Identifying freight performance and contextual indicators

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Contents

Executive summary

Freight is an essential contributor to any economy. Reducing barriers or frictions in the movement of goods can reduce costs for producers and consumers and can improve the customer experience. The importance of freight to New Zealand is heightened, given the country's comparatively distant production centres and markets and its status as a small open economy. Improving the understanding of the operation and performance of the sector is therefore a valuable contributor to the productivity of New Zealand.

This research fundamentally aimed to identify a discrete set of indicators which could be used to track the overall performance of the freight sector over time. These indicators need to be able to withstand the various global disruption trends, continuous improvements in technology, changing customer preferences and an enhanced ability to collect, assimilate and interpret data.

As many of these trends and methods are dynamic or are in their comparative infancy, the focus of this research was to use and develop existing information, or present a way forward which would enable the implementation of the indicators once technological advancements had occurred.

Freight sector context

The freight sector in New Zealand is undergoing many changes. Increasing population and enhanced standards of living have led, and are leading, to increased volume and value of freight as highlighted by the *National freight demand study* (Ministry of Transport 2014). These increases have led to a number of responses in the sector including greater consolidation of freight, larger vessels and heavier loads on vehicles.

Changing consumer needs and supply chains (eg e-commerce) have also added a layer of complexity in the freight sector. A key response to this trend has been an increased focus on 'last mile' deliveries and more diversification of freight transport with smaller (often private) vehicles being involved in the movement of goods.

Technological innovations, such as intelligent transport systems and global positioning system tracking, are currently being used and are likely to be developed and integrated throughout the sector more widely. The use of video analytics will continue to improve along with automation. Automaton in the freight sector is also prevalent in ports, with Ports of Auckland in the process of employing automation in container terminals for example. Other expected changes in automation include the increasing trends worldwide towards driverless and autonomous vehicles.

These trends are improving the ability, and the need, of the freight sector (government, freight operators and consumers) to measure and understand performance and operations – although capabilities have not yet progressed to a point where all freight moved can be tracked in real time.

As a result of the freight planning processes that were initiated following the NZ Productivity Commission's (2012) freight inquiry, the NZ Transport Agency (the Transport Agency) led the development of the *Upper North Island freight story* (2013b) and the 2015 Upper North Island Freight Accord. The accord was developed with input from decision makers across central and local government and the private sector to identify the critical opportunities and challenges for moving freight more effectively and safely. The accord recommended the commissioning of this research to identify freight indicators, in order to provide future round-table discussions with a consistent and objective account of major freight trends.

Role of indicators

The collection of indicators is a useful input to a well-functioning sector. Publishing information fundamentally enables the 'state' of the sector to be understood. This can serve as an important evidence base to underpin future policy and investment decisions, as well as to track the impact of government initiatives.

The need to understand 'what matters' was established early in considering the identification of a suite of indicators. Fundamentally, this is a subjective exercise, but an exercise that should be transparently guided by objective 'facts' as well as opinions of affected stakeholders. The information presented in table ES.1 was used to help guide the selection criteria of indicators.

Table ES.1 Selection criteria of indicators

Tier	Criteria	Rationale
Non-negotiable	Role of government	The primary use of these indicators is for the government in its role as infrastructure owner and safety and market regulator. Robust information can enable governments to gauge efficiency of the sector, determine the effectiveness of interventions, understand externalities and make infrastructure decisions. The presence of these indicators can also serve as a way of holding government to account for investment and policy decisions. In this sense, making sure indicators align with core government roles is paramount.
	Ongoing	To be of relevance, indicators need to have a long-term horizon and be unlikely to become 'obsolete'. The ability to track the performance of indicators over time provides early indication of whether the sector is heading in the 'right' or 'wrong' direction and can serve as a catalyst for government or industry response. By making indicators focused around 'issues of importance' to the sector, it is hoped these will endure changing situations such as political cycles and technological changes. The availability of historical data also enables the ability to put current values into context and to explore the potential utility of the measures themselves.
	Practical	For an indicator to be of use it needs a level of practicability – ie it must be able to be obtained (either technically, or commercially). It is important to note, however, that changing technological trends in the market may alter the perceptions of practicality over time. For the purposes of this exercise, it is assumed the technical ability to capture data is likely to improve over time, although commercial constraints may remain.
Preferable	Stakeholder interest	In recognition of the inherent levels of subjectivity involved in selecting 'freight indicators', the level of stakeholder support or interest for a particular indicator has influenced decision making.
	Mode/operator agnostic	For an indicator to be of most use, it would ideally be applicable to all modes of freight without prejudice. This agnosticism enables like-for-like comparison where relevant and can also promote competitive tensions, which should lead to a more efficient sector in the long-run. However, this will not be the case in all instances, hence this is an aspirational objective.
	Complementarity	The indicators would ideally be considered as a group as well so they cover all bases and complement each other, thus building a comprehensive perspective on the New Zealand freight industry.

Proposed indicators

The proposed freight indicators that best adhere to the above criteria are summarised below in table ES.2. Indicators have been presented at a national/aggregate level and key freight corridor level in recognition of the fact there are different audiences (with different demands) for this information.

Table ES.2 Table of proposed indicators

National/aggregate level indicators	
Indicator categories	**Supporting measures**
Core freight indicators	Total import and export Total tonne kilometres Total tonnes Modal share Total freight intensity Overall contribution of freight sector to economy Average age of fleet
Port performance	Total (volume and value) of freight throughput by port Volume per hectare Vehicle (and rail) dwell/turn times at ports Off-port congestion
Greenhouse gas (GHG) emissions	Emissions efficiency by mode Total emissions from the freight industry
Safety	Workplace fatalities and severe injuries by industry Truck occupant deaths and severe injuries 'Other road user' deaths and severe injuries involved with truck crashes Maritime commercial (number of deaths) Rail freight deaths and serious injuries (total number of freight rail deaths)
Human capital	Current employment numbers by ANZSIC level 4 categories Detailed measures on employment categories where there are sector concerns
Key freight corridor level indicators	
Core freight indicators	Total heavy vehicle trips along key freight corridor Total number of freight train trips along key freight corridor Tonnes moved along key freight corridor Length of freight corridor Freight corridor safety
Asset condition trends	Smooth travel exposure Track quality index
Freight resiliency score	Disruption vulnerability Travel time added Asset condition Freight volume per annum
Travel time reliability	Travel time reliability (peak and average) Buffer index

Next steps

This research identified eight freight indicator categories that best met the criteria explained above. While these indicators and the supporting evidence were based on stakeholder conversations, they were not developed under the banner of formal stakeholder consultation, ie concepts were explored, and stakeholders were not asked to 'endorse' findings.

It is therefore fundamentally recommended that the eventual guardian of this work, most likely a combination of the Ministry of Transport and the Transport Agency, consider and further refine this work before undertaking any formal stakeholder consultation. This consultation could also explore the best approach to capturing, visualising and presenting the indicators as well as plugging knowledge gaps where they exist.

A full suite of recommendations is included in chapter 5.

Abstract

This research identified eight freight indicators which can be used to understand the performance of the freight sector. The use of indicators in the freight sector is a substitute for 'perfect information' and while technological developments and improvements in the capture and synthesis of data may get us closer to this state, the freight sector is not yet at this point. The proposed suite of freight indicators were identified through desktop analysis combined with broad stakeholder consultations and a clear focus on the mutual issues that 'matter'. It is hoped that by focusing on mutual issues of interest, these indicators will endure inevitable changes in policies, technology and market dynamics. This durability will ultimately enable trends to be tracked and monitored over time and give the sector one source of the truth. This report highlights a range of potential areas for further research and suggests a number of next steps to refine and formalise the findings of the research.

1 Introduction

1.1 Project background

New Zealand is a small and distant, open but relatively undiversified economy, with geographically disparate economic centres and natural resource concentrations. These characteristics present significant challenges in the transportation of goods and serve to highlight the importance of freight systems to New Zealand's wellbeing.

The size of the New Zealand market means that many producers look offshore in order to increase scale and profitability, while consumers are heavily reliant on imported goods. Our size means we must rely on trade in order to grow and improve our standard of living.

New Zealand's distance from key markets, and lack of scale, however, leads to comparatively high transport costs and lengthy times to get products to market. This is a key risk to New Zealand's ability to participate effectively in the global economy. Therefore the freight system needs to be as efficient and effective as possible. This will help raise the prosperity of New Zealand's businesses and workers, and enhance consumers' purchasing power (NZ Productivity Commission 2012).

Domestically, New Zealand is also a dispersed nation. Major population centres extend from Northland to Southland across two main islands. This presents significant distances that imports and domestic freight must often be carried. Moreover, raw materials, resource concentrations and manufacturing capabilities are similarly dispersed. The task to move export freight is correspondingly substantial.

These factors reinforce the notion that the importance of trade to the economy cannot be understated. This importance is succinctly captured in NZ Treasury's *New Zealand economic and financial overview 2016* report which states:

> *Trade is essential to New Zealand's economic prosperity. Exports of goods and services make up around 30% of gross domestic product (GDP) and New Zealand's trade interests are well diversified*

Similarly, the US Department of Transport, Federal Highway Administration (USDTFHA 2002) noted that improvements in freight carriage can be expected to have important economic effects:

- Lower costs or better service, or both, in freight movement have a positive effect on all firms engaged in the production, distribution, trade and/or retail sale of physical goods.
- Reducing the per-mile cost of goods carriage means any production or distribution facility can serve a wider market area, with potential gains from scale efficiencies.
- It also means a factory can draw supplies from a wider area with potential gains in terms of the cost and/or quality of parts and materials coming to the factory.

A better understanding the issues and challenges in the provision of freight can therefore have profound benefits for the productivity of the national economy. To measure the sector's effectiveness it is important to identify, measure and understand freight performance and contextual indicators.

The importance of measurement and observation is highlighted by the 'Hawthorne effect', whereby people, firms, and governments will modify their behaviour because they are being observed (Landsberger 1958).

We also posit that overall performance of the freight sector can improve over time by measuring a meaningful suite of indicators. This view is underpinned by a belief that transparency and accountability drive private sector and government performance. Moreover, improved information provision can better inform investment and policy decisions.

The task of identifying, measuring and understanding freight performance and contextual indicators is a complex undertaking. The sheer volume of indicators in various jurisdictions, coupled with asymmetric definitional issues, makes international comparisons challenging. In a domestic context, understanding nuances across all parts of the supply chain is inherently challenging, and gaining common ground is difficult given the subjectivity and competitive elements at play.

However, seeking to establish a consistent set of indicators over time to track the overall industry is a worthwhile endeavour. These indicators can act as a touchstone for the overall performance of the freight industry and can signal areas for greater attention and action by private sector participants and policy makers alike.

1.2 Purpose

In November 2016, the Transport Agency commissioned research to identify freight performance and contextual indicators.

The movement of freight is important to the economic wellbeing of New Zealanders and the government invests to enable freight connections to offer efficient, safe and resilient access to opportunities and markets. However, there are few domestic empirical indicators that can track how effective interventions have been on delivering this outcome.

This project examined potential freight indicators that might be tracked over time. These indicators are not only used to quantify the success of government transport initiatives, but also to identify areas where resources may be focused to improve economic and safety impacts, as well as mitigate externalities.

The increasing need for indicators comes as the changes and challenges of the modern economy evolve. Current and projected changes in technology in particular are broadening the ability to collect and assimilate data, along with increasing the ease of collection and accuracy of data collected. With increasing amounts of data, the ability to evaluate performance and identify areas of required improvements is enhanced.

Indicators also provide the ability to highlight and track the changes resulting from technological evolution and its effect on the economy. Of particular interest are the changes technology will have on the freight industry as digital disruption trends, technological improvements and the changing face of markets accelerate the industry. With global trade paramount to the New Zealand economy, these changes will have a large impact on the industry and indicators will enable the tracking of changes and its effects.

1.3 Methodology

The methodology for this engagement evolved throughout the course of the research in response to the emerging research findings. However, in general, the project consisted of five main phases:

1. Literature review and scoping: The first phase of this report is an initial literature scan to understand and determine the breadth of reporting of indicators both domestically and internationally. Seeking to understand developments in the collection and provision of data was also undertaken. This phase was primarily done through desktop research, although attendance at a Transport Research Board

conference on *Freight data innovations* also enabled contemporary learnings to be considered, and through testing and validation of concepts with freight data experts.

2 Stakeholder engagement: Stakeholder engagement played an important role in the research given the distinct specialisms across the wider sector. Stakeholders also helped in developing an understanding of what data and information was already collected and reported. Understanding what was important to stakeholders, what trends issues and challenges were emerging, and what was possible with current data sources and information, helped guide the final indicators and discussion in the report.

3 Initial identification of indicators: The identification of an initial set of indicators stemmed from the literature review and stakeholder engagement. This was also supported through the development of transparent criteria to select chosen indicators.

4 Further research and refinement of identified indicators: Once an initial set of indicators was identified these were refined through further literature research and stakeholder conversations. In some instances, these indicators were amended and enhanced, and in some instances indicators were recommended not to be included or explored any further.

5 Development of recommendations and further research areas: This research report was then documented and recommendations were developed to support the continuation of momentum built up behind this report. Noting alignments to existing platforms and initiatives such as the *New Zealand transport domain plan* (Domain Plan) (Transport Knowledge Hub 2016) were crucial considerations.

1.4 Intended audience

The intended audience for this research is broad; however, we would expect this report to be of most use to the following:

- Government – primarily in its function as asset owner, investor and regulator of the sector, but also in its functions as policy setter and funder of activities.
- Regional and local government – specifically for the development of regional transport plans.
- Freight sector participants – who may use the indicators to further understand the operating environment and potentially use these to help guide operational decision making and dialogue with government.

It is conceivable this research may also be used by the general public or to help a wider audience understand and develop performance and contextual indicators in other industries.

1.5 Stakeholder engagement

Stakeholder engagement was an iterative process and helped guide both research and identification of indicators. It should be made clear that although there was wide engagement with stakeholders to guide the research and indicators, there was no express expectation that stakeholders would support proposed indicator sets and measures (ie they were not being asked for formal approval in the same way consultation programmes might, or asking for access to specific data sets). Stakeholders were asked their views on issues and challenges as well as to provide general commentary on the usefulness of current and proposed new indicators.

Stakeholder organisations contacted are listed in appendix B. The views and comments from stakeholders have been anonymised, combined and summarised in theme sets throughout the remainder of this research report. Where there were conflicting opinions or views that were not aligned, the majority view has been relied upon where relevant.

We are grateful for the time, effort and energy that all stakeholders provided in contributing to this report.

1.6 Report structure

This research report has been developed broadly in line with the methodology described in paragraph 1.3.

