Airport Diagnostics and Evaluation Tool

IE3100 Systems Design Project
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CHANGI airports international

Problem Overview

Company Background
Changi Airports International (CAI) is a leading consultant, manager and investor in the global aviation market. CAI designs integrated solutions that enable its clients and partners to fulfil their potential of being world class airports. Singapore Changi Airport's outstanding business performance, operations and infrastructure have attracted numerous requests for aviation consultancy services from overseas airports.

Problem Description
CAI, as an airport consultant, is regularly required to benchmark an airport's performance and provide data-driven bases for the recommendations that they provide to their clients. In doing so, it bases its recommendations on three airport drivers that all airports have in common:
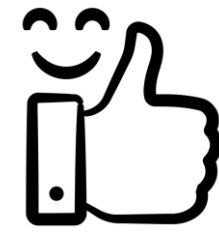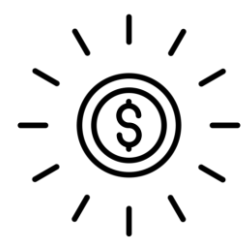
1.Operational Expenditure 2.Passenger Satisfaction 3.Commercial Revenue.

Objectives
CAI has yet to find what factors link all three drivers together as well as how they correlate to each other. As such, the aim of this project is to establish a data analytics system for the purposes of an airport evaluation:
1. Automate data extraction and cleansing
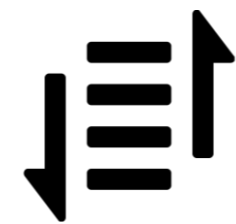2. Establish the relations between and within the 3 airport drivers

Methodology

Translation
CAI works with many airports from various countries, they receive reports in many different languages.
- Translated Portuguese to English

Sorting
The reports contain many data that may not be required.
- Manual sorted Chart of Accounts (COA)
- Cleansed Monthly Financial report
- Cleansed Airport Service Quality (ASQ) report

Analysis
- Histogram Analysis
- Linear Regression Analysis
- Coefficient of Determination (R^2)
  - shows goodness-of-fit
  - using R Studio

Visualization
The relationships and trends in the data can be illustrated with:
- Neo4j
- PowerBI

Data Cleansing & Extraction

Robotic Process Automation (RPA)
✓ develops the action list
  - by watching the execution of the task with the graphical user interface (GUI)
✓ automates the manual process
  - by repeating the tasks in the GUI
✓ cuts down on manpower requirements
✓ more user friendly to learn from scratch
✓ ease of maintenance and sharing of the system by CAI
✓ many readily available software
  - Blue Prism, UiPath, Automation Anywhere

