XXII SITRAER 2025
Simpósio de Transporte Aéreo

Vertiport project in Brazil: A Conceptual Study

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PAPER ID: xyz

ABSTRACT

This study aims to explore a methodological approach applied to the conceptual design of vertiports for Advanced Air Mobility. This is achieved through the analysis and comparison of two distinct conceptual case studies in São José dos Campos - SP and Joinville - SC. The research begins with a rigorous selection of locations, based on socioeconomic, demographic, and urban mobility data, to establish technical and strategic parameters for infrastructure implementation. The definition of implementation sites was based on multiple evaluative criteria, supported by the Analytical Hierarchy Process (AHP) method, seeking to reconcile operational, urban, and normative aspects. The developed project encompassed both the airside and landside of the structure, adhering to current technical guidelines, in addition to the elaboration of an integrated architectural proposal. The results obtained offer relevant insights for future applications and demonstrate the importance of a systemic and multidisciplinary approach in planning vertiports within diverse urban contexts.

Keywords: Advanced air mobility, Vertiport, Infrastructure, Conceptual project, Case comparison.

ACKNOWLEDGEMENTS

The authors would like to thank Eve Air Mobility for the support and sharing of informations regarding aircraft dimensions and necessary infrastructure for operations. We would like to thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brasil for Financial Support. Grant No. 176789/2025-1. We would also like to thank FLYMOV – Flight and Mobility Innovation Center, a research group from ITA funded by São Paulo Research Foundation (FAPESP) under the Research Grant No. 2021/11258-5, for encouraging and supporting this type of research.

GENERATIVE AI USAGE STATEMENT

This research did not use generative AI.

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1 INTRODUCTION

The advent of Advanced Air Mobility (AAM), defined as an air transportation system that moves people and cargo using highly automated aircraft, and in particular its subset Urban Air Mobility (UAM), marks a significant transformation within the urban ecosystem. These emerging operations necessitate a fundamental reconfiguration of the infrastructure grid, calling for innovative and robust solutions to ensure the safety, efficiency, and integration of both legacy and next-generation aviation systems (Guterres, 2025). One key element of this new infrastructure is the vertiport, a term used to describe a dedicated facility or infrastructure for the take-off, landing, and servicing of eVTOL (electric Vertical Take-Off and Landing) aircraft, typically in an urban environment.

This paper examines the increasing convergence between the evolving UAM modality and the foundational principles of vertiport design, as well as its highly modular infrastructure, as shown in Figure 1. It provides a detailed analysis and methodology of how existing, often underutilized, spaces can evolve to effectively interface with UAM technologies and necessary infrastructure.

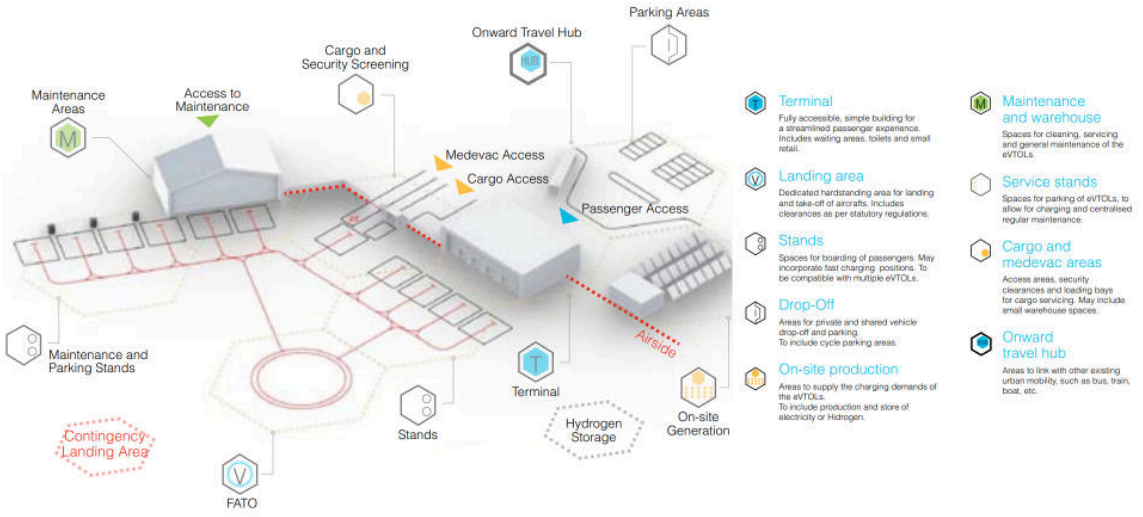


Figure 1: Modular infrastructure for future vertiports design (2022).

