Intermodal freight transport in the wake of an earthquake: key enablers and existing barriers in New Zealand

Cécile L'Hermitte

University of Waikato

Waikato Management School, Hamilton

Liam Wotherspoon

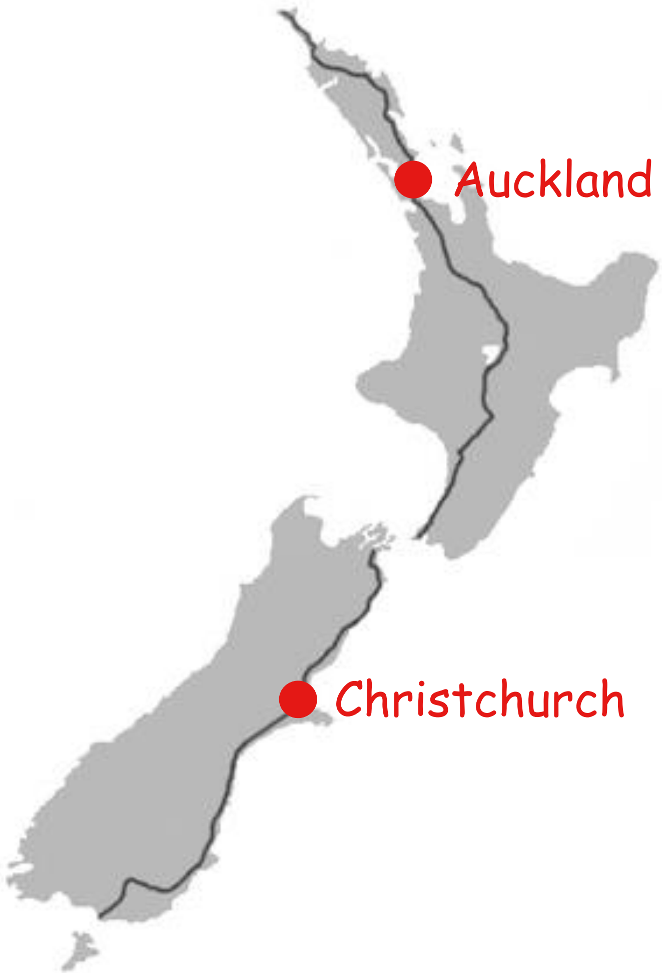
University of Auckland

Faculty of engineering, Auckland

Meet Mrs Jones…

Meet Mrs Jones...

Meet Mrs Jones...



Meet Mrs Jones...

Meet Mrs Jones...

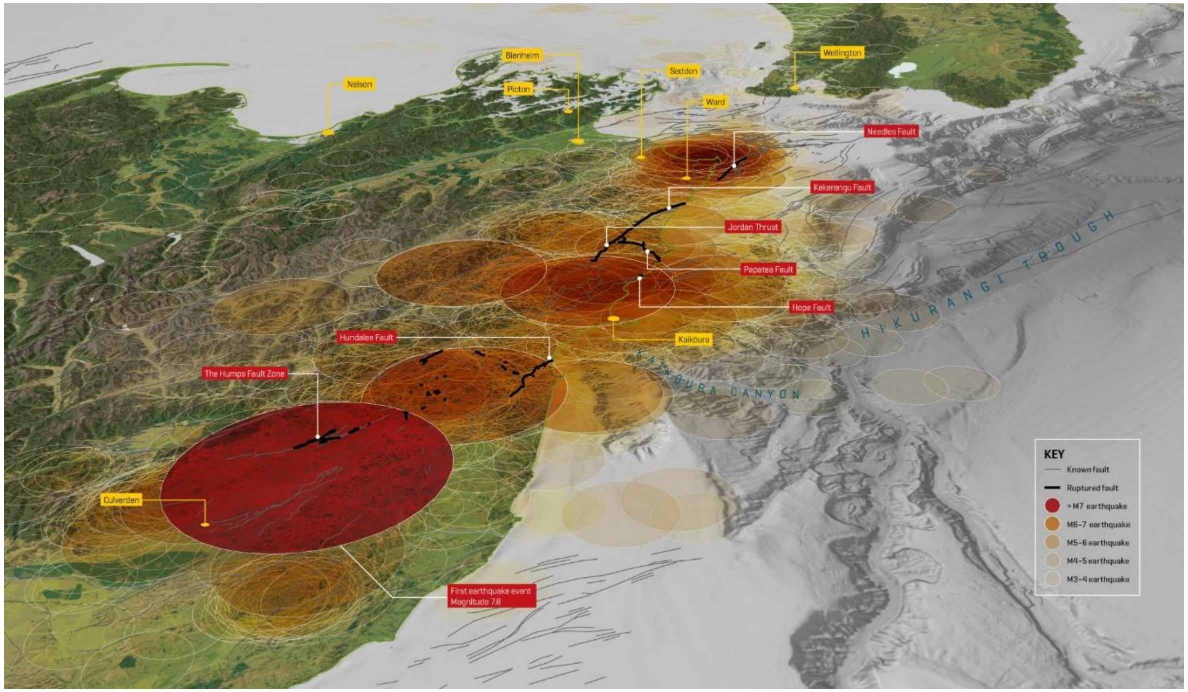
Will Mrs Jones receive her new TV tomorrow???

