

# Analysis of Airside and Terminal Side Congestion at Bandaranayaka International Airport

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## I. INTRODUCTION

Air transport is vital for global connectivity and economic growth. However, rising demand and limited infrastructure have caused increasing congestion at airports worldwide. Bandaranayaka International Airport (BIA), Sri Lanka's main gateway, was designed for 6 million passengers annually, but this limit has been exceeded. Although a new terminal is under construction, delays have worsened airside and terminal congestion, creating a major challenge for Sri Lanka's aviation sector.

## II. PROBLEM STATEMENT

The research aims to examine congestion in Bandaranayaka International Airport (BIA) and suggest improvement methods.

Research Questions:

1. Which operational areas at BIA experience the highest congestion?
2. What are the main causes of airside and terminal-side congestion?
3. Which international best practices can be adapted for sustainable congestion mitigation at BIA?

Objectives:

1. Identifying the critical points of airport traffic congestion, including both terminal-side and airside operations
2. Identifying the key causes contributing to airport congestion at Bandaranayaka International Airport
3. Benchmark BIA's performance with international standards and propose short- and long-term mitigation strategies

## III. LITERATURE REVIEW

Airport congestion occurs when traffic demand exceeds runway or terminal capacity. According to Brueckner and Jan [1], such conditions require short-term measures like slot allocation or congestion pricing, while Cohen and Coughlin [2] highlight the need for long-term capacity expansion. From an operational perspective, Bao *et al.* [3] proposed a dynamic ground-movement control method to reduce taxi delays, and Jiang *et al.* [4] showed that arrival and pushback rates directly influence airside congestion through cell-transmission modelling. At the terminal, Yang *et al.* [5] found that counter-sharing improves check-in efficiency, while Oprea *et al.* [6] demonstrated that discrete-event simulation helps identify

passenger-flow bottlenecks. From a managerial standpoint, Lin [7] and Huai *et al.* [8] emphasised that pricing structures, terminal capacity, and passenger arrival behaviour affect congestion outcomes. Graham [9] and Wan *et al.* [10] further noted that effective coordination and capacity planning such as A-CDM are essential for sustainable congestion management. However, most studies focus on large developed-world airports. Limited research examines airports in developing countries, where infrastructure constraints and operational limitations differ. This study addresses this gap by analysing both airside and terminal-side congestion at BIA and comparing its performance with international standards

## IV. MATERIALS AND METHODS

A case-study approach was used to analyse congestion at BIA, combining primary observations and secondary operational data collected from 1 August 2024 to 31 July 2025.

To achieve the first objective, flow mapping and on-site observations (during peak and non-peak hours) were conducted at key operational areas, including the runway, taxiways, gates, check-in counters, immigration counters, and baggage claim. This helped visualise crowding patterns and locate bottlenecks

To achieve the second objective, descriptive statistics were applied to flight movement records, delay logs, and passenger waiting-time data to quantify congestion levels. For example, to ensure accuracy, waiting-time observations and field notes were cross-checked across multiple days and during peak periods. Comparisons were made with international standards

To attain the third objective BIA's performance was benchmarked against global best practices such as A-CDM, digital queue management, dynamic slot allocation, and simulation-based planning. A comparative analysis was conducted to recommend short-term operational solutions and long-term infrastructure improvements.

## V. RESULTS AND DISCUSSION

The study found that the Bandaranayaka International Airport (BIA) is highly congested in activities both at the terminal-side and airside.

### 1. Identification of Congestion Points

Field observations and flow mapping across the runway, taxiways, check-in, immigration, and baggage claim areas revealed several operational bottlenecks.

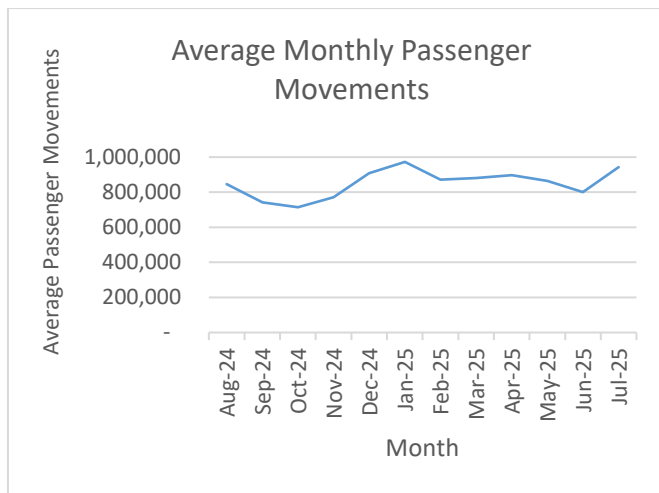


Fig. 1. Monthly aircraft movements at BIA from August 2024 – July 2025.

Airside congestion was observed mainly during peak arrival and departure waves, while terminal-side congestion occurred at check-in counters and immigration queues. These observations confirm that congestion is present across both sides of airport operations.

### 2. Causes of Congestion Based on Operational Data

**Airside Causes:** Figure 1 indicates that aircraft movements peak during the months of December and January, which coincides with the tourist season. Given that BIA operates on a single runway, its effective handling capacity is exceeded during these peak periods. The consequence is aircraft queuing, extended taxi-in/taxi-out, and increased runway pressure. Recorded ROTs have often been more than the ICAO guideline of 50–60 seconds, reflecting limited runway throughput during periods of high demand.