The central aim of this study is to develop a conceptual study, due to the lack of real-life data, developing a flexible and scalable architecture that can support the operational needs of both conventional civil aviation and the emerging UAM sector. This includes a complete three-dimensional project illustrating this new architecture within a real-world setting (Pak et al., 2024).

2 METHODOLOGY

The methodology adopted in this study consists of a structured process for the development of conceptual vertiport projects in two previously selected cities. Initially, municipalities with implementation potential are defined, considering criteria such as demographic and socioeconomic characteristics, and regional transport data. Following this

selection, all subsequent steps are conducted independently for each city. Subsequently, the urban site selection process for vertiport implementation is conducted. For this purpose, the Analytical Hierarchy Process (AHP) method is utilized, which is based on multi-criteria evaluations that consider attractiveness, accessibility, and demand distribution. With the definition of the implementation site, the conceptual design of the vertiport begins, encompassing both the airside and landside. This stage is developed based on current regulations and the needs of potential users, ensuring the functional and operational adequacy of the infrastructure. Finally, an architectural proposal is elaborated for each vertiport, with the objective of visually representing the adopted solutions and offering an integrated vision between form, function, and urban context.

3 RESULTS

The following sections present the steps developed for the two vertiport design cases, including a description of the data used and calculated for the models, as well as the conceptual design of the projects. The results are organized in a logical sequence, with dependencies between phases. It begins with the selection of the cities, accompanied by a brief justification for each choice and the presentation of the demographic and socioeconomic data considered. Next, the demand analysis is presented, with a description of the mathematical models adopted and their respective results. Based on these first two stages and statistical data, possible locations for the construction of vertiports are identified through a multi-criteria analysis. This analysis guided the development of the airside, landside, and, finally, the architectural design of the vertiports in the cities of São José dos Campos - SP and Joinville - SC.

3.1 Cities chosen

The selection of São José dos Campos - SP and Joinville - SC for the conceptual implementation of vertiports is motivated by a combination of strategic, economic, and geographical factors shown in Table 1 (IBGE, 2024). Both cities stand out in the national landscape due to their strong industrial presence, high level of human development, and consolidated urban infrastructure. Furthermore, they present profiles that favor the adoption of innovative mobility solutions, such as vertiports, by integrating dynamic and expanding metropolitan regions.

Table 1: General data of selected cities in 2025

Data	São José dos Campos	Joinville
Territorial area (km^2)	1.099,409	1.127,947
Population (inhab)	724.756	616.317
Population density (inhab/km^2)	634,03	546,41
GDP per capita (R$)	61.316,00	74.532,00
Average income (R$)	5.009,40	3.488,14

3.2 Location of sites

The definition of the most suitable location for vertiport implementation in each city is carried out using a multi-criteria approach based on the Analytic Hierarchy Process (AHP)

method (Whitaker, 1987), complemented by Individual Priorities Aggregation (IPA). AHP is a decision support methodology that allows complex problems to be structured into a hierarchy of criteria and sub-criteria, enabling the comparison between alternatives based on qualitative and quantitative judgments. Initially, eight relevant criteria for site selection were defined: available infrastructure, noise, accessibility, privacy, efficiency, hours of operation, environmental impact, and safety. Each analyst evaluated the relative importance between the criteria and between the sites in relation to each criterion. These individual evaluations are consolidated through IPA, which generates a collective priority representative of the analysts from each city. The final site scores were obtained by combining the criteria weights and the scores assigned to the sites for each criterion, thus allowing for the definition of the most suitable alternative in each city.

