

COMPETITIVITY, STRATEGY AND VALUE ON AIRPORTS

A Method of Diagnosis, Suggestions and Actions for International Airports with a Case Study of CNF

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Abstract

Airport and aviation industry segment analysis require a holistic approach, observing practical aspects, as well as technological and historical ones. Having a literature review and secondary data as basis, this work presents an introduction to help contextualize the development of this segment throughout the decades. Some fundamental aspects are presented, not only technological but also sociological in nature, building a foundation for future research to study the segment with a broaden understanding, more adequate to this industry that shows accelerated growth and strongly represents modern society. A set of factors that exert influence on the competitiveness of international airports are identified in tables that classify macroenvironmental, sectorial and corporation factors, as well as their influence on airport competitiveness, observed through the analysis of CNF airport perspectives and performance, also showing need for a structured, coordinated and strategical approach, involving local public institutions, airport concessionaries and private economy agents, focusing on items of regional relevance that demand high speed, high value to weight and targeted at distant markets that offer potential for both imports and exports. As a result, some international airport influential competitive factors are identified and presented, as the more representative items for the successful strategy of certain airports, evidencing the commercial aviation and airport industrial characteristics as structures for processing passengers to/from aircraft.

Keywords: Competitivity; Strategy; Airports; Infrastructure; Air Transport

1. General Introduction

When looking at walls and gates of ancient civilizations in the likes of the Ishtar gate, an analogy can be traced to contemporary societies, in which the modern synthesis of the same aspects is represented by the airports, where a mix of innovation and social interaction set the building blocks of this infrastructure. Airports are the gateways of nations for commerce, tourism, politics, military, and it is likely that they will be among the hallmarks of present culture, standing for its aspects of internationalization and technological innovation.

According to ICAO's World Air Transport 2018 Report [1] (International Civil Aviation Organization), commercial aviation attended to 4,3 billion passengers (6.4% growth), in 37.8 million takeoffs (3.5% growth) and with a profit growth of circa 7.1%. During the same period, average world's GDP experienced a growth of 3.7% in accordance with IMF's 2018 World Economic Outlook [2] (International Monetary Fund).

Considering a continuous aviation evolution, that will likely grow, as long as modern society evolve, one question poses itself: what would be the adequate strategies for investing in the much necessary infrastructure for the segment?

1.1 Research Question

The current study, therefore, intends to tackle the following question:

“Which is the set of factors that exert influence on the competitiveness of international airports?”

The question is stated and evaluated considering a context of competitiveness defined by the management classic and contemporary studies and applied to the airport infrastructure sector.

The resulting approach is then applied to a practical example, a case study for one Brazilian airport: Belo Horizonte International Airport – CNF, which is a fair representation of a mid-sized international airport, on its way to evolve and succeed in this a dynamic, constant evolving and competitive aeronautical segment.

1.2 Overall Objective of this Study

Identify factors that positively and negatively influence the competitiveness of international airports, and verify them for the case of CNF, measuring them through their value generation.

1.3 Specific Objectives of this Study

The specific objectives chosen for this study are:

- **Identify the macroenvironment’s influence** factors
- **Identify the sector’s influence** factors
- **Identify the corporate’s influence** factors
- **Apply the method to CNF**
- **Compare the performance** of CNF to some benchmarks

It is expected that some factors will be developed or potentially present, even when dormant, at the given airport, while some other factors will always be absent due to the specific scenario. The quest is then, chase the first set, which represents a better use of resources, while avoiding the second set, which represents a waste of time and effort.

1.4 Airport Segment Overview

Gordon [3] emphasizes that, throughout the decades, it’s apparent that commercial aviation and airports have become industrial structures for processing passengers to and from the aircraft, and to better achieve this, certain strategic items stand out and are present in notable successful airports:

- Geographic positioning in relation to demand, urban areas of high GNP/GDP and intense commercial activity
- Average optimal fuel-efficient range of aircraft in current technology and other airports and urban areas within this optimal radius
- Infrastructure support such as:
 - Adequate ATC and Nav aids
 - Wide, functional, and scalable terminals
 - Runways with adequate length and pavement
 - Optimal “in-terminal” PAX dislocation, considering distance and time
 - Precise and productive security check devices to process PAX
 - Quick, efficient, and preferably automated system for managing cargo and luggage
 - Efficient and inobtrusive refueling systems
 - Diverse and integrated ground transportation modals
 - Overall scalability and adaptability

When presenting some well succeeded international airports, Kasarda & Lindsay [4] show some

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common aspects, that can be viewed as minimal conditions for a successful strategy in airport infrastructure segment. Some other factors are more peculiar and often originated from historical, geopolitical, social, or even random conditions. Finally, airports don't work alone, and there are network factors, in accordance with the way one airport connect and compete with the others within its influence reach.

All these factors will define the adequate sizing for infrastructure and investment level for a given airport, and a methodology that provides a rational systemic approach for these definitions is a valid support for the segment.

2. Methodology

The study was executed in a basic theory assessment following two distinct cycles, one with preliminary approach and the other stating the results.

At first the conceptual basis was placed to define, in accordance with management theory, and using bibliographical survey, definitions for competitiveness, competitive strategy and value generation. The first cycle executes a literature and secondary data revision, defining the criteria for benchmarking and stating the applicable theory and conceptual approach segmentation for the airport industry, choosing the relevant factors as well as the representative airports to be compared. As an additional result, a set of structured questions is elaborated to be presented to decision makers in both, government, and corporate sectors, in order to validate the final diagnostics. The second and final cycle traces a parallel analysis of the chosen airports and the CNF case study according to the defined criteria, meanwhile collects the answers to the set of structured questions, and through categorial analysis and synthesis and together with the comparative approach, will elaborate the diagnostics, conclusions, and prescriptions to the given airport, in this case CNF.

3. Management Theory Basis

The theory support for definition and segmentation concepts according to management theory were chosen among studies of competitiveness, internal organizational resources according to Penrose [5], microeconomics of Jensen [6], internationalization and macroeconomics of Chudnovsky [7], sustainable market positioning and growth competitive strategies as in Ferraz, Kupfer and Haguenaer [8]. The synthesis of these basic concepts is taken from the works of Porter [9][10][11], Rumelt [12][13], Wernefelt [14], Shapiro [15], Prahalad and Hamel [16][17], Barney [18][19][20][21], Teece [22], as well as Teece, Pisano e Shuen [23][24] and Paiva [25].

As a result of this analysis, it's observed that competition strategy is based on influential forces of a certain industry sector and develops itself through identification and improvement of the competencies pertinent to this strategy, not only in current scenarios but also in future ones. This set of competencies establish the foundation for a favorable positioning of a company when facing a market and its competition.

