Development of Optimisation Tool for Local Freight Service

DEPARTMENT OF INDUSTRIAL SYSTEMS ENGINEERING & MANAGEMENT

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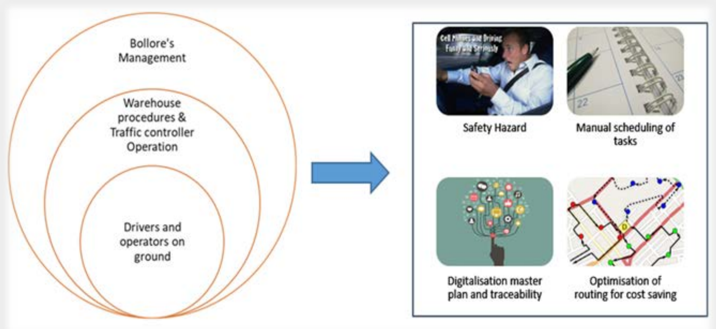
Abstract: Bolloré Logistics is interested in developing an optimisation tool for its local freight pickup and delivery services The current allocation of trucks to complete the pickup and delivery services are completely manual Besides the need for an optimisation model, it was identified at a later stage that there were certain operational issues affecting the efficiency of the transportation service Such as ineffective dissemination of job orders from Traffic Controllers to Drivers and primitive communications methods that pose safety issues to Drivers An integrated solution including frontend (Web and mobile application) and backend (database and optimisation model) is developed to solve the problems identified The integrated solution is validated both qualitatively and quantitatively with Bolloré and academic supervisor Comparison of results has also shown that the proposed solution is capable in reduction of leftover orders thus resulting in cost savings for Bolloré

Problem Description

A 3-pronged approach through a top down analysis was conducted to understand in depth the Logistic issues faced by Bolloré Logistics The approach, which analyses problem from the perspective of multiple stakeholders

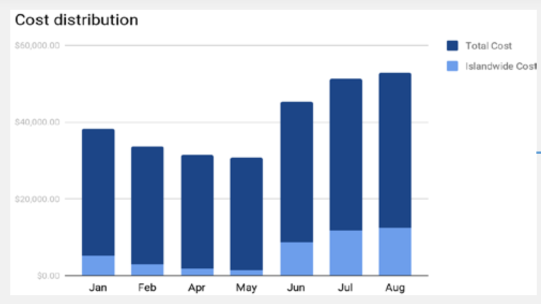
Preliminary Analysis

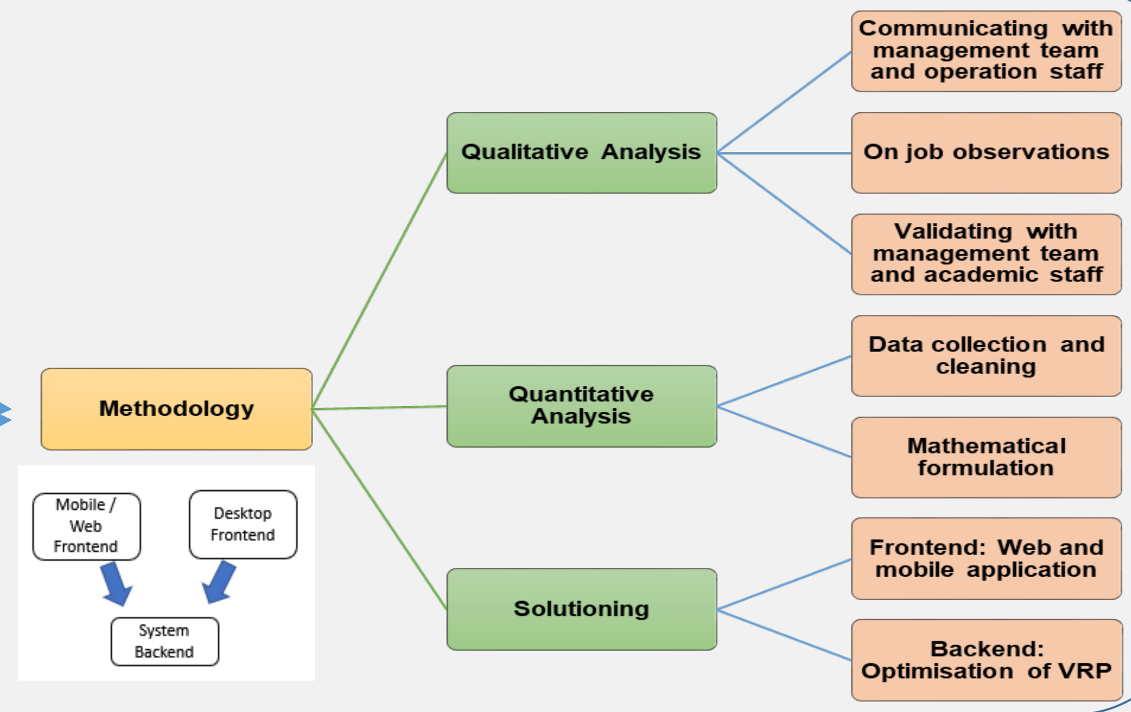
1. Stakeholder Analysis
2. On-Site Analysis
3. Operation's Process Analysis