For the city of São José dos Campos, four possible sites are analyzed for vertiport implementation, namely: the SJC Prof. Urbano E. Stumpf International Airport, given its potential as an existing air transport hub in the region, with consolidated airport infrastructure and easy connection to other transportation modes. A possible site in the Urbanova neighborhood is being studied due to its proximity to the University of Vale do Paraíba (UNIVAP) and high-end residential areas. Colinas Shopping Mall is considered as a potential site due to its strategic location between the city's three most populous neighborhoods. Finally, a site next to the Technological Park is considered, as it is a hub for innovation and technology, housing companies, startups, and research institutions. Figure 2 shows the possible sites on the map.

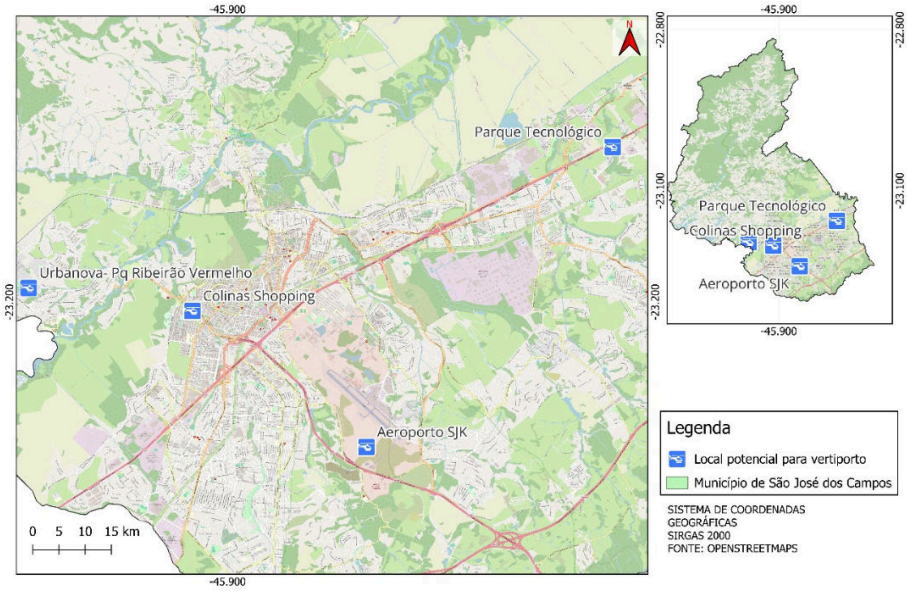


Figure 2: Possible sites for vertiport implementation in São José dos Campos (2025).

For Joinville, three potential locations were analyzed: a large empty plot of land near the University of Joinville (UNIVILLE) and Garten shopping mall. Another location evaluated was near the North Terminal, with potential for intermodal integration. Finally, the last site considered was the spacious area located in the parking lot of the Arena Joinville, in the Bucarein neighborhood. This site is close to arterial roads and Joinville's central area, offering easy access and good visibility. Figure 3 shows the Arena Joinville site and its potential for eVTOL connections and flights on the map.

