Customer-centric transportation network modelling

Agent-based modelling in PwC (Australia) Insight Analytics

November 2014
Introduction

Public Transportation Services across Australia are undergoing transformation driven by:

- a need for inter-modal integration

  Change in demographics affecting existing understanding of capacity

- major infrastructure investment

  Approximately $50 billion (Federal) over the next 5 years

- change in customer information collection

  Previously done using surveys of sales figures, spot passenger enter/exit counts, CCTV footage
Smart cards
A better view of Customer Experience
Objectives
## Project Objectives

Customer Centric view of Infrastructure

### Project Aims in support of customer focus in decision making

- **Capability to understand the potential number of customers impacted by an incident**

- **Capability to take a network view of incidents instead of an individual incident view, in order to understand network behaviour when incidents occur.** This builds a capability to forecast network behaviour at a high-level, in the event of future incidents.

- **Providing customers with more accurate predictions of the potential incident related delays depending on where they are on the network, irrespective of geographic location and time of travel;**

- **Enabling evidence based operational and maintenance decisions about predicted response times, allocation of resources, and prioritisation of incidents; and improvements in the root cause analysis of incidents;**

- **Identifying specific incidents upon which to perform root cause analysis, e.g. why certain incidents always occur more at a particular location or on a particular type of rolling stock type.**
Project Objectives
Metrics to support Customer Centric Decision Making

A potential enabler of customer centricity is the ability to understand the impact of delays (and other network activity) on the customer population through a Lost Customer Minutes measure.

Definition:
Lost customer minutes (LCM) is an estimate of the sum of the delays for all journeys within the network.

Concept originated from QoS measures in Utility Service Delivery (e.g. electricity, water)
Network Model
AnyLogic
Flexible tool for a complex domain

There is a clear need to combine Discrete-Event and Agent-Based modelling approaches:

• Existing tools aren’t customer-oriented but train-oriented
  
  *Tools such as RailSys and OpenTrack are great but train-centric*

• Customers are individuals with motivation

  *Transportation services are used as part of daily economic activity*

• Systems are evolving in response to customers’ needs

  *Customer satisfaction drives revenue*

AnyLogic addresses issues of existing model re-use, representation of customer agency and model scalability.
## Model Description

### Data Sources

<table>
<thead>
<tr>
<th>Category</th>
<th>Data Item</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Layout</td>
<td>Signals</td>
<td>Existing GIS data set</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Driver Route Diagrams</td>
</tr>
<tr>
<td></td>
<td>Track geometry (incl. junctions and sidings)</td>
<td>OpenStreetMap and Government GIS sources.</td>
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<tr>
<td></td>
<td>Stations and platforms</td>
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</tr>
<tr>
<td>Train Data</td>
<td>Train set types</td>
<td>Operator</td>
</tr>
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<td></td>
<td>Capacity (per carriage)</td>
<td>Passenger fleet rolling stock diagram book</td>
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<tr>
<td>Timetable</td>
<td>Timetable (route, train type, number of carriages)</td>
<td>Train Planning team</td>
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<td>Operating Rules</td>
<td>Operating rules to recover the network</td>
<td>Discussions with Operator</td>
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<td>Operating rules in hot weather</td>
<td>Speed restriction data</td>
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<tr>
<td>Incident Data</td>
<td>Types of incidents</td>
<td>Operator</td>
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<tr>
<td>Passenger Data</td>
<td>Smart card data</td>
<td>Government Agency</td>
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<tr>
<td></td>
<td>Existing usage statistics</td>
<td>Publicly Available</td>
</tr>
</tbody>
</table>
Model Implementation

Our own TrainMoveTo
**Model Implementation**

Lost Customer Minutes calculation

LCM measure is based on the variance from the scheduled arrival time multiplied by the number of customer who alight at a given station.

Scenario 1: Late departure time, recovery during journey

Scenario 2: On time departure, delay experienced during journey

Scenario 3: Late departure, no recovery during journey
Model Description

User Interface
Model Outputs
**Model Outputs**

Train Graph

**The train graph and network animation show:**
- where trains are on the network
- whether trains are running to the timetable
- whether trains are able to make the return journey
**Model Outputs**

Network Incident Graph

The network incident graph shows:

- Incident count and duration
- Incident recovery*
- Trains & customers affected
- Lost Customer Minutes build-up

*Recovered from an incident is considered to be when all trains are back to timetabled operations
Model Outputs
Network Incident Graph

Incidents, trains delayed, and customers delayed

Shading legend
- Normal operation
- Recovering from incident(s)
- Incident(s) occurring

Line 1

Incidents Chart Customers at Stations Bar Up Down Lost Customer Minutes Chart

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**Model Outputs**

Compare Strategies – Network Incident Graph

**Questions being addressed**

What is the impact of various response strategies?

How long do recovery crews have to clear an incident before the network is dramatically affected?

Which incident should be prioritised if multiplied incident are occurring?

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**Strategy A**

1. Difference in Initial Incident delay

**Strategy B**

2. Impact on network recovery time

3. Impact on Customer Hours Lost

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Model Outputs
Customers at Station

The network view of customers at stations shows:

• The number of customers currently waiting at station on the network (including their direction of travel)
• The number of customers on each train between stations on a given line
**Model Outputs**

**Individual Train View**

**Train Graph**

**Customer Count**

Individual train outputs show:

- the number of customers on the train and their destination station
- If, where and when the train has experience any delay on its journey
Outcomes
Lost Customer Minutes
Comparison of train-centric vs customer-centric

Lost customer minutes

Option 1 - Predictive Model
Option 2 - Timetable Perspective
Option 3 - Mean Headway
Option 4 - Customer Perspective
**Project Impact**
Advance Understanding of Customer Experience

**Customer information KPIs**
- Customer information to estimated lost customer minutes

**Organisational KPIs & targets**
- Having one customer focussed delay metric enables the organisation to create customer focused metrics and targets.

**Lost Customer Minutes enables…**

**Business decision appraisal**
- Decisions can be evaluated according to its estimated impact on the customer and appraised accordingly in a consistent manner.

**Investment prioritisation**
- Investments can be evaluated according to their estimated impact on lost customer minutes.

**Customer focused response to incidents**
- Incidents can be prioritised according to their potential impact on customers.

**Incident impact measurement**
- Incident can be measures consistently against a customer focused framework.

**Investment prioritisation**

- Customer information KPIs

**Customer focused prioritised response to incidents**

- Lost Customer Minutes enables…

**Organisational KPIs and targets**

- Business decision appraisal

**Customer information KPIs**

- Customer focused response to incidents
Future work

Add other forms of transportation

Extend customers into pedestrian domain

Extend representation of current and future network assets and rules
Questions