INDICATORS FOR EVALUATION OF AIR OPERATION AUTHORIZATIONS IN BRAZILIAN CIVIL AVIATION

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ABSTRACT

One of the roles of a regulatory agency such as ANAC is to implement public policies in line with the strategy defined for the civil aviation sector. As such, it is the Agency's responsibility to identify directives to be followed and decide how those policies will apply to regulatory and inspection activities. Considering the process of authorization and monitoring of services provided through air operations as one of ANAC's functions, the following question is posed to this research: how can the regulatory agent systematically evaluate requests for authorization of air operations? The objective of this work is to develop a set of results-oriented indicators to measure adequate services, focusing on evaluating requests for authorization of scheduled air transportation operations, which should be granted by the regulatory agent.

Key words: Civil Aviation, operations, authorization, indicators, Civil Aviation Policy.

1. INTRODUCTION

Currently, the process of authorizing of scheduled air services is conducted by the National Civil Aviation Agency's (ANAC) Air Service Operations Management Unit (GOPE). GOPE's function is to endorse technical opinions from other ANAC internal areas and from external consultative members (such as Local Airport Administrations – AAL) about solicitations for operation submitted by airline carriers. The HOTRAN Electronic System, which allows for dissemination of all scheduled air operations in country on ANAC's website, has been put in place to manage all solicitations submitted by those airlines carriers. However, no analysis based on monitoring of existing operations is performed when authorizing scheduled air operations. Indicators may and should be used to perform such monitoring, as they permit managing authorizations vis-à-vis the goals of the regulatory agency and the National Civil Aviation Policy (PNAC). A few indicators are already included in ANAC's internal normative directives. However, these indicators have been drafted without due consideration to both monitoring and well as PNAC's guidelines.

Along those lines, this article addresses the definition and use of indicators to evaluate scheduled air operation authorizations based on the existing strategy for Brazilian civil aviation. This paper describes a methodology for selection and use of indicators, demonstrating how they can be used to evaluate new operation authorizations, using the National Civil Aviation Policy (PNAC) (BRAZIL, 2009) and the concept of adequate service provision as evaluation criteria. This subject has been largely discussed by transportation planning bodies.

To meet that purpose, this article initially introduces PNAC by describing its core aspects related to air service operation and authorization. Next, indicators are briefly defined and classified. In section 4, this study presents the main steps of a methodology for selection and use of indicators. The subsequent item demonstrates the practical use of the proposed indicators.

2. THE NATIONAL CIVIL AVIATION POLICY (PNAC)

National policies are a set of guidelines and strategies that should guide the planning process of institutions responsible for their implementation, thus establishing strategic objectives and activities for a given sector. In Brazil, one of those institutions is the National Civil Aviation Agency (ANAC), which follows the strategies defined by the Civil Aviation Secretariat (SAC), a government body directly linked to the President of the Republic. Another important point is the possibility to integrate the sector-specific policy, PNAC, into the context of national policies, thus reflecting the political intent of Brazilian society for development of the Civil Aviation System. In the absence of a specific policy designed for ANAC, it is possible to infer relevant elements to guide the elaboration of indicators based on information available in the aviation sector.

PNAC cites strategies in the areas of operational safety, infrastructure, and the environment, among other relevant ones. Adequate air service provision is the area of interest within the scope of this article. Several sources (including legislation and public policies) seek to define adequate air services, including Act N° 8.987, dated February 13, 1995, that provides for the concession and permission regimen for public service delivery contemplated in article 175 of the Federal Constitution (BRAZIL, 1988). However, in order to delimit a scope, this work only covers PNAC-defined guidelines that deal with adequate air service, thus making this research more specific. According to PNAC (BRAZIL, 2009), adequate provision of scheduled, public air transportation services assumes service continuity, regularity and punctuality, among other factors, thus ensuring characterization.

Also according PNAC, in order to guarantee service continuity, regularity and punctuality, it is necessary to establish measures capable of identifying and

eliminating threats to those principles, and thus ensure rapid, positive responses to natural, material and human factors that may interrupt air service provision.

3. INDICATORS

Indicators are relevant, concise and easy-to-interpret parameters used to illustrate the main characteristics of a subject under analysis (CEROI, 2004 *apud* Villella *et al.*, 2008). An indicator should be an objective way to comparatively measure an actual situation against pre-established standards, in the light of an existing strategy. An indicator makes sense only when it is actually utilized by a relevant management sector. Indicators are variables that synthetically reflect a given social concern and correctly place this concern in the decision- making process, as long as the indicator in question bears social significance beyond the meaning of its own scientific configuration (MMA-Espanha *apud* Villella *et al.*, 2008).

