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IDENTIFICATION OF KEY FACTORS OF BRAZILIAN HUB AIRPORTS AND POTENTIAL NEW CANDIDATES

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ABSTRACT

Historically, Brazilian hubs have been concentrated at the airports of São Paulo and Brasília. However, new airlines, concessions to private operators, and investments in infrastructure could decentralize the national air network. This article analyzes the characteristics that explain the selection of certain airports as hubs in Brazil and identifies new candidates. 45 airports were studied, of which 9 were considered hubs based on the destination networks of the country's three main airlines. An exploratory factor analysis revealed a primary component relevant to identifying these hubs and the importance order of the investigated characteristics. Factors related to passenger terminals were most important, followed by airside factors, and lastly, socioeconomic factors of the region. A binary logistic regression confirmed that this component distinguishes hubs from non-hubs with over 90% accuracy. Porto Alegre and Curitiba were identified as potential new hubs, despite challenges related to peripheral location or proximity to existing major hubs.

Keywords: Hub Airports, Key Factors, Brazilian Hubs.

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1. INTRODUCTION

O'Kelly (1998) attributed the emergence of the hub-and-spoke network model to the deregulation of the U.S. airline industry that took place in 1978. This model concentrates airline operations at designated hubs, which distribute flights to spoke airports. This model gained global popularity, and Brazil, as an emerging aviation market, has also been developing its hub-and-spoke networks. Costa et al. (2010) noted that Brazil's civil aviation deregulation in the 1990s mirrored the U.S. experience, leading to the rise of low-cost carriers like GOL and the demise of full-service airlines such as VASP, VARIG, and TransBrasil. This deregulation led to reduced airfares, improved operational efficiency, and increased market competitiveness, which concentrated passenger traffic at major airports such as São Paulo-Congonhas, Guarulhos (CGH and GRU), and Brasília (BSB)—traditional hubs for GOL and LATAM. However, Brazil's major carriers have not fully adopted hub-and-spoke structures similar to those of U.S. carriers like American Airlines in Dallas-Fort Worth, United in Chicago-O'Hare, and Delta in Atlanta. Campinas (VCP) is the closest example in Brazil to the U.S. hub-and-spoke model, primarily serving the airline Azul.

The liberalization of civil aviation in Brazil did not coincide with the modernization of outdated airport infrastructure, which remained under state control until the 2010s. These factors, coupled with Brazil's two worst air disasters (GOL 1907 and TAM 3054), led to an unprecedented crisis in the sector, known as the 'Air Transport Blackout,' which resulted in a record number of flight cancellations and delays. According to Oliveira et al. (2016), airlines sought to reorganize their networks to decentralize operations and alleviate congestion at the busiest airports following this crisis. Since the 2010s, major events such as the 2014 World Cup and 2016 Olympics have prompted the concession of Brazilian airports to global operators. This has created new opportunities for infrastructure investment, potentially fostering the emergence of new airlines and a reorganization of the networks of the three major carriers: GOL, LATAM, and Azul.

Regarding the current state of hub airports in Brazil, three significant studies can be identified. Siqueira (2008) examined the criteria for preparing airports to function as hubs, identifying key factors such as geographical location, airport infrastructure, and airline interest. Constraints such as slot allocation issues, nighttime operation bans, aviation regulations, and maintenance facility shortages may hinder airports from achieving hub status. CGH, GRU, BSB, Rio de Janeiro (GIG), and Belo Horizonte (CNF) showed potential to become aviation hubs. Costa et al. (2010) highlighted the lack of consensus among scholars on the precise definition of hubs, emphasizing them as pivotal points for flight and passenger distribution. A large terminal does not qualify as a hub unless it functions as a flight distribution center. In their survey, over three-quarters of industry experts preferred defining hubs as airports facilitating flight connections rather than solely having substantial infrastructure. The authors also queried experts on which airports currently function as hubs and which ones should play that role. BSB, CGH, and GRU were cited most frequently as current hubs, while BSB, GIG, and GRU were top candidates for future hub status. Manaus (MAO), Recife (REC), CNF, and VCP were also identified as potential hubs, with the latter three becoming Azul hubs later on. Experts suggested CGH should not operate as a hub despite its current role, and GIG was noted for underutilizing its infrastructure suitable for a national hub. Moura (2019), through multicriteria analysis, identified the most suitable airport in Northeast Brazil to become a LATAM hub. Criteria included airside features (runway and taxiway capacity, slot restrictions, maintenance hangar availability), landside attributes (finger-equipped gates, baggage processing areas, terminal size), and support services (airport access, hotel availability, convention centers). REC was identified as the best-prepared airport. In summary, current literature on Brazilian air transport hubs is limited, particularly in differentiating key hub characteristics from non-hubs in the country.

