Resilient and adaptable transport across modes: key enablers and existing barriers in New Zealand

Dr Cécile L’Hermite  
Senior Lecturer, University of Waikato, Waikato Management School

Dr Liam Wotherspoon  
Associate Professor, University of Auckland, Faculty of Engineering

Context
As illustrated by the 2016 Kaikoura event, earthquakes can cause severe disruptions in freight movements. To ensure supply chain continuity, businesses need to swiftly adjust their transport operations across routes and modes (e.g. from road to coastal shipping). Since disruptions to freight flows can be mitigated if more than one transport mode is used, integrated intermodal transport has long been recognised as a critical factor of transport resilience and the ability of commercial organisations to deal with shocks such as natural hazards. However, rapid modal shifts involve a significant level of coordination because modes operate differently and actors typically control only a part of the transport chain. Little is known about the ability of the New Zealand freight transport system to adapt and recover from a natural hazard. In particular, the factors influencing rapid modal shifts in the aftermath of such a disruptive event are not well understood. Therefore, this research investigates what facilitates/impedes the efficient reconfiguration of freight movements when an earthquake strikes New Zealand. In doing so, this project establishes an initial assessment of the mechanisms and strategies supporting modal shifts in the wake of a natural hazard and identifies a number of opportunities to achieve a more integrated transport network across modes in New Zealand.

Theoretical background
This research uses the principles underlying the innovative concept of synchromodality, defined as the real-time planning of freight movements and rapid shifting between transport modes to create efficient flows of goods. Synchromodality creates an extremely adaptable system with the transport modes and legs being the elements of a modular system that can rapidly respond to constraints and disruptions (Figure 1). However, synchromodality requires the various transport operations to be tightly integrated through the development of interfaces between modes and operators. The focus of this research is on the physical, digital and business interfaces that interconnect the various transport modes, make them fit together and, ultimately, support the building of adaptable and resilient supply chain networks.

Physical interfaces refer to the physical elements of the transport system (transport linkages, nodal points, vehicles, and standard load units).

Digital interfaces relate to the use of data and technology to support the ongoing collection and exchange of information needed to formulate new transport plans.

Business interfaces are the inter-organisational elements that increase interoperability and govern the relationships of the organisations interacting in the transport system.

Research questions
1. What physical, digital and business elements facilitate rapid modal shifts in the aftermath of an earthquake in New Zealand?
2. What physical, digital and business elements impede rapid modal shifts in the aftermath of an earthquake in New Zealand?

Qualitative research design and methodology
In order to ground this study in the New Zealand reality and to provide narrative support to the research topic, a case study approach was used, with the 2016 Kaikoura earthquake being the focus of the analysis. A total of 19 semi-structured interviews were conducted with 27 key informants from May to July 2020. To capture different stakeholder perspectives, various participants were interviewed, including policy makers, industry representatives, transport service providers (across all modes), seaports, users of freight transport (i.e. shippers/cargo owners), and the New Zealand Defence Force.

A thematic analysis of the interview transcripts was undertaken by using 10 a-priori categories identified from the existing literature. In particular, a coding framework based on the above-mentioned physical, digital and business interfaces was used to identify the key enablers and existing barriers to the development of a resilient and adaptable transport system across modes. Figure 2 illustrates this methodological approach.

Preliminary Findings

**Physical**
- A level of redundancy in the New Zealand road network
- Availability of coastal shipping capacity (domestic and international ships)
- Availability of airlift capacity (especially for perishables)
- Cargo unitisation and the use of shipping containers
- The rapid upgrade and use of the Spring Creek intermodal terminal (close to Blenheim)

**Barriers**
- Vulnerable infrastructure of the New Zealand smaller, domestic seaports
- Lack of relocation options for the Cook Strait Ferries
- Lack of rail transport services branching off the main trunk line
- Curtain-siders traditionally used for road transport in New Zealand
- International ships operating mainly from North to South
- Insufficient shipping capacity in New Zealand
- Inability to rapidly identify the transport capacity available across modes

**Digital**
- Truck drivers reporting ground information
- Ground information immediately shared with authorities
- Seaport information systems in place to deal with the influx of containers
- Electronic booking systems facilitating the management of changes in freight transport
- Lack of timely information about the accessibility of the transport network
- Fragmented freight tracking information
- Lack of advance demand information preventing efficient resource planning
- Complexity inherent in one-to-many customer communication (e.g. trucking company ↔ shippers/cargo owners)
- Lack of interoperable information systems leading to the use of manual processes and verbal information
- Advanced analytical tools (e.g. simulations, digital twin) insufficiently leveraged

**Business**
- Adjusted and coordinated transport schedules across modes
- Well-established industry contacts (e.g. with transport and logistics suppliers, government officials, etc.)
- Plug and play relationships with transport suppliers
- Transport operators rapidly making their own decisions (without any intervention from government departments)

**Barriers**
- Modes subject to different operational requirements and constraints
- Lack of understanding of the specific transport requirements of each mode
- Irregularity and uncoordinated services provided by international shipping lines calling at New Zealand ports
- Four-fold increase in the regulated charges established by the Commerce Commission
- Lack of trust and reticence to engage with competitors in a whole market solution

Case study presentation: 2016 Kaikoura earthquake

**What happened?**
- On 14th November 2016, a 7.8-magnitude earthquake struck the north-eastern part of the South Island of New Zealand and was followed by multiple severe aftershocks.
- Major transport routes were closed immediately after the event, including sections of State Highway 1 and of the Main North Line railway.

**How was transport adjusted?**
- The Kaikoura event changed the broader transport patterns between the two islands and around the upper South Island of New Zealand.
- Rapid modal shifts occurred (e.g. from road to rail between Blenheim and Christchurch; from road to coastal shipping between Auckland and Christchurch).

**Data collection: case study/interviews**
- 19 semi-structured interviews with 27 key informants
- Focus: 2016 Kaikoura earthquake

**Data analysis: thematic analysis**
- Coding framework based on 10 physical, digital and business interfaces

**Outcome: identification of key enablers and existing barriers**
- to the development of a resilient and adaptable transport system across modes

Conclusion
This study shows that New Zealand transport operators are able to rapidly find the most optimal alternative solution when a disaster strikes and disrupts freight movements. From this perspective, the New Zealand transport network as an adaptive system is able to swiftly respond to changes in its environment and to rapidly reconfigure the movements of goods across routes and modes. However, the research also highlights a number of vulnerabilities in the New Zealand transport network and the following two issues:

- The need for a system view that integrates all modes and their respective constraints, and provides a holistic and modular approach to transport that goes beyond individual operations and individual modes;
- The importance of building redundancies at all levels: infrastructure (e.g. seaports), routes (including alternative ones), modes, equipment (e.g. cargo containers), safety stock (less reliance on just-in-time deliveries).

Acknowledgements
This research is supported by a proposal development grant awarded by Te Hiranga Rū QuakeCoRE.