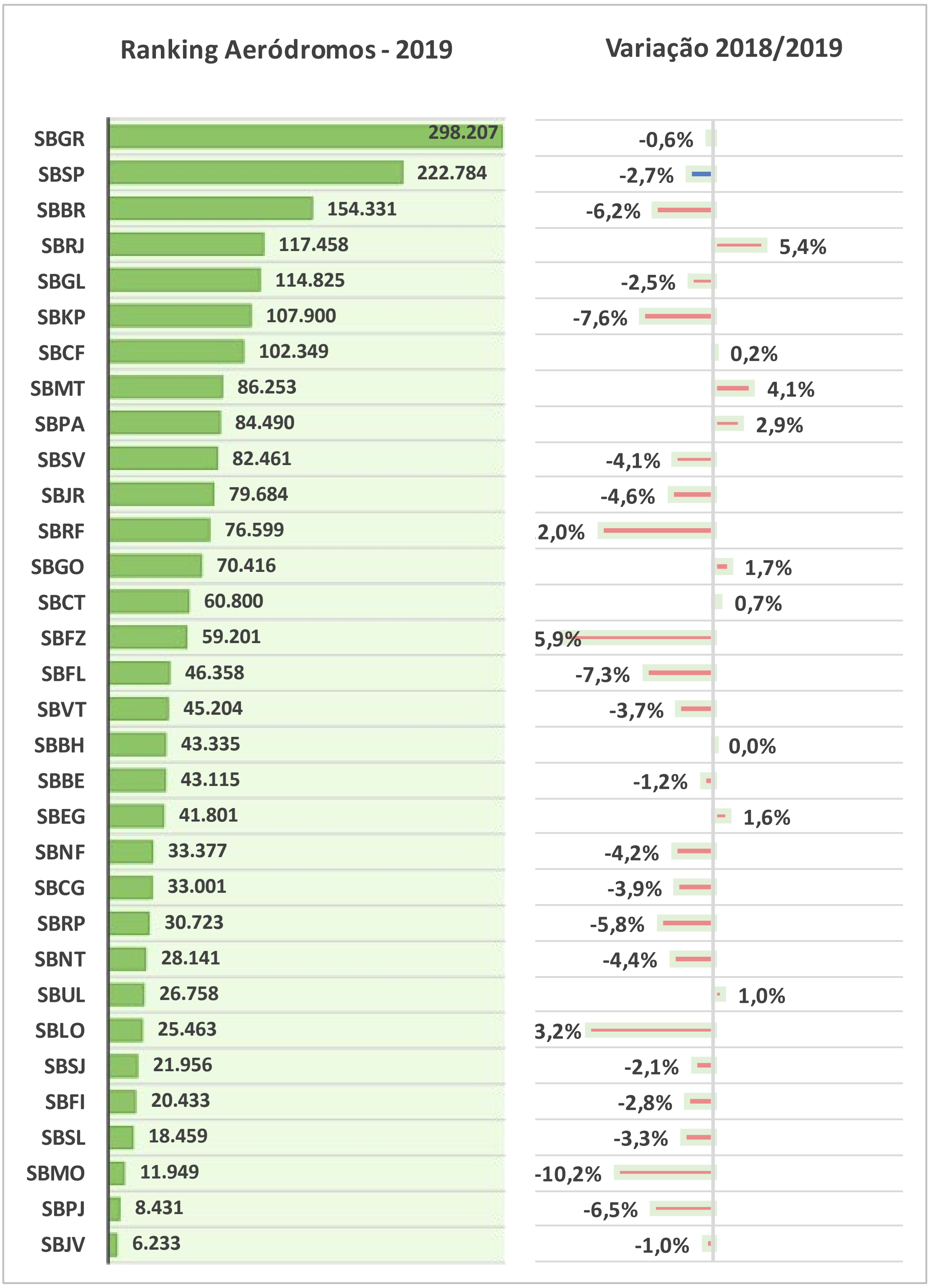


Figure 33 - Aerodrome movement ranking in 2019.

How to create an operational performance report?

A report includes in an organized way the operational development, whether of the ACC, APP or TWR of a locality in a given period. Such a report should have essential chapters such as introduction, development, conclusions and bibliography. In addition, before starting these chapters it is necessary to contain a table with the description of the document, abstract, acronyms and abbreviations, in this order.