... NOOO!!!

The 2016 Kaikōura earthquake

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

- 14th November 2016
- 7.8-magnitude earthquake followed by multiple aftershocks
- Major transport routes between Picton and Christchurch were closed immediately, including SH1 and the Main North Line railway



Source: [New Zealand Geographic, 2017]

- Massive infrastructure damage in the upper South Island

Source: [Infometrics, 2016]

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

- Massive infrastructure damage in the upper South Island

Source: [stuff.co.nz, 2016]

Research focus

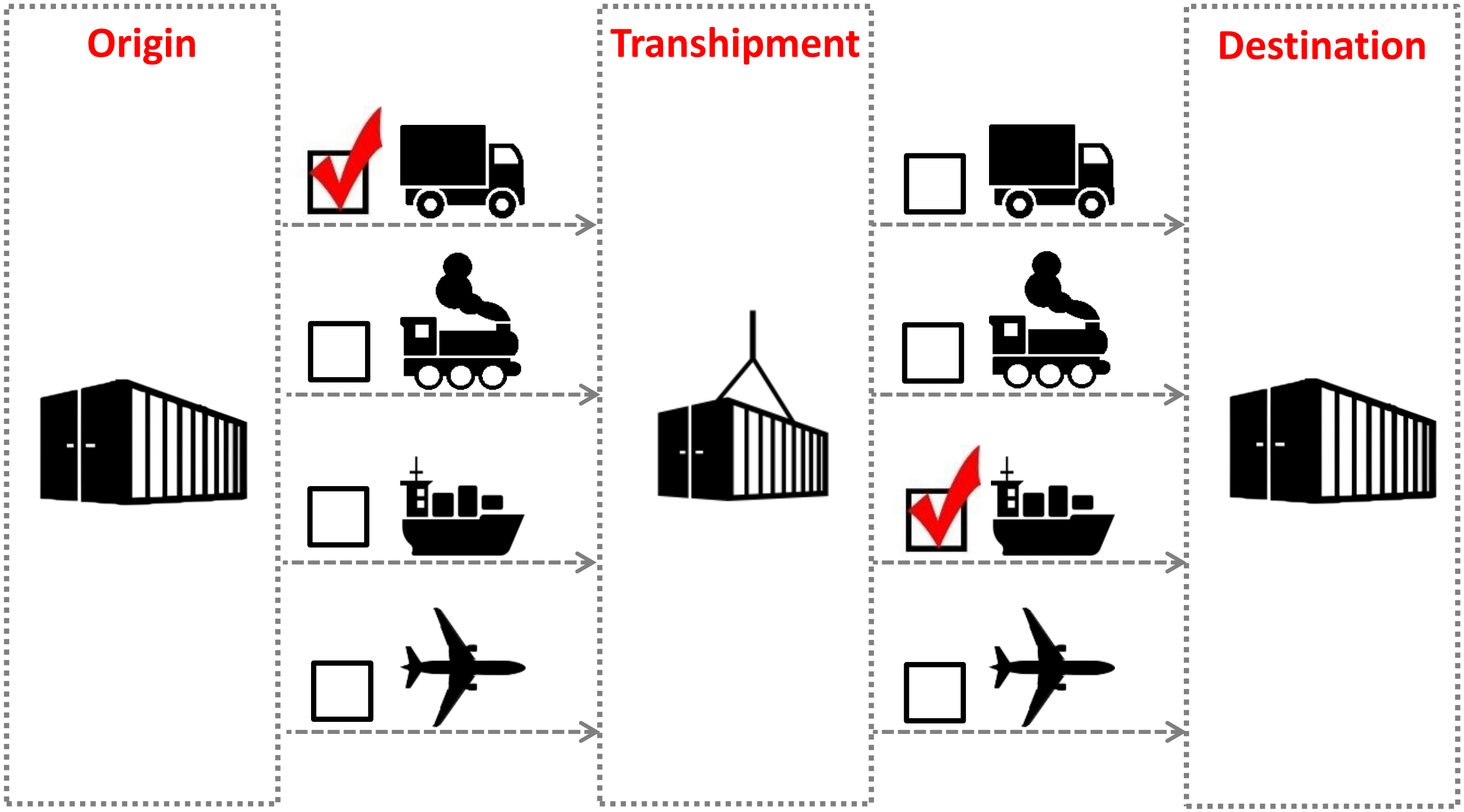
- Earthquakes disrupt pre-existing transport networks and freight operations
  - To ensure supply chain continuity, transport operations are swiftly adjusted across modes
  - However, the factors influencing rapid modal shifts in the wake of an earthquake were not well understood

The research aimed to identify the key enablers and existing barriers to the rapid reconfiguration of freight movements when an earthquake strikes