- Chapter 1 provides an introduction to this research.
- Chapter 2 provides a definition of 'freight' for the purposes of this research, an overview of the freight task in New Zealand, emerging trends in the freight sector (including the impact of increasing data and technological trends). Stakeholder insights are an inherent component of this chapter.
- Chapter 3 describes the proposed freight indicators, including the rationale for collection, a summary of the international literature and a proposed methodology.
- Chapter 4 provides a conclusion, discusses some of the inherent limitations in the findings and identifies a range of areas that would benefit from further research and action.
- Chapter 5 provides a bibliography of literature cited.
- A range of appendices is also included:
  - Appendix A provides a concise literature comparison of freight indicators measured in a selection of various jurisdictions.
  - Appendix B provides a list of those stakeholder organisations interviewed.
  - Appendix C provides a summary of key stakeholder insights.
  - Appendix D provides a short discussion on indicators which were considered but not progressed.
  - Appendix E provides a glossary of terms and abbreviations used in this report.

2 Freight sector trends and challenges

The freight sector is wide ranging and impacts upon a variety of stakeholders and complementary sectors. From retail, manufacturing, agriculture and forestry, all sectors and supply chains are mutually inclusive of freight. The freight sector fundamentally enables producers and consumers to access the goods and markets they need.

The importance of freight sector to other industries is highlighted in the national accounts (Statistics NZ 2013). The freight sector plays a different role across various industries with approximately 19% of all inputs to the petroleum and coal product manufacturing sector consisting of freight 'costs' compared with life insurance representing less than 1% [1].

This heterogeneity of freight makes it difficult to derive general observations about the sector.

2.1 Definition of 'freight'

To aid with communication and to focus the research, it was necessary to define the term 'freight sector'.

The breadth and reach of the freight sector presented real challenges in undertaking this research. For example, if left undefined, it was possible that almost all transport movement could be considered 'freight'. It is important to note that this definition is necessarily narrower that the totality of the freight sector:

> *Freight is any undertaking for the purposes of matching production to consumption, primarily through the large-scale transportation of goods by truck, train, ship or aircraft.*

Important considerations in shaping this definition include:

- *Freight is any undertaking*: The freight system is not just about the modes of movement. It is also about the various port operations, the warehousing and logistics operations and the freight forwarding capabilities (amongst other things) that support the totality of freight movement.
- *Inclusion of large scale movement of freight:* The distinctions between 'freight' and 'non-freight' appear to be blurring. Initiatives such as 'My Food Bag', home delivery from supermarkets and 'Uber Eats' all present challenges in distinguishing freight movement from non-freight movement. It is conceivable all movements of freight and goods can eventually be tracked as data capture improvements are made, but the current level of data provision is not conducive to distinguishing between these consumption uses. Accordingly, the focus for most of the indicators identified in the research was on 'large scale' movements with last mile solutions being largely excluded.. It is acknowledged that as the ability to capture 'last mile' impacts improves, this should be a stronger focus for future indicators.
- *Focus on goods only:* Freight systems rely on the utilisation of capital and labour. The movement of employees to arrive at their place of employment in the freight sector was explicitly excluded from this research for similar reasons to the rationale for the exclusion of last mile solutions. It is increasingly difficult to distinguish freight movements from non-freight movements under these circumstances, which presents real issues in the provision of durable and robust indicators.

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[1] The groups used to calculate the freight sector in this report include: road transport, rail transport, other transport, air and space transport, postal and courier services, transport support services, and warehousing and storage services.

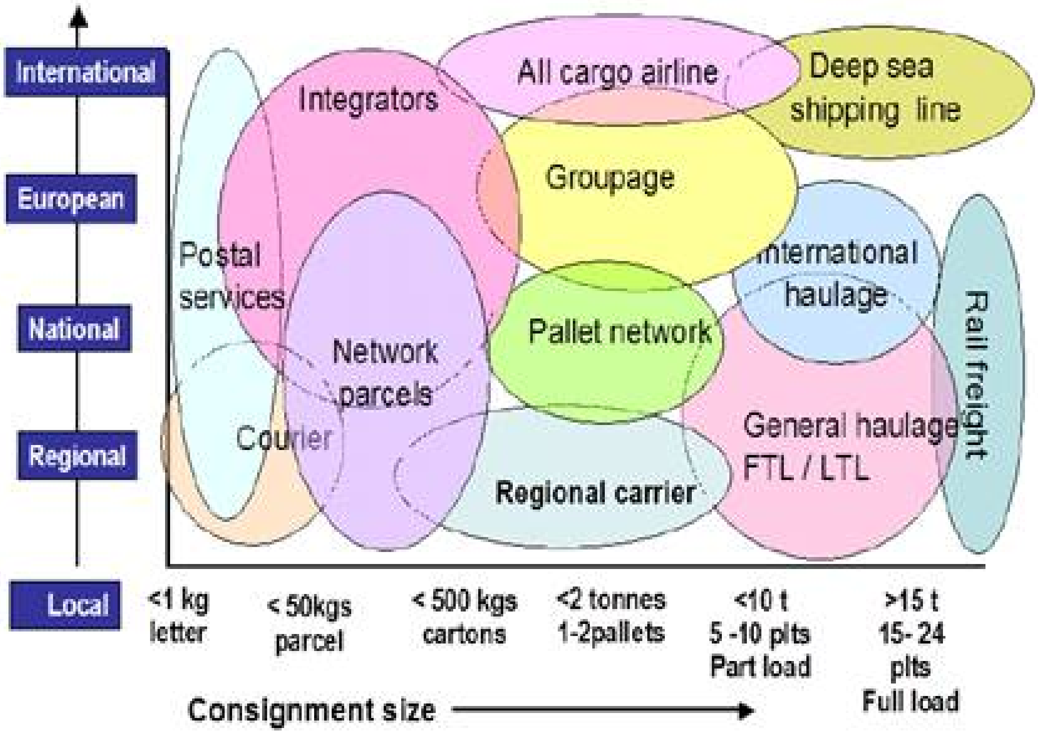
- *Inclusion of a wide range of transport modes:* A key finding of the research was the general consensus that many modes have a role in the movement of freight. Under certain conditions, freight modes have different strengths and weaknesses, and so the inclusion of a wide range of modes in the provision of freight indicators is desirable. Presentation of indicators on this basis will help governments and freight users understand these differences, and potentially enable investment and policy decisions that maximise the inherent advantages, and interdependencies, of each mode.
- *Exclusion of pipelines:* Physical pipelines contribute to the freight task from an opportunity cost perspective, and are particularly relevant in regards to the movement of fuel in New Zealand. Arguably, if fuel was not being moved through pipelines it would need to be moved by other means and add to the overall freight task. Due to the very narrow scope of freight types moved, the limited control or influence from the government, and the limited expected relevance for several indicators, pipelines were excluded from the research.
- *Consideration of movements related to international and domestic freight:* In general, no distinction was explicitly made between freight travelling within New Zealand's borders whether it was bound for domestic or international markets. The difficulty in distinguishing between these two dimensions, in most instances, presented some practical challenges which were considered to be beyond the scope of this research.

2.2 Current freight task

The importance of the freight task to the New Zealand economy cannot be understated. As an example, imports and exports are vital to our economic success, with more than $53 billion of goods exported and more than $56 billion of goods imported (Statistics NZ 2018b). The efficient movement of these goods is therefore a crucial consideration.

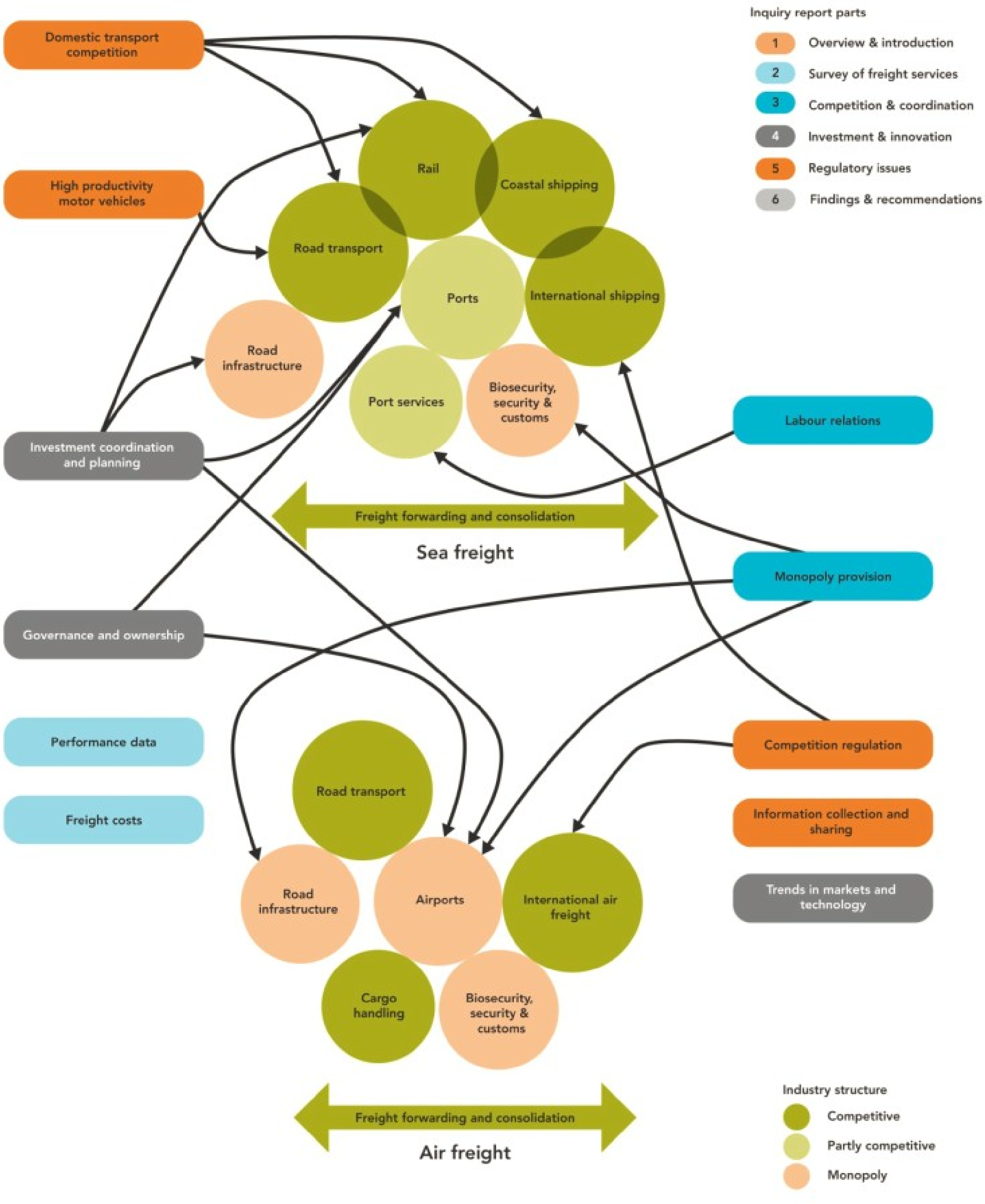
Like any jurisdiction, there is a wide range of contributors to the freight task in New Zealand and each part of the supply chain has an important role. The International Transport Forum provides a generic representation of the components of a traditional freight system as demonstrated in figure 2.1.

Figure 2.1 Example of freight transport system (ITF 2016)



More relevantly for New Zealand, the NZ Productivity Commission looked to pictorially represent the international freight transport system component as part of its inquiry into international freight transport services. This depiction is provided in figure 2.2.

Figure 2.2 International freight transport services depiction (NZ Productivity Commission 2012)



The reality is that it would not be practical to develop a full depiction of the freight sector in New Zealand. Suffice to say that it is a broad and complicated picture with many participants involved from the public and private sectors.

To aid with the context for future discussions about freight indicators, table 2.1 provides an overview of the type of freight moved in New Zealand by certain modes, as well as a high-level indication of the natural advantages and the key stakeholders involved.

Table 2.1 Overview of modal characteristics

Mode	Common freight moved	Key stakeholders and their roles	General modal advantages
Road transport	Road transport is the prominent mover of freight with the *National freight demand study* (MoT 2014) estimating 70% (tonne kilometres) of all domestic freight being moved by road.	The main highways are owned and operated by the government through the Transport Agency. Local authorities generally own and maintain local roads with the help of central government funding.	An ability to accommodate shifting demands, move relatively time critical goods, serve almost any location in New Zealand, and also its higher utilisation rates.
Rail	Rail moves around 16% of New Zealand's total freight task (in tonne kilometres). Freight services are offered in three key markets (KiwiRail 2014): • long distance transport of domestic goods between major centres • moving import/export goods to and from major ports • transporting bulk commodities such as coal, milk, logs and steel.	The government, through KiwiRail, owns most rail infrastructure and all freight rolling stock in New Zealand. Auckland and Wellington regional authorities also contract for metropolitan rail services over the KiwiRail track.	Rail has advantages where there are sufficient domestic freight volumes moving long distances between defined points. Moving import/export goods to and from major ports through busy urban networks, or utilising inland hubs to consolidate volume and achieve savings through scale.
Maritime	Coastal shipping (around 15% of all freight moved measured in tonne kilometres) of domestic cargo can be divided into two main categories (Rockpoint 2009): • bulk commodities, such as cement and petroleum products moved on dedicated bulk carriers. • general cargo, mainly carried in containers or on RORO ships. International large scale freight is almost entirely moved by international ships.	Ports are generally owned by local authorities but operate at an arm's length as commercial businesses. There are a few ports partly privatised through the New Zealand Stock Exchange.	It is a fuel efficient, more environment friendly and cost-effective mode, especially for bulk and non-time critical domestic goods moved long distances.
Aviation	Movement of high-value time critical freight for both domestic and international purposes. Key freight types include high-value food and beverage as well as postal. These goods are often significant in value and its importance cannot be determined by weight.	Auckland and Christchurch airport operate the major international terminals. There are a number of smaller domestic terminals around New Zealand.	An important advantage of airfreight is timeliness.

The precise quantification of the current freight task is challenging to accurately capture given definitional uncertainties, existing data gaps and the presence of legitimate commercial sensitivities. The *National freight demand study* (MoT 2014), however, presents an excellent starting point to understand freight movement. This study estimated the scale of the current freight task in 2012 as set out in table 2.2.

Table 2.2 New Zealand's freight task (2012)

	Tonnes		Tonne-kms	
Mode	**Million tonnes**	**Percent of total**	**Billion tonne–kms**	**Percent of total**
Rail	16.1	7%	4.2	16%
Coastal shipping	4.3	2%	3.6	14%
Road transport	215.6	91%	18.5	70%
Total	236.0	100%	26.3	100%

Source: MoT (2014)

The *National freight demand study* also estimated freight movements by broad commodity groups as shown in table 2.3.

Table 2.3 Summary of freight movements by broad commodity groups (2012)

Commodity group	Tonnes lifted (million)	Tonne-km (billion)
Milk and dairy	26.4	2.5
Logs and timber products	37.3	4.6
Livestock meat and wool	9.8	1.5
Other agriculture and fish	10.2	1.1
Petroleum and coal	13.2	3.9
Aggregates	27.0	0.8
Building materials fertiliser and other minerals	18.4	1.5
Steel and aluminium	3.4	0.3
Other manufactured and retail goods	38.5	7.6
Waste	7.4	0.2
General freight	44.4	2.1
Total	**236.0**	**26.3**

Source: MoT (2014)

These broad categories represent most, if not all, freight moved in New Zealand though road transport, rail and coastal shipping.