A step-by-step for the development of each chapter is presented:

STEP 1: INTRODUCTION: It is necessary to present a summary of the objectives of the study and the methodology that was applied.

The following topics may be included::

- About the report
- Scope of the report
- Source of the data
- KPA and KPI
- Meteorología
- Conceptualizations of ATM indicators

STEP 2: DEVELOPMENT: This is where the content of the study carried out in each locality and the data obtained can be found.

The following topics may be included::

- TMA/ACC overview of the study – Presents a scheme of the geographical area (TMA/ACC) and public and private aerodromes. In addition to the sectorization and the mix of aircraft that use the airspace.
- Airport(s) – Here it can be talk about the runways, taxiways and the main types of aircraft that operate at the airport.
- Basic information – Must include information on geographic area, number of total, operational and non-operational TWR and APP ATCOs, number of sectors, and number of public and private airfields.
- ATCO Characteristics – Contains information on the effectiveness of the dependencies (TWR, APP) according to the operational index, time of experience, level of English, etc.

- Traffic Evolution – Describes the evolution of traffic, the total movements of general, commercial and military aviation.
- Traffic variability – Presents the variation of movements in relation to the days of the week, month and year.
- Meteorology – Contains meteorological information typical of the region.
- ATM Indicators – This is where each indicator studied is presented with its results and discussions.

STEP 3: CONCLUSIONS: In the conclusions, the main ideas developed during the study should be closed, without presenting new facts.

STEP 4: REFERENCES: It should contain everything that was consulted during the preparation of the report.

In the DECEA performance portal (Figure 35) you can find some reports that were prepared according to this model, which can serve as an example and future references. (URL: https://performance.decea.mil.br)

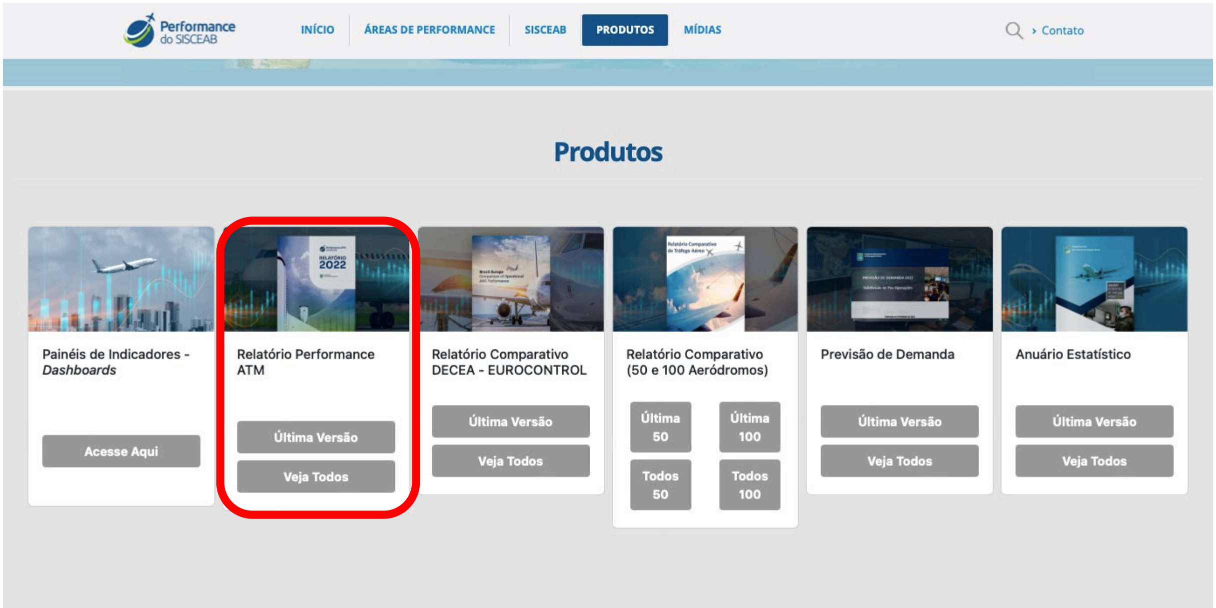


Figure 34 - Consultation of DECEA performance reports.

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