武蔵野大学

Taxiway Optimization for Runway Duplication at Fukuoka Airport

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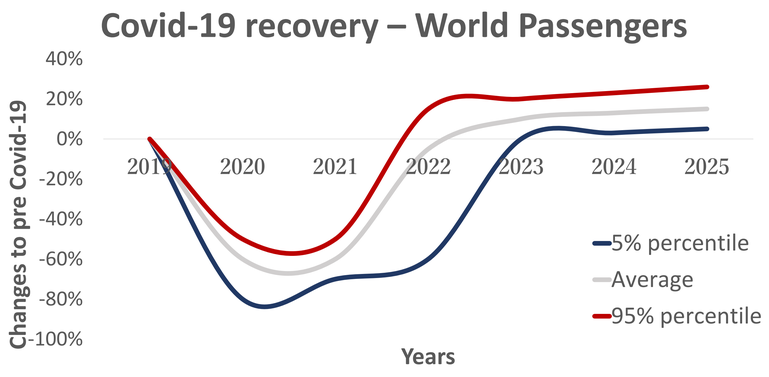
MY SHA
~Taxiway Optimization Program~

Background

Aviation demand, which declined during the COVID-19 pandemic, is expected to fully recover to pre-pandemic levels by 2023 and continue to further increase. Therefore, there is a need to improve the efficiency of air traffic control in addition to airport capacity. Particularly, congestion among aircraft is an important problem. In recent years, NASA and the FAA have initiated research on this topic to improve the efficiency of ground transfers and departures at airports.



Purpose of the Study

Fukuoka Airport, which is to be optimized for this project, is one of the most congested airports in Japan per runway, and delays in takeoffs and landings are considered a problem. In addition, since **an additional runway will be added in 2024**, the optimization of the new runway was considered. In this study, we will address route optimization and taxiway operation at regular intervals for Fukuoka Airport, which will have an additional runway. We will also work to **reduce exhaust emissions** by decreasing the number of stop sections.

Why I chose Fukuoka APT

Fukuoka Airport is not a hub like JFK and Atlanta Airport. **So why did we choose it?**

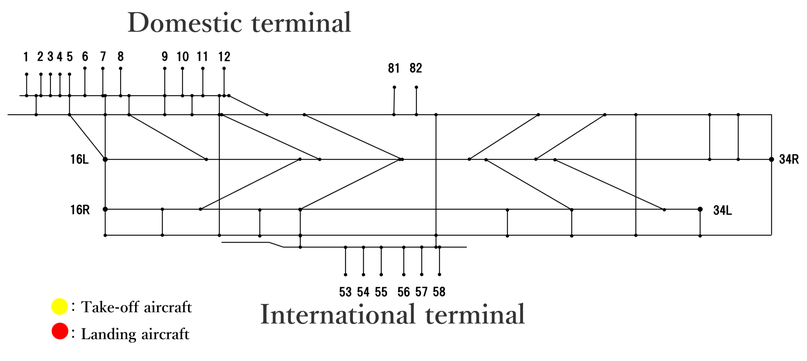
1. When we started this research, we wanted to start with an airport that had a simple taxiway, not one that was spread out like a spider's web.
2. There will be two runways instead of one.
3. The most takeoffs and landings per runway per day of any airport in Japan.

Methods

First, distance data for taxiways at Fukuoka Airport was obtained using Google Maps.
Based on this data, **the Dijkstra method** and **queueing theory** are used to find the shortest taxiway route, and a program is constructed to head to an open runway while maintaining a certain interval between runways, making it possible to calculate the time for aircraft to leave the boarding gate, delay time, and to present a new timetable for takeoff and landing aircraft.

The Dijkstra method used here is an algorithm for solving the single-start shortest path problem, where the starting point is a point on a graph.

Queueing theory is a model designed to analyze waiting times. It answers the simple question of a person trying to get in line: "How long do I have to wait?".



※ Fukuoka Airport Based on route optimization and output timetable

※ A graphical representation of Fukuoka Airport in using the Dijkstra method.

Result

The criteria for an airport to determine that on-time departures and on-time landings have not been achieved is when an aircraft is **15 minutes or more late**.

In 2022, Fukuoka Airport has an on-time departure rate of 90.59% and an on-time landing rate of 90.76%. This study has shown that, assuming passengers are present at departure time, the on-time departure rate is 100% and the on-time landing rate is also 100%, meaning that delays for **all aircraft can be reduced to less than 15 minutes**. In addition, since the program is designed to maintain a constant interval between flights, **traffic congestion on taxiways is reduced to zero**, and passengers are less likely to feel anxious that *the aircraft will not take off*.

Discussion

We believe this program will allow us to do this.

- No need to stop at taxiways, eliminating the need for energy to move forward again and contributing significantly to emissions reductions.
- It can be used for all airports where runways do not intersect by changing the distance data between nodes. If runways are crossed, this can be handled by changing the variable for the interval at which the runways are used.
- If an emergency occurs at an airport, the timetable can be re-presented by sealing off routes (eliminating weights between nodes) or adjusting intervals.
- It can reduce the workload on air traffic controllers.

Deliverables

Visualized timetable

Summary and Copy of this Poster

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