



Rafael Mesquita Antunes de Figueiredo

**Hub-and-Spoke Strategy in Air Transportation Networks: A
Contribution for Modeling Cases in South America and
Brazil**

Tese de Doutorado

Thesis presented to the postgraduate program in Production Engineering of The Department of Industrial Engineering, Pontifical Catholic University of Rio de Janeiro, PUC-Rio, as partial fulfillment of the requirements for the degree of Doctor in Production Engineering.

Advisor: Prof.Dr. Nélio Domingues Pizzolato

Co-advisor: Prof.Dr. Morton O'Kelly



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Dedicated to my mother Selma and my father Júlio César.

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Resumo

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O mercado de transporte aéreo de passageiros vem processando mais de 50 milhões de viagens por ano, número que cresceu a uma taxa expressiva de 10% ao ano entre os anos de 2003 e 2008. Ao mesmo tempo, a economia Brasileira conseguiu estabilizar-se com um aumento relativo do poder de compra da população em geral, combinado à crescente participação das empresas do tipo *low-cost/low-fare*, fazendo com que o Transporte Aéreo ficasse mais acessível para segmentos maiores da população. Um tipo de estratégia bastante efetiva e muito bem disseminada ao redor do mundo é a configuração de redes utilizando a estrutura *hub-and-spoke*, a qual visa à otimização dos serviços e permite que as companhias obtenham expressivas taxas de redução de custos. Isso consiste basicamente na utilização de grandes aeroportos, conhecidos como *hubs*, que concentram as operações e os fluxos entre os outros aeroportos, chamados de *spokes*. Esse fato possibilita que ganhos em economias de escala e de escopo apareçam nas ligações entre os hubs. Esta tese de doutorado faz uma análise detalhada da estratégia hub-and-spoke, mostrando suas principais características e passando pelos diferentes tipos de modelagem encontrados na literatura e propõe dois novos tipos de modelos: o primeiro considera o continente Sul-Americano como um mercado único para o transporte de passageiros (em uma rede com 50 nós) e se utiliza do conceito de *major* e *mini hubs*. O segundo, busca a resolução de um problema maior, em uma rede com 135 nós, levando em consideração somente o mercado Brasileiro, possibilitando assim a obtenção de uma solução ótima para instâncias maiores de dados. Para o segundo modelo, a solução consiste na resolução do problema em duas fases. Em ambos os modelos, o software de otimização AIMMS foi utilizado para a obtenção dos resultados e o Software de Informações Geográficas (SIG) e de transportes TRANSCAD foi utilizado para análise dos fluxos.

Palavras-chave

Transporte Aéreo; *hub-and-spoke*; localização.

Abstract

Figueiredo, Rafael Mesquita de; Pizzolato, Nelio Domingues (advisor); O’Kelly, Morton (co-advisor). **Hub-and-Spoke Strategy in Air Transportation Networks: A Contribution for Modeling Cases in South America and Brazil.** Rio de Janeiro, 2010. 150 pp. PhD Dissertation – Department of Industrial Engineering, Pontifical Catholic University of Rio de Janeiro.

The Brazilian air passenger market has been processing more than 50 million trips per year, a number that grew by an impressive rate of 10% per year between 2003 and 2008. At the same time, the Brazilian economy went toward stabilization with a relative increase in the purchasing power of the population in general, combined with the increasing participation of the low cost/low fare companies, helping to make the air transportation mode available to larger segments of the population. An useful strategy and well disseminated all over the world is the configuration of air networks using the hub-and-spoke structure, which optimizes air services and allows air carriers to obtain substantial rates of cost reduction. It basically consists of using major airports, called hubs, to concentrate the operations and flows amongst other airports, called spokes. This fact enables gains in economies of scale and scope along the linkages between hubs. This PhD Dissertation makes a deep analysis of the hub-and-spoke strategy, showing its main features and going through the different types of modeling found in the literature and proposes two new types of models: the first one considers the South America continent as a unique market for passengers (using a network with 50 nodes), using the concept of major and mini hubs. The second one aims to solve a bigger problem, with a network with 135 nodes, taking into consideration only the Brazilian market. The solution consists of solving this model in two stages. For both models, the optimization software AIMMS was used to obtain the results and the GIS/Transportation software TRANSCAD was used to illustrate the pattern of flows.

Keywords

Air Transportation; hub-and-spoke; location.

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