3.1 Competitiveness Definition Applied

A relationship between financial performance and competitiveness, as well as a quantitative measurement for value generation can be built, based on the knowledge of value Generation according to Ferraz, Kupfer & Haguenaer [8] as well as on the synthesis proposed by Paiva [25], but the last also relates the competitive strategy with its macro and sectorial environment aspects, hence being adequate to support this study.

Therefore, the construction of a model of competitiveness and other fundamental concepts, proposed by Paiva [25] in his synthesis of a series of classical definitions, mostly from models such as: Barney's RBV (Resource Based View) [18][19][20][21], Porter's five competitive forces and Porter's diamond [9][10][11], and Scherer's SCP (Structure, Conduction and Performance – originally: ECD – Estrutura Conduta e Desempenho) [26]. Paiva presents in his – Competitiveness, Strategy and Value a model that is adequate to back this study up on its definition of competitiveness as:

(...) “the ability of a firm to formulate and implement competitive strategies that allow it to sustain or improve its generation of value, when facing the existing macroenvironment, industry sector, restrictions and internal capacities.” [25]

3.2 Competitiveness Strategy and Value

Starting from this definition, a three-dimension focus can be built, setting a tool for evaluating the company’s potential to compete. These dimensions are:

- (i) **Competitiveness;** (ii) **Competitive Strategy;** (iii) **Generation of Value;**

These dimensions interact with each other bidirectionally and move the goals toward the company’s performance. This process will take place in four different spaces, or realms if preferred, and the interaction occurs in between the adjacent spaces, concurring to the results in performance. These spaces are the macroenvironment, sector, firm, and performance, and Figure 1 illustrates this relationship.

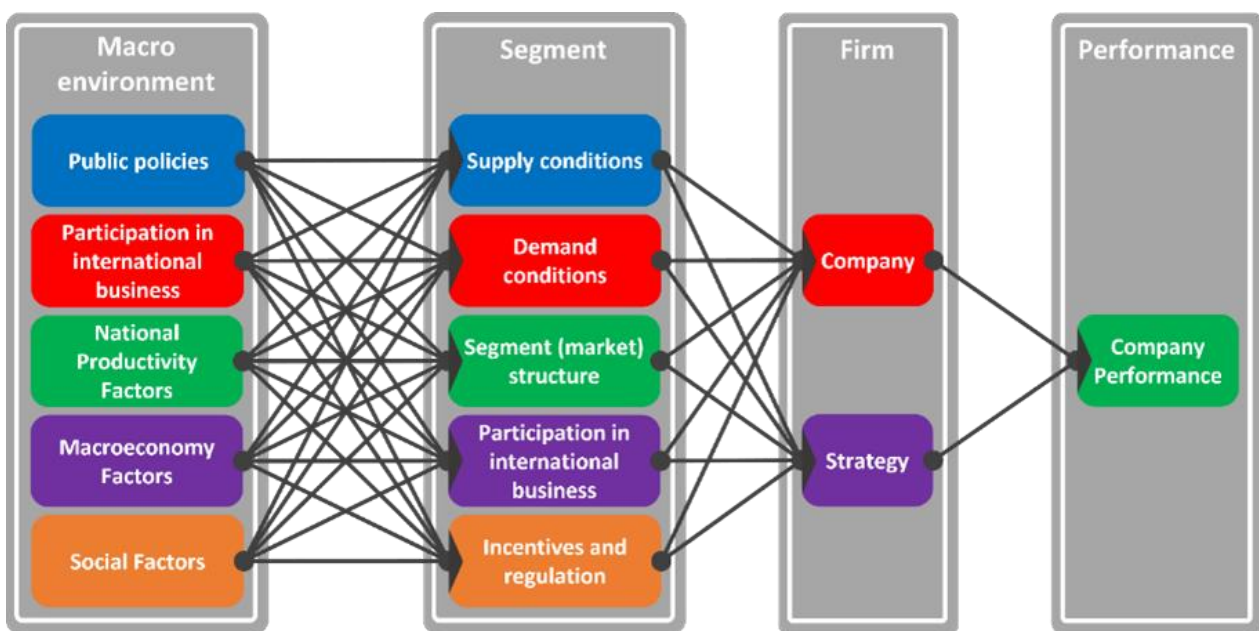


Figure 1 - Influence of diverse competitiveness dimensions on model

For the current study, the macroenvironment includes factors related to the airport metropolitan area, state or province and country, with all geopolitical, economical, and sociological implications, to cite a few. The sector is defined by airport infrastructure and aeronautical factors, such as technological development, specific applicable regulation, marketing structures, demand needs, and so on. The firm space shows specific conditions of the evaluated airports, for example, in the case study, CNF. Its strengths, opportunities, weaknesses and threats, the chosen strategies, current and desired internal processes, among others. Finally, some metrics can be chosen to evaluate the firm options and the other spaces to validate or change ongoing strategies, aiming to maximize competitiveness and value generation.

Paiva’s paradigm focus is bringing to evidence the competencies that actually generate value and sustainable competitive advantages, identified in the macroenvironment, sector and firm scenarios [25]. This is the reason why it’s adequate to back this study up.

4. Theory Basis Applied to Airports

The subsequent tables present application of the competitiveness, strategy and value approach to the airport analysis, segmenting it into macroenvironment, sector, firm, and value generation spaces. The example presented is for the case study of CNF. Additionally, the analysis is also the basis for the semi-structured questions evaluation. Table 1 brings the Macro environmental issues.

Table 1 – Macro Environment Variables – CNF study case and semi-structured questions

Macro environment Variables		Belo Horizonte International Airport – Confins – CNF	
		CNF	Semi-structured questions
Location	Weather	mild	
	Distance from other metropolitan areas Short routes: 300 a 1,000 Mid routes: 1,000 a 2,500 Long routes: 2,500 a 5,500 [Km]	<p>South American relative isolation is perceived when we access the range from CNF, specially when GDP is considered.</p> <p>Short routes: Brazilian cities with relevant GDP and political influence are within reach. Through South/Southeast, there are Rio de Janeiro, São Paulo, Curitiba and even Florianópolis; Going west there are Brasília, Goiânia, up to Campo Grande; in Northeast direction, there is Salvador.</p> <p>Mid routes: Arcs up to 2,500 Km reach all Northeast, Southeast, South and Midwest Brazilian regions. Northward Belém and Manaus are within reach. International destinations in this range are La Paz, Assunción, Buenos Aires and Mondevidéu.</p> <p>Long routes: Ranges up to 5,500 Km access all South America and Central America up to Panama City and San José de Costa Rica. The Caribbean is within reach including Aruba, Santo Domingo, Puerto Principe, San Juan de Puerto Rico, Punta Cana and Kingston in Jamaica. Going Northwest the limit is Galapagos islands and towards south, even the northernmost part of Antarctica can be reached.</p>	
	Natural Resources	Iron, gold, precious and semi-precious gems and diverse mineral resources. Water and hydraulic energy is abundant. Fertile soil, high insolation, and weather that's good for agriculture. Biodiversity is also rich.	