Segnestam (2002) *apud* Magalhães (2004) points out that a review of international literature shows that most existing initiatives for developing indicator systems emphasize database and software development without due attention to the adequate formulation of their scope, i.e. the tools and ways to integrate these very systems into the processes they should serve. This results in either expensive, short-spanned systems, or in others that cannot be incorporated to work processes.

According to Royuela (2001) *apud* Villela *et al.* (2008), an indicator should: (i) provide information about problems being addressed; subsidize policy development and priority definition by identifying key factors; (iii) contribute to follow up of actions defined, and particularly to integration ones; and (iv) be a tool for information dissemination at all levels.

3.1. Types of Indicators

There are different types of indicators to respond to different needs of information and to support decision makers in different types of analysis. These different types of indicators can be classified according to the level of analysis they must meet, as well as according to their function or relevance. When classified by relevance, indicators may be: descriptive; performance, efficacy or efficiency-related; and global (EEA, 1999 *apud* Villela *et al.*, 2008). The characteristics of each type of indicator are summarized in Table 1.

Table 1: Types of Indicators by Function (Adapted from EEA, 1999 *apud* Magalhães, 2004).

Type of Indicator	Description
Descriptive	Describe, characterize a given topic. Reflect an actual situation without reference to what it should have been.
Performance or Efficacy/Effectiveness	Compare current conditions against a series of values of reference, e.g. goals or expected results.
Efficiency	Allow for evaluation of the efficiency of actions, reflecting the quantitative and qualitative relation between inputs and results achieved.

As cited by Magalhães (2004) and Villela et al (2008), the main criteria for indicator selection are: representativity; relevance vis-à-vis the scale of analysis (in space and time); adequacy to the needs of the target group (experts, managers, general population); pertinence to planning objectives; consensus about its validity); breadth of scope; existence of values of reference that attribute significance to values arrived at; and existence

of scientific basis. Some papers applied indicators in civil aviation without a methodology bounded with a state politician and they also didn't cited a literature review about indicators (Wang, *et. al*, 2004; Wu, 2005; Lourenço and Pires, 2005; Sim *et. al*, 2006). Gustavo (2011) reported an example of application indicators in urban road transportation using some criteria for selection above cited.

4. A METHODOLOGY FOR DEVELOPMENT OF INDICATORS TO EVALUATE AIR OPERATION AUTHORIZATIONS: A PROPOSAL

The methodology utilized in this paper was elaborated by Magalhães (2004), with the ease of understanding, clarity, simplicity and absence of ambiguities; feasibility in the context of data availability and magnitude of cost and time to obtain data; capacity to capture change; comparability at the international level (which implies fit with international standards and international objective to support transportation planning; it allows for definition of a set of indicators to monitor and evaluate the implementation of public programs and policies. This work is limited to application of a portion of the methodology, whose steps are described in Figure 1.