Costing Analysis

1. Fixed costing for Dedicated Truck
2. Variable Costing for Island-Wide Truck



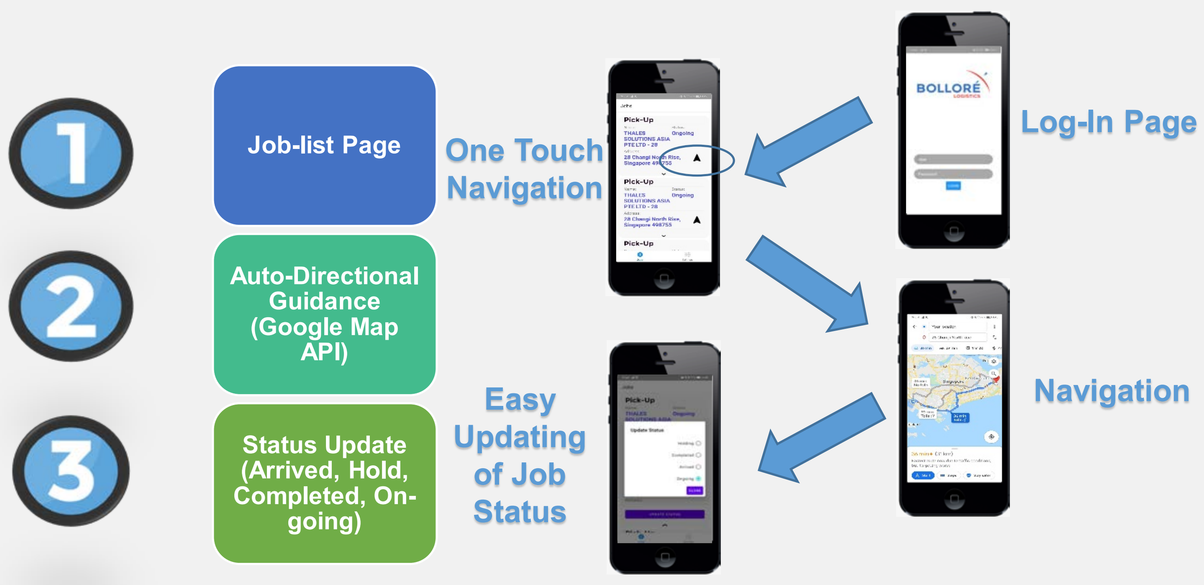


Deliverables

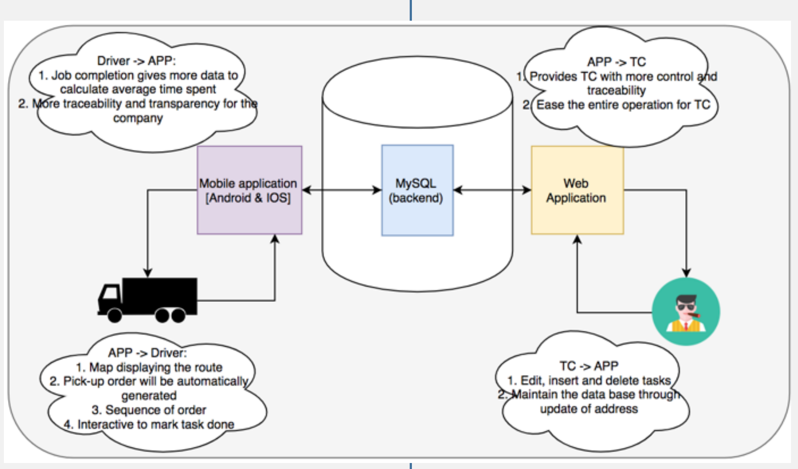
Mobile-App

Functional Requirements of Truck Drivers

1. Access to GPS navigations for each destination
2. Notify and update the Traffic controller the status of a job



Font End

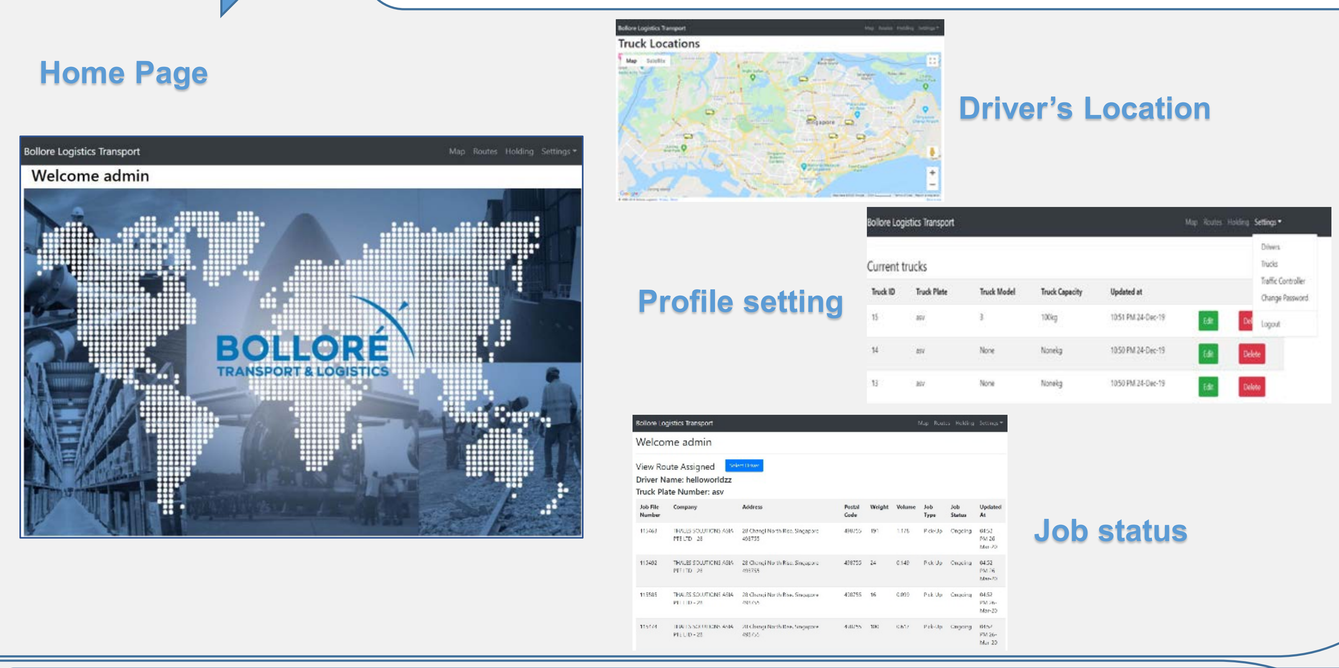


Back End (Management)

Web-Page

Functional Requirements of Traffic Controllers

1. Keep track every driver's current location to better manage the drivers during transport operations
2. Access a centralised database for storage of delivery and pickup status to facilitate assignment of jobs to drivers



Objective for Bolloré Logistics

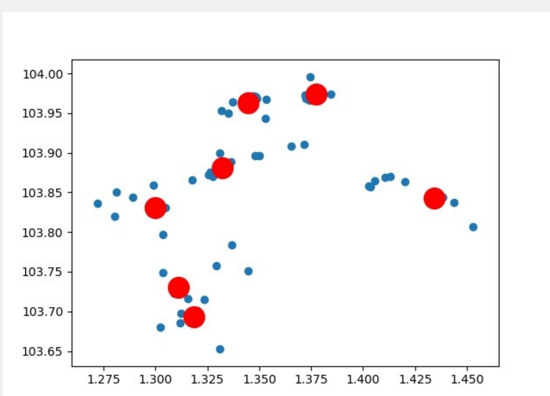
Maximise the total weight of jobs served by Bolloré fleet of trucks