**Terminal-Side Causes:** Figure 2 demonstrates that passenger movements follow the same seasonal pattern as aircraft operations. The annual volume exceeds the terminal’s original design capacity of 6 million passengers, creating congestion at key processing points such as check-in, immigration, and baggage claim. The clustering of departures during peak-season months intensifies queue formation and delays. Passenger traffic patterns mirror aircraft movement trends, with annual volumes exceeding design capacity by nearly 50%.

ICAO Runway Occupancy Time (ROT): 50–60 seconds for medium aircraft

IATA Check-in Waiting Time Standard: less than 10 minutes

### 3. Benchmarking and Practical Strategies

When compared with international standards, BIA underperforms in several areas: ROT exceeds ICAO limits, reduces runway efficiency, check-in waiting times exceed IATA’s 10-minute guideline, passenger demand exceeds terminal design capacity by nearly 50%.

Based on these benchmarks, several strategies used internationally are applicable to BIA: Dynamic slot allocation to distribute peak-hour aircraft movements, A-CDM to improve coordination among ATC, airlines, ground handlers, Digital queue management and expanded self-service counters to reduce check-in congestion, Long-term infrastructure upgrades such as Terminal 2 completion and runway/taxiway improvements.

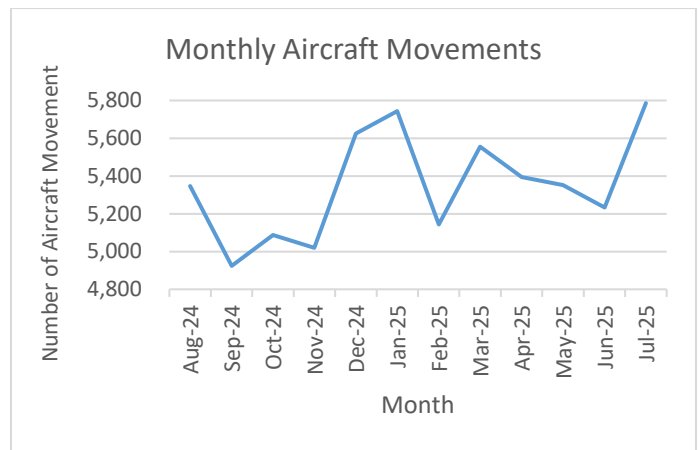


Fig. 2. Monthly passenger movements at BIA, August 2024 – July 2025.

These measures directly address the gaps identified in the data and align BIA with global best practices.

## VI. CONCLUSION

The research revealed major congestion at Bandaranayaka International Airport (BIA) because of constrained capacity, weak scheduling practices, and weak coordination. The research also underlined the relevance of short-term solutions like optimized gate usage, queue management, and dynamic scheduling in conjunction with longer-term remedies like investment in infrastructure and IT-enabled integration to sustainably enhance operational productivity and passenger experience.

## REFERENCES

- [1] Brueckner and Jan, “UC Berkeley ACCESS Magazine Title Airport Congestion Management: Prices or Quantities,” 2009. [Online]. Available: <https://escholarship.org/uc/item/8qs9k927>
- [2] J. P. Cohen and C. C. Coughlin, “Congestion at Airports: The Economics of Airport Expansions,” 2003. [Online]. Available: <http://www.bts.gov/>
- [3] J. Bao, J. Kang, J. Zhang, Z. Zhang, and J. Han, “A dynamic control method for airport ground movement optimization considering adaptive traffic situation and data-driven conflict priority,” *J Air Transp Manag*, vol. 124, Apr. 2025, doi: 10.1016/j.jairtraman.2025.102753.
- [4] Y. Jiang, Q. Xue, Y. Wang, M. Cai, H. Zhang, and Y. Li, “Traffic congestion mechanism in mega-airport surface,” *Physica A: Statistical Mechanics and its Applications*, vol. 577, Sep. 2021, doi: 10.1016/j.physa.2021.125966.
- [5] S. P. Yang, T. Q. Tang, T. Wang, and L. Chen, “How to Improve the Efficiency of Check-In Counter: A Counter-Sharing Method,” *J Adv Transp*, vol. 2023, 2023, doi: 10.1155/2023/4484202.
- [6] C. Oprea *et al.*, “Analyzing Passenger Flows in an Airport Terminal: A Discrete Simulation Model,” *Computation*, vol. 12, no. 11, Nov. 2024, doi: 10.3390/computation12110223.
- [7] M. H. Lin, “Airport congestion pricing and capacity: Cost recovery with per-flight or per-passenger charges,” *Economics of Transportation*, vol. 42, Jun. 2025, doi: 10.1016/j.ecotra.2025.100410.
- [8] Y. Huai, E. Lee, H. K. Lo, and A. Zhang, “Airport charge, terminal capacity, and suggested airport arrival time: Considering non-aeronautical business,” *Transportation Research Part B: Methodological*, vol. 196, Jun. 2025, doi: 10.1016/j.trb.2025.103222.
- [9] Graham Anne, “Managing Airports An international perspective,” 2018.
- [10] Y. Wan, C. Jiang, and A. Zhang, “Airport congestion pricing and terminal investment: Effects of terminal congestion, passenger types, and concessions,” *Transportation Research Part B: Methodological*, vol. 82, pp. 91–113, Dec. 2015, doi: 10.1016/j.trb.2015.10.006.