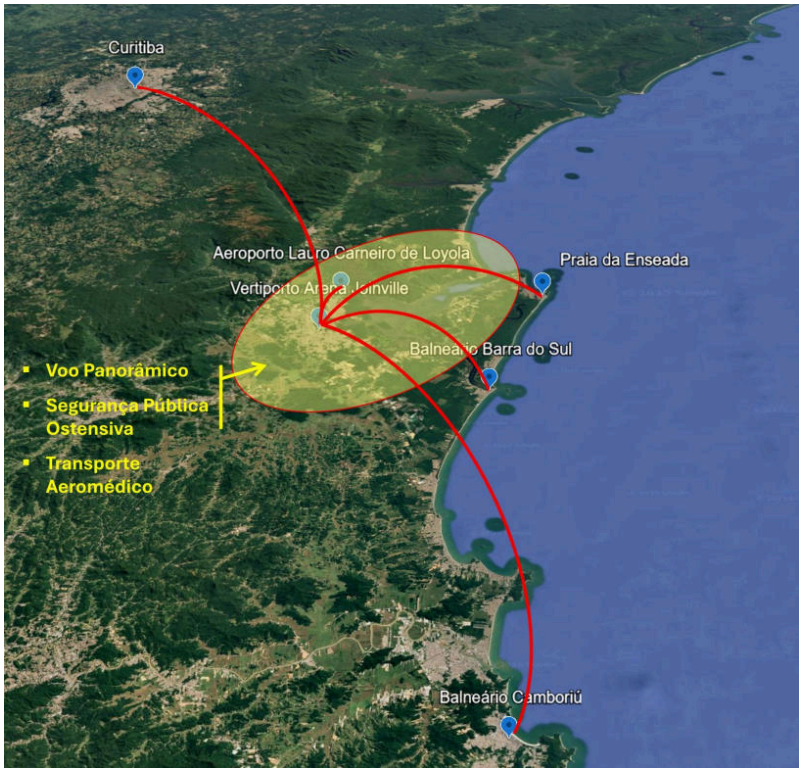


Figure 3: Arena Joinville site and possible flight paths (2025).

Table 2 presents the scores (probability of being chosen) for each of the sites studied in both cities.

Table 2: Site Scores for Each City

Score (%)	Site	City
49.672	Aeroporto Stumpf	SJC
31.223	Parque Tecnológico	SJC
20.168	Shopping Colinas	SJC
12.902	Bairro Urbanova	SJC
36.702	Arena Joinville	JVE
32.447	Universidade/Shopping	JVE
30.851	Terminal Norte/Subestação	JVE

Judging by the scores for each city, the cites Aeroporto Stumpf and Arena Joinville were chosen, due to them achieving the highest scores.

3.3 Airside project

The conceptual design of the vertiport began with the airside design, taking into consideration the same standards (ANAC, 2022) (DECEA, 2023) for both cities, with design dimensions respecting the most popular eVTOL aircraft currently on the market, the EVE, which has a diameter of 15.2 meters.

Figure 4 shows the FATO (Final Approach and Take-off Area) sized based on the dimensions of the model aircraft used for the studies.

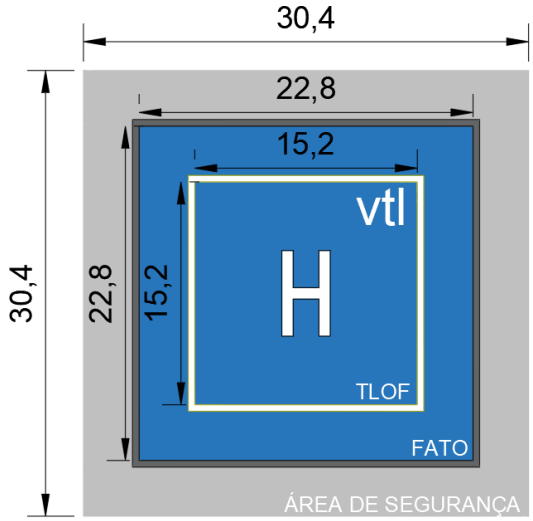


Figure 4: FATO (2025).

Next, we have the representations of the TLOFs (Touchdown and Lift-off Areas), with sufficient area to accommodate a diversity of eVTOL aircraft and stands sized to house charging and cooling systems. Figure 5 represents the airside designs developed for the chosen cities. On the left, we have the design for Joinville, and on the right for São José dos Campos.