Public Policies	Ownership and Management	Brazilian Federal Government grants rights to a Private Concessionary - BH Airport SA Part of group CCR - Companhia de Concessões Rodoviárias Camargo Corrêa/Andrade Gutierrez/Soares Penido.	<p>(b1). What are the main points of progress brought after the granting of rights of CNF for BH Airport Concessionary?</p> <p>(b2). Was there any setback?</p> <p>(b3). What are the strategies implemented to raise private resources for the so-called “industrial airport”?</p> <p>(b4). What are the requirements for companies?</p> <p>(b5). What is the counterpart offered by the state? (b6). Is there any coordinated effort between the public and private sectors to provide the specialized education needed by the airport?</p> <p>(b7). Are there any specific activities promoted or supported, aiming optimal integration with CNF?</p>
	Public Incentives to infrastructure	Intensive right before and in the years following the granting process to the concessionary, due to infrastructure modernization government efforts for FIFA 2014 World’s Cup and Rio 2016 Olympics.	
	Private Resources Incentives and Policies	Not part of the study.	
	Incentives to specialized Education	A coordinated effort is needed, between public and private sector, especially airport and aeronautical companies to develop specialized labor in both technical and higher level.	
Country and International Business	Exports (Billion USD)	Agriculture (89,9) Petro-Chemical (38,9), Steel (36,2), Machinery (12,5), Automotive (9,2), Gems (4,2), Aeronautical (3,7), Electronics (3,4)	<p>(c1). Which export and import sectors can be leveraged from a more efficient international airport?</p> <p>(c2). Is national participation in international trade blocks considered satisfactory for Minas Gerais’ state business?</p> <p>(c3). Can tourism development be intensified? Under what categories? (medical, educational, sports, business or leisure)</p>
	Imports (Billion USD)	Petro-Chemical (47,7), Machinery (21,3), Electronics (22,1), Medical-Pharmaco (12,6), Automotive (12,2), Fertilizers (9,1), Naval (4,5)	
	National commerce Trading blocs	Mercosul	
	Tourism business, leisure, sports, medical educational	Business	
National Production Factors	Transport modal integration	Partial integration via roads	<p>(d1). What is the strategy for integrating diverse transport modes at Confins airport - CNF?</p> <p>(d2). How is electricity supply structured for CNF área? How are future expansions planned?</p> <p>(d3). Is there a plan for specialized labor training to attend airport activities?</p> <p>(d4). Are there lines of credit or specific tax incentives for sectors related to the airport?</p>
	Energy availability and matrix	Available within a small margin, unable to attend a large intensification of demand. Hydroelectric matrix with thermoelectricity backup.	
	Labor cost, availability and specialization	Little availability of specialized labor (insufficient degree of specialization). Unqualified labor is plenty and at low cost.	
	Capital	Financial resources are poorly available, hard to access and	

	cost, access and availability	interest rates are very high yielding a high capital cost.	
Macro economy Factors	Population metropolitan area	5.96 Million inhabitants	<p>(e1). Which regional businesses have better chance of benefiting from an airport structure?</p> <p>(e2). How is the integrated development between these businesses, the state and the airport concessionary planned?</p> <p>(e3). How are the free trade zones in CNF structured and operated?</p>
	GDP metropolitan area	35.8 Billion USD	
	Population Country	208.5 Million inhabitants	
	GDP Country	1,738.0 Billion USD	
	Regional Business	Mining, agriculture, automotive industry.	
	Special Trading Free Zones, free commerce and economy	Free commerce, market economy and facilitated customs (industrial airport)	
Social Factors	<p>Critical Integration Aspects</p> <p>For connecting the airport to local and regional communities and the country</p>	<p>Positive Aspects: Job offerings to locals, migrants and immigrants, with integrated education opportunities; Electricity availability is more robust due to airport demand; Good accessibility and options of transportation; Possibility to expand local and regional business to wealthier markets, even to international ones.</p> <p>Negative Aspects: Intense influx of people; environmental issues, air and noise pollution; Congestion at peak hours; Airport needs to occupy large land area and with restrict access to any place that impacts airport security and safety.</p>	<p>(f1). How are specialized airport jobs promoted to the Community? Has manpower been locally trained, or does it come from abroad?</p> <p>(f2). How is the integrated development of the airport and its neighboring cities planned in terms of integrated transport routes?</p> <p>(f3). How is the integrated development of the airport and its neighboring cities planned in terms of electricity supply?</p> <p>(f4). How is the negative impact of airport activities minimized on issues of access, environment and noise?</p>

Table 2 brings the Sector issues, again applying them to the International Airport of Belo Horizonte (Confins) – CNF and the semi structured questions resulting from this analysis.

Table 2 – Airport Segment Variables – CNF study case and semi-structured questions

Airport Segment Variables		Belo Horizonte International Airport – Confins – CNF	
		CNF	Semi-structured questions
Supply Conditions	Congestion Levels runway/terminal	Acceptable in current demand	<p>(g1). Are the current and planned runways for the CNF airport considered short for use in a scenario of intensification of international routes?</p> <p>(g2). What are the main CNF Terminal limitations in terms of amount of PAX/year processed at the airport?</p> <p>(g3). What are the main CNF Terminal limitations in terms of cargo</p>
	Aircraft type	Wide body and narrow body	
	Runways	1 Runway (second planned): 16/34 3.600 m asphalt second 2.500 m asphalt	
	Terminals	2 terminals for PAX 1 terminal for Cargo	

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	Cargo Docks trucks/trains	Docks for trucks only	<p>volume Ton/year processed at the airport?</p> <p>(g4). How can the airport intensify the volume of refrigerated products (cool chain) transported?</p> <p>(g5). What improvements could be made to terminal's customs clearance and security check sectors to handle a greater passenger flow?</p> <p>(g6). What are the strategies applied to Catering and support GSEs for aircraft transit in order to expedite operations and increase the volume of service for CNF in movements/year?</p> <p>(g7). What are the strategies and limitations for optimizing the use of parking lots and retail stores associated with the airport?</p>
	Cool chain	Present (occasional demand)	
	Customs	Present (intensive demand and agile flow)	
	Hangars	Adequate	
	Fuel	Adequate	
	GSEs	Adequate	
	Security	Adequate	
	Catering	Adequate	
	Comércio logista	Adequate (with low demand)	
	Parking Lots	Adequate (with low demand)	
Demand Conditions	PAX Type tourism/business	Tourists and business	<p>(h1). Which type of passenger/cargo generates better revenue to the airport?</p> <p>(h2). What type of aircraft and routes generates better revenue to the airport?</p> <p>(h3). How could an integrated strategy among state/city governments, and airport concessionary be implemented to expand the scope of customers, i.e., passenger profile and type of cargo for CNF?</p> <p>(h4). Is there any strategy for attracting airlines to operate and establish hubs or bases at the airport?</p>
	Cargo Type Cool chain, parcel, electronics	Regular cargo, autoparts, electronic components (industrial airport) and fruits (cool chain)	
	Flight Type Domestic/inter national	predominantly domestic	
	Type of traffic origin-destination or connection	Both types origin-destination and connection are equally present	
	Predominant operation types General Aviation: private; executive; corporate; Commercial Aviation: cargo; long haul; or regional	comercial and regional domestic narrow body	
	Linhas aéreas dominantes	Gol Airlines Azul Airlines	
	Hub or line end	Hub	