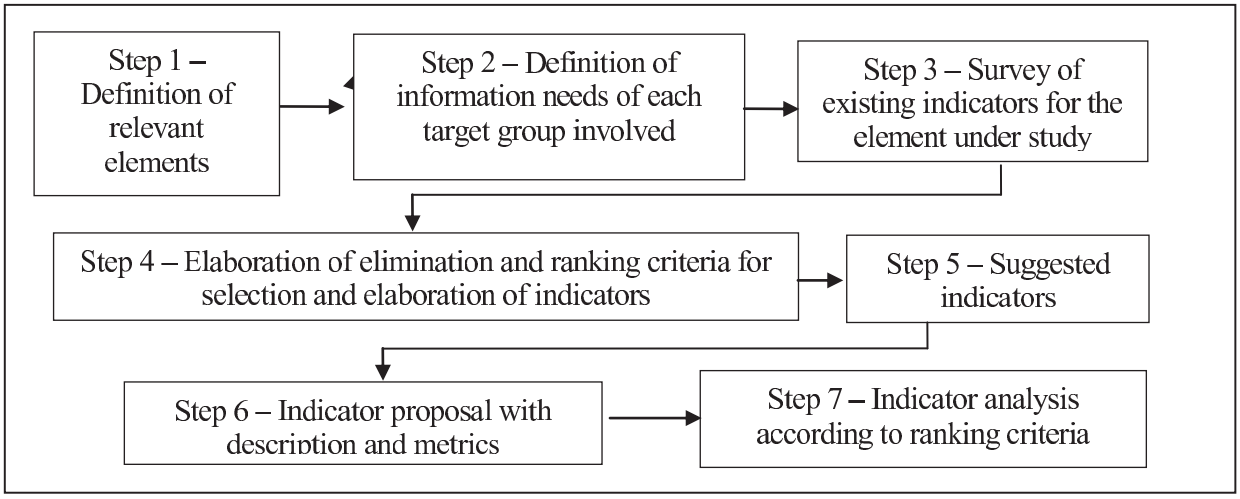


Figure 1: Methodological Steps (modified from Magalhães, 2004).

The next item covers the application of this methodology while also presenting some steps in greater detail, in order to explain how this methodology applies to the specific case of air operations in Brazil. Step 1 defines the relevant elements that will be addressed by the indicators. Step 2 defines the information needed by the target groups to establish parameters for indicator elaboration. A review of specialized literature to identify existing indicators is carried out in Step 3. The next step consists of elaboration of criteria for ultimate choice of indicators. Indicators other than the ones devised in step 3 may be suggested in step 4 of the methodology. The description and metrics of each indicator selected are included is Step 5. In the last Step, each of the selected indicators is analyzed.

5. DEVELOPMENT OF INDICATORS FOR AIR OPERATION AUTHORIZATIONS

This section defines indicators for evaluation of air operation authorizations according to Figure 1.

5.1. Definition of relevant elements

The strategic actions included in PNAC (BRAZIL, 2009) are used to define the relevance of elements, particularly concerning

the three concepts that reflect adequacy of civil aviation services, corresponding to the following specific factors:

- Continuity: inspect air service providers in such a way that the regulatory body is able to build contingency plans for possible situations of service interruption;
- Regularity: promote measures that identify and eliminate threats to continued provision of air transportation services and that respond quickly and effectively to natural, material and human factors capable of affecting service regularity;
- Punctuality: promote integration among public agencies and entities and carriers, in such a way as to prevent delays deriving from their inherent functions;
- Competition: stimulate and analyze competition between airline carriers.

Even though the concept of continuity has been generally applied to provision of essential public services such as electricity and water supply, among others, it is possible, in a continental-sized country such as Brazil, to frame the idea of continuous provision of air services in a given locality with the objective to meet the demand in remote areas. In some areas of Northern Brazil, the only fast means of transportation of patients is by air, e.g., the city of Rio Branco (AC), thus making air services essential to medical care in the region.

In some ways, this situation "obliges" the regulatory body to create incentives for airline carriers even when such operations imply a deficit for providers. For example, Grubesic and Matisziw (2011) cited the goal of Essential Air Service (EAS) in the United States is to provide a minimum level of air transport service from smaller, often remote communities to the national network. These authors says that results suggest that redundant coverage of EAS market areas by alternative Federal Aviation Administration (FAA) designated hub airports can contribute to EAS airport market leakage and that alternative definitions of EAS community eligibility have the potential to dramatically increase programmatic efficiency and reduce federal monies spent on EAS subsidies

5.1.1. Aspects related to Mobility

Act 11.182 (BRAZIL, 2005), article 48, paragraph 1, provides that "commercial exploitation of any airway is hereby assured to domestic air service providers registered with ANAC, when in exclusive compliance with the operational capacity of each airport and with the regulatory norms for adequate air service provision established by ANAC." This means that an airline carrier may operate any airway service as long as it respects the limits of infrastructure and adequate service norms.

This point is worth discussing, as the concept of adequate services is different from region to region in Brazil. In the case of airports with scarce infrastructure and great competition among carriers, such as Guarulhos Airport, continued operations may not be a very important factor, as there are numerous carriers that are eager to provide services where their competitors have failed. In remote regions, however, continuity is one of the most important elements for adequate service analysis.

According to Magalhães and Yamashita (2007), continuity is a relevant sub-element of mobility as it relates to an individual's access to means of transportation. As such, it must be analyzed in relation to interruption in the offer of air transportation services, particularly in remote regions of the country.

Also according PNAC, one of the proposals to improve air service would be to stimulate the development and expansion of air services provided in routes reporting low and medium traffic density, aimed at increasing the number of cities and municipalities receiving air services (BRAZIL, 2009). In that case, the related relevance element would be space availability for this means of transportation, referring to air service mobility. The reach of an air network should be part of air transportation

regulatory policies, as the goal here is to meet public and social interest by providing essential transportation services in some Brazilian regions.