The importance of freight is also highlighted by the MoT's (2016c) *Transport and trade report* which highlights the volume and value of freight being moved internationally. The report details the different products and also provides commentary on the destination of exports. The report highlights that:

- Air trade volumes are very low relative to sea trade, but they account for significant value. In 2015, the tonnage exported by air was 0.2% of export volumes but made up 14.8% of value. Only 0.5% of import volumes were moved by air but they made up 21.8% of import value. This is consistent with the nature of airfreight which is often of high value and/or time constrained.
- The nature of sea freight is highlighted in the freight mix section in pages 23–24. Sea freight remains the largest in terms of volume and value. The volume and value of freight imports and exports over the years has been increasing overall; however, exports are susceptible to changes in dairy prices in particular and imports are susceptible to changes in oil prices. Notably, 31% of sea trade tonnage was containerised and made up 73% of sea trade value.

The above has demonstrated the size, scale and nature of the freight task in New Zealand and the importance of international trade. It has also demonstrated the inherent complexities involved in truly 'understanding' the sector. Because there are so many participants, and because the sector is so dynamic, it is often difficult to generalise.

Despite this complexity, there are, however, a number of trends issues and challenges that have substantial impacts on the sector and are worth discussing as these provide context to chapter 3 and the discussion of freight indicators.

2.3 Sector trends, issues and challenges

Through a combination of stakeholder interviews, desktop research and attendance at relevant conferences, a range of trends, issues and challenges in the freight sector were identified. The material elements are summarised below and a consolidated list of stakeholder 'insights' is provided in appendix C.

These trends, issues and challenges are important considerations when studying the practicality and durability of potential freight indicators.

2.3.1 Changing markets

The freight sector does not exist in lieu of demand for goods – commerce is a necessary precondition for the existence of freight activity. Therefore, it is important to understand some of the demand-side trends and issues affecting the freight sector so that useful indicators can be identified.

2.3.1.1 Global macro trends

As a small and distant market, New Zealand's fortunes are inextricably linked to the forces shaping global trade.

Globalisation is the dominant megatrend that has altered the demand for goods and services, and New Zealand is far from immune to this. The ability for labour and capital to migrate across borders, coupled with rapid technological change, has led to a fast-moving and increasingly dynamic global economy. Activities that occur in overseas jurisdictions – whether they be geopolitical, macro-economic, or technologically driven – all now have the potential to cause seismic impacts on the demand for New Zealand goods, the supply of inputs for production, and supply of goods for final consumption.

The effects of globalisation are well captured in a speech by Bill English at the Pacific Parliamentary and Political Leaders Forum in 2013 (NZ Parliament 2013).

> *We are a cork bobbing in the ocean of the global economy. Others generate the waves and we need to understand what's generating those waves and develop our capacity to deal with the waves.*

An example of this dynamic in practice is the decline of coal production in New Zealand, whereby the price for international coking coal fell from over US$280 a tonne in 2012 to around US$90 in 2016. Global environmental pressure to transition away from coal use, improvements in hydraulic fracturing technology which promoted the uptake of shale gas (a direct substitute for coal in electricity generation) and an overhang in coal supply, all contributed to the falling prices – which had indirect flow-on implications for the wider coal market in New Zealand.

While these factors were predominantly driven at the global level, they had material impacts for Solid Energy (New Zealand's dominant coal miner at the time) and KiwiRail (which had significant forward contracts for moving coal between the West Coast and the Port of Lyttelton).[2]

It is not possible or relevant, to summarise all of the impacts of globalisation and other macro-economic issues in this paper. However, it is important to acknowledge that demand for goods and services, whether they be in New Zealand or overseas, can change rapidly, and freight systems must react and adapt, or risk being left behind.

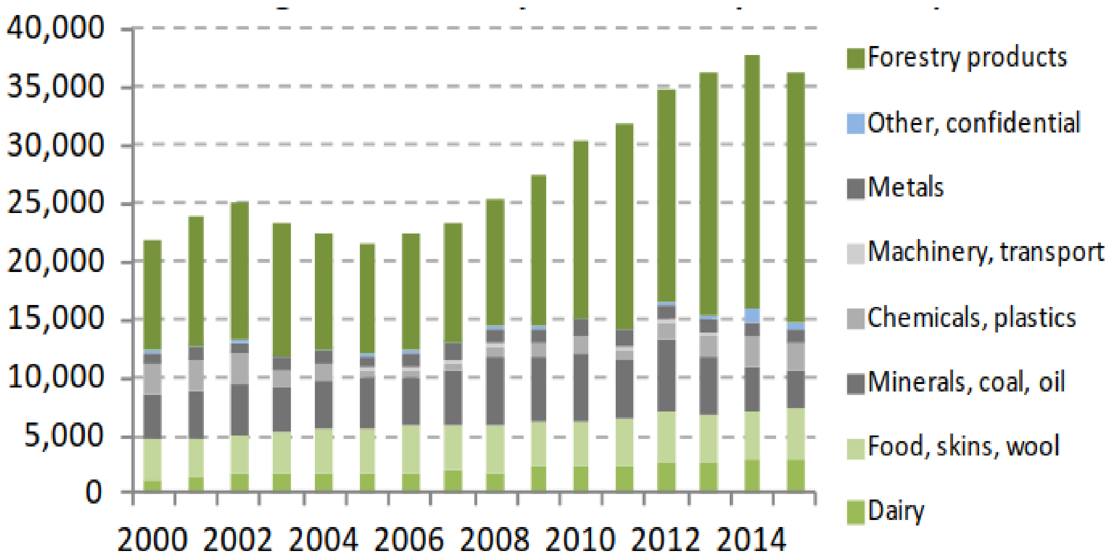
This dynamic presents real challenges in identifying durable freight indicators, as demand for different goods can change rapidly and activities within the freight sector can also evolve quickly. It is therefore preferable to understand these trends, and choose indicators that are likely to best withstand these pressures (or indeed highlight these market shifts over time).

2.3.1.2 Changing freight mix

As noted above, New Zealand as part of the global economy is susceptible to changes in the international dynamics and world prices. This means that the nature and composition of our freight task can change quickly. By way of example, between 2000 and 2015 the tonnage of sea exports, other than forestry products, grew by 21% yet forestry product exports grew by 122% (MoT 2016c)

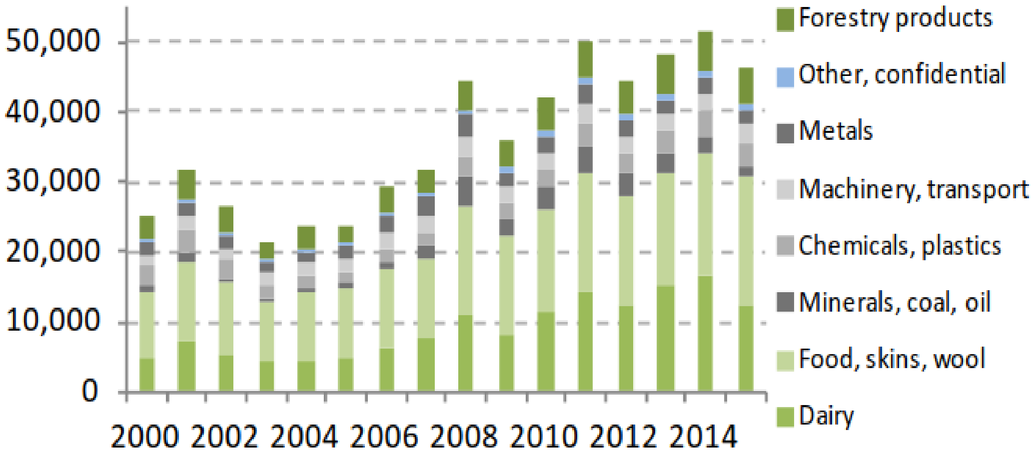
A graphical representation of some of these dynamics is displayed in figures 2.3 and 2.4.

Figure 2.3 Sea export volumes (2000–2014), (000 tonnes)



[2] This dynamic was not just a New Zealand phenomenon, with a reported $44bn reduction in market capitalisation from the top four coal miners in the US between 2011 and 2016 – or a 99% reduction in shareholder value. Cited through www.australianmining.com.au/features/decline-coal-three-charts/

Figure 2.4 Sea export values (2000–2014), (NZ$ m)



As the freight mix changes, the demands and needs of freight operators and the freight system can often change in direct reaction. This can be seen in a number of ways, including:

- collaboration between sector participants
- increased truck movements
- diversified service offerings, such as an increased focus on passenger and tourism offerings within KiwiRail.

While it is inevitable that information not in the public domain will be at the centre of these discussions and negotiations, the provision of information on the general trend of freight flows can contribute to a more informed debate about the appropriate time and nature of investment and regulation decisions that support or hinder the above market responses.

2.3.1.3 The rise of e-commerce

Although not captured explicitly in the definition of freight for the purposes of this research, it is worth noting the increasing worldwide trends of e-commerce, and instant demand deliveries. This is having effects across the supply chain including through into logistics sprawl and its impacts on ‘first and last mile delivery’[3]. The direct impacts of e-commerce are likely to be felt disproportionately by the fast-moving consumer goods industry, although more indirect impacts may be broader in nature.

The impacts of ‘first and last mile’ delivery include increasing traffic congestion, GHG emissions and potentially changing nature of cities. For instance, individual parcel deliveries increase the need for consolidation of freight closer to markets. The use of freight hubs and warehousing is often used as a response to this.

There are also numerous instances of shifting last mile solutions emerging with scooters, bikes and other modes now being used to deliver some types of goods. This is particularly prevalent in food deliveries, smaller parcels and in overseas jurisdictions. This phenomenon is blurring the line between ‘freight’ and

[3] ‘First and last mile’ is defined as freight transport logistics over the first and the last part of the way to the customer. In freight transport, the first and the last mile are often the most cost intensive (Macioszek 2018).

personal vehicles which can present some challenges for the definition of ‘freight’ and the ability to track relevant details related to freight movements.

The ability to track ‘first and last mile’ deliveries is also increasing with technological advances. One of the widely discussed disruption trends around the world is the use of blockchain technology. Blockchain can create a traceable path beginning with raw materials; from manufacturers to retailers and ending with customers; enhancing the ability to cut out counterfeiters.[4] As governments and organisations move more towards blockchain technologies and other digital trends the ability to track last mile goods in the future may be significantly enhanced.

2.3.2 Data

Technological improvements will substantially improve the current ability to capture data. This may enable both government and industry to make more informed decisions more often. Fundamentally, it is expected that ‘in-vehicle’ or ‘out-of-vehicle’ data capture techniques will eventually enable the origin and destination of all journeys to be theoretically captured and mapped in real time. Moreover, the presence of radio frequency identification (RFID) tags and blockchain can enable a much better understanding of the provenance of movement of specific goods. The main questions will therefore be in relation to the ability of governments and/or private sector interests to bring these data sets together.

Improvements in technology enabling enhanced data capture in the freight industry are too technical for a detailed consideration in this paper. However, major potential areas of data improvements and disruption trends for the freight sector are discussed briefly in the following sections.

2.3.2.1 In–vehicle data (telematics)

In-vehicle intelligent transport systems are starting to shape the transport industry and the freight sector is not immune.

Telematics is the long-distance transmission of computerised information, which is particularly relevant for the freight sector. Newer model vehicles are coming with in-built computers which enable enhanced global positioning systems (GPS) tracking and video analytics. This can enable improvements to freight efficiency, safety and a wider range of operational benefits to the users.

Improvements using telematics are highlighted by Frost & Sullivan’s (2016) study on light commercial vehicles and found that developments in telematics also present opportunities for growth and performance. The study highlights telematics opportunities by integrating video-based safety solutions, mobile–based freight exchange and field service management with mainframe telematics to improve safety, operational efficiency load management and to reduce empty miles.

Telematics are being used to record driver behaviour and are starting to be used more widely in the insurance industry as premiums are based on recorded driver performance. Telematics have the ability to improve safety by improving driver performance in regards to the risk taken by the driver and can also ensure that drivers are sticking to regulated hours travelled before the need for a rest. As more new vehicles are utilised in the network it can be expected that the proportional number of crashes involving trucks should reduce.

Fleet telematics also have the ability to increase productivity as the ability to manage the fleet increases. Fleet tracking improves dispatching abilities enabling dispatchers to know where all drivers are located at any one time and optimise the movement of a given fleet. Optimisation can also occur by taking more

[4] Insights from the 2017 EY Global Blockchain Summit.

efficient routes to avoid congestion. In-vehicle data enables a wide range of possible improvements to the freight sector.

2.3.2.2 Out-of-vehicle data

'Out of vehicle' intelligent transport systems are becoming more prevalent in New Zealand's transport system and the trend towards increasing use of digital solutions to aid transport is likely to increase as technology improves. Hyde et al (2017) looked into some of the technology applications in Auckland city for traffic monitoring as demonstrated in table 2.4.

Table 2.4 Technology applications in Auckland city for traffic monitoring

Technology	Application and coverage
Bluetooth	Bluetooth sensors supply travel time data for the Transport Agency, MoT and local authorities. Bluetooth sensor networks are installed in most of New Zealand's largest cities including substantial coverage in Auckland.
Global navigation satellite systems (GNSS/GPS) data	GPS data is collected to provide near real-time information for transport managers and road users, and to monitor the performance of public transport services. This is available from a number of sources nationwide. There may be a cost associated with obtaining this data.
Mobile	Mobile activity data is collected nationwide, but is not currently used for traffic management or monitoring purposes. This is an emerging area that the Transport Agency and local authorities are investigating and developing. The Transport Agency has a national licence for Google travel time data.
Weigh-in-motion (WIM)	Vehicle count and weight data by axle is collected at eight locations on the SH network (Auckland, Waikato, Bay of Plenty, Gisborne, Hawkes Bay and Canterbury). There are two sites in Auckland: the Harbour Bridge and Drury.
Automatic number plate recognition (ANPR)	ANPR uses cameras to recognise number plates from which vehicles can be identified. ANPR cameras aid in the assessment of volumes and route utilisation as well as revenue collection.
Fibre optic	Fibre for traffic monitoring purposes is installed along SH 1 in Auckland terminating at the Auckland Harbour Bridge with a total length of 40–50 km available. Applications and technology to collect and analyse fibre optic data for traffic monitoring are emerging.
Closed circuit television (CCTV)	CCTV cameras are routinely installed in urban environments at intersections and other locations throughout New Zealand for traffic monitoring, security and other purposes. There are over 1,600 cameras installed and linked to a video management system that uses video analytics technology for monitoring purposes.
Traffic counts	The Transport Agency and local authorities maintain regular traffic count programmes through using loop and tube counters which can produce classified vehicle counts and speed profiles.
Sydney Coordinated Adaptive Traffic System (SCATS)	Traffic signals in most urban areas in New Zealand are managed through SCATS, which is a source of traffic counts by in-ground (stop-line and advance) detectors.

Source: Hyde et al (2017)

The use of telematics, sensors and live tracking does not just result in the generation of more information. These technological developments can also help improve the operational efficiency of the sector. For example, Auckland's Joint Transport Operations Centre monitors live traffic flows and uses more than 450 CCTV cameras, as well as sophisticated modelling, to analyse and optimise traffic flows.

