ANALYSIS OF THE TRUCK TRIP
GENERATION CHARACTERISTICS
OF SUPERMARKETS AND
CONVENIENCE STORES

Janice Asuncion1*, Dr. Shannon Page2, Dr. Rua Murray3, A/Prof. Susan Krumdieck1,
Department of Mechanical Engineering, University of Canterbury
Faculty of Environment, Society and Design, Lincoln University
Department of Mathematics, University of Canterbury
INTRODUCTION
Significance and Rationale of the Study

WHAT IS TRUCK TRIP GENERATION (TTG)?

- Used to understand the impacts of truck traffic on congestion and the environment.
- TTG for firms
  - GOAL: reduce the total costs of transport and operations and maximise profits.
WHY SUPERMARKETS?

- Supermarkets (and convenience stores) are ubiquitous features of the urban and suburban landscape.
- High turnover of goods.
- Most residents living in the city don’t like trucks!

FACTORS USED TO DETERMINE TTG FOR STORES (PREVIOUS STUDIES)

- Size of the store (gross floor area, retail area, etc.)
- Number of store employees
- Geographical location of the store
- Turnover of goods (proxy is used!)
PARTICIPANTS

- A survey and truck count study was conducted at 8 participating food retail markets in one town in New Zealand in May 2011.
- The participants are 4 supermarkets (S1, S2, S3, S4), 2 convenience stores (C1, C2), 1 bulk food store (BS) and 1 farmer’s market (FM).
DATA COLLECTION

- Survey of store managers about the physical and operational characteristics of their store
- 2 days manual truck counts
- Interview with drivers about origin of loading
PARAMETERS FOR STUDY

- Retail trading area
- Storage space
- Number of parking spaces
- Number of full-time equivalent employees
- Weekly operation hours
- Product variation score (*)

MEASURING PRODUCT VARIATION

- 6 commodities chosen:
  - Bread, jam, honey, oil, eggs, yogurt
- For each product, count the number of brands the store carries

Supermarket: high product variation

Convenience Store: low product variation
RESULTS

SIZE OF STORE STRONGLY AFFECTS TTG

R² - value : 0.92
'Very strong correlation'

R² - value : 0.84
'Strong correlation'
**PARKING SPACE AND EMPLOYEE COUNTS STRONGLY AFFECTS TTG**

![Graph showing the relationship between number of parking spaces and number of trucks generated.](image)

- **R^2 - value**: 0.91
- "Very strong correlation"

**PRODUCT VARIATION STRONGLY AFFECTS TTG**

![Graph showing the relationship between product variation score and number of trucks generated.](image)

- **R^2 - value**: 0.89
- "Very strong correlation"

**OPERATIONAL HOURS DOES NOT AFFECT TTG**

![Graph showing the relationship between number of hours and number of trucks generated.](image)

- **R^2 - value**: 0.30
- "No correlation"
## Trip Length Classification/Bins

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Origin of loading is &lt;= 20 km from the store</td>
</tr>
<tr>
<td>Regional</td>
<td>Origin of loading is 20 – 200 km away from the store</td>
</tr>
<tr>
<td>Long Haul</td>
<td>Origin of loading is &gt; 200 km away from the store.</td>
</tr>
</tbody>
</table>

## Truck Type Classification/Bins

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Small trucks ranged from private cars, cars with trailers, pick-ups, and vans</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium trucks ranged from 2, 3, 4-axle single units, 2-axle tractor 1-axle trailer, 2-axle tractor 2-axle trailer, and 3-axle tractor 1-axle trailer.</td>
</tr>
<tr>
<td>Large</td>
<td>Large trucks all those with a total of 5 or more axles.</td>
</tr>
</tbody>
</table>
TRUCK TYPE AND TRIP LENGTH DISTRIBUTION FOR THE STORES

Most trucks/vehicles are coming from local farms

A lot of trucks are coming from local warehouse/DC

Generates very few trucks but half are long-haul.

FREIGHT AND ENERGY
CALCULATING FUEL INTENSITY

Note: Calculations are based on just one link of the complex supply chain

ASSUMPTIONS

<table>
<thead>
<tr>
<th>Estimated Mileage Range of Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>Large</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid fuel conversion using Higher Heating Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
</tr>
<tr>
<td>Gasoline</td>
</tr>
</tbody>
</table>
ESTIMATED ENERGY CONSUMPTION FOR THE DELIVERIES

Note that calculations did not factor in trip chaining of the trucks and based on the interviews only 19% of trucks delivered to only 1 store and returned to its origin of loading.

FUEL INTENSITY OF STORES

Note: Using size as the proxy for tonnage of food delivered which potentially skewed the results for the Farmer's Market.
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

- Strongest factors determining TTG are:
  - Retail trading area
  - Parking space
  - Product variation score (new parameter)
- A framework for analysing freight energy consumption using TTG.
- The Farmer’s market model MAY have the lowest fuel intensity.
FUTURE WORK

- Consider trip chaining.
- Influence of the geographical location
  - Results may differ for towns of different size or geographical area
  - Current study is being undertaken on the influence socio-economic indicators of the market shed

ACKNOWLEDGEMENT

- This work is supported under Contract C01X0903, Towards Sustainable Urban Forms, National Institute of Water and Atmospheric Research Ltd. (NIWA).
Contact Information:

Janice Asuncion
Janice.Asuncion@pg.canterbury.ac.nz