5.1.2. Aspects related to Efficacy

The concept of punctuality currently adopted in aviation refers only to services provided by airline carriers. Today, punctuality is assessed through monthly counting of the proportion of flight stages that have been operated in accordance with the schedule outlined in the Transportation Timetable (HOTRAN), vis-à-vis all flight stages that have actually been completed.

This concept has become obsolete for civil aviation's new environment, as it doesn´t focus on one flight stage, but rather on the set of flights specified and aggregated in HOTRAN. Furthermore, it does not contemplate the impact of airport infrastructure in punctuality analysis. For example, the Brazilian airport network presents restrictions owing to excessive demand, this being the case with Congonhas and Guarulhos airports. Management of its scarce capacity directly impacts the quality of air service provision. For that reason, analysis of punctuality must be expanded to involve airport operators, as they as well influence service provision by means of efficient (or deficient) allocation of insufficient infrastructure.

It is important to stress that responsibility for timely operations should not fall solely upon the airline carrier that provides the service. Air service users have a contract with the airline carrier that transports them. However, the process of transporting this user depends upon actors that are not clearly stated in the deal. The boarding and deplaning process, for instance, utilizes airport infrastructure. As such, in this specific part of the process, responsibility should be shared between the Local Airport Administration (AAL) and the airline.

Often, the time elapsed between shutting down the doors of an airplane and the actual take off depends exclusively on services provided by the AAL, with direct impact on service punctuality. For all those reasons, the concept of punctuality is directly linked to transportation efficacy, which in aviation supports the relevant element of timing as proposed by Magalhães' methodology. This element relates to the capacity of both an airline as well as an airport to timely perform a planned air operation.

In aviation, regularity is another concept that connects with the idea of Air Transportation Mobility. According to Magalhães' Methodology, the relevant element linked to this concept is that of precision, or accuracy.

The concept of precision is the carrier's capacity to take a defined object to the right destination. In order to adapt this particular methodological concept, this study assumes that an operation will not be deemed complete in case it is not successful in transporting the object to the initially proposed destination. For that reason, in this study the concept of accuracy is understood as the capacity of an airline carrier, an airport or a sector to offer and accomplish a pre-determined, planned air operation. When an airline carrier cancels a planned activity due to either technical and meteorological conditions, or to construction work in an airport, this airline carrier breaks the terms of the contract with air transportation users and is thus unable to carry the object to the right destination.

5.1.3. Aspects related to Efficiency

Finally, PNAC cites encouragement to competition among service providers as another important policy to be implemented: "Stimulate competition in the civil aviation sector." (BRAZIL, 2009). Competition is a fundamental factor of adequate service provision and may lead providers to offer services that are better than those provided by their competitors, thus privileging high quality services to become the user's choice. However, it must be understood that the aviation market is not homogeneous, i.e., its regulated agents are not similar in either size or economic power. As a regulatory agency, ANAC's role is to continuously evaluate the level of concentration on different markets and

the diversity of operators, thus stimulating emergence of new and trustworthy providers and preventing service gaps in selected regions.

As to time efficiency, service provision should be timely so as to optimize the use of available infrastructure, particularly in airports whose demand is higher than supply due to airport restrictions. For that reason, passenger boarding and deplaning time is an important factor of service provision efficiency. This factor is particularly important for sound planning of structure use and for good customer service, as the effects of one agent in the air service production chain may affect other agents. According to the Magalhaes Methodology, all those factors compose the set of relevant elements linked to market efficiency. Along those lines, an analysis of PNAC highlights the assumption that relevant elements for air operations are the ones presented below, with their respective definition:

- Mobility: continuity, recurrence of services and space availability for the means of transportation;
- Transportation efficacy: accuracy and timing;
- Transportation market efficiency: market concentration and diversity of operators; and
- Timely transportation market efficiency: time spent in passenger boarding and deplaning/cargo loading and unloading.

5.2. Definition of information needed by each target group in relation to elements of timing and accuracy

Before defining the needs, it is necessary to define the target groups involved in operations: the air service provider, represented by the airline carrier; the infrastructure provider, represented by the AAL and the AA, in addition to the Air Transportation Controller (CTA), whose functions are described below. Initially, according to Magalhaes and Yamashita (2007), the Controller is the agent responsible for monitoring and inspecting public expenditures, investments in the sector, and results achieved by programs. Thus, the CTA's main concern relates to the planning and implementation processes. Considering these peculiarities, in the PNAC context the Controller should: evaluate the effectiveness of selected means; evaluate the efficacy of selected means; and evaluate the efficiency of selected means, among other activities.

