Manpower Optimization of Mobile Cleaning Teams at Airside

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ESD
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Changi Airport Group (CAG) is the manager of Singapore Changi Airport, a leading air hub in Asia. CAG performs the key functions of airport operations, air hub development, retail and commercial activities, infrastructure development and airport emergency services.[1]

Problem Statement:

An gradual ramp-up of flights is expected as COVID restrictions are slowly being lifted. There is a need to create a model to optimize the amount of manpower resources needed to :

1. Respond to and clear the FOD (Foreign object debris) bins or smart bins at the airside.

2. Perform sweeping and litter picking at the aircraft stands and airside roadways.

Methodology:

1. Setting up of Variables

Coming out with variables needed for our optimization model which will be done on Excel, solved using Data Solver.

2. Data preprocessing

- Sorting and cleaning of data such as flight volume, coordinates of the stands, distances between each stand, time taken to check and clear the bins.

- Using SQLite, Excel and QGis.

3. Regression Modelling of Variables

- Model the relationship between the rate of bins filling up (that smart bins can track) and the flight volume.

4. Building of 1st Optimization Model

- Setting up of constraints and assumptions
- Without smart bins to track the rate of bins filling up.

5. Final Optimization Model

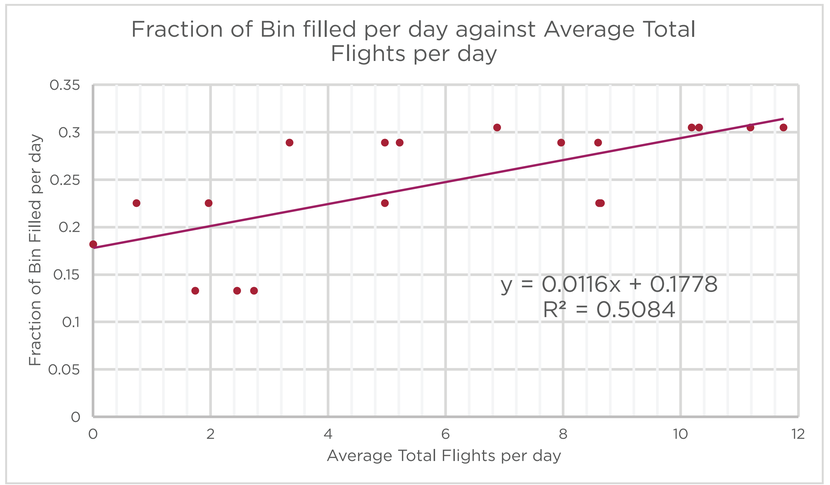
- Adding in smart bins, which allow us to track the rate of bins filling up and using our regression model to predict the rate of bins filling up based on flight volume.

6. Evaluation of the Model

- Limitations of our model based on the assumptions made.

Regression Modelling

A linear model best describes the relationship between the fraction of bin filled and the average total flights per day.



Final Optimization Model

Step 1

Monthly
Monthly Flight Volume for each Area

Daily
Daily Flight Volume for each Area

Daily
Fullness of Bin per day for each Area

Step 2

- Client/User can change the parameters of the model:
  - i) Number of stands or bins opened per area
  - ii) Number of rounds by workers per day
  - iii) Checking and Clearing Timings per bin, current assumption: 2 minutes and 4 minutes (if fully filled) respectively
  - iv) Total (Includes non-working) Hours per shift
  - v) Working Hours per shift
  - vi) Average Flight Volume per day for the month

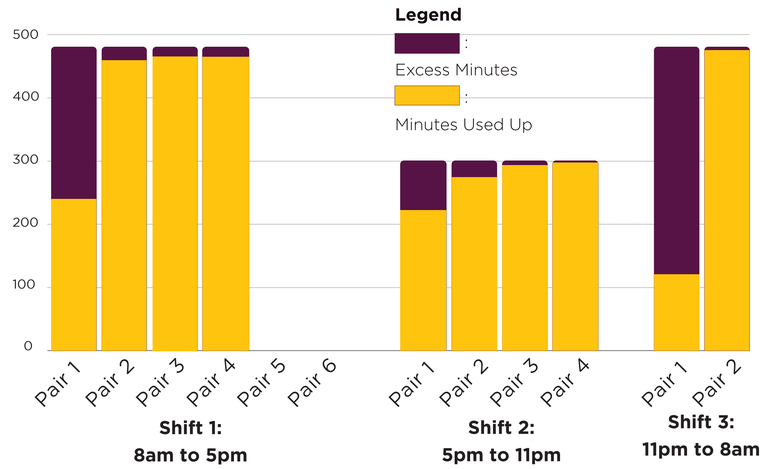
Step 3

- Sum up the clearing time per bin based on the fullness of bin, checking time per bin, travel time between each bin for each area and each shift (for a round).

Step 4

- Consider the total time taken per pair per shift and optimize the number of pairs such that the excess time per pair is minimum. Such that a pair would cover a greater number of areas (lesser excess time per team). Remaining excess time used for sweeping tasks. For example, November 2019: Currently, 6, 4, 2 pairs of workers for each shift respectively.

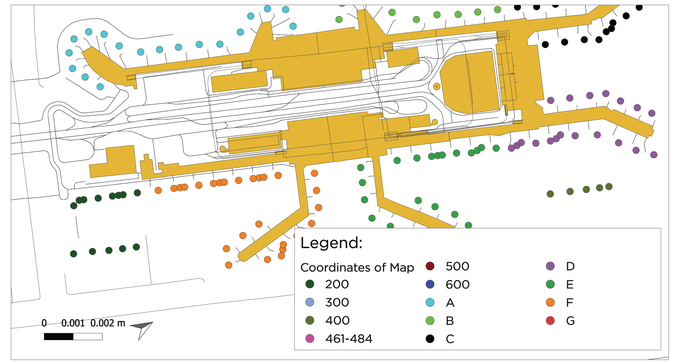
After Optimization: 4, 4, 2 pairs of workers needed (shown below). Helped to reduce manpower cost of 2 pairs of workers.



Limitations

1. Limited number of points for regression modelling.

2. QGis Distance Matrix: Linear Distances. However, in reality the travelling path between stands (dots on the map) may not be linear, which would differ the travelling time calculated.



3. Does not take into the account that if flight volume is very high, more than the current number of teams is required.

1: https://www.linkedin.com/company/changiairportgroup/