UiPath
This project uses UiPath due to its systematic structure.
1. Identify
   - location of files
2. Extract
   - data from the various files
3. Consolidate and Output
   - data in a single file
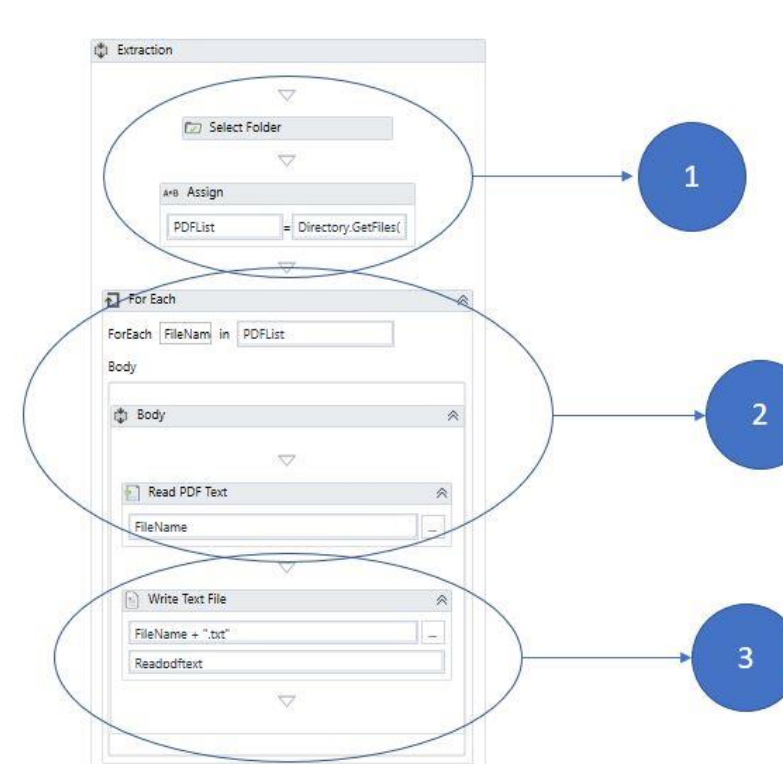
Work Done to Date
1. Web Page
2. PDF Scraping
3. Output files of .csv and .txt
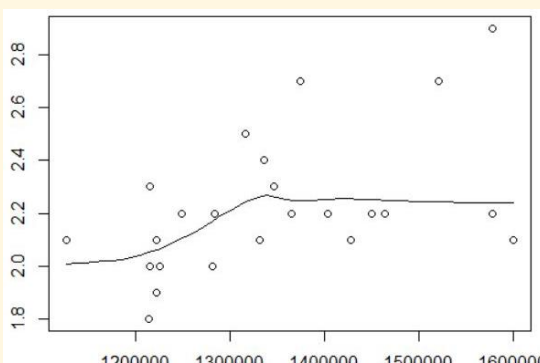
Future Exploration
1. Selective Scraping
   - isolate elements then scrape
2. Automated language translation
3. Optical Character Recognition (OCR)
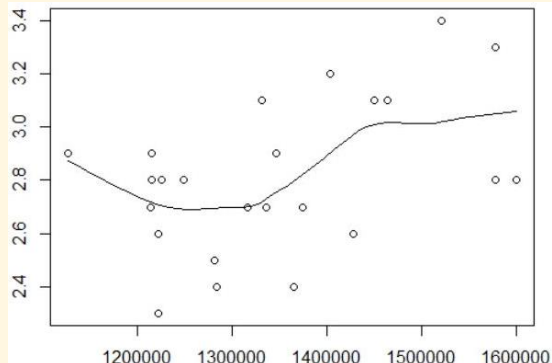
Airport Drivers Correlation

Commercial Revenue

Correlation between factors within Commercial Revenue (Top 2 Factors)

F&B vs Total Pax
$R^2 = $ **0.216**

Fuel vs Total Pax
$R^2 = $ **0.171**

Passenger Satisfaction

Correlation between factors within Passenger Satisfaction

Survey questions used 30 factors to measure overall Passenger Satisfaction. Weightage of each factors was calculated with $Y = a_1X_1 + a_2X_2 + ... + a_{30}X_{30} + C$

Survey asked passengers to rank their own personal most important factors.

ACTUAL Most Important Factors

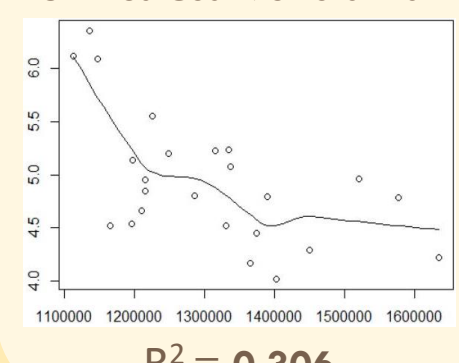|	2016	2017	2018
1st	Ambience of Airport	Ambience of Airport	Ambience of Airport
2nd	Comfort of waiting/ gate areas	Comfort of waiting/ gate areas	Comfort of waiting/ gate areas
3rd	Availability of washrooms/ toilets	Cleanliness of airport terminal	Cleanliness of airport terminal

PERCEIVED Most Important Factors

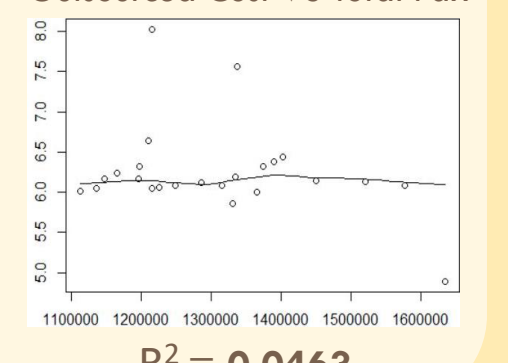|	2016	2017	2018
1st	Waiting time check-in queue/line	Waiting time check-in queue/line	Waiting time check-in queue/line
2nd	Ease of wayfinding	Ease of wayfinding	Ease of wayfinding
3rd	Feeling of being safe and secure	Internet access/Wi-Fi	Feeling of being safe and secure