Beca (2016) highlights various freight movements and road use patterns sampling various freight vehicles. The studies show current freight movements using a variety of sources including (but not limited to) traffic volume data, WIM sensors and aggregate statistical information derived from commercial GPS data.

These freight studies show the flows from and to ports for the direction of travel of commercial trucks and highlight areas where freight trips are generated. The studies provide another clear example of how GPS data can be used to understand freight movements.

The use of data innovations in the freight industry is also clearly an international topic of interest. In fact, it was highlighted at the Transport Research Board's – Innovations in Freight Data Workshop, May 2017[5]. Some of the additional applications highlighted included:

- *Approaches to monitor truck loading activity in New York city using video analytics:* In this example, video analytics are aimed to help develop a data-driven methodology for predicting freight demand in New York City. This will help align off-street loading capacity with on-street loading availability for improved street efficiency. Understanding the required loading space and the freight requirement spaces in urban metropolises becomes more important as more people move to live in cities. The availability of street space is limited and analysing the required space is important to help determine requirements for freight and businesses.
- *Video analytics to classify movements and vehicles*: This example has important applications for safety consideration as it has the ability to focus on near misses. Leveraging the widely available video cameras there is an ability to analyse near misses and aim to reduce the number of near miss crashes which will help in the reduction of road trauma. Camera analytics is particularly important to freight, and as cameras are more widely used in freight vehicles this will highlight the behaviour of drivers and other members of public.

These and many more other technologies are starting to be undertaken and accepted by the wider industry. As more technologies emerge and data increases, the ability to track information and make more efficiency gains will continue. Particularly when 'out-of-vehicle' information is coupled with continued advancements and use cases for other technologies (such as RFID tags) to create synergies that harmonise origin and destination information alongside commodity/freight moved information.

2.3.3 Future freight sector

All of the above factors, as well as issues outside the scope of this report, continue to shape the way that the freight sector operates. A selection of these issues is captured below.

2.3.3.1 Scale efficiencies and collaboration

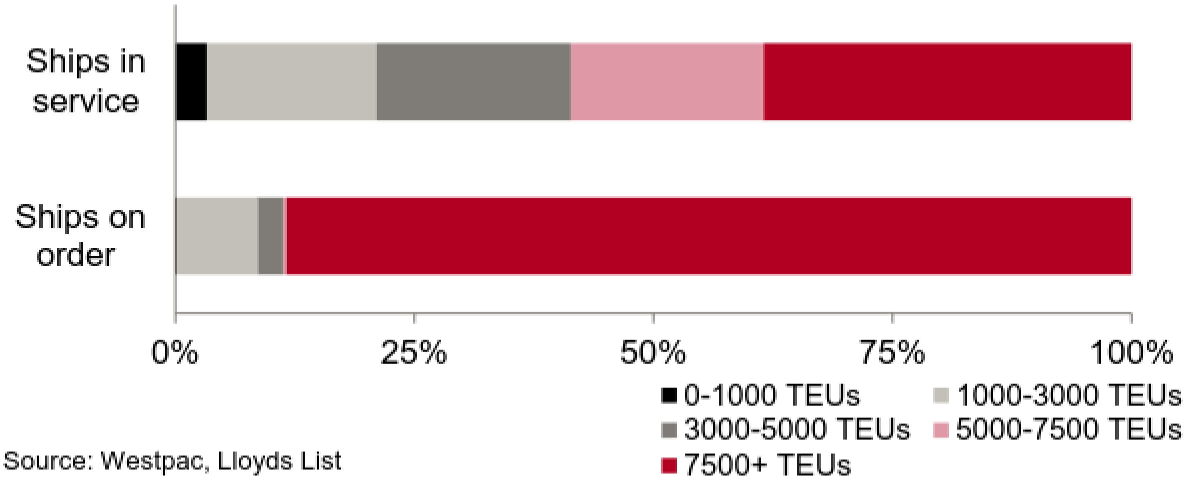
A major international trend for 'large scale freight' across all transport modes has been the drive towards scale efficiencies. The intention to invest more capital in larger transport assets is commonplace and this has the effect of increasing economies of scale and driving down per-unit costs for transportation. It is noted this trend for 'large scale freight' differs to the 'last mile' trend experienced for the movement of some goods including fast moving consumer goods (FMCG).

Westpac (2015) *Industry insights* notes there is a strong trend towards investment in larger ships. The forward order book demonstrates that over 80% of new container ships are expected to be larger than 7,500 twenty foot equivalent units (TEUs). This view is supported by many movements within the New

[5] Insights from the Transport Research Board – Innovations in Freight Data Workshop, May 2017.

Zealand port network to accommodate this growth, including through investments in new handling equipment and dredging activity.

Figure 2.5 Share of global container capacity by ship size (Westpac 2015)



Source: Westpac, Lloyds List

The consolidation of goods and transportation can be seen in the land transport sector by the introduction of high productivity motor vehicles (HPMV) and increased investment in roads to accommodate the heavier vehicles. The move to intermodal hubs and inland ports, growth in larger integrated logistics firms and partnering between ports and others is also evidence of this trend (which is explained in more detail below).

These developments are also reflected in annual fleet statistic trends with increasing numbers of heavy vehicles. The ability to move more freight on the same amount of vehicles adds to the efficiency and effectiveness of the overall system.

A further industry trend is a movement towards greater collaboration to accommodate these consolidated freight volumes. An example of one such alliance is the Port of Tauranga and Timaru ports strategic alliance. As consolidation continues, it is likely that further alliances or cross-ownership structures emerge as larger ports seek growth.

These collaborations and consolidations are also evident with the increasing number of inland freight hubs. Inland hubs aggregate freight at a single point for dispatch via road and rail networks (predominantly). Inland hubs were considered by stakeholders interviewed through this research project to be an increasingly important part of the supply chain with natural constraints emerging at some sea ports in New Zealand.

2.3.3.2 Automation

One of the changing trends already having an impact on the freight industry is the move towards automation. This trend is being experienced across all activities in the supply chain and is prominent at aggregation points (port, warehouse and logistic hub operations) as well as in the physical transportation of goods.

For example, automation in the ports sector can be demonstrated through recent activities at Ports of Auckland:

> *This stage of automation will increase our terminal capacity from just over 900,000 TEU a year to 1.6-1.7 million TEU annually...Automation will also help us operate sustainably. Automated straddle carriers will use up to 10% less fuel, reducing our carbon*

footprint. They need less light and operate more quietly, reducing our impact on neighbouring communities. And they will lower our costs, making our operation more competitive and sustainable long-term.

These moves towards greater process automation are generally expected to increase efficiency and lower costs overall. Automation also has an impact on labour force requirements. Along with the progression of process automation at ports and in warehousing, it is perceivable in the future that autonomous and driverless vehicles will be a reality and have a great impact on the freight sector.

The Transport Agency and MoT both highlight the possibility of autonomous and connected vehicles although there is no certainty on the exact date these will be available.

It is also important to note there are different levels of automation and these are already being used to greater or lesser degrees. The five levels of automation as highlighted by the Society of Automotive Engineers. The automation levels are:

0) No automation

1) Driver assistance

2) Partial automation

3) Conditional automation

4) High automation

5) Full automation.

According to Flämig (2016), assisted and partially automated systems are already common in series-production vehicles. Driver assistance programmes such as anti-lock brake systems and electronic stability systems are widely available. Some lane change and lane departure warning systems and adaptive cruise control functions are mandatory in some overseas jurisdictions. As an example, lane departure warning systems are mandated in the EU for all new type approvals from 2013 and all new vehicles from 2015.

The level of automation is increasing, which has many impacts on the freight system. If autonomous vehicles are fully functional there will be reductions in the need for truck drivers along with mandatory break times no longer being an issue. Furthermore, fully autonomous vehicles have the potential to reduce human error in driving and increase efficiencies in movement and production.

Testing of fully autonomous cars is currently underway. The most prominent example cited is Google's self-driving car, which started its testing in 2009 and then became Waymo in 2016. With some of the largest companies in the world testing autonomous and driverless vehicles the potential for autonomous vehicles to become a reality is more and more likely. Muoio (2017) reported on the 18 companies most likely to get self-driving cars on the road first, as assessed by Navigant Research, with Ford ranked most likely.[6]

The sheer number of companies involved in testing and developing fully autonomous and connected vehicles points to a likelihood of these vehicles moving freight becoming a reality. It is not proposed to create a formal measure of the number of autonomous and connected vehicles in operation in New Zealand at this juncture, primarily because of the low numbers of these vehicles, and the difficulty in

[6] Other companies ranked include: Baidu, BMW, Bosch, Daimler, Delphi, Ford, General Motors, Honda, Hyundai Motor Group, nuTonomy, PSA, Renault-Nissan Alliance, Tesla, Toyota, Uber, Volkswagen Group, Volvo and ZF.

categorising uptake across the various stages of automation (for example, some vehicles may have the capacity for L1 or L2 automation, but users may ’turn off’ this functionality.

2.3.3.3 3D printing

3D printing is another potential disruptor to the freight and transportation sector. While the specific impacts are unknown, research from Bhasin and Bodla (2014) suggests 3D printing could reduce total supply chains cost by 50–90%. As production moves from make-to-stock in offshore/low-cost locations to make-on-demand closer to the final customer, this will have major implications on the supply chain, with the movement of raw materials, rather than finished products, likely to be the result. This may have the potential to alter supply chains within countries, and lead to the risk of over/under investment in certain infrastructure.

Research from Birtchnell et al (2013) aims to understand how the development of 3D printing technologies affects transportation. The research contrasts potential future scenarios such as desktop factories, localised manufacturing and others. All these potential scenarios will change the scope of the freight sector by either reducing international freight needs to consolidating all freight locally.

2.3.3.4 Land use changes

The rise of e-commerce, just-in-time logistics chains, and increasing gentrification of major demand centres is leading to an increasing trend of logistics sprawl.

Evidence clearly demonstrates that as areas grow in scale and density they tend to become more productive, offering the potential for higher wages and profits (Kamal-Chaoui and Robert 2009). A major result of this phenomenon is that ‘lower value’ activities get pushed out into the urban fringes, and this can have negative consequences for surrounding areas, including increased congestion and reduced amenity value.

Warehouses and freight hubs are increasingly tending to relocate to multiple outer suburban areas with good access to highway interchanges, large available land space, affordable rents and access to employees. These changes are beneficial to line haulage freight as they become faster and more cost efficient. This can have implications for travel time reliability in major urban areas, however, as ‘last mile’ freight has to travel longer distances, and ‘in and through’ freight is already using congested urban and regional networks.

Examples of this trend can clearly be seen in Auckland where future urban land on the urban periphery is increasingly being utilised for industrial activities, while more ‘valuable’ inner city land is being utilised for higher value activities such as retail parks, mixed use and residential dwellings.

The impact of e-commerce and just-in-time delivery models also means it is important to have logistics hubs near enough to major population centres to satisfy demand. More companies such as Amazon are offering as little as one-hour delivery times overseas. This trend is also affecting New Zealand, as more companies compete to deliver faster and better services, the competition has flow-on implications for the locations of warehousing and logistics assets across the country.

2.3.3.5 Contracting models

A comparatively minor but nonetheless important trend to note is the increasing awareness of the risks involved in the use of third party operators.

This model has several important implications for the freight industry:

- On the positive side, it is likely the freight industry as a whole may have gained from this specialisation in the form of greater vehicle utilisation and better logistics management (BITRE 2003).

- However, there remain some concerns about the impact these arms' length transactions can have on promoting the right incentives for health and safety obligations and human capital issues.

While there are undeniable impacts on the freight sector which will inevitably impact some of the freight indicators presented in chapter 4, there are data integrity issues to overcome as any outsourcing of freight activities can make it more difficult to truly understand the state of the sector.

2.4 Response to changes

There is an element of uncertainty involved in all of these 'trends'. Predicting the timing, magnitude and significance of these issues for the New Zealand freight sector is immensely challenging. Identifying indicators that are both current and future proofed is the ultimate goal, although an element of humility must be adopted.

The remainder of this research paper documents and identifies indicators that balance what is 'ideal' against what is 'practical'. The indicators proposed are a collection and collation of views heard through our research and should ultimately be the subject of further testing and clarification before being formally adopted.

3 Role of indicators

The role of information provision in any market is critical. It underpins an understanding of relevant trade-offs inherent in any sector and enables consumers, producers and governments to make better decisions more often. More specifically, trusted and objective information can also be used to promote and facilitate dialogue between the public and private sectors so that policy and investment decisions can be discussed with a better handle on the expected impacts across the sector.

The concept of 'perfect information' is a condition that must be met in order to avoid market inefficiencies. It is also assumed to be present in economic models (Investopedia 2017a), as all consumers and producers should have perfect knowledge of price, utility, quality and production methods of products and can therefore make rational decisions about where to invest scarce capital.

The importance of robust information in the freight sector is no different from general market theory. Indices, metrics and indicators are all essential to enable efficient operations in the market. By understanding the comparative state, performance and future expectations of the freight sector, participants can make investment decisions that lower costs of production, lower prices and improve quality of output.

Traditionally, techniques to capture important market information have been fairly simplistic – people sitting on the side of the road physically counting vehicles is a good example of how rudimentary these processes can be. Opportunities are now open to the market to exploit 'perfect information' as the digital revolution takes hold, and techniques to capture relevant data continue to improve.

> *In an ideal world, statisticians would be able to track freight consignments across multi-link supply chains from initial origin to final destination, revealing the structure of logistics networks and product routing* (McKinnon and Leonardi 2009)[7]

In such a world, economic theory suggests that this will lead to better market outcomes as more efficient operators thrive and lesser competitors fail – and ultimately consumers will win through lower prices.

However, what this informational utopia ignores is the fact that markets are complex and constrained, and so there are natural barriers to effective uptake. Most importantly for this research:

- *Transaction costs:* The time, effort and cost required to collect, assimilate and understand all information flows imposes a barrier on the extent to which freight sector information can truly be understood and presented. For example, it is currently prohibitively expensive for all movements of freight to record origin and destination (as well as freight type, volume and value) within a centralised database.
- *Property rights and information asymmetries:* In many instances, the 'owner' of the data and information has the sole property rights to that data, and is entitled to utilise this property right to gain a competitive advantage. For instance, understanding the movement of all empty containers in New Zealand may enable governments to incentivise even better market outcomes; however, there are no reasons why the owners of all empty containers should disclose their current operating practices to the market. Similarly, there is an argument that road user charges (RUC) data would be helpful in determining the flows of vehicles; however, there is no requirement for actual trips to be publicly published.

[7] International Transport Forum (2016) Logistics Development Strategies and Performance Measurement

So, in a world where information matters, but natural constraints and limitations on access to relevant data and information exist, how should the provision of indicators be prioritised? How do we separate the signal from the noise?

To answer this question, it is imperative to define 'what matters'. This will of course be a subjective exercise, as 'what matters' will differ depending on the perspective being considered. However, it is important for the purposes of this research that assumptions being made about 'what matters' are transparent.