Theoretical background

- Synchromodal transport
  - The real-time planning of freight movements and rapid shifting between modes to create efficient flows of goods
  - Transport is booked mode-free => the modal split and travel route are optimised for each shipment
  - The modes are the elements of a modular system that can be configured and reconfigured rapidly
  - Swift modal/routing adjustments are made in response to/in anticipation of transport constraints (congestion, road closure, etc.)
  - Developed to create more flexible and adaptable transport systems
  - Tested in Europe

- Synchromodal transport



(Farahani et al., 2018)

Theoretical background

- Review of the literature on synchromodal transport
- 9 interfaces grouped into 3 categories:
  - **Physical interconnectivity** – the physical elements of the transport system (infrastructure, vehicles, standard load units)
  - **Digital interconnectivity** – the use of data and technology facilitating freight routing/re-routing
  - **Business interconnectivity** – the elements that increase interoperability and govern the relationships between organisations

Qualitative methodology

PHYSICAL INTERCONNECTIVITY		
1	**Transport linkages**	Connections between freight origin and destination (e.g. roads, railways, shipping routes, etc.)
2	**Nodal points**	Points in the transport network bringing the different modes and operators together (e.g. ports, intermodal terminals)
3	**Vehicles**	Vehicle range and capacity across all modes (e.g. trucks/trailers, rail vehicles, vessels, aircraft), available where and when needed
4	**Standard load units**	Receptacles used to consolidate freight items and move them between modes without handling each item individually (e.g. shipping containers)
DIGITAL INTERCONNECTIVITY		
5	**Information availability**	Collection and exchange of information to assist rapid decision making
6	**Interoperable technologies**	Standardised and compatible information systems across transport modes and operators
BUSINESS INTERCONNECTIVITY		
7	**Operational alignment**	Homogeneity of practices and reconciliation between modes that work with different constraints (e.g. load units, service timetables, etc.)
8	**Collaborative network**	Establishment of relationships and trust between highly diverse actors (and sometimes competitors) involved in transport operations
9	**Transport orchestration**	A central transport coordinator enhancing collaboration across multiple modes and operators

Research questions

- The 3 forms of interconnectivity were used to investigate the New Zealand context

- 2 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 methodology

Data collection: interviews
19 semi-structured interviews with 27 key informants
Focus: 2016 Kaikōura earthquake

Data analysis: thematic analysis of the interview transcripts
Coding framework based on the 9 physical, digital and business interfaces identified from the literature

Outcome: identification of 14 enablers and 17 barriers
to the rapid reconfiguration of freight operations across modes in the wake of the Kaikōura earthquake

- Physical interconnectivity

Physical enablers	Physical barriers
Availability of coastal shipping capacity (domestic and international ships)	Inadequate secondary road network
Availability of port capacity (including inland ports)	Vulnerable infrastructure at the smaller, domestic seaports
Availability of airfreight capacity (especially for perishables)	Curtain-siders traditionally used for road transport in NZ instead of container trailers
The rapid upgrade and use of the Spring Creek intermodal terminal	Insufficient shipping container capacity

Findings

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

- Digital interconnectivity

Digital enablers	Digital barriers
Electronic booking systems in place	Lack of standardised data format
	Lack of interoperable information systems leading to the use of manual processes and verbal communication
	Lack of advance demand information preventing efficient resource planning

Findings

- Business interconnectivity

Business enablers	Business barriers
Well-established industry contacts (e.g. with transport suppliers, government officials, etc.)	Modal operators not fully understanding the specific transport requirements of other modes
Transport operators rapidly making their own decisions (without any intervention from central government departments)	Modes subject to different operational constraints (load weight, volume, pallet height, etc.)
	Lack of trust and reticence to engage with competitors in a whole market solution

Findings

- Overall, this study highlighted:
  - The ability of the New Zealand transport system to adapt in the aftermath of the Kaikōura earthquake
  - 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 need for a standardised data format and for interoperable technological tools that enhance visibility and facilitate transactions across modes
  - The importance of building redundancies at all levels: infrastructure (e.g. roads, seaports), modes, equipment (e.g. shipping containers), safety stock (less reliance on just-in-time deliveries)

Outputs

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato

- 2 papers
  - Under review: L'Hermitte, C., Wotherspoon, L. and Mowll, R. “Intermodal freight transport in the wake of a disaster: key enablers and existing barriers in New Zealand”, *International Journal of Disaster Risk Reduction*.
  - In progress: submission to the Information Systems for Crisis Response and Management (ISCRAM) Asia Pacific Conference, Melbourne, 8-10 November 2021, https://iscramasiapacific.com/

What's next?

- Marsden fast-start proposal submitted in February 2021
  - Capacity optimisation across transport modes in the event of a prolonged Cook Strait ferry outage
- Further research avenues
  - Evaluating the costs, benefits and net impacts of building redundancies in the transport/supply chain system
  - Identifying and quantifying the interdependencies between the different parts of the transport system (ports, modes, etc.) + establishing how these contribute to resilience/vulnerability
  - Modelling freight movements through transport nodes and links

Discussion

Questions? Comments? Ideas? Rebuttals?