Finally, Table 3 brings the Firm and Value issues. The metrics for performance are simply the amount of PAX per year and tonnage per year processed by the airport, as well as the number of movements a year.

Table 3 – Corporate & Performance Factors – CNF study case & semi-structured questions

Corporate Variables (Airports)		Belo Horizonte International Airport – Confins – CNF	
		CNF	Semi-structured questions
Corporate Factors	Critical factors for success	Attract and establish routes based from/to CNF or with connection in it. Consolidation of economic sectors that rely on aero transport for their business model. Intensification of tourism flow. Increase on cargo flow through CNF Metropolitan and state GDP Growth.	<p>(i1). What are the greatest difficulties for the airport’s operations expansion, in scopes of regional and international flights as well as cargo and passengers?</p> <p>(i2). What are the greatest difficulties/bottlenecks for the expansion of operations at the airport, considering the current infrastructure?</p> <p>Ex. Expansion of:</p> <ul style="list-style-type: none"> • NavAids; • Runways; • Aprons; • terminals; • boarding gates; • parking lots; • road access; • modal integration; • electricity; • fuel offering; • security areas; • custom clearance <p>(i3). Which new technologies generate adaptation impacts/difficulties on airport infrastructure, both in general terms for CNF?</p> <p>Ex.:</p> <ul style="list-style-type: none"> • NavAids; • automation; • ultra-long-haul flights; • More Electric Airplanes - MEA; • Hybrid electric airplanes • biofuels; • Supersonic aircraft; • High altitude flights; • Autonomous aircraft; • Low carbon footprint and low noise; <p>(i4). What strategies have been adopted to prepare for the airport's growth in future decades?</p>
	Weaknesses	Feasibility and cost of expansions. Geographic isolation limits optimal access to regions with higher GDP.	
	Points in need of research and development	All airports will have to adapt to new aeronautical technologies, among which the following can be highlighted: - Greater optimal range of aircraft due to the use of: more automation; Better aerodynamics; lighter structures; More efficient engines; - Trend towards Point-to-Point models for: ultra-long-range aircraft capable of connecting any point on the globe; and more electric, smaller aircraft for longer flights within the optimum range; - Biofuels, which are little less efficient in terms of performance, requiring longer runways and closer destinations; - More demanding noise requirements; - Hybrid aircraft, combining combustion/electric, generally a heavier aircraft, suitable for shorter range routes and will require: longer runways; optimized and controlled descent paths for energy reuse, specific airways and ground infrastructure for recharging batteries during transit; - “Zero carbon emission on ground operation” policies demand electric tow vehicles infrastructure for ground taxi as	

		<p>well as airport ground control adaptation.</p> <ul style="list-style-type: none"> - “Supersonic aircraft comeback” for specific demands. They are smaller aircraft in size, but optimized for cruising at higher speeds, requiring longer runways for takeoffs; specific corridors for acceleration and climb; - Autonomous aircraft, especially for cargo transport, which will require ground infrastructure for remote operation and precision approach and landing systems; 	
	<p>Functions with greatest impact on objectives</p>	<p>Expanded and optimized cargo terminal structure and modal integration. Consolidation of free economy zone and support and facilitation of customs activities. Information on promotion and strategic intentions.</p>	
	<p>Greater potential to generate differentiation</p>	<p>Preparation, in the next two decades, to receive autonomous cargo flights and ultra-long-range flights and electrical infrastructure for hybrid aircraft.</p>	
Performance	<p>Passengers boarded per year</p>	<p>15,2 MPAX/year</p>	<p>(j1). What is the expectancy for airport's passenger and cargo flow and aircraft movements yearly for the next decade? (j2). What are the ongoing strategies to allow reaching these goals? (j3). What are the main metrics used to assess service quality and customer satisfaction? (j4). What are the strategies and objectives for these metrics' evolution?</p>
	<p>Cargo Volume transported per year</p>	<p>0,41 Mt/year</p>	
	<p>Movements TakeOff/Landings serviced per year</p>	<p>102 Mil Movements/year</p>	
	<p>Quality of services</p>	<p>Not Studied</p>	
	<p>Clients satisfaction</p>		

Likewise, application is for the International Airport of Belo Horizonte (Confins) – CNF and the semi-structured questions resulting from this analysis.

5. Formulated Structured Questions

The questions (a1) to (j4) were then used as a basis to elaborate two questionnaires, one applied to individuals that are decision makers of the government sector, and the other applied to individuals that are decision makers of the corporate sector. The questionnaires have just seven questions each. The questions then, group a subset of the concepts listed from (a1) to (j4). Additionally, it shall be noted that some questions are common to both, government, and corporate scenarios. Table 4 summarizes the questionnaires.

Table 4 – Questionnaires applied to government servers and corporate workers

Questions			ref.
1	Govt.	Which would be the possible strategies to expand the national and international influence for CNF? Which would be the main destinations and why?	(a3). (a4). (a5). (a6). (g1). (g2). (g3). (g5). (g6). (g7).
	Corp.		
2	Govt.	What are the advantages and disadvantages brought by privatization and concession policies for administering and exploring CNF?	(b1). (b2).
3	Govt.	What are the strategies implemented to attract private capital to the so called “industrial airport”?	(b3). (b4). (b5). (b7).
2	Corp.		(d4).
3	Corp.	In your opinion, which technological advances expected for the next decade will pose bigger challenges in terms of airport infrastructure adaptation, in general as well as for CNF airport?	(a1). (a2). (a6). (f4). (i3).
4	Govt.	Which local business have best chances to take benefit from the airport infrastructure and presence and why?	(c1). (c2). (c3). (e1). (e2). (e3).
5	Govt.	What are the main points of attention when providing the necessary exploration foundation and infrastructure for a large and complex airport?	(d1). (d2). (f2). (f3). (f4).
6	Govt.	Is there any coordinated effort between private and public sectors to provide specialized education needed for specific airport labor?	(b6). (d3).
4	Corp.		(f1).
5	Corp.	How would an integrated strategy between government and airport administration could be implemented to broaden the air routes and reach more diverse passenger profiles and cargo types for CNF airport?	(g4). (h1). (h2). (h3). (h4).
6	Corp.	In your opinion, what are the greatest challenges and bottlenecks for the expansion of CNF international airport operations?	(i1). (i2).
7	Govt.	Which, in your opinion, should be the government/corporate strategies adopted to support and structure the airport growth for the next decades?	(i4).
	Corp.		(i4). (j1). (j2). (j3). (j4).