It is then important to consider how indicators should be presented, regardless of 'what matters'. There is no value in identifying the 'right' indicators, only for the presentational approach to undermine the communication.

Finally, it is important to consider accountability for the development and alignment of these two strands – 'what matters' and how the information should be presented. This can enable discussions on validity, custody and ownership of information and the eventual 'live' presentation of a consistent indicator set.

Ultimately, we need a clear understanding and articulation on *why* certain indicators are provided, *who* will benefit from using them, and guidance on *how* they should be interpreted.

The remainder of this chapter discusses:

- indicator selection criteria
- architecture and principles underpinning the presentation of the indicators
- those indicators determined to best represent the performance of the freight sector in New Zealand.

3.1 Selection criteria

Determining the 'right' freight indicators to focus on is a challenging exercise. Different people have differing views about what is important, and more often than not, these preferences are mutually exclusive or cannot be jointly pursued for practical reasons. The development of transparent selection criteria is designed to remove some of this contention by making assumptions clear.

This research advocates six criteria as identified in table 3.1, which explicitly contemplates two separate tiers of criteria to further refine relative importance. The remainder of this chapter summarises the basis for the selections.

Table 3.1 Criteria for selection of freight indicators

Tier	Criteria	Rationale
Non-negotiable	Role of government	The primary use of these indicators is for the government in its role as infrastructure owner and safety and market regulator – robust information can enable governments to gauge efficiency of the sector, determine the effectiveness of interventions, understand externalities and make infrastructure decisions. The presence of these indicators can also serve as a way of holding government to account for investment and policy decisions. In this sense, making sure that indicators align with core government roles is paramount.
	Ongoing	To be of relevance, indicators need to have a long-term horizon and be unlikely to become 'obsolete'. The ability to track the performance of indicators over time provides early indication of whether the sector is heading in the 'right' or 'wrong' direction and can serve as a catalyst for government or industry response. By making indicators focused around 'issues of importance' to the sector, it is hoped these will endure changing situations such as political cycles and technological changes. The availability of historical data also enables putting current values into context and exploring the potential utility of the measures themselves.
	Practical	For an indicator to be of use it needs a level of practicability, ie it must be able to be obtained (either technically, or commercially). It is important to note, however, that changing technological trends in the market may alter the perceptions of practicality over time. For the purposes of this exercise, it is assumed the technical ability to capture data is likely to improve over time, although commercial constraints may remain.
Preferable	Stakeholder interest	In recognition of the inherent levels of subjectivity involved in selecting 'freight indicators', the level of stakeholder support or interest for a particular indicator has influenced decision making.
	Mode/operator agnostic	For an indicator to be of most use, it would ideally be applicable to all modes of freight without prejudice. This agnosticism enables like-for-like comparison where relevant and can also promote competitive tensions, which should lead to a more efficient sector in the long run. However, this will not be the case in all instances, hence why this is an aspirational objective.
	Complementarity	The indicators would ideally be considered as a group as well so they cover all bases and complement each other, thus building a comprehensive perspective on the New Zealand freight industry.

3.1.1 Role of government

Describing the role of government (central, regional and local) in the freight sector comes with some inherent challenges. Most notably, different ideologies naturally lead to contention about the level of intervention or involvement in the freight/transport sector. While the level of intervention will forever remain a vexed topic, a number of core functions performed by government were used to focus on 'what matters'.

Most simply, government has five main functions with respect to freight:

- asset ownership
- regulation

- policy
- funding
- governance.

These functions can then be grouped into three key objectives that lie at the heart of the government's role in the sector:

1 Maximising allocative efficiency: Understanding demand pressures on transport systems is important for an asset owner as it enables allocative efficiency for maintenance and capital expenditure. This position becomes more important as the size and scale of the government role increases in the provision of transport assets.[8]

2 Minimising externalities: The movement of freight creates a range of externalities that are borne by third parties, for example safety and environmental impacts. The government has a role to understand these externalities in the first instance, and potentially use this information to intervene in markets where marginal social cost is greater than the marginal benefit.

3 Maximising operational efficiency: Supply chain optimisation in the freight sector leads to efficient utilisation of land, labour and capital.

The extent to which governments should look to intervene in markets to achieve these three objectives will always be subjective and dependent on a range of factors. However, a robust understanding of the freight sector will be needed before any investment, policy or regulatory decision is pursued.

A crucial finding of this research is that freight indicators can serve as 'flags' for whether a particular aspect of the sector is trending in the right direction, or not. Where it is not, stakeholders can have discussions around policy or investment decisions to rectify the negatively trending indicator. This is not to say they will necessarily be 'triggers' for action, but they will inform policy discussion that is cognisant of the issues of the day. Given the government's key role in support of the freight sector, it is critical that these indicators therefore ultimately link back to the potential levers for government.

It is also important to note that as the quantum of data and information increases, the potential for governments to provide more information to the market widens. However, at some point, the provision of information to a market will become an implicit subsidy. Accordingly, freight indicators should only be collected when government has a core function in understanding the information to begin with, or where the information is useful to the sector, but can only be collected through government intervention (ie a public good).

3.1.2 Ongoing and durable

One of the important learnings from the literature review was that the pace of change in the freight sector is rapid – whether this be from changing consumer preferences, improvements in technology, or freight sector responses.

This pace of change poses important issues for the collection and presentation of freight indicators. Most notably, it is important not to spend scarce time, energy and effort collecting an indicator that may be

[8] The government is investing record amounts in the transport system, and will invest more than $36 billion through the National Land Transport Fund over the next decade, including: $19.5 billion on state highways, $8.5 billion on local roads, and $4 billion on public transport (MoT 2018e).

obsolete in the near future. Rather, indicators should be considered to be important now, and expect to be durable over time to enable consistent comparison and consideration.

Another useful way of ensuring that indicators remain durable, is to focus on the issues that matter to all stakeholders. While political ideologies and technology change, often the ‘issues of concern’ remain the same. This focus on issues, combined with the idea expressed above of these being ‘flags for action’ rather than official triggers, is a crucial underpinning of all indicators.

Furthermore, the availability of historical data provides a useful test for durability.

This view of indicator durability was strongly supported by stakeholders interviewed as part of this research.

3.1.3 Practical

The concept of practicality is equally important when considering which indicators to pursue, or not.

At one level, the custodians of the eventual data set must be able to collect and collate the underlying data. If it is a time consuming and/or an expensive process that must be undertaken, then this may raise some risks about the ongoing durability of information collection.

At another level, the information must also be presented practically. There is limited value in spending time, effort and energy collecting and collating information only to present it in a convoluted way that cannot be understood by the relevant communities of interest.

3.1.4 Stakeholder interest

A key part of this research project was the level of stakeholder interaction undertaken to understand what the issues in the sector are, and what is of most interest to capture and present on an ongoing basis.

To this end, the level of stakeholder support and interest in a particular indicator guided our determination of the final indicator list.[9]

While universal support for any concept or indicator was not possible, this research focused on those issues that were unopposed or obtained majority support throughout stakeholder discussions.

3.1.5 Mode/operator agnosticism

A concept reiterated throughout stakeholder discussions was ‘Mode agnosticism rather than mode antagonism’. Many stakeholders argued that different modes all have a role in a well-functioning economy, and each has its own natural advantages and disadvantages.

The advantages and disadvantages of various modes are not always clear cut and overlaps will occur, particularly over the course of time. There will also be instances where there are limited alternatives and movement of goods will be dependent upon the availability of one mode.

[9] It is important to note that we undertook stakeholder engagement with 24 parties over the course of the research and the level of engagement was pitched more towards the exploratory ‘what are the issues’ end of the spectrum rather than ‘will you support this suite of indicators’. There was not a uniform level of support for all indicators, given the project scope. A summary of the key findings of the stakeholder engagement is provided in appendix C.

For example:

- Road freight is considered to be a flexible freight option that is preferable when moving smaller, varied and time-critical products or large scale products over short distances where there are limited alternatives.
- Domestic sea freight is considered to be an important mode for transporting high-volume and less time-sensitive products.
- Air freight is considered to be an important mode of transportation for higher value, lower volume, and time-critical products.
- Rail freight is considered to be an important mode of transportation for high-volume, less time-sensitive products that benefit from being connected to major domestic logistics nodes.

Therefore, contemplating freight indicators that are applicable across different transport modes is preferable. This can enable like-for-like comparisons across certain metrics which can lead to competitive tensions, which are good for customers. This indicator is not a strict requisite, but is desirable wherever possible.

3.1.6 Complementarity

The final selection criterion employed has focused on the interrelationship *between* indicators on this list. Ideally, indicators would refer back to each other, or could be considered in concert, as this improves the reliability and durability of all indicators.

This criterion is not a strict requisite, but is desirable wherever possible.

3.2 Presentational architecture and principles

The following figures and tables presented in this chapter are for illustrative purposes only. The figures and tables are identified to highlight the different presentational approaches and a framework that can be used to develop the final indicator set.

A number of different factors were considered in determining the appropriate framework to understand and present a set of freight indicators. Of most importance are:

- level of spatial aggregation
- level of sectoral separation
- visualisation.

3.2.1 Spatial aggregation

The most important consideration from a spatial perspective is whether an indicator is provided at an aggregate (national level), a partially disaggregated ('key freight corridor level') or a fully disaggregated level (real-time data capture).

This research showed that real-time data collection across all elements of the freight sector was likely to happen. Currently, understanding freight indicators in real time at the 'transport unit' level may be desirable for policy and investment decision making; however, the cost and practicalities of doing this are currently prohibitive.

Accordingly, it is proposed that a hybrid of aggregate and partially-disaggregated (or at a key freight corridor level) should be adopted. This recommendation is supported by the concept of 'subsidiarity' where the impacts of the indicator should be measured at the level of government that is best placed to mitigate them. For example:

- Aggregate level information is favoured where the impacts or issues at stake are largely national. For example, this is the case for aggregate indicators around GHG emissions.
- Key freight corridor level information is favoured where the impacts or issues at stake can be managed centrally and locally. For example, freight corridor reliability is often an issue that requires local and national level policies and investments.

While the definition of ‘national level' indicators is fairly clear, defining ‘key freight corridors’ is more challenging.

3.2.1.1 Defining key freight corridors

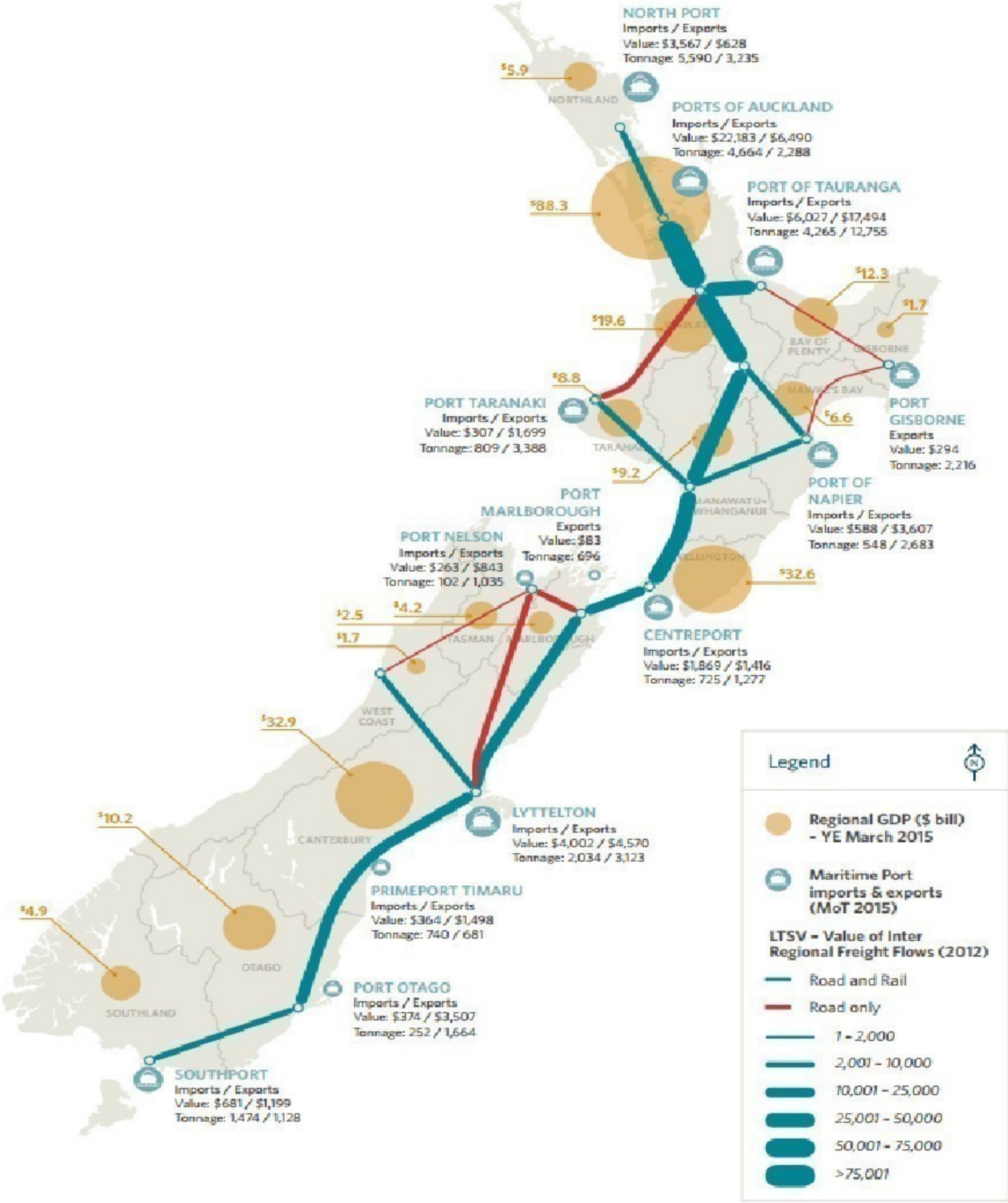
Key freight corridors are those routes where a significant amount of volume or value of freight is moved on a consistent basis. These corridors are often multi-modal in nature, and the Transport Agency long-term strategic view is a good starting point for where these corridors might be. This map is provided in figure 3.1.

It is intended that key freight corridors are represented across all regions, as this reflects the role that regional councils, including unitary authorities, have in planning and funding land transport in their areas. Over time these corridors may change in importance, given the dynamic nature of the sector, and so the establishment of an ongoing forum to discuss these changes has particular merit.

There are questions surrounding whether to measure the flows of freight or to measure the actual freight moved along the corridor. In future the ability to track every parcel and item moved is likely; however, in lieu of the data being available, the approach undertaken by the Transport Agency in its long-term strategic view (LTSV) is a good starting point. The adapted map is provided in figure 3.1.

In the future when data is more granular and readily available it can be expected that a map detailing all freight indicators and data along with an interactive platform will be utilised.

Figure 3.1 Key freight corridors (adapted from Transport Agency LTSV)[10][11]



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[10] Care will eventually need to be taken when presenting port statistics as current methods cover coastal traffic but do not include ferry traffic which is treated as an extension of the land transport network. Rail traffic can be derived from the rail statistics in FIGS but there is no regular information on road ferry traffic.