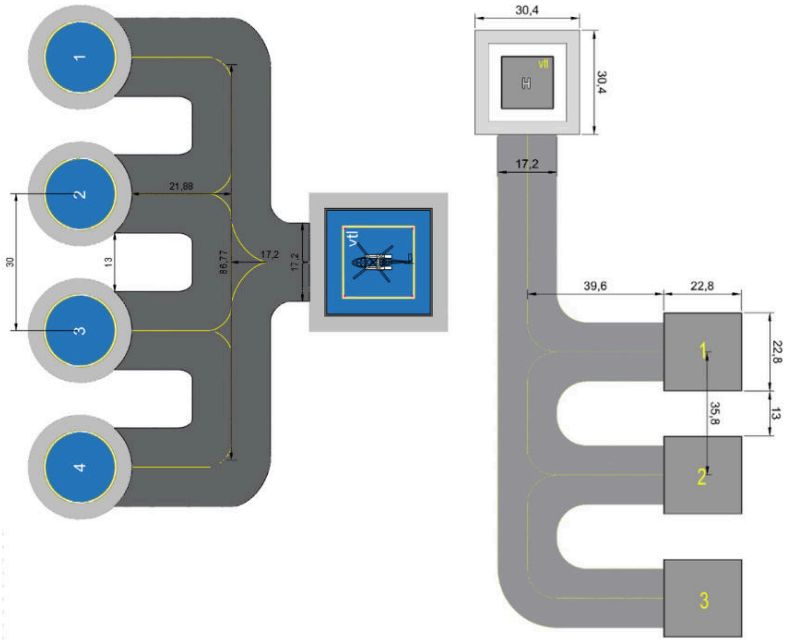


Figure 5: Airside projects (2025).

3.4 Landside project

The planning of the vertiport's ground infrastructure starts with a detailed evaluation of passenger movement projections, encompassing both the total daily volume and periods of highest flow intensity (Fernandes et al., 2021). This analysis is fundamental for establishing

the appropriate dimensions for each vertiport sector, ensuring that the installed capacity is compatible with operational requirements (Ashford et al., 2011).

For São José dos Campos airport, a daily operation of 12 hours was considered, with an average of two stands occupied simultaneously and a ground time of 30 minutes per aircraft, estimating a total of 48 daily operations. Each aircraft has a capacity for 4 passengers per trip. With a 75% occupancy rate, this results in 144 passengers transported per day. In a full occupancy scenario (100%), the daily capacity reaches 192 passengers.

For each occupancy rate, two distinct scenarios of passenger flow distribution throughout the day are considered. The first scenario is characterized by a smooth flow, with gradual and moderate variations around the hourly average, reflecting constant and balanced demand. The second scenario contemplates the occurrence of two peak periods, in which passenger concentration is significantly higher, while in the remaining hours, movement remains at average levels.

For the Joinville vertiport, passenger demand projections were developed from detailed hourly profiles, considering an effective operational activity period of approximately 16 hours daily (from 06:00 to 21:00). These estimates are crucial for the adequate sizing of the vertiport's ground infrastructure. In a utilization scenario corresponding to 75% of this reference demand, a movement of approximately 146 passengers per day is projected, with a maximum flow of 15 passengers per hour.

For a smoother demand distribution with more homogeneous hourly fluctuations:

The reference estimate indicates a total of 190 passengers per day, with hourly peaks around 16 passengers per hour. In a utilization scenario corresponding to 75% of this reference demand, a movement of approximately 143 passengers per day is projected, with a maximum flow of 12 passengers per hour.

3.5 Architectural design

Next, the architectural designs for the two vertiports mentioned above are shown. These designs aim to offer a glimpse into the future, showcasing how these new facilities can seamlessly blend essential infrastructure with appealing architecture (Associação Brasileira de Normas Técnicas, 2020).

Figures 6 and 7 demonstrate the project developed at the chosen sites, for São José dos Campos and Joinville, respectively.



Figure 6: Airport Stumpf site - 3D (2025).



Figure 7: Arena Joinville site - 3D (2025).

4 CONCLUSIONS AND FUTURE STUDIES

The conceptual study of vertiports in Brazil, focusing on São José dos Campos - SP and Joinville - SC, highlights the importance of in-depth analyses for the future of Advanced Air Mobility (AAM), which is an emerging and widely studied topic, though little documented so far. The employed methodology, which included site selection based on socioeconomic and demographic data, proves sufficient for the location decision regarding the implementation of infrastructures like vertiports. These cities were chosen due to their strategic, economic, and geographical relevance, presenting profiles that favor the adoption of innovative mobility solutions. In São José dos Campos, the SJC Prof. Urbano E. Stumpf International Airport was the selected location for vertiport implementation, while in Joinville, the Arena Joinville was the chosen one. Both choices resulted from a multi-criteria analysis using the Analytic Hierarchy Process (AHP) method. The development of airside and landside projects, along with the architectural proposals, demonstrates the feasibility and necessity of a systemic

and multidisciplinary approach for integrating AAM into diverse urban environments, which should be integrated with even more areas in future work, aiming for greater connection with the already existing infrastructure and also adaptation to the evolution of the technologies involved.

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