The structured questionnaires were answered by corporate executives and politicians, all decision makers with empowerment to steer the strategies for both Belo Horizonte International Airport – CNF and the State of Minas Gerais. The respondents’ positions, jobs and public office records are

COMPETITIVITY, STRATEGY AND VALUE ON AIRPORTS - Diagnosis, Suggestions, Actions & CNF Case Study presented in Table 5. The names were preserved for privacy assurance. The answers were analyzed according to Bardin's methodology [27].

Table 5 – Questionnaire Respondent profile

Subjects that answered the questionnaire	Sector	Code	Subject's Current and/or prior job or function relevant to research	Date, time and means of responding
Respondent 1	Government	R1-G	Minas Gerais State Governor, Senator for Minas Gerais, Minas Gerais State Secretary for Planning and Management	October/06/2021 20:55 e-mail
Respondent 2	Government	R2-G	Minas Gerais State Secretary for Economy Development, Subsecretary for Economic Development, Subsecretary for Strategic Development and Public Private Partnership – PPP, Director of Planning and Strategic Investment for Brazilian Planning Ministry	October/20/2021 16:20 Mobile (WhatsApp)
Respondent 3	Government	R3-G	Vice-director of the Department of Public Construction (Departamento de Obras Públicas do Estado de Minas Gerais DEOP-MG)	October/19/2021 22:35 e-mail
Respondent 4	Government	R4-G	Minas Gerais State Governor, Senator for Minas Gerais, Federal Congressman for Minas Gerais Belo Horizonte Municipal Mayor	October/20/2021 11:36 Mobile (WhatsApp)
Respondent 5	Government	R5-G	Minas Gerais State Secretary for Economy Development	November/09/2021 12:40 Mobile (WhatsApp)
Respondent 1	Corporate	R1-C	Director for Infrastructure and President of BH Airport, CCR's Director of New Business, Telecom's Director for Governmental Relations in Brazil, Consultant for Public Private Partnership – PPP and Concessions for Infrastructure.	October/26/2021 10:39 e-mail
Respondent 2	Corporate	R2-C	Executive Director from AVNORTE – Associação de Desenvolvedores do Vetor Norte (Association for Belo Horizonte North Area Sector Development)	October/22/2021 19:02 e-mail

When analyzed as a whole, the set of answers shows a tendency to group the approaches in four distinct subsets, that can be perceived with a metric analysis of the speech. For this method application, IRaMuTeq 0.7 alpha 2/R-3.5.1 software was used, making it possible to access the intensity and focus given to each set of speech subjects.

- **1st Subset:** with circa 25% of the answer focus, it refers to industrial and productive themes, such as regional industry, natural resources, labor, production factors and even customs. Emphasis leans slightly towards corporate segment, though public sector is also often quoted.
- **2nd Subset:** concentrates 29% of the emphasis of the answers, and relates to airport geographical positioning, airline exploration and competition with other airports, as well as access to internal and external markets.
- **3rd Subset:** it's the most frequent class of responses, with more than 30% of occurrences, presenting the aspects tied to the primary users, being PAX and cargo. It relates to modal integration aspects, access roads, terminals, movements, and the airport surroundings as well as some usage bottlenecks.
- **4th Subset:** with a mere 16% of presence among the answers, this is exactly the subset that describes the strategic actions, with structural aspects and stating the necessary symbiotic relation of the public and private sectors, as well as the concessionary issues, logistics, goals, and perspectives. Some fiscal concerns also show, but always with a long-term goal structuring in mind.

When considering that the responders are high level decision makers such as governors, state secretaries and airport president directors, it is surprising that so many operational and short-term concerns are present, in a mostly reactive approach instead of a more fundamental long term strategic line of thought, that could result in a more coordinated effort for the airport optimized and rational growth.

This metric and the questionnaire response analysis corroborates the secondary data diagnostics and shows room for an optimization on the exploring models for CNF airport and the area that surrounds it, although that demands a coordination of public, private and third sectors, that shall be guided by the government and would leverage not only the airport, but all regional production development

6. Airport Potential Estimation

A viable way to estimate the potential of an airport is to plot a Least Squares Regression Line, relating the GDP or GNP of the airport's metropolitan area with the PAX/year for passengers or Tonnage/Year for cargo, resulting in some metrics for value expectancy of a given airport.

Pre-pandemics (COVID-19) secondary data were used, based on the following compilation: ACI [28], ANAC [29], IATA [30], IBGE [31][32], ICAO [1], ITA [33], ITC [34], OCDE – OECD [35]. Table 6 presents the chosen airports and data used for plotting the regression lines.

Table 6 – Relation between metropolitan area GDP and passenger and cargo flow

City	Airport (IATA)	Index (i)	GDP per capita [USD/inhab]	Passenger anual influx [PAX/ano]	Cargo anual influx [Ton/ano]
Los Angeles	LAX	1	65.368	84.557.968	2.158.324
Washington	IAD	2	106.789	24.817.677	273.385
Memphis	MEM	-	56.644	4.644.490	4.336.752
Amsterdam	AMS	3	72.567	68.515.425	1.778.382
London	LHR	4	68.496	78.014.598	1.794.276
Dubai	DXB	5	30.823	88.242.099	2.654.494

Bangkok	BKK	6	8.739	46.049.914	1.260.330
Seoul	ICN	7	43.909	62.157.834	2.921.691
Belo Horizonte	CNF	8	6.003	15.164.077	410.000

Memphis airport (MEM) was taken out of the analysis as an outlier, due to its very peculiar operation, with large cargo influx related to FedEx flights. For the remaining airports, a 2nd order Least Squares Polynomial Regression was executed as described in Boyd & Vandenberghe [36]. Two trendlines were plot, one for cargo operations and the other for PAX operations, both as a function of the airport's metropolitan aera GDP.