In relation to timing and accuracy, this study has found that the target groups and their needs of information are:

- CTA: How good is the sector's performance in air transportation timing and accuracy?
- Service Provider: How good is my own timing and accuracy as compared to the sector's average?
- Airport Infrastructure Provider: Compared to the sector's average, how good is the timing and accuracy of services that utilize the airport infrastructure I provide?

5.3. Survey of existing indicators for elements of timing and accuracy

A review of legislation only returns references to transportation timing as it relates to flight punctuality. For ANAC, the Punctuality Index is the proportion of flight stages operated in accordance with the schedule in HOTRAN's respective documentation, vis-à-vis all flight stages effectively carried out, while taking into consideration the tolerance limits established by the Civil Aviation Department (DAC) (1999). However, the index is based on flights and not on stages of flights. In the past,

changes to the schedule of a given airline carrier were rare.

With that, the same flight could be on schedule for years. Another indicator found for transportation accuracy is the Regularity Index, i.e., the proportion of total flight stages foreseen in HOTRAN that are effectively carried out in accordance with DAC (1999). Today, market dynamics are greater and an airline carrier may change flights and flight numbers at any time, and even several times a month. As such, flight-based analysis is not the best alternative, as it does not accurately represent timely operations. For that reason, this indicator should be discarded as it is not a true representation of the timing element.

5.4. Criteria for selection and elaboration of timing and accuracy indicators

Based on the survey of selection criteria and their application, it is possible to define elimination and ranking criteria for indicators that reflect timing and accuracy elements, as presented next. The Air Punctuality Index (IPA) is the quotient of the number of air operations whose start is delayed by 15, 30, 60 or 240 minutes, by the total number of planned operations, as represented in equation 1:

$$IPA = \frac{\sum_{i=1}^{n} op_{delay}}{\sum_{i=1}^{n} op} \; x\; 100 \qquad (1)$$

where: op_{delay} = number of air operations delayed (15, 30, 60 or 240 min);

op = total number of air operations;

n = total number of simple stages by O/D pair;

As to elimination criteria, this indicator aims to accurately represent part of the relevant element of timing. Thus, elimination criteria defined for this case are: to represent timing in a given origin/destination pair and to permit significant comparison between distinct situations, e.g., to compare the timing of air services provided in selected airports against state, regional and national standards.

The indicator Net Time Deviation by Operation (DLT) is the quotient of the sum of the difference between the planned schedule and the time of execution of an air operation, by the sum of air operations in an origin/destination pair, as presented in equation 2. This indicator also aims to represent timing through the quotient of the difference in minutes between a planned operation and the one executed for each origin/destination pair, airport or even airline carrier. This indicator also allows for significant comparison between distinct situations, e.g., comparing time deviation for execution of air services provided in selected airports against state, regional and even national standards.

$$DLT = \frac{\sum_{i=1}^{n} |h.op.plan - h.op.exec|}{\sum_{i=1}^{n} op \qquad O/D} \qquad (2)$$

where: *h.op plan* = time scheduled for the operation;

h.op exec = time of operation execution (wedged and non-wedged);

op = total number of air operations;

n = total simple stages by O/D pair.

The Air Regularity Index (IRA) is the quotient of the number of air operations executed by the total number of planned operations, as represented in equation 3. This indicator should permit significant comparison between distinct situations, e.g., comparing the regularity of air services provided in selected airports against state, regional and even national standards. In the case of IRA, it would be advantageous to aggregate data by airport, type of object being carried (passenger or cargo) and origin/destination pair. In addition, and if possible, such aggregation should be done on a monthly, quarterly, biannual, annual and quinquennial basis, thus allowing for seasonal analysis.

$$IRA = \frac{\sum_{i=1}^{n} op.exec}{\sum_{i=1}^{n} op} \; x\; 100 \qquad (3)$$

where: *op exec = number of air operations executed;*

op = total number of air operations;

n = total simple stages by O/D pair.

