

Analysis and Optimization of Air Networks for Short Haul Air Transportation

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ABSTRACT

This paper presents the results of some studies related to application of network formulation and optimization techniques for simple air networks. The approach followed in this study is such that it can be progressively expanded to analyze the network at a micro level by including more constraints. A review of literature indicated that several different cost, and profit models coupled to Linear Programming (LP), Integer LP, and heuristic approaches, have been used to solve such problems. The focus of the paper is to define optimal network configurations and obtain an insight into the behavior of such networks when there is a fluctuation in passenger demand, sudden decrease in aircraft utilization, or introduction of other aircraft in the network. The air network in India linking five cities is taken as a case study to formulate a simple network problem, using Operating Cost models, with an indirect input of revenue based on traffic variation. The problem is solved using the LP codes available in MATLAB™ optimization toolbox, which produce fractional flight frequencies; these are rounded off to the nearest integer values. Branch and bound heuristic algorithms leading to an integer linear programming approach have also been attempted. A fraction of passenger demand is spilled over for lower levels of aircraft utilization and load factor and peak flight frequency requirements are simultaneously imposed. The results indicate that these constraints contribute more significantly to the spill over effect than the rounding of frequencies to integer. A comparison of the results of some existing models obtained during literature survey for maximum level of service (LOS) when applied to same conditions over different routes or links is presented. Another two models that maximize revenue and profit, respectively, have also been attempted and the results obtained are collated. Seven different cases are applied to these models, beginning with a simple baseline case and then successively increasing the complexity. In this study, the main aim was to study the problems and alternatives available in problem formulation that could be scaled-up to build higher-level models in design of optimal air networks for short haul air travel. Based on the formulation of the problem for determining optimal flight frequencies for a given network, a procedure to accomplish network structure effects has been arrived. The capabilities of MATLAB™ to formulate the ILP problems are also explored in this study. The current study on basic air network problem and the sensitivity of results indicate that the optimization tools can be further explored to formulate as IP problem to effect the spillover in passenger demand, which will be taken up as a future work. The authors believe that this type of study is most relevant for studying the Indian air transportation scenario, in line with the new civil aviation policy of India, which has identified regional and short-haul air travel as a thrust area.

Keywords: Cost-Revenue-Profit models; Air Network Optimization; Integer LP

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