Optimisation Model

Weighted K Means Clustering

- Weighted K Means used to cluster customers by their address
- Total weight of parcels in each cluster is balanced with the weighted function
- Each truck in Bollore's fleet will be assigned a cluster

Example of Clustering Results

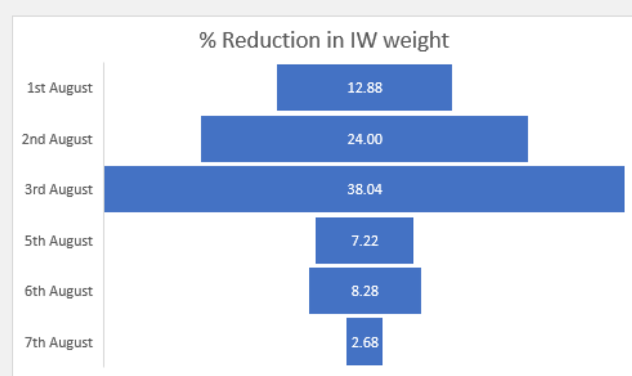


K-Iteration Routing for Each Cluster

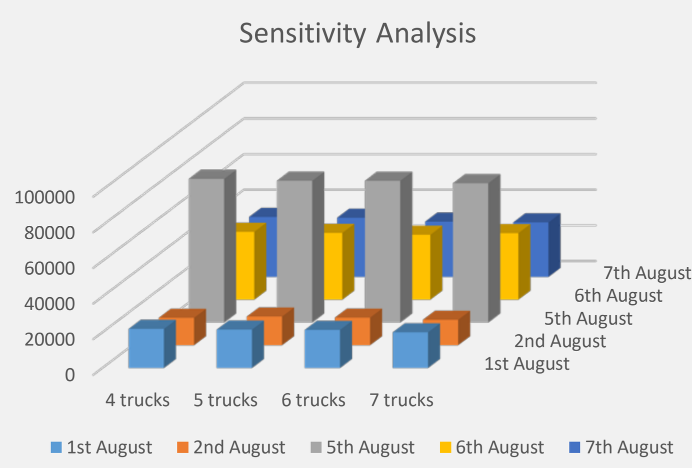
1. Standardisation of Weight, Volume and Number of Pallets for all nodes (node characteristic - min characteristic) / (max characteristic - min characteristic)
2. Calculate standardisation index for all nodes (06 x standardised weight) + (02 x standardised volume) + (02 x standardised number of pallets)
3. Select k nodes with the best standardization index and randomly select one
4. Perform capacity check to see if truck can travel to selected node
5. Repeat step 1 to 4 for the entire kth iteration to generate 1 solution
6. Perform steps 1 to 5 for K times to generate K solutions
7. Select the solution that picks up the heaviest total parcel weight

Results

Reduction of weight across all days



Sensitivity analysis by varying number of trucks



- Successful in reducing the weight collected by the islandwide truck
- Varied the number of trucks in operation
- Bolloré can make use of the results collected in the long term to determine number of trucks to rent for each season

Validation

Qualitative Validation

- On job training to observe entire operation
- Identify operation constraints and check accuracy with Bolloré management team
- Created heuristic model and consult with ISE academic staff

Quantitative Validation

Date Simulated	Total Original Weight for Pickup and Delivery (in kg)	Total Weight Accounted for in Model (in kg)	Difference:
01/08/2019	3090395	3098395	80*
02/08/2019	2194538	2194538	0
03/08/2019	107433	107433	0
05/08/2019	95350615	95350615	0
06/08/2019	5029788	5029788	0
07/08/2019	40097838	40037838	60*

*Differences are due to missing job weights which are replaced by a dummy weight of 20kg

- Weight inputted into equals to weight outputted

Learning Points

- Project management: Agile methodology
- Operation Research : Process mapping & optimisation
- Programming languages: Python, Javascript, HTML, CSS
- Utilisation of libraries: CPLEX, sklearn, Flask, AWS, MySQL and React Native

Limitations & Recommendations

Limitations

- Model highly dependent on accuracy of data inputted
- Assumptions made can result the modelled service time to differ from the actual service time
- Model is unable to handle dynamic insertion of jobs

Recommendations