5.5. Definition of information needed by each target group in relation to elements of continuity and space availability for the means of transportation

In relation to continuity and space availability, this study has found that the target groups and their needs of information are:

- CTA: How good is the air service sector's mobility?
- Service Provider: How good is the mobility of the air service I provide as compared to the sector's standards?
- Airport Infrastructure Provider: Compared to the sector's average, how good is the mobility of services that utilize the airport infrastructure I provide in relation to the sector's standards?

5.6. Survey of existing indicators for elements of continuity and space availability

An extensive review of legislation in the area of air services did not return indices or operational indicators that represent those elements.

5.7. Criteria for selection and elaboration of continuity indicators

The Service Provision Frequency Index (IFS) is the quotient of the number of air operations with frequency of up to 5 (five) days a week by the number of total operations, as presented in equation 4. The objective of this indicator is to identify airline carriers that provide most air operations to a given destination. The rationale is that the IFS indicator will demonstrate the available frequency of air operations to the public in a given origin/destination pair. It also aims to verify which destinations are mostly available, in order to process aggregations by airport based on either high or low number of planned operations.

$$IFS = \frac{\sum_{i=1}^{n} op.freq_{7.6.5}}{\sum_{i=1}^{n} op} x\ 100 \quad (4)$$

where: *op freq 7, 6, 5* = number of air operations with frequency of 7, 6 and 5 days a week;
op = total number of air operations;
n = total simple stages by O/D pair.

5.8. Criteria for selection and elaboration of indicators for space availability

The Regional Coverage Index (ICR) is the quotient of the difference between the product of the regions' Importance Factor times the number of operations in that region, and the operations and the total number of operations, as presented in equation 4. Its objective is to increase the weight of air operations that serve selected regions of the country, thus guiding service offer to users who live in remote, less developed areas. The elimination criterion for this indicator is pertinence to the planning objectives of more accessible air transportation. Observation of the breadth of air operations may subsidize the elaboration of incentive policies for service provision in remote regions.

$$ICR = \frac{\sum_{i=1}^{n} F_i\ x\ op.reg}{\sum_{i=1}^{n} op} x\ 100 \quad (5)$$

where: *Fi*= Region's Importance Factor;
op reg = number of air operations in a given region;
op = total number of air operations;
n = total simple stage by O/D pair O/D.

It would be worth verifying which steps, regions, states or cities need further development, particularly the ones with precarious road or railway access. In that case, the Region's Importance Factor would

be higher, thus attributing additional weight to operations in those regions. There are many studies about similar index. For example, Matisziw and Grubesic (2010) proposed a new metric that incorporates measures of access to air transport as well as accessibility within air transportation networks. These authors suggested marked differences between core-based statistical areas throughout the United States.

5.9. Survey of Existing Efficiency Indicators

An extensive review of legislation in the area of air services did not return operational indicators that represent the diversity of providers and the level of air transportation market concentration. For that reason, the proposed indicators that represent this element may serve as a tool for future operational analyses related to adequate air services and monitoring of PNAC implementation.

5.10. Criteria for Selection and Elaboration of the Provider Diversity Indicator

A selection of indicators for the element Diversity of Providers was done based on the criteria listed above. The elimination criteria for these indicators are ease of understanding, clarity and simplicity. The Provider Diversity (QP) indicator is the number of existing providers for the same origin/destination pair, as represented in equation 6 below:

$$Q_p = \sum_{i=1}^{n} P_i \quad (6)$$

where: *Qp* = Number of providers in each origin/destination pair;

Pi = Existing providers in each O/D pair.

The objective of this indicator is to identify airline carriers that offer air operations for a given stage or route. Analysis of the number of providers for a given destination may also be helpful in designing policies and establishing priorities for selected remote regions, and even for high competition routes.

The idea here is for this indicator to display service providers working in selected markets. It would be interesting to verify which routes, regions, states or cities count with the highest number of providers and which are the ones that present unmet demand, since the adequate service provision evaluation criterion may vary between regions, e.g. an area with considerable diversity of providers and another one where providers are scarce. Furthermore, temporal aggregation, be it monthly, biweekly or annual, is also recommended.

5.11. Criteria for Selection and Elaboration of the Market Concentration Level Indicator

The indicator Market Share of Provider (PPM) is the ratio between services offered by providers under analysis and the total market offer, as represented in equation 7:

$$PPM = \frac{\sum_{i=1}^{n} op.offered_j}{\sum_{i=1}^{n} op.ffered} x\ 100 \quad (7)$$

where: *op.offered (j)* = Number of air operations offered by the 2 largest providers;

op.offered = Number of total air operations offered;

n = Total providers in the market.