Operational Expenditure

Correlation between factors within OPEX
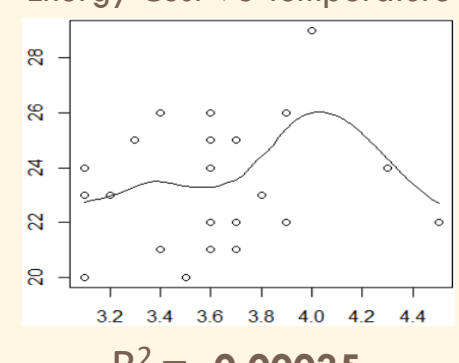
Utilities Cost VS Total Pax
$R^2 = $ **0.306**
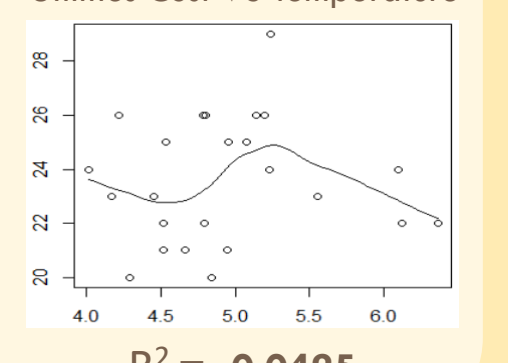
Outsourced Cost VS Total Pax
$R^2 = $ **0.0463**

OPEX VS Temperature

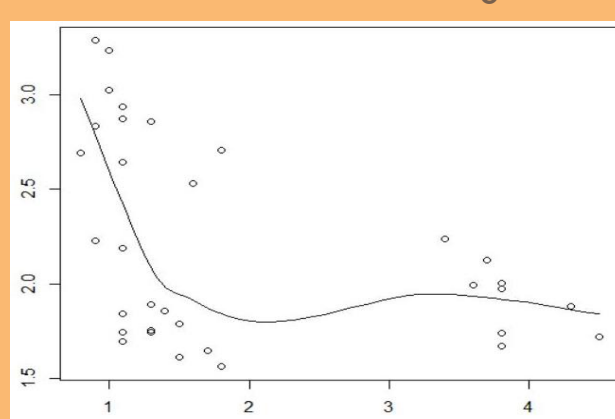Energy Cost VS Temperature
$R^2 = $ **-0.00035**

Utilities Cost VS Temperature
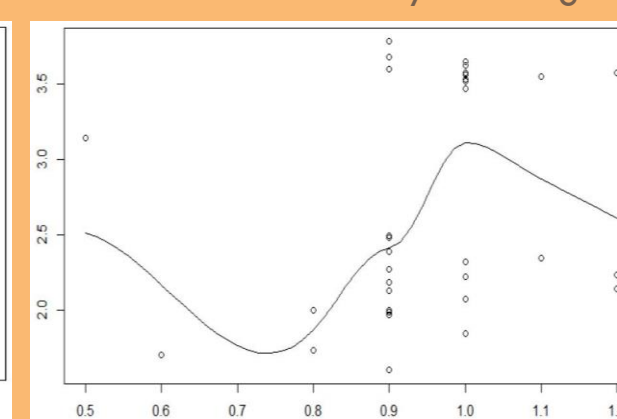$R^2 = $ **-0.0425**

Commercial Revenue VS Passenger Satisfaction (Top 3 Factors)

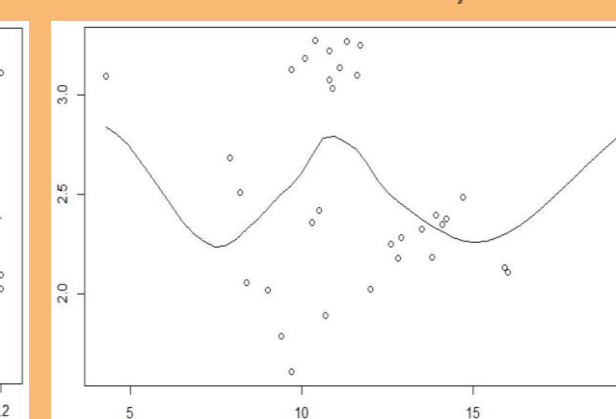Parking/Value-for-Money Parking VS Revenue from Parking
$R^2 = $ **0.145**