[11] Please note the units for interregional flows are expressed in $millions for value and volume is in tonne 000's.

3.2.2 Visualisation

The ability to identify and present the most essential aspects of time-varying data is critically important in many areas of science and engineering, according to Wang et al (2008). The use of effective data representation can enable better decision making and provide information to the market in a way that is easy to digest, and not get 'lost in translation'.

The presentation of freight indicators will exist alongside a myriad of other information captured and published by the Transport Agency and MoT (as well as other industry participants), but the point of difference for this suite is that it is housed in one place, and ideally is interactive. It is clear that interactive and concise dashboards are performing an increasingly important function for users.

A common and easily understood visualisation of data is important to its understanding and to help facilitate discussions. A common display and presentation encourages a common understanding across the sector and will help both government and private sector participants in discussing issues and improvements.

For these reasons, it is proposed that a bespoke data visualisation platform (web tool) be used. The specific design elements including back-end data housing and specific front-end design is beyond the scope of this research project; however, different approaches to the representation of different data sets have been canvassed through this research and are discussed briefly below.

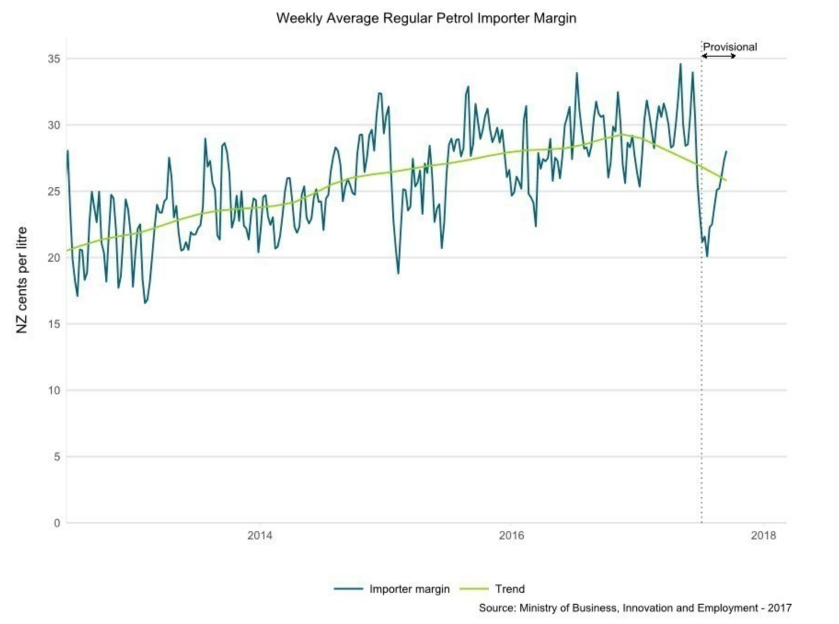
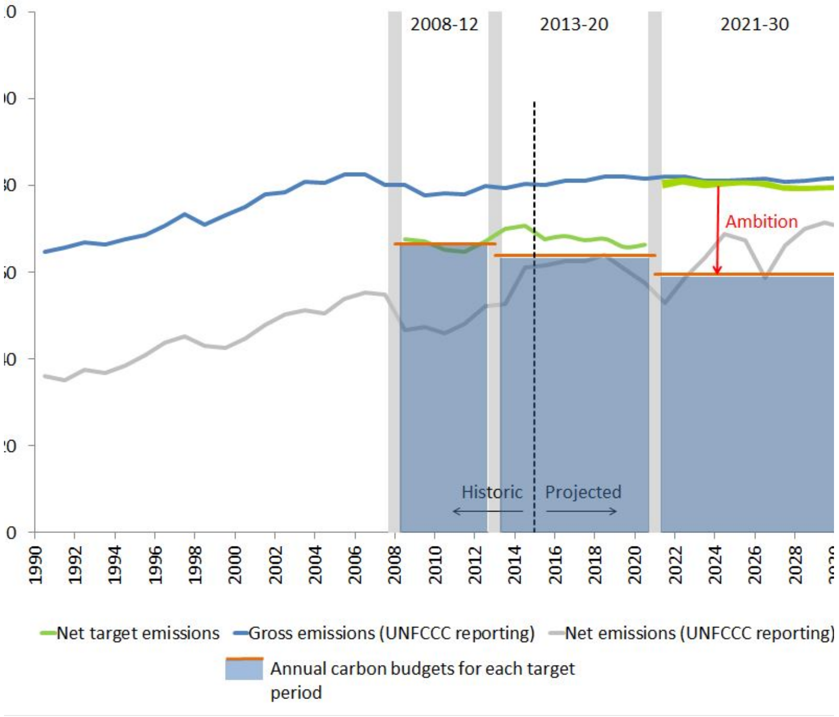
To remove doubt, the focus of the section below is purely to highlight the different presentational approaches that can be undertaken for the eventual final suite of indicators. The examples below are to show potential methods of visualisation.

3.2.2.1 National or aggregate level indicators

National level freight data, such as GHG emissions, is important for the national economy as this ties into Paris Climate Agreement obligations and the government's obligations under this agreement. It will be useful at a modal level because this can lead to investments in certain modes over others to address GHG emission objectives.

Given that it is the 'aggregate score' that is of interest, more so than by level of emissions by freight corridor, national level indicators should be presented as a 'trend' with historic information (and potentially projections) prominent. Trend data is commonly presented across government with examples of this type of representation provided in table 3.2. These examples are for presentational purposes only.

Table 3.2 Data visualisation examples – national level indicators

Example	Description
	The MBIE fuel price monitor shows the 'importer margin' estimated to be earned by the liquid fuel sector over time. It includes historic information, a trend line and provisional projections to enable consumers to see how this marker moves over time. www.mbie.govt.nz/info-services/sectors-industries/energy/liquid-fuel-market/weekly-fuel-price-monitoring
	The Ministry for the Environment (MfE) publishes aggregate New Zealand emission trends and forecasts over time at a gross and net level. This is a good model to replicate as it shows whether we are trending towards or away from stated targets. www.mfe.govt.nz/climate-change/reducing-greenhouse-gas-emissions/emissions-reduction-targets

3.2.2.2 Key freight corridor data

Key freight corridor data presents opportunities to view data in a more visually appealing way compared with national level data. In particular, it enables spatial representation and comparator analysis between different indicators and different corridors.

For instance, users will be able to click on key freight corridors and view a suite of indicators that show the performance of the corridor. If the user then clicked on one of the indicators, it could show comparisons of that indicator across corridors.

A prominent example of this can be demonstrated through the MBIE Regional Economic Activity Report (REAR) web tool, which shows regional performance as well as comparative performance across regions on individual indicators. Examples of this are provided in table 3.3.

Table 3.3 Data visualisation examples – key freight corridors

Example	Description
	The MBIE REAR web tool presents a map of New Zealand that demonstrates the 'key performance indicators' across all regions of New Zealand. http://webrear.mbie.govt.nz/summary/new-zealand
	The MBIE REAR web tool also enables a comparative representation of regional performance across individual indicators. For example, it can present the comparative income spread for all regions of New Zealand. http://webrear.mbie.govt.nz/summary/new-zealand

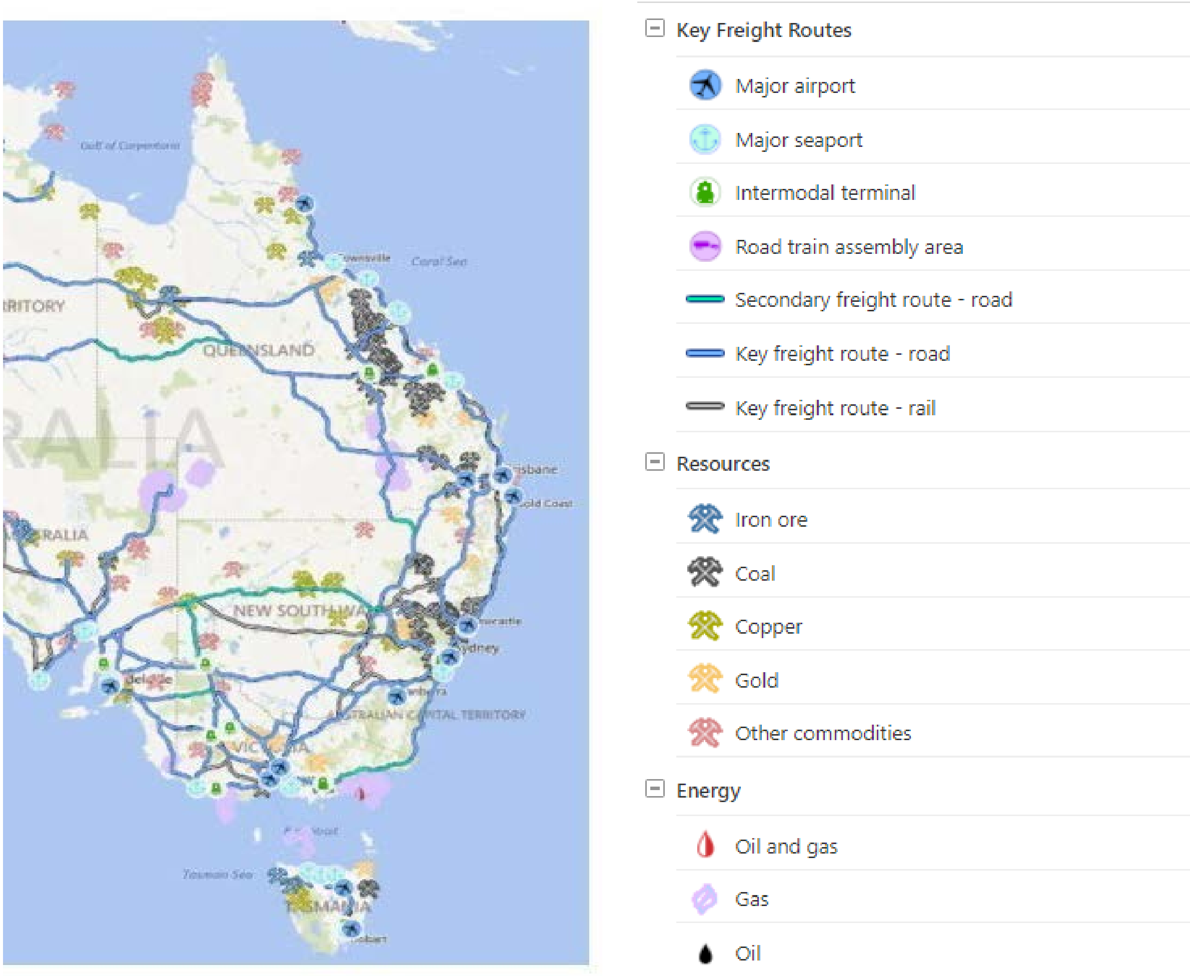
The representation of data in this way can enable users to customise their experience and focus on the data that matters to them. Overcoming this subjectivity bias is a big challenge in undertaking this research and so putting some of the power back in the hands of users is helpful in this regard.

Another useful example of how this 'corridor reporting' can look is provided in Australia where a version of figure 3.1 is supplemented by generators of freight, aggregators of freight and natural resources – such as forestry assets, mills, prominent dairy farmland, milk factories, meat works and aggregate deposits. An example of this reporting is shown in figure 3.2.

An important recommendation of this research is that the interactive web tool is formally designed to bring these ideas and concepts to reality.

It is also important to note that any representation of key freight corridors would need to align with the One Road Network Classification (ONRC) tool wherever possible, particularly for the highest road classification which is likely to capture many of the 'key corridors' by definition. Furthermore, important rail routes should also be included.

Figure 3.2 Map of key freight routes in Australia[12]



Source: Department of Infrastructure and Regional Development, http://maps.infrastructure.gov.au/KeyFreightRoute/

3.2.2.3 Regional level indicators

Regional councils, including unitary authorities, have a role in planning and funding land transport in their areas. They approve regional land transport programmes (put forward by regional transport committees) that set out regional objectives and priorities and those activities proposed by councils in the region and the activities the Transport Agency proposes for state highways.

Regional-specific indicators have not been advocated in this report as key freight corridor level information was deemed more relevant by the majority of stakeholders interviewed. However, this is not to say that regional-specific data does not have value, which it clearly does. Better understanding freight flows at a regional level can play an important role in regional transport planning deliberations.

Regions are still clearly welcomed and encouraged to collect regionally significant data that helps inform regional transport planning and the hope is that the indicators identified in this research can be 'regionalised' to the extent relevant to support consistent discussions wherever possible. It is also noted

[12] Please note that only the eastern seaboard of this map is provided for presentational purposes.

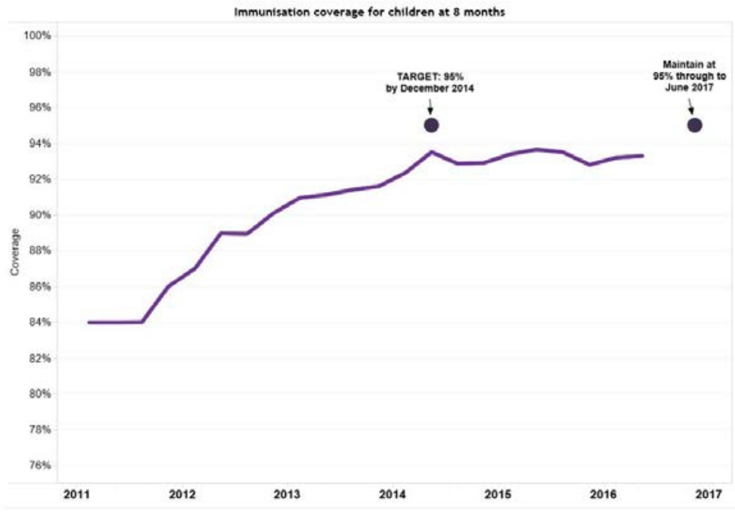
that the key freight route indicators promoted in this research often form a good proportion of total regional freight movement and so help in this respect.

3.2.2.4 Exception reporting and inclusion of targets

Another important consideration for the presentation of freight indicators data is the inclusion of an ‘exception’ function. This can take the form of the presentation of a threshold, high or low, that can indicate whether an indicator is tracking to an unacceptable (or desirable) level. By explicitly including an exception reporting component, governments can also be held accountable for actions (or inactions). A traffic light system could also be applied to show whether the data is trending in the right direction, or not.

An example of this can be envisioned for the condition of assets across key freight corridors. There could conceivably be an asset condition score that is considered unacceptable, and this ‘bottom line’ could be included in the presentation of asset condition scores over time. This could serve as an explicit trigger for new or enhanced asset maintenance and investment programmes.

Table 3.4 Examples of exception reporting (or targeting) in New Zealand

Example	Description
	This example was taken from earlier in the year when Auckland was rationing its water supply following a severe storm. A similar example can be envisaged where targets/bottom lines are included, and can serve as a way of ‘triggering’ action and accountability. Source: Radio New Zealand.
	The better public service targets are published by the State Services Commission and explicitly include targets, trends and a traffic light system to show progress. This could be envisaged for certain transport indicators. www.ssc.govt.nz/bps-snapshot

3.2.2.5 Importance of accessing underlying data

In addition to the presentation of data, it is also helpful for analytical purposes to extract and present the underlying data. The ability for users to extract the underlying information to interrogate, forecast and analyse the data is vital as it provides true transparency of reporting. It is therefore expected that users will be able to download the underlying excel sheet(s) or data repository that will be a part of the presentation of data.