The objective of this indicator is to identify the two airline carriers that concentrate most of available air operations to a given destination, airport or region, among other possibilities. Concentration may decrease service offer rates to users. The elimination criterion for this indicator is pertinence to the planning objectives of most accessible and competitive air transportation.

The PPM indicator should partially demonstrate the level of market concentration of air operations available to the public in a

given origin/destination pair. It would be interesting to verify which destinations are most concentrated and also to perform aggregation by airports with either more or less concentration of providers. Temporal aggregation is also valid to monitor a given market's behavior over a period of time.

6. CASE STUDY: APPLICATION OF INDICATORS

This item aims to apply some of the indicators defined in the previous items using real data, with the objective to demonstrate the application of this measurement to the CTA's specific air service field. Initially, IPA and IRA were applied to air operations in the Brasília Airport. For IPA application purposes, this study considered as delay every 30 or 60 minutes past the original time scheduled (Figure 2). It is possible to infer that IPA30 presents a growth trend, owing principally to the mid-year vacation season, which reports a majority of leisure-oriented travel. This indicator also shows high incidence due to meteorological problems in other regions of the country which affected this particular airport while the study was being conducted. IRA remained stable over that quarter. However, as compared to the sector as a whole, this airport's IRA is 20% higher than the average in national airports, suggesting a management problem. Almeida *et al* (2005) and Fremder (2009) reported that costs of delays are very representative in relation to total operational costs. Reduce delays is a important goal for the Brazilian aviation policy.

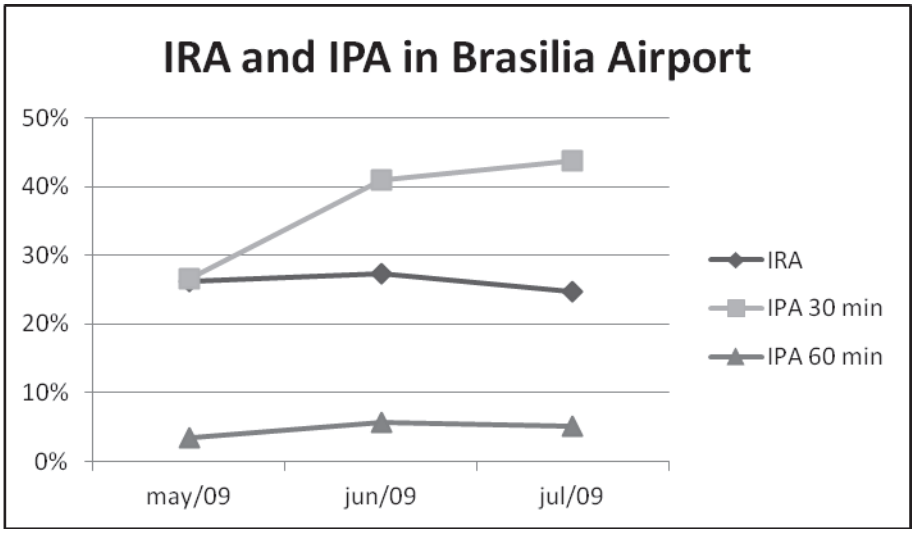


Figure 2: Application of IRA and IPA30, IPA60 in Brasilia (May to Jul, 2009).

This study measured the DLT of real carriers, herein denominated X and Y, on the Belém/Brasília route, aggregated by quarter, resulting in 12.81 for Y and 11.01 for X. This indicator demonstrates that, on this specific route, and over that particular quarter, airline carrier Y is less timely than carrier X, i.e.: its operations are less punctual as compared to airline carrier X. This indicator may be used to analyze new operations for this route, in addition to supporting determination of an acceptable DLT goal for adequate service provision.

IFS was applied in the airports of Campo Grande, Curitiba, Porto Alegre, Salvador and São Paulo/Guarulhos, as described in Table 2. When aggregated by airport, the Campo Grande, Curitiba and Porto Alegre Airports' IFS was very similar, demonstrating that, on average, 80% of these airports' operations offer more than 5 operations a week. As to the Salvador Airport, it is possible to notice that airline carrier Y offers more operations than airline carrier X, with IFS higher by 5.13%.

In relation to the Guarulhos Airport, aggregation was done in such a way as to compare domestic and international passenger carrying operations. There is greater availability of national air services, which is explained by the fact that a portion of Guarulhos' activity relates to connecting flights for national passengers boarding international flights, while another portion relates to arrival and departure of passengers to the city of Sao Paulo.