This study fills a crucial gap in research by identifying and analyzing the key factors influencing hub selection in Brazil. It has two primary objectives: first, to uncover the critical determinants that contribute to an airport's potential to become a hub, and second, to evaluate the suitability of existing hubs, pinpointing those that may struggle to maintain their status while also highlighting potential candidates for new hubs.

2. METHODOLOGY

2.1. Data Collection

Data was collected from 45 Brazilian airports, as listed in Table 1. These facilities were selected for analysis based on their handling of over 200,000 passengers nationally, according to data from the Brazilian National Civil Aviation Agency (ANAC) for 2023. The factors obtained from each airport, along with their respective sources (Table 2), were grouped into three categories: airside, landside, and socioeconomic. Although demand and supply variables are well-established in airport research, this study adopts a novel approach by accounting for Brazil's unique context, characterized by regional economic disparities and infrastructure challenges. The first category includes attributes related to runways and aircraft aprons. The second encompasses aspects from passenger entry into the airport, including parking spaces and check-in counters, to the boarding process, such as the number of jet bridges, and finally, to arrival at the destination, including baggage claim carousels. This group also includes the passenger terminal's capacity and area. The third category relates to the socioeconomic characteristics of the metropolitan/integrated development region (if applicable), or the city where the airport is located. For the year 2023, population and GDP data for these areas were collected from the Brazilian Institute of Geography and Statistics (IBGE).

Table 1 List of Brazilian Airports

Airport	State	IATA	Operator	Airport	State	IATA	Operator
São Paulo	SP	GRU	GRU Airport	Recife	PE	REC	AENA
São Paulo	SP	CGH	AENA	Petrolina	PE	PNZ	CCR
Campinas	SP	VCP	AVB	Salvador	BA	SSA	VINCI
Ribeirão Preto	SP	RAO	VOA-SP	Porto Seguro	BA	BPS	SINART
Rio de Janeiro	RJ	GIG	RIOgaleão	Fortaleza	CE	FOR	Fraport
Rio de Janeiro	RJ	SDU	INFRAERO	Juazeiro do Norte	CE	JDO	AENA
Belo Horizonte	MG	CNF	BH Airport	Natal	RN	NAT	Zurich
Uberlândia	MG	UDI	AENA	Maceió	AL	MCZ	AENA
Montes Claros	MG	MOC	AENA	São Luís	MA	SLZ	CCR
Vitória	ES	VIX	Zurich	Imperatriz	MA	IMP	CCR
Porto Alegre	RS	POA	Fraport	João Pessoa	PB	JPA	AENA
Florianópolis	SC	FLN	Zurich	Campina Grande	PB	CPV	AENA
Navegantes	SC	NVT	CCR	Teresina	PI	THE	CCR
Joinville	SC	JOI	CCR	Aracaju	SE	AJU	AENA
Curitiba	PR	CWB	CCR	Belém	PA	BEL	NOA Airports
Foz do Iguaçu	PR	IGU	CCR	Santarém	PA	STM	AENA
Londrina	PR	LDB	CCR	Marabá	PA	MAB	AENA
Maringá	PR	MGF	SBMG S/A	Manaus	AM	MAO	VINCI
Brasília	DF	BSB	Inframérica	Palmas	TO	PMW	CCR
Goiânia	GO	GYN	CCR	Macapá	AP	MCP	NOA Airports
Cuiabá	MT	CGB	COA	Porto Velho	RO	PVH	VINCI
Campo Grande	MS	CGR	AENA	Boa Vista	RR	BVB	VINCI
				Rio Branco	AC	RBR	VINCI