The equations used for the calculation and plot of the 2nd order polynomial curves (quadratic regressions), are presented in equation (1) as follows:

$$y_i = \beta_2 X_i^2 + \beta_1 X_i + \beta_0 + \varepsilon_i \quad (1)$$

where: X_i : metropolitan GDP per capita

y_i : airport's annual influx

$(\beta_0, \beta_1, \beta_2)$: parameters to be determined

ε_i : errors to be minimized

For each airport, "i" varying from 1 to 8 for the case study

Taking matrix notation, for the set of data presented (and excluding MEM) results in forms (2) & (3):

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \\ y_7 \\ y_8 \end{bmatrix} = \begin{bmatrix} 1 & X_1 & X_1^2 \\ 1 & X_2 & X_2^2 \\ 1 & X_3 & X_3^2 \\ 1 & X_4 & X_4^2 \\ 1 & X_5 & X_5^2 \\ 1 & X_6 & X_6^2 \\ 1 & X_7 & X_7^2 \\ 1 & X_8 & X_8^2 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \\ \varepsilon_7 \\ \varepsilon_8 \end{bmatrix} \quad (2)$$

$$\vec{y} = X \vec{\beta} + \vec{\varepsilon} \quad (3)$$

Considering the best parabolic curve adjusted to the given set of points shall be the one that minimizes the error value, therefore presented in equation (4):

$$\hat{\beta} = \arg \min_{\beta} S(\beta) \quad (4)$$

Where, by the least squares technique, equation (5) is shown as a result:

$$S(\beta) = \|\vec{y} - X \vec{\beta}\|^2 \quad (5)$$

Developing the calculation further, equation (6) presents the following as result:

$$\hat{\beta} = (X^T X)^{-1} X^T \bar{y} \text{ with } R^2 = \frac{\sum_{i=1}^n (\hat{y}_i - \bar{y})^2}{\sum_{i=1}^n (y_i - \bar{y})^2} \quad (6)$$

- where:
- R^2 : correlation coefficient
 - y_i : annual measured airport influx
 - \hat{y}_i : estimated annual influx calculated
 - \bar{y} : average of the errors

For each airport, “i” goes from 1 to n = 8 for the case study

In summary, for the set of data presented in Table 6 (excepting MEM), the plot on **Error! Reference source not found.**, shows the two trendlines: being the first in blue, with left scale, in which there is the estimate tendency for PAX/year as a function of the GDP, while the second, presented in red, with right scale, states the estimate tendency for ton/year also as function of the Metropolitan GDP.

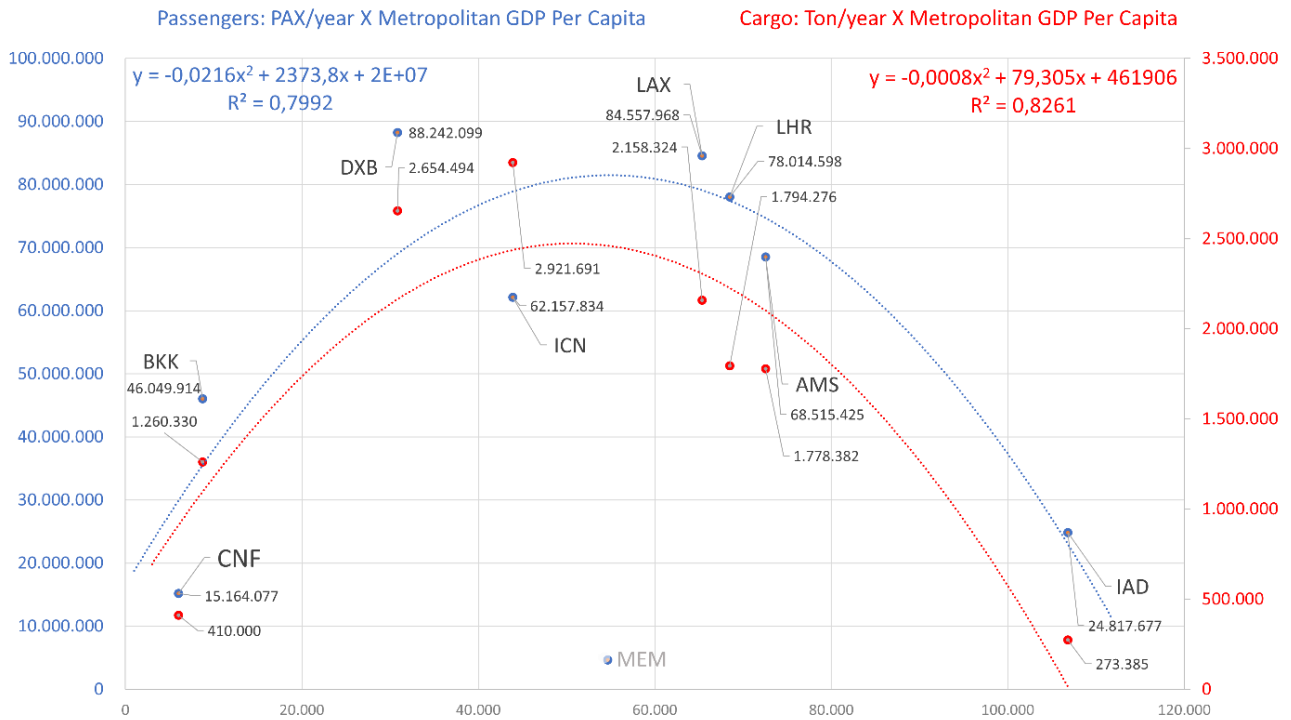


Figure 2 - Graphic of Estimated Relation between GDP Per Capita and Airport Flow

The polynomial second order parabolic relation was chosen since, from qualitative analysis, it can be observed that there is a saturation point in airport capacity for processing PAX and cargo, so the parabola is a viable and simple option for an initial estimate. The correlation coefficients are around 0.8, which indicates a causality relation, though values above 0.9 were desired, if a more quantitative study, considering a more robust set of data were to be carried on. Perhaps this further study should consider not only GDP per capita, but the percentage of GDP from the airport’s metropolitan area in relation to the national GDP, as well as some factoring of the access to wealthier markets and tendency to explore industrial segments more adequate to air transport.

As for the immediate result, CNF seems to be operating below the average expectancy trend curves, indicating a potential for growth, still leveraged by traditional optimization methods.

7. Considerations on CNF Diagnostics & Prognostics

Initial estimates show that CNF could grow up to doubling its usage if efforts are done in a rational and coordinate manner. Some of the development issues are related to the airport's geographical positioning, proximity to other accountable GDP metropolitan areas, reminding that competition among Brazilian regions also exert influence over CNF.

Both aviation and transport new technologies are expected, bringing some groundbreaking advances, in fields such as e-VTOL, biofuels, hybrid propulsion, more electric airplanes, autonomous flights, electric and autonomous cars, and the list goes on. Though some optimism is shown in the questionnaire answers over this topic, the truth is, historically all the technology advances exert pressure instead of alleviating the pressure over airport infrastructure, and the same shall be expected nowadays and in short term future.

