# NEW ZEALAND INTERMODAL FREIGHT NETWORK AND THE POTENTIAL FOR MODE SHIFTING

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## 1. Introduction

The most prevalent mode of freight transport in New Zealand is by road. According to the New Zealand Business Council, freight volumes may increase by 70-75% over the next 30 years[1].

In light of peak oil and climate change issues, the sustainability of over-reliance on road freight is questionable. A shift to less energy intensive and lower emissions modes, such as rail and coastal shipping, may address these problems.

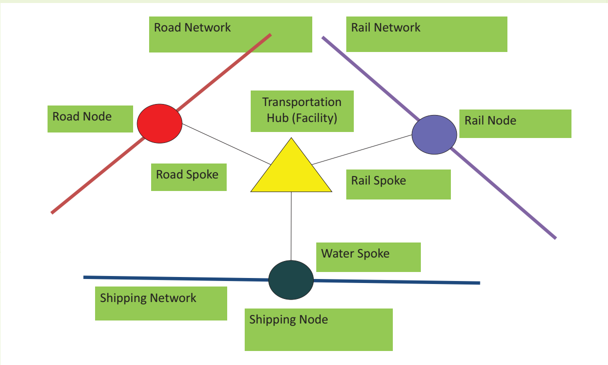
*State highway*

*Train station*

*Seaport*

## 2. Hub-and-Spoke Approach

The hub-and-spoke method is used in the development of the Geospatial Intermodal Freight Transportation (GIFT)[2] Network which is built using ArcGIS.




*The Hub-and-Spoke Approach in the Creation of an Intermodal Network*

This model solves optimal routes with cost or deterrence functions such as distance, time, operational costs as well as energy and environmental attributes on the network and spokes. Existing geospatial datasets from Land Information New Zealand are used together with synthesised datasets created by the authors.

*Construction of the Intermodal Network*

Cost functions on the network and spokes include geographical distance, time of delivery, transfer and operational costs, freight energy, and emissions such as $CO_2$, $PM_{10}$, $So_x$. These values are currently derived from US studies[2,3] but at present are being calculated for New Zealand.

## 3. Case Studies

Two scenarios are investigated:

**A.** Distribution of 1 TEU from Auckland to Wellington

| Route | Primary Mode | Total Time (hr) | Total Operational Costs ($) | Total Energy (MJ) | Total $CO_2$ (g) | Total $PM_{10}$ (g) | Total $SO_x$(g) |
|---|---|---|---|---|---|---|---|
| **Min Time** | Road | 7 | 462 | 4496 | 425,463 | 46 | 90 |
| **Min Operational Costs, Energy, CO2** | Rail | 17 | 419 | 1215 | 100,703 | 66 | 26 |
| **Forcing Ship Route** | Ship | 34 | 423 | 5812 | 470,972 | 441 | 1400 |

**B.** Distribution of 1 TEU from Auckland to Christchurch

| Route | Primary Mode | Total Time (hr) | Total Operational Costs ($) | Total Energy (MJ) | Total $CO_2$ (g) | Total $PM_{10}$ (g) | Total $SO_x$(g) |
|---|---|---|---|---|---|---|---|
| **Min Time** | Road | 21 | 917 | 8302 | 772,955 | 197 | 470 |
| **Min Operational Costs** | Ship | 45 | 570 | 7945 | 648,342 | 593 | 1887 |
| **Min Energy, CO2** | Rail | 37 | 867 | 3268 | 271,436 | 231 | 373 |

## 4. Modal Shift Benefits

The model was used to asses the benefits of increasing rail share for shipping Steel from Auckland to Wellington. Steel is non-perishable product, thus timeliness of deliveries may be traded for energy and emissions savings.

| | Current Road Share 80% | Current Rail Share 20% | Hypothetical Road Share 70% | Hypothetical Rail Share 30% | Savings |
|---|---|---|---|---|---|
| **Number of TEUs** | 3,692 | 923 | 3,231 | 1,384 | |
| Total Operational Costs (S) | 1,943,709 | | 1,925,113 | | **18,596** |
| Total Energy (MJ) | 16,456,286 | | 15,050,143 | | **1,406,143** |
| Total $CO_2$ (g) | 1,545,047,143 | | 1,405,864,286 | | **139,182,857** |
| Total $PM_{10}$ (g) | 214,286 | | 222,857 | | **-8,571** |
| Total $So_x$ (g) | 330,857 | | 303,429 | | **27,429** |

1. New Zealand Business Council. 2011. Future Freight Solutions: An Agenda for Action. *Technical Report from the New Zealand Business Council for Sustainable Development.*
2. WINEBREAK J. et al. 2008. Assessing energy, environmental, and economic tradeoffs on intermodal freight transportation. *Journal of the Air and Waste Management Association.*
3. COMER B. et al. 2010. Marine Vessels as Substitutes for Heavy-Duty Trucks in Great Lakes Freight Transportation. *Journal of the Air and Waste Management Association.*