A BI-OBJECTIVE SLOT ALLOCATION MODEL UNDER AIRPORT CAPACITY AND RESOURCE UTILIZATION

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(238023R)

Degree of Master of Science in Engineering

Department of Civil Engineering

University of Moratuwa
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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree Master of Science in Civil Engineering

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DECLARATION

Candidate

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The above candidate has carried out research for the master's dissertation under my supervision.

Name of the supervisor: Prof. J. M. S. J. Bandara

Signature of the supervisor: Date: 26.08.2025

ABSTRACT

The aviation sector faces increasing pressure to balance rising demand for flights with limited airport infrastructure. Airport performance remains hindered by inefficient slot allocation and underused resources. A lack of detailed analysis between demand and declared capacity has sparked widespread discussions among policymakers regarding capacity expansion. However, recent research shows that most airports do not fully utilize their declared capacity for operations. Instead, they often choose to enhance capacity through infrastructure development. Requests from airlines for additional slots are sometimes rejected, potentially causing billions of dollars in annual losses due to poor management of existing slot allocations. While many previous studies offered optimization solutions, a practical approach involves better utilization of available resources to allocate new slots and utilize unused capacity rather than expanding capacity. This research introduces a bi-objective mathematical model aimed at achieving two goals: improving resource utilization (including runway, apron, and terminal gate capacity) through new slot scheduling and considering real-time constraints to optimize delay propagation while maintaining separation minima. Bandaranaike International Airport (BIA) serves as a case study to validate the model. The MATLAB-developed linear programming model increased average airside resource utilization to 62.7% on peak days, up from 44.9%. During critical hours, the new schedule effectively reduced traffic intensity, delays, and congestion. A comparison of cumulative delays, based on propagated delays in specific operations between the optimized and non-optimized schedules, highlights the significant benefits of implementing optimized scheduling systems. The proposed slot allocation model can serve as a decision-support tool for the aviation industry, facilitating slot allocation for new entrants and reducing delays across existing flight schedules through more efficient resource utilization.

Keywords: air transport, slot allocation, minimizing delays, declared capacity, capacity expansions

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