Table 2: IFS Measurement in Specific Airlines Carriers and Airports (on 09/05/2009).

Airport	Airlines Carriers	IFS
Campo Grande	All	80.56%
Curitiba	All	80.74%
Porto Alegre	All	80.93%
Salvador	X	94.87%
Salvador	Y	100.00%
Guarulhos	Z	82.05%
Guarulhos	Domestic passengers airline carriers	92.13%
Guarulhos	International passenger airline carriers	85.40%
Guarulhos	Airline cargo	39.58%

Due to the complexity of ICR calculation, this study assumed the following hypothetical situation: the initial assumption is that there are only two airports in two regions of a given country. One airport does not face problems with unmet demand or availability of air services, as is the case with Congonhas Airport; the other airport is located in a remote region, with difficult access by all modalities but air transportation, as is the case with the Rio Branco Airport. Besides that, only airline carriers X and Y operate to meet the needs of both airports. The value of the Region's Importance Factor in the remote area, such as Rio Branco, was established at 20, while the Importance Factor for the well served region was established at 1, as shown in Table 3. The higher the importance factor, the heavier weight is attributed to operations in that region, which may be the result of an incentive policy for service provision in a region that needs to become further developed.

Table 3: ICR Measurement by Specific Carriers and Airports (on 09/05/2009).

Airline carrier	Importance		Operations			ICR		
	Rio Branco	Congo-nhas	Rio Branco	Congo-nhas	Total	Rio Branco	Congo-nhas	Average
Y	20	1	2	179	821	4.87%	19.89%	12.38%
X	20	1	5	178	900	11.11%	19.78%	15.44%

Based on that hypothesis, analysis of existing operations by both airlines carriers shows that Y has 2 operations to the remote area, while X has 5, according to Table 3. In the airport of Congonhas, operations are equivalent. For that reason, the ICR of airline carrier X is higher than that of airline carrier Y, as airline carrier X offers more operations to the remote area and an equivalent number of operations to the well served airport.

7. CONCLUSIONS AND RECOMMENDATIONS

Considering the scope of information related to air operations authorized by the Regulatory Agency, this study concludes that the hypothesis defined by the author, i.e., that a set of indicators based on the sector's strategy allows for evaluation of air operation authorizations provided by the regulatory agent, has been proven.

This hypothesis has been proven through practical application of selected proposed indicators. Evaluations of IPA and IRA over a trial in the Brasilia Airport have already provided input to the CTA in the sense that analysis of new authorizations will be required, as the airport does not provide adequate air services and reports a higher delay rate than the average rate in remaining Brazilian airports.

Concentration of operations in some airports goes against PNAC directives, which stimulate competition among operators. This study also identified airlines carriers with greater recurrence of services as compared to others, which suggests different treatment on the part of the CTA, considering that one of PNAC's objectives is to expand the offer of services to users. Furthermore, it is part of the regulatory agent's mandate to stimulate service provision in remote areas where air transportation is sometimes the only possible means of conveyance.

Attributing greater weight to this type of operation may be helpful to the CTA when deciding whether to authorize an operation that is being claimed by several airline carriers, particularly in the case of operations for which scarce infrastructure is made available.

Another point worth citing after practical application is that it has been demonstrated that the selected indicators allow for evaluation of the end results of this public policy. Using indicators as a planning tool makes it possible to diagnose the current situation and the corrections needed to achieve the planned condition. For the CTA, indicator measurements provide a basis to verify the correct application of actions that target execution of the scope proposed by the Planning Agent. From the Planning Agent's point of view, these indicators allow for assessment of compliance with the policy. For that reason, analysis of end results by means of the proposed indicators serves the purposes of ANAC (CTA), SAC (Planning Agent).

As a recommendation, it would be fundamental to complement this academic work by involving other civil aviation agents. It is worth highlighting that the set of indicators should provide a logical framework not only for evaluation of air operations, but of all agents who are responsible for service provision.

Definition of a set of indicators is only the first phase of a huge task. The next step would be to verify appropriate standards for each indicator, thus composing a set of indicators capable of representing adequate air service execution based not only on policy, but on the sector's planning as a whole. As such, in addition to involvement of planning agents, it would be important to conduct broad discussions not only about what adequate air services mean, but also about the type of air transportation that is desired by Brazil, based on the vision of policy makers, regulatory agents, air line carriers, airport authority and transportation users.

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