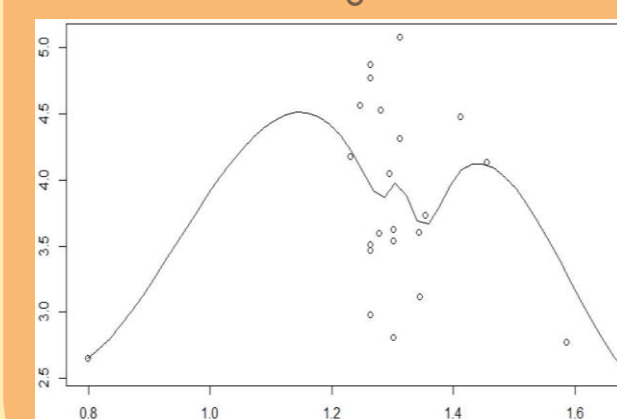Availability of bank/ATM facilities/money changers VS Revenue from Money Exchange
$R^2 = $ **0.0156**

Shopping Facilities/Value-for-Money Shopping facilities VS Revenue from Duty Free
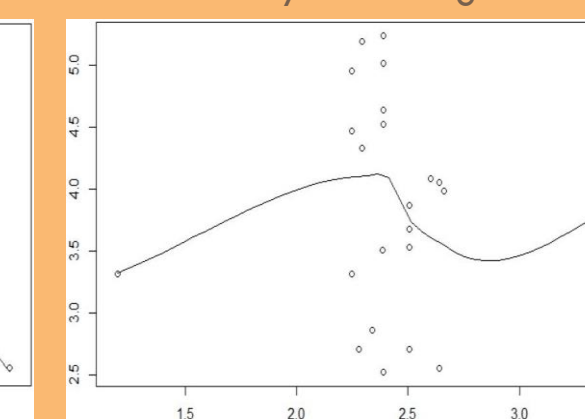$R^2 = $ **-.0209**

Passenger Satisfaction VS Operational Expenditure (Top 3 Factors)
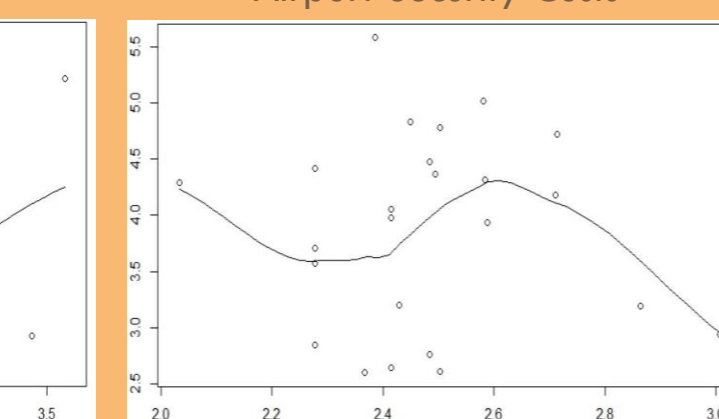
Cleaning Score VS OPEX from Cleaning Costs
$R^2 = $ **-0.0413**

Security Staff and Inspection VS OPEX from Security Screening Costs
$R^2 = $ **-0.0447**

Courtesy and helpfulness of Security Staff VS OPEX from Airport Security Costs
$R^2 = $ **-0.0411**

Visualization

neo4j
✓ graph database management system
✓ designed for optimizing fast management and traversal of nodes and relationships
✓ highly scalable and native graph database
✓ delivers constant real-time performance

Power BI
✓ forecasting capability
✓ real-time access to information
✓ identify trends and potential issues early
✓ with advanced analytics integration through R scripts and visuals

Recommendations

1. Modify the survey questions
   - Be more specific
   - Ask follow-up questions

2. Experiment with non-linear models
   - Linear model may not be the best fit model for the 3 drivers