3.2.2.6 Alignment with existing programmes

It is also important to align the development of freight indicators with existing programmes underway – for instance the continual development of the ONRC performance measures. This joined-up approach may lessen the burden of collection of data on behalf of the government, and in terms of sector input. Harmonising data sets may also create consistency of definitions, which is important to hold the quality of debate on freight.

An early indication of the development of freight indicators as part of ONRC indicators can be found in Road Efficiency Group (2016).

4 Proposed freight indicators

The research described in preceding chapters outlines a range of contextual trends, issues and challenges in the freight sector and characterises the basis on which indicators should be chosen. It also describes at a high-level the proposed presentational approach.

This chapter discusses the specific selected indicators and provides an indication of how and where they should be presented in the eventuality that the Transport Agency, MoT or another custodian takes on responsibility for implementation of this initiative.

Also included in this chapter is a consideration of whether freight indicators should be captured under an 'aggregate dashboard' or a 'key freight corridor dashboard'. To support this view, sections 4.1 and 4.2 set out the proposed breakdown of the indicators.

4.1 National level indicators

It is proposed that the following information be presented and tracked at an aggregate/national level:

- core freight metrics:
  - total import and export volumes and values
  - total tonne kilometres
  - total tonnes
  - modal share
  - total freight intensity
  - overall contribution of freight sector to economy
  - average age of fleet
- port performance
- GHG emissions
- safety
- human capital.

4.2 Key freight corridor indicators

It is proposed that the following information be presented and tracked at a key freight corridor level:

- core freight metrics:
  - total heavy vehicle trips along the key freight corridor
  - total number of freight train trips along the key freight corridor
  - tonnes moved along the key freight corridor
  - length of the freight corridor
  - freight corridor safety
- asset condition trends

- freight resiliency score
- travel time reliability.

In general terms, each dashboard will include some base information that is often a building block for a number of the more conceptual indicators that have been devised and developed through various stakeholder conversations and ancillary research.

Appendix A provides a comparative analysis of other jurisdictions' attempts to capture a similar set of freight indicators. Appendix D also canvasses several indicators that were considered to be valuable in theory, but unachievable in practice.

4.3 Core freight metrics – national level

4.3.1 Why this is important

Having a set of base metrics is necessary to understand performance of the sector at the highest level. Tracking important markers of the size, scale and magnitude of the total freight task will set the general context for government policy about whether additional interventions are required, or whether greater focus and support for the freight sector is required. These metrics often form the building blocks for other more conceptual indicators.

4.3.2 Definition and sources

The following metrics, and their respective definitions, are believed to be good markers of the size and scale and magnitude of the total freight task in New Zealand. In many respects, these indicators are already being captured and provided by government and so representation in this dashboard is more about validation of their importance to the sector.

Table 4.1 Proposed metrics for core freight indicators

Proposed metrics	Rationale and definition	Source and custodian
Total import and export	The presentation of this indicator represents the size of our trade sector, for goods. Broadly speaking any increase and decrease of exports or imports will have a corresponding impact on freight movements. It is proposed that both volume and value of exports and imports (at sea port and airport nodes) continue to be presented. To the extent that different categories of freight (container, bulk) can be reported, this should continue.	Statistics New Zealand (2017c) Data also available through MoT (2018c) – freight information gathering system (FIGS) data
Total tonne kilometres	Total tonne kilometres by road and rail is an important metric as it allows an estimate of the modal split to be defined.	MoT (2017h) – Freight and the transport industry: Freight volume
Total tonnes	Freight volume in tonnes. Air freight and sea freight is currently collected and captured in tonnes. Presenting the overall freight weight in tonnes shows whether there are increasing volumes of international freight being traded. Domestic movement of freight also shows whether total freight volumes are increasing or decreasing over time.	Sea and air – MoT (2017e)

Proposed metrics	Rationale and definition	Source and custodian
Modal share	Modal share is important to understand as it relates to how goods are being moved. It can also signal whether greater policy and investment emphasis should be placed on one mode over another. Significant work has been undertaken in the past to disaggregate freight movements by mode and region, and it is recommended that this work continue periodically. More regular assessments of modal share data at a national level can be determined through an assessment of MoT tonne km data as reported in FIGS and the transport monitoring indicator framework (TMIF).	MoT (2014b)
Total freight intensity	Freight intensity can highlight New Zealand's reliance on freight and potentially track the relationship between freight and the economy.	MoT (2017d) and Statistics New Zealand (2018a) GDP/total freight tonne kilometres
Overall contribution of freight sector to the economy	It is important to understand the contribution of freight to the economy along with its support function to other industries and sectors. This metric coupled with the freight intensity metric described above can provide some guidance on whether the sector is becoming more efficient, or whether the mix of the economy is trending more towards service provision (rather than export of raw materials). There is a current limitation in this measure as not all transport activities are freight related.	MoT (2017c) and Statistics New Zealand (2017d) Gross domestic product (GDP) by industry – transport, postal and warehousing[13]
Average age of fleet	The average age of the fleet is important to understand as newer fleet can be assumed to be more efficient to run, generally safer and produces less externalities. Specific measures include: • average age of trucks • average age of rolling stock. A discussion of the merits of including a measure for maritime and air should be considered in the consultation phase.	MoT (2018d) Average age trucks – MoT annual fleet statistics. KiwiRail: average age of rolling stock – KiwiRail has the ability to report on average age.

[13] The current example from the MoT is provided in 2010 prices. It is possible to use current prices as this will enable comparisons across different sectors and other data, this should be discussed as part of the further development of indicators.

4.3.3 Implementation plan

In most instances, this data is already available. Therefore, the implementation pathway is about aggregating the right information into the right format. The following proposals will assist with this:

- Collaboratively (industry and government) agree and confirm the list of core freight metrics through the consultation phase proposed in the research recommendations (see section 5.1.2). This should also include consultation on the merits of including a maritime and an aviation measure.
- MoT should continue to be the custodian for most of this data and be responsible for coordinating with other data owners as required.
- Undertake research into the best way of achieving (and reporting) an accurate understanding of modal splits.

4.4 Port performance – national level

Table 4.2 National level port performance – alignment to criteria

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementarity
Government has an oversight role in the performance of ports (given their natural monopoly characteristics) and also has a strong role in providing and planning associated landside transport infrastructure.	Ports are likely to have a strong ongoing role in the performance of the freight supply chain, regardless of trends that are affecting the industry.	Port performance measures on containers are largely already available and public through FIGS. However, reporting other metrics at a disaggregated level may present some commercial challenges.	Stakeholders endorsed the view that port performance should be measured as ports play an important role in the freight industry.	Air, sea and ports are captured. Further investigation into inland ports is suggested.	Port performance directly affects measures such as travel time reliability and safety.

4.4.1 Why this is important

Ports (air, sea, inland) are clearly important parts of the supply chain. They are the entry and exit point for the export and import of goods, and are particularly relevant for a small, distant and open economy such as New Zealand's. According to the New Zealand Productivity Commission (2012) the costs of being economically distant from key markets – both in terms of pure transport costs and the opportunity costs of time – impede New Zealand's ability to participate effectively in the global economy. Understanding the performance of these key nodes can have positive impacts on the New Zealand economy.

Additionally, ports can serve an important storage function to enable the timely delivery of freight. With an increasing focus on 'just-in-time' delivery, this storage function cannot be understated.

It is also important to reflect on the symbiotic relationship between port efficiency and the remainder of the supply chain. Put simply, ports can be a choke point (or an enabler), because delays or poor operational reliability can have cascading impacts on other parts of the supply chain. This further reinforces the merit in continuing to understand their comparative performance.

A range of existing seaport metrics already exist in New Zealand. These are reported through (FIGS) and include (but are not limited to):

- container throughput: the number of containers moved through a port per annum (by value and volume)
- crane rates: the number of containers a crane lifts on and off a container ship in an hour
- Ship rates: the number of containers moved on and off a container ship in an hour
- vessel rates: the number of containers moved on and off a container ship in an hour of labour[14]
- overseas ship visits: the number of foreign ships using New Zealand port facilities.

Metrics relating to performance of airports and inland ports are much less publicised – for both commercial reasons and as well as practical reasons (for instance the difficulty in measuring throughputs, volumes and values from postal and parcel freight).

Currently captured data (as provided in FIGS) is useful in broadly demonstrating 'on-port' efficiency for sea ports. Amongst other things, what this data does not indicate is:

- 'On-port' efficiency metrics for airports and inland ports
- Congestion 'outside the port gates' for road and rail freight in particular. This issue in particular is canvassed periodically in the media (Ashton 2016). It is also a metric that naturally has a symbiotic relationship with 'on-port' metrics.

Better understanding the performance of port activity, including both 'on-port' and 'outside-port', could give a better indication of the performance of the freight sector. Coupling port performance metrics with other indicators included in this research, most notably travel time reliability, will arguably enable the operational efficiency of freight to be better understood.

4.4.2 Definitions

Concisely defining 'port operations' as well as determining the 'performance of port operations' is a complex proposition.

There are three main types of port operations:

- Sea port: In New Zealand, this is defined as a company formed and registered under the Companies Act 1955 as a port company in accordance with section 4 of the Port Companies Act 1988.[15] Commonly cited examples include: Ports of Auckland Limited, Port of Tauranga and Port of Lyttelton.
- Airport: In New Zealand, this is defined as any specific area of land or water intended or designed to be used either wholly or partly for the landing, departure, movement, or servicing of aircraft; and includes any other area declared by the Minister to be part of the airport; and also includes any buildings, installations, and equipment on or adjacent to any such area used in connection with the airport or its administration.[16] The most prominent examples are Auckland International Airport Limited and Christchurch Airport Limited.

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[14] The difference between ship and vessel rates is due to allocated crane hours/elapsed crane hours.

[15] Port Companies Act 1988, section 2.

[16] Airport Authorities Act 1966, section 2.

While sea ports and airports are fairly well understood in concept, the definition of an inland port is more difficult. For instance, is there a functional difference between a well-recognised inland port (such as Wiri or Metro Port) and major warehousing facilities?

This research could not locate a commonly accepted definition of inland port activities in New Zealand. However, when focusing on inland ports, one generally supported definition is the one by Rodrigue & Notteboom (2017) 'A....terminal that is linked to a maritime terminal with regular inland transport services'. According to this definition, an inland port has a level of integration with sea ports and supports a more efficient access to the inland market both for inbound and outbound traffic. This implies an array of related logistical activities linked to the terminal, such as distribution centres, depots for containers and chassis, warehouses, logistical service providers and customs clearance.

Stakeholders made clear that the key point of difference was the level of control the organisations had over direct inbound and outbound movements. Major warehouse facilities and distribution centres are often under full control of the business that uses them, whereas inland ports are directly linked to seaports and are more responsive to the supply and demand pressures of its customers. Inland ports can be seen as an extension of the seaport itself and were referred to by some stakeholders as the 'new port gate'.

This definition of an inland port naturally includes some subjectivity about the size and scale of operations, as well as the inherent link to other parts of the supply chain. For the purposes of this research, the definition provides a clear steer when coupled with our starting definition of freight (section 2.1) that contemplates the large-scale movement of goods.

Beyond the existing and implied definitions of port infrastructure in New Zealand, a wide range of factors will ultimately influence assessments of performance, including:

- *The nature of the freight.* The type of freight that is predominantly moved, managed and maintained within a port operation will naturally lend itself to certain indicators. For instance, land-side requirements for bulk and liquid freight are considerably different from container freight.
- *The size and scale of port operations.* Bigger port operations typically tend to benefit from economies of scale. Therefore, it would be unsurprising to see 'better' productivity and efficiency metrics for these types of operations. This does not always mean that one port operation is more efficient (as a smaller port operation may be fit for purpose).
- The point in the economic cycle. Each freight item will have different supply and demand pressures and can be influenced by a wide range of factors. For instance, logging production can be a function of the investment decisions of resource owners and the demand patterns of overseas markets. Milk powder production can be influenced by weather patterns in New Zealand and even trade deals negotiated offshore. All commodities are heavily influenced by global prices. In these instances, port operators have very little influence over throughputs – and therefore indicators can suffer unjustifiably. The precise stage of the investment cycle can also influence capital investment decisions (ie borrowing costs may be at the top of a cycle which may make investments in efficiency enhancing capital more difficult).

Given the breadth of issues that encompass port efficiency, this research advocates for a continuation of reporting on several existing sea port measures – but inclusion of some new metrics to improve the depth and breadth of the indicator.

Table 4.3 provides an overview of definitions, limitation and advantages of several potential metrics that support reporting on port performance.