A scalable infrastructure and investing in potentially air transported economy segments such as tourism or other activities that demand high speed transport and products with high intrinsic value and low mass (light weight) are attitudes that should be encouraged. Some issues relate to the infrastructure and others are relative to regional economy, government policies or international markets. Herein the most fundamental are presented.

7.1 Infrastructure Items

Starting with infrastructure, some items were considered:

(a). Second Runway: CNF needs a second runway, and provisions for it are already in course, nonetheless the airport, for an optimization point of view, should concentrate in accessing metropolitan areas with greater GDP, which implicates in international long-distance routes that demand longer runways to support heavier airplanes. Additionally, the tendency to have airplanes with longer range, in both, regional flights and long-haul ones, together with better fuel efficiency, that tends to place the optimal fuel range into the 6.500 km in the next years, also demands longer runways. It's worth mentioning that biofuel tendency also makes the aircraft heavier, since it's a cleaner but less energetic type of fuel when compared to fossil ones. Besides, electrical and hybrid aircraft tend to be heavier. All the expectancy tends to longer runways, so the second CNF one should be around 3,500 m to 4,000 m size, instead of the currently planned 2,600 m one.

(b). Electric Energy Availability: considering electrical and hybrid aircraft as well as electric cars, taxis, and buses demand attention to infrastructure planning since these new technologies present high demand for high electrical power and current over airport net. It's important to note that this demand shall be supplied by clean/green energy matrix (low carbon footprint). It is expected that this clean abundant energy shall be provided by photovoltaic and/or biofuel thermoelectric plants, that will be fundamental for next decades airport growth.

(c). Transport Modal Integration: in CNF, focus for access and integration is concentrated on the connection of Belo Horizonte, the main city, and the airport, via one specific road, nicknamed "Linha Verde". It's not a good example of modal integration. Other regions from the state of Minas Gerais that could be served by the airport to ramp their economies up shall be attended to some transport integration, expanding CNF influence radius. Railway integration for distances within the range of 300 Km should be implemented through radial directions from/to the airport. Belo Horizonte metropolitan area should be integrated by subway lines.

(d). Environment issues: airport activities are already studied and controlled in the sense of minimizing their environmental impact. There are concerns over the hydric management as well as several areas of environmental protection and even archeological sites in the neighborhood of the airport. Likewise, bird wildlife activity is a constant concern. But all in all, the environmental regulation is well established and complying with it accordingly will ensure rational and sustainable expansions.

(e). Cool Chain: one of the viable leverages for CNF competitiveness is through strategies related to agroindustry products, such as flowers, fruits, vegetables, and cheese, all already with certain tradition in Minas Gerais state. To intensify this segment via air transport, airport's cool chain shall be modernized and enlarged. It's an investment that can also support chemical, pharmacological, and medical industry activities that may demand air cargo operations and refrigeration.

(f). Security Transport: Minas Gerais state has an almost three centuries old tradition of gold, precious and semi-precious stones exploration. In order to back this segment up, security transport structure shall be ensured. This might require specific access restrictions to certain areas, specially of the cargo terminal. This shall be done without disturbing other terminal sections.

This basic initial diagnostic intends solely to access some attention points that emerged during the study. Some of them are well known by airport concessionary and government, such as the transport modal integration, but improvements are generally impeded by budgetary restrictions and limitations

7.2 Promising Industrial Segments

When analyzing industrial activities within CNF area of influence, one can observe that steel and heavy milling production is not adequate for air transport. Minas Gerais tourism is not part of the world known Brazilian archetypical beaches and rainforest images and the most common business centers: São Paulo, Rio de Janeiro and Brasília, will generally diverge the action from federal government away from Minas Gerais peculiarities, hence, an internal development strategy shall be constructed in order to enable airport growth.

It shall be observed that this strategy shall take into account the fact that air connections serve regional economy in two ways. The first one is taking production out, exporting goods, as well as bringing people in, bringing the tourists. But it must be remembered that importing goods is also a way of doing business, as well as taking people out, transporting local people to be tourists elsewhere. Both public and private segment should coordinate the most viable destinations to expand the airport's area of influence, considering taking the best advantage of these two ways.

In general, an analogy with a tripod can be drawn to identify industrial segments that are "cut out for aero transportation". The "**tripod of potentially aero transportable segments**" is:

- Demand for displacement at high speed or **urgent transportation**;
- High value by transported weight (**high value to weight ratio**);
(a must or "sine qua non", since heavy freight won't justify air transport)
- Geographically **distant targeted market**;
(optimization criteria shall seek markets with potential business "way in and way out")

When analyzing economy segments pertinent to Minas Gerais state, some highlights are:

(a) Mining: steel industry production is not generally aero transportable, due to low value/weight ratio and low demand for speed. The gold and precious/semi-precious stones market could be a possible one, but it would require the final product with some sort of associated design to some sort of regional art to maximize the value/weight ratio. Additionally, this segment doesn't require urgency, thus only two of the three characteristics are found.

(b) Agroindustry: this segment requires a coordinated effort to produce fruits, flowers, vegetables, or dairy taking advantage of the airport infrastructure. For these products to enter in a market with stronger currency and higher buyer capacity they shall have a high-quality appeal, some sort of origin brand or seal to imply quality control and environment responsibility, fetching higher prices to justify the transporting costs. This effort shall be conducted by government policies, that could gather the numbers of small and medium farmers towards a common goal. Nonetheless it represents an opportunity for the whole state, since currently there is a large fruit production at the Jaíba river valley that is already aimed for export, but it is flown through Campinas SP International Airport (VCP), evading part of the income to other state, and increasing logistics' costs. Another barrier is that, in the neighboring areas of CNF, hydric resources must have a very rational use to support these agricultural activities, since these specific cultures demand a lot of water. Grain production shall not have incentives in this area, since they have low value/weight ratio thus not meeting the basic requirement for aero transport freight.

(c) Tourism: in Minas Gerais State, this is not the common Brazilian one, but there are some attractions, currently more popular among national tourism. Advertising campaigns abroad could

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leverage international tourists' interest in natural resources of the state, such as caves, waterfalls, and other potential such as gastronomy and arts and culture. Other opportunities are medical and educational tourism, but again government incentives are fundamental for the initial structuring of these business models since the segments seldom coordinate by themselves specially because it comprises of competing firms.