Table 2 Categories and Factors

Categories		Factors	Sources
Airside	RWY1	Total Length of Runways (m)	Operators' Website
	RWY2	Runway Capacity in Movements/Hour	
	APR1	Apron Stands	
	APR2	Apron Area (m^2)	
Landside	TER1	Passenger Terminal Area (m^2)	Operators' Website
	TER2	Hourly Capacity of the Passenger Terminal	
	TER3	Number of Gates Equipped with Jet Bridges	
	TER4	Number of Baggage Claim Carousels	
	TER5	Number of Check-in Counters	
	TER6	Number of Vehicle Parking Spaces	
Socioeconomic	ECO1	Population of the Metropolitan Region (in millions)	IBGE
	ECO2	GDP of the Metropolitan Region (in billions of R$)	

2.2. Definition of Current Brazilian Hubs

The definition of a hub is often ambiguous in the literature, and airlines seldom explicitly disclose which airports function as their hubs in official documents. Hence, this study sought to identify which airports serve as flight and passenger connectors for Azul, GOL, and LATAM by examining their current air networks. Data on market share for each airline at 45 airports (ANAC, 2023) and the list of destinations offered at each airport by these airlines in 2024 (from flightconnections.com) were collected. The only source of information on the percentage of connecting passengers at these airports was the 2014 "O Brasil que Voa" report by the Civil Aviation Secretariat. Although the data is ten years old and may not accurately reflect current conditions, it still provides a general historical perspective on the main Brazilian hubs. It is important to note that many airports in the Amazon region exhibit high rates of connecting passengers due to the remoteness of certain locations, which are accessible only by air, even though these airports do not function as traditional hubs. Figure 1 shows probable hubs for each airline using a scatter plot of market share, number of destinations, and percentage of connecting passengers. For Azul, VCP, CNF, and REC stand out. GOL's main hubs are GRU, CGH, BSB, GIG, and SSA. For LATAM, GRU and BSB serve as the primary hubs, while CGH, GIG, and FOR also play significant roles as secondary hubs, given their considerable number of destinations and market share. Thus, out of the 45 airports listed, 9 are currently hubs in the national air transport network.

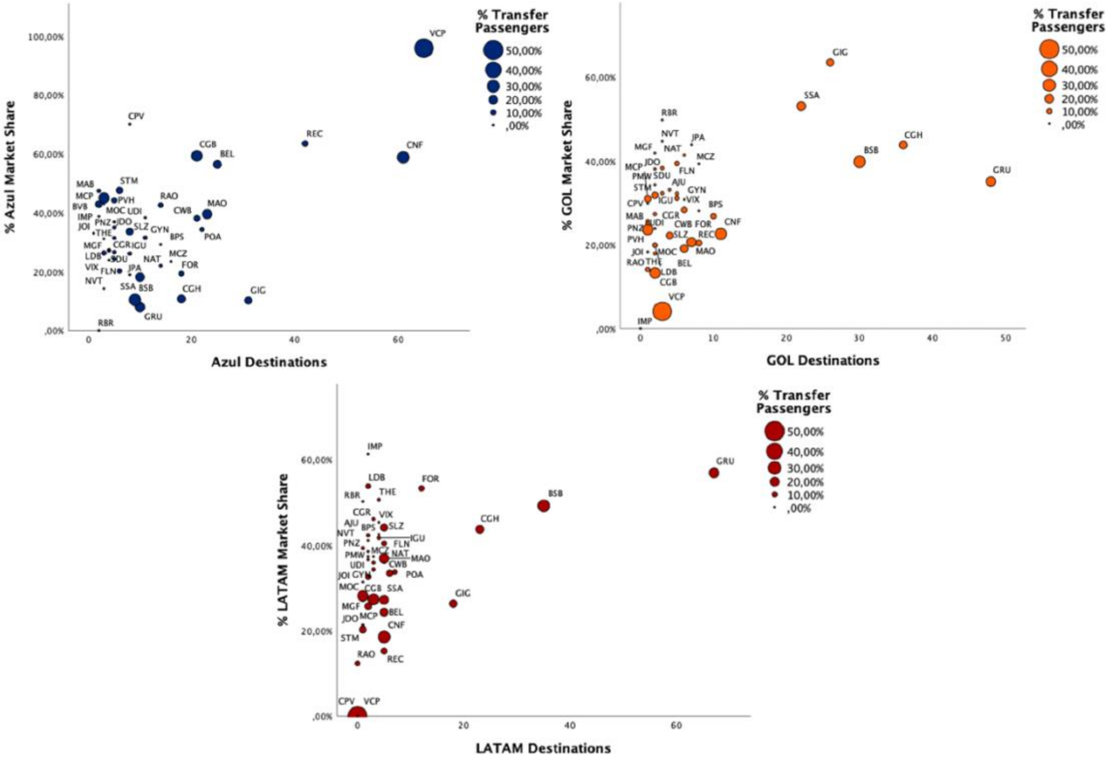

Figure 1 Analysis of Azul, GOL and LATAM Hubs

2.3. Exploratory Factor Analysis + Binary Logistic Regression

The model proposed in this article aims to identify the key factors influencing the selection of hub airports in Brazil by national airlines. It was developed in two stages using the statistical software SPSS version 28. In the first stage, through Exploratory Factor Analysis (EFA), all collected data on airside, landside, and socioeconomic factors that may influence Brazilian hubs were consolidated into principal components. EFA, specifically Principal Component Analysis (PCA), was selected to reduce data dimensionality and reveal significant patterns that simple correlation analysis might overlook. By eliminating redundancies and focusing on the most critical components, EFA enhances the robustness of the subsequent analysis. In the second stage, Binary Logistic Regression (BLR) was conducted to determine whether these components identified through EFA can effectively distinguish hub airports from non-hubs, or if other factors not captured by the model are influencing the selection of hub airports in Brazil.

EFA is a statistical method used to explore the underlying structure in multivariate data and reduce the number of variables from P to a smaller, simpler set of variables K, where K < P (Washington et al., 2011). This method evaluates the relationships between variables (such as those listed in Table 2) to extract latent components that represent underlying factors in the dataset (Osborne, 2014). The goal of BLR is to develop a well-fitted model describing the relationship between a binary dependent variable and a set of independent variables (Washington et al., 2011). In this model, the binary variable takes the value of 1 for the 9 airports previously categorized as Brazilian hubs and 0 for the others. The independent variables refer to the components extracted in the first stage. The BLR formula, detailed in Hosmer and Lemeshow (2000) and described in Equations (1-2) shows: Y as the dependent variable (Y=1 for hubs, Y=0 for non-hubs); β_0 as the constant; $\beta_1 + \beta_2 + \cdots + \beta_m$ as the regression coefficients to be estimated; $x_1 + x_2 + \cdots + x_m$ as the independent variables; and P as the probability of an airport being classified in the hub category.

$$\mathrm{Y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_m x_m \tag{1}$$

$$\mathrm{P} = \frac{e^Y}{1 + e^Y} \tag{2}$$

3. RESULTS AND DISCUSSION

3.1. Exploratory Factor Analysis Results

In the first stage, EFA using PCA was performed to extract components. All investigated variables had communalities greater than 0.5. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.840, and Bartlett's test of sphericity yielded a p-value of less than 0.001, both indicating that the data were well-suited for EFA. The analysis revealed a one-component solution with an eigenvalue greater than 1, explaining 82.29% of the total variance and indicating a strong correlation among all the investigated variables. Table 3 presents the extracted component and the corresponding factor loadings for each variable in descending order. Landside factors had the strongest influence on this component, followed by airside factors related to aprons, runways, and, lastly, socioeconomic factors. The most influential factors were terminal area, number of gates with jet bridges, check-in counters, parking spaces, and terminal hourly capacity, all related to the passenger terminal. The number of apron stands emerged as the most significant airside factor. Factors such as the number of baggage carousels and apron area had loadings exceeding 0.9, while runway length and capacity were less significant among airport infrastructure attributes. GDP and population of the metropolitan area had the least impact.

Table 3 EFA Results

Category	Factor	Component 1
Landside	TER1	0,979
Landside	TER3	0,962
Landside	TER5	0,950
Landside	TER6	0,947
Landside	TER2	0,942
Airside	APR1	0,941
Landside	TER4	0,916
Airside	APR2	0,914
Airside	RWY1	0,855
Airside	RWY2	0,843
Socioeconomic	ECO2	0,809
Socioeconomic	ECO1	0,806

3.2. Binary Logistic Regression Results

In the second stage, the component generated in the previous phase was tested in the BLR. The Model Omnibus Coefficient Test was significant, indicating a considerable improvement in fit compared to the null model. The Hosmer-Lemeshow test statistic would indicate poor fit if the significance value were below 0.05, but the model showed significance close to 1.000, indicating a good fit to the data. Thus, observed and predicted values are approximately equal. The model also demonstrated a Nagelkerke R^2 value of 0.844, suggesting that 84.4% of the variation in the dependent variable can be explained by the independent variables in the model.