- (d) Textiles:** fashion industry is one of the standout activities present in Minas Gerais. However, in order to position it as an aero transportable segment, a careful strategy must be placed, since the value/weight ratio must be high, which leads to high design and more expensive fashion. Additionally, urgency is not associated with textiles unless specific scenarios of novelty and some amount of branding is applied. The characteristics are somewhat contradictory and placing this segment on aero transportable is a "risky stretch".
- (e) Electronics:** the first segment that has been established in CNF industrial airport, mostly by taking credit of fiscal and customs benefits given by the government to the companies established inside the industrial airport facilities. There are advantages in facilitated procedures for importing raw materials and stock items as well as easy exporting procedures for the finished products. But it's very government dependent, since the distance targeted market and high value/weight are present, but the demand for speed is only an issue for specific electronics such as updates on trendy products like latest cellular phone models and products alike.
- (f) Aeronautical industry:** aerospace segment may also take advantages from the industrial airport infrastructure, as it can be seen by Amsterdam's Schiphol AMS, and Dubai's DXB. In CNF there is a large MRO (Gol/Aerotech) and IAS, an aeronautical engine maintenance facility. The same customs processes that benefit electronics also apply to aeronautical LRUs and maintenance components, so it's a natural choice.
- (g) Pharmaceutical and Chemical:** This is a segment that takes advantage from cool chain infrastructure, and potentially may develop a symbiotic relationship with the agroindustry, since the same cool chain to export agricultural items can import chemicals and pharmaceutical goods, setting the two-way business. They also comply with the urgency, high value per weight and distant markets, being a promising segment.

Finally, it's important to note that the application of an industrial airport model to CNF, as well as the promotion of economic activities in Minas Gerais state, taking the airport into consideration to leverage segments that are aero transportable will transition the exploration model from Hub to end line destination, since the way of establishing trade for these products is mostly via bilateral agreements. This is a very desirable position for CNF because it reduces interdependence with other airports while minimizing effects of a change in exploration models in aviation, from Hub & Spoke to Point-To-Point.

If the airport is at a node with a consolidated industry and market, with access to adequate GDP metropolitan areas, any of the exploration models will pass through this airport, assuring its competitiveness, continuity, and sustainable growth.

8. Concluding remarks and future works

Belo Horizonte International Airport – Confins – CNF is a successful case and often receives the best evaluation among Brazilian airports. Why, then, shouldn't BH Airport and Minas Gerais state government be satisfied?

According to what this study shows, considering the current GDP per capita of USD 6,000,00 for Belo Horizonte metropolitan area, the expected influx performance for CNF would be of 33.5 MPAX/year of passengers and 0.91 Mton/year of cargo. Hence, the diagnostics shows an operation at 50% of the airport's true potential. This sets the need for implementing strategies to improve competitiveness and a better positioning for CNF in the airport sector. Such strategies should place the airport above this average standard. A good example is Memphis airport, whose symbiotic relationship with FedEx along with the intensification of e-commerce generate a huge demand for air transported cargo, creating a singular successful scenario.

8.1 Study Limitations

This current study has limitations related not with the technical approach, but with resources available for the research. The study's structure and scientific options have broad potential and didn't constitute any sort of restriction to the results.

On the other hand, there are some practical limitations. First one is due to the limited access to the professionals that have potential for being quality respondents to the questionnaires. They shall present a systemic and strategic vision, in order to contribute to building concepts for strategy and competitiveness understanding applied to airport infrastructure sector. Hence, they are figures of prominence in the political and corporate scenario, and besides being of rare occurrence, have very limited availability to take part in such studies, which makes the process of attaining robust samples, a very difficult task.

Finally, UpToDate information on international airport performance consists of specialized and valuable data, therefore being sold by specialized consultant companies. Thus, building a robust sample, consisting of the more representative metric to apply into a comparative analysis to establish competitiveness evaluation, measured by value generation ends up being a costly procedure. The current study was carried on without any specific budget, therefore using secondary free data available from public institutions.

The main research limitations are thus, related to sampling size, respondent to the questionnaires and robust data to establish a comparative analysis with Confins – Belo Horizonte International Airport, nonetheless the methodology is valid and promising.

8.2 Further Study Suggestions

Possible further studies may apply the same method with other airports for which such diagnostics and predictions are useful or needed. Another possibility is the method's application for other industry segments.

Among the airport infrastructure segment, and specifically applying to the case study of CNF, a more quantitative study would complement well the current one. The suggestion would be a more robust modelling and parameters estimation procedure, aiming to equate a relationship of the airport's metropolitan area GDP or GNP with the PAX/year and/or Ton/year metrics considering a larger airport sampling for building the trendlines.

This sample shall, for example, consider the ratio between metropolitan GDP and national GDP, bringing information over the country's airport internal competition. When one considers airports in the likes of ICN, AMS, DXB, BKK and LHR, there is very little national competition and most of their nation's GDP will flow through these airports. If one shall analyze LAX, for instance, this is not the case. This concentration of the GDP does not happen in CNF, since Brazilian GDP flows through several strong metropolitan areas such as Rio de Janeiro, São Paulo/Campinas, and Brasília, just to name a few. Another parameter should be established to correlate the distance from the studied airport to the others, pondered by their metropolitan or national GDP.

As a result, a more robust quantitative modelling, with a trendline of either second or third order regression and a correlation coefficient around 0.95 shall emerge from such a study, conferring a more precise analysis method

8.3 Conclusion

There are several well studied and defined formulae to establish sizing of a large international airport considering an established demand for air travel, and there is an extensive bibliography about it. There is also thorough material over airport evaluation considering the end user point of view, the passenger, and his/her impressions over what an adequate airport should be according to their needs.

Both approaches show a common basis, over which a minimum set of requirements is established for the inner works of the airport. Despite that, comply with minimum requirements is a necessary but not sufficient condition, and a good product shall have its foundation set into deeper concepts.

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This point of view shows the importance of precisely estimate the potential of a region to generate demand for the airport. Additionally, the public, private and third sectors shall articulate and gather themselves to promote the activities adequate and empowered by the airport, generating a symbiotic relationship that propels all the segments. Competitiveness as a multi-factor and interdisciplinary concept shall be brought to light. This is a more complex task therefore less explored one, nonetheless it can generate more profound and sustainable gains.

It's, therefore shown that the set of factors that exert influence on the competitiveness of international airports are identified in tables 1, 2 and 3, that classify macroenvironmental, sectorial and corporation factors. Their influence on airport competitiveness is observed through the analysis of CNF airport perspectives and performance seen in sections 6 and 7, all in all leading to the need for a structured, coordinated and strategical approach, involving public institutions, airport concessionaries and industry, agriculture and commerce agents, that shall focus on items having regional relevance, but also demanding high speed or urgent transportation, high value to weight ratio and targeted at geographically distant markets which also offers potential business for both imports and exports.

This is a preliminary overview of the scenario. Equally as an airport, this current study is just an entrance door, a pathway to a line of thought that raises and calls for further, deeper, more specific studies. An arousing interest in this type of approach is perhaps the most relevant contribution intended by this research.

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