As shown in Table 4, using a cutoff probability of 0.5, the predicted accuracy is 94.4% for non-hubs and 77.8% for hubs, resulting in an overall accuracy of 91.1%. This indicates that the component identified in the first stage and the factors analyzed have a good potential to distinguish hub airports from non-hubs in most cases. Out of the 45 airports analyzed, only 4 showed discrepancies between observed and predicted results from the model. Two of these airports were initially considered non-hubs based on destinations and market share of airlines in Figure 1, but were classified as hubs by the BLR, suggesting potential as candidates to become new hubs. The other two airports, classified as hubs, were indicated by the model as non-hubs, which may point to potential weaknesses in their future hub performance.

Table 5 presents the variables of the logistic regression equation and their coefficients (B). The statistical test used the Wald chi-square value [(B/Standard Error)²] and a 95% confidence interval for the corresponding degrees of freedom (df). Both Component 1 and the constant showed significance < 0.05. The coefficient of +7.174 for Component 1 indicates that this independent variable has a positive effect on identifying an airport as a hub. Equations (3-4) present the logistic regression using the coefficients from Table 5 and the decomposition of Component 1 with the factor loadings shown in Table 3, all expressed in standardized values (z) and ranked in descending order of influence. In this context, TER1 is identified as the most significant factor, while ECO1 is the least. Y distinguishes hub airports from non-hub airports; the higher the Y value, the greater the probability P (Equation 2) that a given airport will achieve a score close to 1.

Table 4 Classification Table

Observed	Predicted		
	0 (non-hub)	1 (hub)	Percentage Correct
0 (non-hub)	34	2	94.4
1 (hub)	2	7	77.8
Overall Percentage			91.1

Table 5 Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I. for Exp(B)	
							Lower	Upper
Component 1	7.174	3.571	4.037	1	<.05	1305.41	1.193	1428972.561
Constant	-3.227	1.521	4.503	1	<.05	0.040		
	Coefficient	Standard Error	Wald chi-square	df	Significance	Exp. Coefficient	95% confidence interval for Exp(B)	

$$\text{Y} = -3.227 + 7.174(\text{Component 1}) \tag{3}$$

$$\begin{aligned}\text{Y} = -3.227 + 7.174(&0.979\ z\text{TER1} + 0.962\ z\text{TER3} + 0.950\ z\text{TER5} + 0.947\ z\text{TER6} \\ &+0.942\ z\text{TER2} + 0.941\ z\text{APR1} + 0.916\ z\text{TER4} + 0.914\ z\text{APR2} \\ &+ 0.855\ z\text{RWY1} + 0.843\ z\text{RWY2} + 0.809\ z\text{ECO2} + 0.806\ z\text{ECO1})\end{aligned} \tag{4}$$

3.3. Potential New Hubs and Weaknesses of Current Hubs

After conducting the BLR, cases where the separation of airports into hubs and non-hubs was not correctly predicted were examined to understand the reasons for misclassification. Figure 2 reveals the relationship between the model's predicted probabilities and the total number of destinations offered at each airport in 2024 (flightconnections.com), as well as the market share of the primary airline (ANAC, 2023). The graph shows that the BLR identifies six airports with predictions close to 1, namely GRU, VCP, CNF, GIG, BSB, and CGH, categorizing them as fortress hubs. However, within the probability range of 0.2 to 0.7, there are six airports close to the 0.5 cutoff. These are airports either aspiring to become central hubs or currently functioning as hubs but whose role is questionable due to certain weaknesses and/or threats. Among these, three airports in the northeast, SSA, REC, and FOR, were previously classified as hubs, but only SSA was predicted as a hub. Conversely, airports in the south, POA and CWB, were initially listed as non-hubs but achieved probabilities higher than 0.5. SDU was correctly classified as a non-hub by the regression. The first three have a market share of over 50% for the main carrier, whereas the latter three have less than 40%. Regarding the number of destinations offered, SDU is an outlier with fewer than 10 locations, while REC comes closest to the range of destinations for airports with probabilities near 1.

Table 6 compares the average factors of the nine airports considered hubs in the preliminary analysis with the values of these variables for airports that achieved probabilities close to the cutoff score. The six airports investigated generally present values below the mean for the hub group, except for SSA in total runway length, POA in terminal hourly capacity, POA and CWB in vehicle parking spaces, and SDU in the metropolitan region's population and GDP. SSA, REC, and FOR function as regional hubs for airlines, connecting northeastern cities to major airports in the country. However, these airports share similar infrastructure and socioeconomic characteristics with non-hub airports, making them less definitive as hubs. Consequently, they risk de-hubbing, where the airline ceases hub-and-spoke operations at the facility. Redondi et al. (2010) described that de-hubbing could occur due to the central airline's bankruptcy, a merger or acquisition that reorganizes the airline network, or cost-cutting decisions by the airline. An airline might shift its hub operations from one of these three to another or even to a nearby airport with similar operational conditions. It is crucial for these airports to develop market strategies, such as financial incentives for primary airlines, to foster a robust airport-airline partnership.

SDU presents a unique case in this analysis. Despite the model indicating a propensity for hub operations, SDU, along with GIG, forms the Rio de Janeiro multi-airport system. SDU currently operates only domestic and short-haul flights, yet it was the fifth busiest airport in Brazil in 2023 (ANAC, 2023). Among the airports in Table 6, SDU has the least infrastructure but boasts high socioeconomic factors due to its location in Brazil's second-largest city, potentially increasing its hub probability in the regression. POA and CWB share similar infrastructure characteristics with northeastern hubs and even higher GDP values in their metropolitan areas. As a result, the model predicted these two airports as hubs. However, the preliminary analysis of airline destination networks shows they do not function as such. Several factors may explain why none of the three major carriers have established hubs at these locations. POA is situated in a peripheral region of Brazil's air network, in the far south of the country. Establishing a hub here might not be strategically beneficial for airlines. While POA could serve as a good connection center for the Mercosur and Rio de la Plata regions, the air networks of Brazil, Uruguay, Argentina, and Paraguay are not well integrated, with connections primarily occurring through major airports. CWB's weakness lies in its proximity to São Paulo's three major airports (GRU, CGH, and VCP), which are the main hubs for GOL, LATAM, and AZUL. Designating another hub close to these significant connection centers may not offer effective operational and financial benefits for the airlines.

It is also important to highlight airports that stand out among the non-hubs group, with probabilities greater than 0.05, such as FLN, NAT, and MAO. FLN has a brand-new passenger terminal and is one of the busiest airports in terms of international passengers. NAT is the most recently inaugurated airport on the list and has good infrastructure. MAO handles significant cargo traffic and serves as a connector for remote areas in the North region (ANAC, 2023). While not immediate candidates for hubs, these airports could become competitive with increased investment and strategic changes by national airlines.

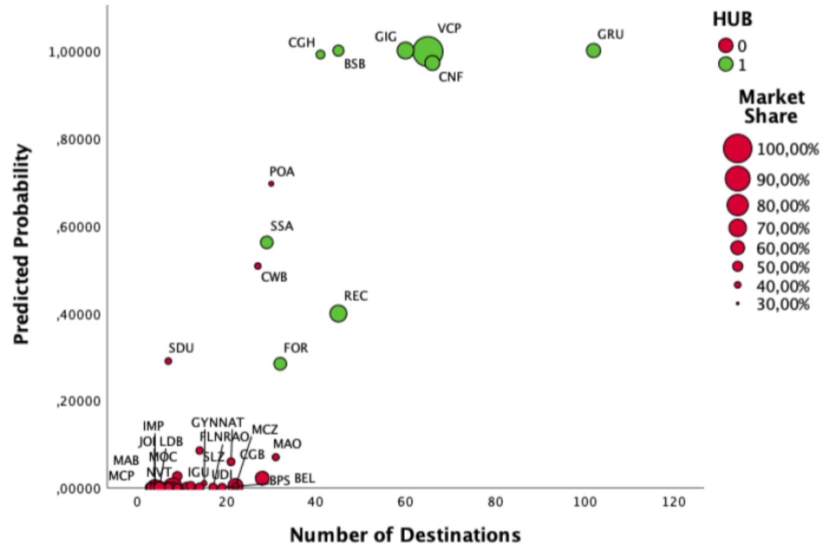

Figure 2 Analysis of Cases Misclassified by the Model

Table 6 Hubs vs. Potential New Hubs

	Hub Group Mean	SSA	REC	FOR	POA	CWB	SDU
RWY1	**4520**	4521	2751	2755	3200	4016	2583
RWY2	**48**	36	38	38	36	32	29
APR1	**59**	27	29	24	28	26	21
APR2	**374363**	86500	103815	155000	122312	85742	95800
TER1	**154650**	79439	79428	72000	72000	77160	61000
TER2	**9668**	5386	7193	8939	10221	3170	3646
TER3	**28**	19	15	15	14	14	8
TER4	**11**	9	7	5	5	9	6
TER5	**120**	60	70	66	62	62	51
TER6	**3800**	2035	2079	900	4300	4032	1100
ECO1	**8,391**	3,318	3,783	3,424	3,679	3,381	11,760
ECO2	**526,284**	138,926	123,744	123,436	215,236	193,193	680,135
HUB?	**1**	1	1	1	0	0	0
Predicted Probability	**0,800**	0,561	0,399	0,284	0,695	0,507	0,290

4. CONCLUSIONS

This study provided a detailed analysis of the factors that influence the selection of hub airports by Brazilian airlines, offering valuable insights for airline strategists seeking to optimize their operations with competitive hubs or establish new hubs in their networks, as well as for airport managers aiming to be chosen as operation centers for specific carriers. The research employed a two-step methodology involving EFA and BLR. In the first step, the analysis identified the most important characteristics that a national airport must have to achieve hub status, considering both airside and landside airport capacity and the economy of the region where the airport is located. In the second step, the model distinguished the unquestionable hubs in the current air network of the country, those hubs that may be subject to potential de-hubbing, and the airports that are candidates to become new connection centers in Brazil. These results provide a solid foundation for strategic decisions in the management and development of airport infrastructure and air transport networks.

One of the key points highlighted by this article is the importance of landside infrastructure in determining a hub airport in Brazil. According to Equation 4, this category had the greatest weight in the analysis, with factors such as terminal area, number of jet bridges, check-in counters, parking spaces, and terminal capacity emerging as critical elements. This underscores the necessity of investing in modern passenger terminal buildings with appropriate infrastructure to enhance the flow and activities of connecting passengers, while also serving to traditional origin and destination passengers. The second most important category was the airside infrastructure, with a greater emphasis on aircraft apron factors compared to runway attributes. Although airside attributes are significant, they showed less influence in predicting an airport's hub status, suggesting that improvements in landside facilities might have a more immediate impact on the feasibility of a hub. Lastly, the lowest loading factors were related to the population and GDP of the metropolitan area. Despite this, the region where an airport is located still has considerable influence on its success as a hub.

The BLR, along with the previous analyses of Azul, GOL, and LATAM's destination networks, identified GRU, CGH, BSB, GIG, VCP, and CNF as fortress hubs in Brazil. These results align with the findings of Costa et al. (2010), who recognized the first three as indisputable hubs, suggested that GIG should operate as a hub, and identified VCP and CNF as potential hubs. At the time of their research, VCP and CNF had not yet been established as hubs by Azul. The model applied in this study also highlighted the dynamic nature of the air transport industry, indicating that some hubs are not immune to shifts in airline strategies and market conditions. Regional hubs such as SSA, REC, and FOR, despite playing significant roles in their respective carriers' networks, face potential threats that could lead to the loss of their hub status. These airports must not only update their infrastructure but also engage in strategic partnerships and market positioning to remain competitive.

The emergence of new national airlines, mergers, or reorganizations of existing air networks may necessitate the establishment of new hubs. It is important to note that POA completely suspended its operations in May 2024 due to historic flooding in the city, with a projected return to service by the end of the same year. Despite this disruption, POA, along with CWB, remains a strong candidate to become a new connection center in Brazil once normal operations are restored. Although these two airports have infrastructures comparable to existing hubs, they have not yet functioned as such, possibly due to their geographical locations or strategic decisions by airlines. SDU faces infrastructure constraints that could hinder its development as a future hub. Additionally, FLN, NAT, and MAO stand out from other non-hub airports and, in the long run, might compete to become key connection platforms for airlines.

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