Table 4.3 Port performance indicator definitions, advantages and limitations

Port performance measure	Port type			Definition/explanation	Advantages	Limitations
	Sea	Air	Inland			
Port throughput and productivity						
Total (volume and value) of freight throughput by port and total	✓	✓		Definition: A measure of the total value and volume of all goods moved through air and sea ports. Where possible, this should demarcate between export, import and domestic movement. This metric is important to show the general trend of New Zealand's import and export of goods. Inland ports are not captured here because they are not the official start/end point for freight – and they would be in effect double counted in understanding New Zealand's export/import freight task. Some elements of this metric are currently captured through FIGS and Statistics New Zealand for airports and seaports. The metric should build on the existing data sets available.	This is a relatively simple metric that is already reported for import and export metrics. This quite clearly shows the size, scale and magnitude of the freight sector over time – through both volume and value measures.	In many respects, port operators (and governments) do not have direct control over the scale and magnitude of freight movements – therefore the direct applicability of this to policy making and investment decisions is questionable. Ports can be spread over multiple areas which can make their definition challenging. Defining the port and port areas should be undertaken with key industry participants as part of the next stages of developing the indicators. Differentiating between domestic movements and import/export movements may prove challenging. The ports may deem some of the information around types of commodities moved and stored and their value as commercially sensitive. The level and granularity of information and willingness to provide information by ports should be discussed in detail with the various port operators during the formal consultations with stakeholders.
Volume per hectare	✓		✓	Definition: The volume of all freight moved through a port operation each year divided by the total footprint of that port operation. Associated inland port movements are treated separately.	This is a relatively simple metric that gives an indication of on-port efficiency. This metric has important implications for land-use planning within a city or a	Hectare is not the only limiting constraint for ports – hours of operations, union conditions and workplace health and safety implications can limit the efficiency story. This metric does not take into

Port performance measure	Port type			Definition/explanation	Advantages	Limitations
	Sea	Air	Inland			
				Understanding the volume of freight (by commodity) moved over a certain footprint is one indication of the efficiency of the port operation. Consideration of inland ports is recognising that they are intimately linked to seaports by definition. This also reflects that seaport and inland port operations can sometimes be land hungry – and so understanding productivity metrics can help (local) governments manage land use planning. Airports are not considered relevant for this metric because freight handling facilities are often only a small part of the wider airport footprint. Freight handling facilities are also often diffuse, and are managed by a range of private sector participants across an airport precinct – so data collection may prove problematic. The relative size of a seaport and an inland port can be gleaned from Google Maps and authenticated through discussions with operators if needs be. When coupled with the value/volume data noted above, this can then inform the eventual productivity calculation. Aligning with the methodology established through the Bureau of Industry Transport and Regional Economics (BITRE 2017b) may also be of assistance.	system – particularly given the competing uses for such land.	consideration the value of port land – nor the surrounding land. There are limitations in the definition of ports (and inland ports) in regards to the treatment of storage space. A formal definition and treatment of whether to include storage space, wharves etc. should be addressed in the formal consultations stages of developing the metrics. Increased terminal efficiencies can be realised through greater densification – this can lead to impacts on other metrics, such as increased truck turnaround time. The measure does not indicate the value of goods managed or moved. There are comparison issues between type of freight (efficiency of bulk vs container for instance) as well as efficiency between modes (inland vs sea port). Dwell time could be used as another proxy for port performance in this regard.
Efficiency and landside transport performance						
Vehicle (and rail) dwell/turn times at ports	✓		✓	Definition: The amount of time that it takes a truck to collect or deliver a container from a port operator, or the average time it takes to load each container onto rail wagons measured in minutes. Sea and inland ports are considered relevant for this metric, because the speed at which trucks and	Vehicle and rail dwell/turn times indicate the level of on port operational efficiency especially when coupled with landside transport metrics. These metrics are both currently	Understanding ownership and responsibilities for delays may be difficult. For instance, overlapping calls and delays may result from late arrival times of ships. Decoupling queuing vs dwelling/turning

Port performance measure	Port type			Definition/explanation	Advantages	Limitations
	Sea	Air	Inland			
				trains can be loaded speaks directly to the efficiency of port operations. Airports are not considered for this metric because freight handling infrastructure is such a small and specialised part of the total airport footprint. Freight handling infrastructure is also often owned and operated by a wide range of participants, which makes collection of information difficult. Some of this information is already captured by operators; however, the methodology of collection may be inconsistent. Given that seaport operators also, often, operate inland ports, it is expected the additional collection costs would be modest.	being reported in some form by some port operators, or have been reported in the past, and so it is hoped that capturing them now should be relatively easy.	has some methodological challenges. There are also limitations in separations of wait time and loading time. For rail there may not be a demand for this measure as its impacts may be minimal. Inconsistent capturing methods may produce skewed results. A standardised method for data collection across ports will enable clearer comparisons. It is recommended the Transport Agency/MoT work with industry to undertake a standardised methodology for data collection. The presentation of this data may present some challenges in terms of consistency of reporting, as well as from a commercial perspective.
Off-port congestion	✓		✓	Definition: The level of congestion outside the port gate. This is a new measure that explicitly acknowledges the importance of the landside transport network in delivering efficient freight outcomes. This metric requires an element of consultation to fully determine the best definition and mechanism for collection. It aims to capture the level of road and rail congestion outside of the port 'gates' (the time waiting outside). The specific level of congestion will be measured as the number of trucks (or rail wagons) waiting to enter the port 'yard'. Video cameras or googling API data could be employed to physically capture this data. Alternatively there is also an opportunity to	This metric provides an additional indication of the efficiency of port operations in New Zealand and can be a symbol for port operators, truck operators and central/local government to consider whether transport investments (or processes) are appropriate. This information can assist future decisions about port (re)development requirements – for example if there is a need to include a separate parking bay for trucks.	It is unclear whether this data is currently captured and whether there would be any issues around commerciality/sensitivity with port operators. It may be difficult to attribute the cause of the congestion – is it port operations, landside transport scheduling, general traffic congestions/disruption on the relevant transport network, or seasonal issues around increased production? Further limitations will be where congestion starts and how this will be measured and further complicated with the potential of multiple entry and exit points and gates. These limitations

Port performance measure	Port type			Definition/explanation	Advantages	Limitations
	Sea	Air	Inland			
				measure the broader levels of congestion around the port to understand if the port is contributing to increased amounts of congestion (as for example, trucks arriving at gates early may park up near the gates, or circle around the area before arriving at their allotted slot time. Airport congestion would be useful to capture, but the difficulty in defining entry and exist points makes this exercise difficult (as there are multiple freight forwarders located at airports).	Supplementing this measure by looking at the general level of congestion around ports, could give additional insights into the performance of the network. As trucks (in particular) have to meet their allocated port slots, they may leave early from their origin to ensure they meet their destination on time, given noted reliability problems on the network. Anecdotally, it was expressed that this means they may spend unnecessary time driving in and around the port entrance.	should be discussed and addressed in formal consultation stages. There may be some issues of consistency in comparing road and rail congestion data – particularly given the fact that KiwiRail can often have a number of ‘idle’ wagons at ports as part of normal operation. In practice this may not be a problem, provided these metrics are tracked over time. Understanding ownership and responsibilities for delays may be difficult.

4.4.3 Supporting evidence

It is not productive to report on each and every metric used to demonstrate port performance around the world. However, several documents and reports summarise some of the best practice indicators that are prevalent across the US, Europe and Australia. Appendix A provides an overview of what comparable jurisdictions are reporting.

While these comparators are often defined slightly differently, and methods of capture vary slightly from jurisdiction to jurisdiction, these form a basis for comparison in a New Zealand context.

Table 4.4 Examples of port indicators from overseas jurisdictions

Indicator	Example of ports where this metric/indicator is measured
Vessel calls	Port of Charleston; Port of Virginia; Transport Canada[(a)], Portopia[(b)], Brisbane. Sydney, Melbourne, Adelaide, Fremantle (BITRE 2017b)
Crane moves (per hour)	Port of Charleston; Transport Canada; Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Truck turn time	Port of Charleston; Port of Virginia; Transport Canada; Port of Oakland; Southern California Harbor Trucking Association
Transactions per annum	Port of Virginia
Dwell times/vessel turnaround time	Port of Virginia; Port of Oakland; Transport Canada; Portopia
Truck wait time outside terminal gates	Port of Oakland
On time vessel arrival	Port of Oakland; Transport Canada
Percent of import shipment placed on customs hold/average customs hold time	Port of Oakland
Berth utilisation	Transport Canada
Container dwell time	Transport Canada Brisbane. Sydney, Melbourne, Adelaide, Fremantle, five ports
Port productivity (TEU/hectare)	Transport Canada
Ship productivity (TEU/vessel)	Transport Canada
Container throughput	Transport Canada; Portopia Brisbane, Sydney, Melbourne, Adelaide, Fremantle
Terminal throughputs	Portopia
Size of port/terminal and/or quay length	Portopia
Rail share of TEUs handled	Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Wharf-side elapsed labour rate	Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Average TEUs per truck on landside of container terminals	Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Average number of lifts per berth visit	Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Time slots used by trucks in all off-peak periods	Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Time slots used by trucks in off-peak periods Monday to Friday	Brisbane. Sydney, Melbourne, Adelaide, Fremantle
Time slots used by trucks on Saturday and Sunday	Brisbane. Sydney, Melbourne, Fremantle
TEUs processed per VBS timeslot used at container terminals	Brisbane. Sydney, Melbourne, Adelaide, Fremantle

Notes: [(a)] Transport Canada is a federal institution responsible for transportation policies and programmes. It promotes safe, secure, efficient and environmentally responsible transportation.

[(b)] Portopia is a self-supporting European Ports Observatory, endorsed by port stakeholders, that provides superior value to the industry and its stakeholders by supplying transparent, useful and robust indicators and the contextual analysis of thereof, leading to improved resource efficiency, effectiveness and societal support for the European Port System. Its consortium and associated partners represent a significant part of the port sector across Europe.

4.4.4 Data sources

The following data sources and custodians should produce the evidence required for the port performance indicators.

Table 4.5 Proposed data sources and custodians for port performance metrics

Port performance metrics	Data source(s)	Custodian(s)
Total (volume and value) of freight throughput by port and total	This information is already reported through FIGS for sea and air ports (MoT 2018b)[(a)] A discussion with inland port operators is required to determine value and volume metrics for inland ports. A discussion with port operators and statisticians may be required to determine the ability to separate out domestic movement of freight if this is seen as a priority.	MoT
Volume per hectare	Google maps will be required to understand the size of each port operation's footprint. This can then be reconciled against official publications and/or discussions with port operators. Volume and throughput can be determined from FIGS data (for seaport) (MoT 2018b). A discussion with inland port operators is required to determine value and volume metrics for inland ports.	MoT
Vehicle and rail dwell/turn times at ports	Several port operators already capture truck turn time information, and make it public.[(b)] A clear limitation for some data is that it is provided on a spot basis and there may be an inclination to have a consistent measure on an average basis. A consistent methodology should be the next step in the development of indicators. KiwiRail has dwell measures that can be adopted.	MoT KiwiRail Port operators
Off-port congestion	Google maps may be required to define the 'radius' around sea port gates and inland port gates. Google API data could be used to demonstrate the level of congestion within that radius. Alternatively, a dedicated camera (or paired ANPR cameras) that is monitored autonomously, could be used to register the amount of time that individual number plates are sitting idle (or virtually idle). Access to KiwiRail schedule data, and performance data, would be required to understand the level of congestion from a rail perspective.	Local authorities Port operators KiwiRail

Notes:

[(a)] While this is published in total the breakdown by port needs additional analysis of the FIGS data.

[(b)] For instance, truck turn time from the Port of Tauranga. www.port-tauranga.co.nz/metroport/truck-turn-time/ . There are clear challenges in terms of getting data and achieving alignment between reporting approaches.

4.4.5 Implementation plan

There is a hybrid of some sub-indicators that have already been captured and some that are proposed to be newly constructed and reported. Accordingly, there is a range of actions required to develop the necessary information for this indicator.

- Appoint MoT as the custodian for this indicator category given the wide range of freight operators included and the reliance on FIGS data. MoT will be responsible for coordinating with other data owners as required.
- Lead a process to collaboratively agree the appropriate port performance measures as well as the definitions of port types – sea, air and inland – as this will impact on which operators/locations are monitored.
- Define the ports that are applicable for this assessment – intuitively this would align to the key freight corridors that are eventually developed.
- Determine a consistent approach and definition to measurement across ports including area, size and the inclusion/exclusion of inland ports.
- Agree on the ability, and more importantly the need, to disaggregate import and exports from domestic movement of freight.
- Determine ability to capture throughput metrics (value and volume) at inland ports.
- Determine the best off port congestion measure (queuing or congestion around a radius) through formalised consultations.
- Discuss outside port gate congestion measure concept with relevant local road authorities to understand data collection options. This could include the utilisation of cameras, sensors or even purchasing of Google API data or eRUC data.
- Align metric(s) with truck/rail turnaround time metrics which exist on-port to understand the full impact of delay for freight operators in dealing with ports. This will require discussion with port operators.
- Consider options and approaches to deal with 'attribution' of off-port congestion.

4.5 Greenhouse gas emissions – national level

Table 4.6 National level greenhouse gas emissions – alignment to criteria

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementarity
Government must understand GHG emissions to comply with the Paris Accord. Government also regulates to internalise the externality of GHG emissions.	Reporting on GHG emissions is likely to be an ongoing issue for New Zealand to manage given the long-term effects of climate change.	GHG emissions are currently estimated and collected by MfE as reporting of energy data and GHG factors are regulatory requirements.	All stakeholders interviewed either agreed or remained silent as to the importance of reporting on GHG emissions.	All modes emit GHG emissions. GHG emissions by mode can technically be distilled through energy returns/ estimates.	This indicator has no direct association with other indicators, although can be supported through some of the core freight metrics (particularly around modal movements).

4.5.1 Why this is important

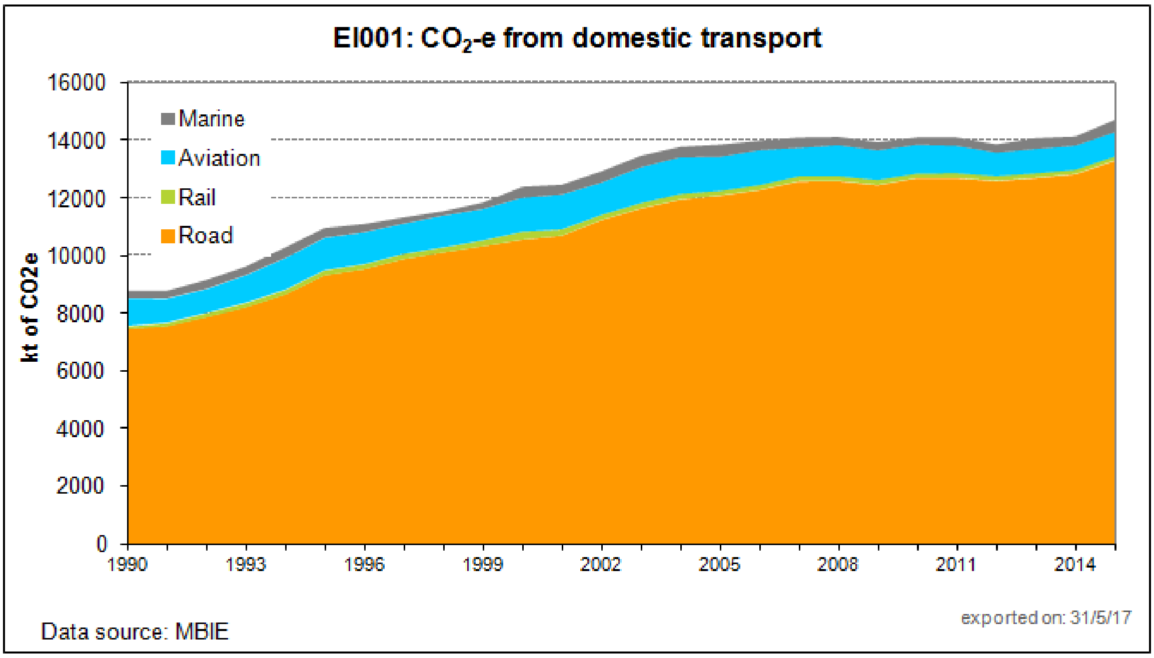
New Zealand ratified the Paris Agreement in 2016, which commits to having a regularly updated emissions reduction target (Bennett 2016). This symbolic commitment is underpinned by growing consensus across the political divide, as well as strengthening support within the public (MfE 2015), for action to respond to the challenges posed by climate change. The current target for New Zealand's reduction in GHG emissions is 30% from 2005 levels by 2030.

There are three targeted ways for New Zealand to meet this 2030 target, the first of which is directly relevant for this research:

- reducing GHG emissions in New Zealand
- growing more trees to absorb emissions
- buying emissions reductions from overseas carbon markets.

The transport sector contributes 20% of New Zealand's total emissions and also makes up 50% of emissions captured under the energy sector. An aggregate view of the comparative breakdown of emissions by mode is provided in figure 4.1. From this, it is clear the road sector is a major contributor of GHG and that this warrants particular attention from an indicator perspective.

Figure 4.1 CO2-e from domestic transport (1990–2015) (Source: MoT 2017b)

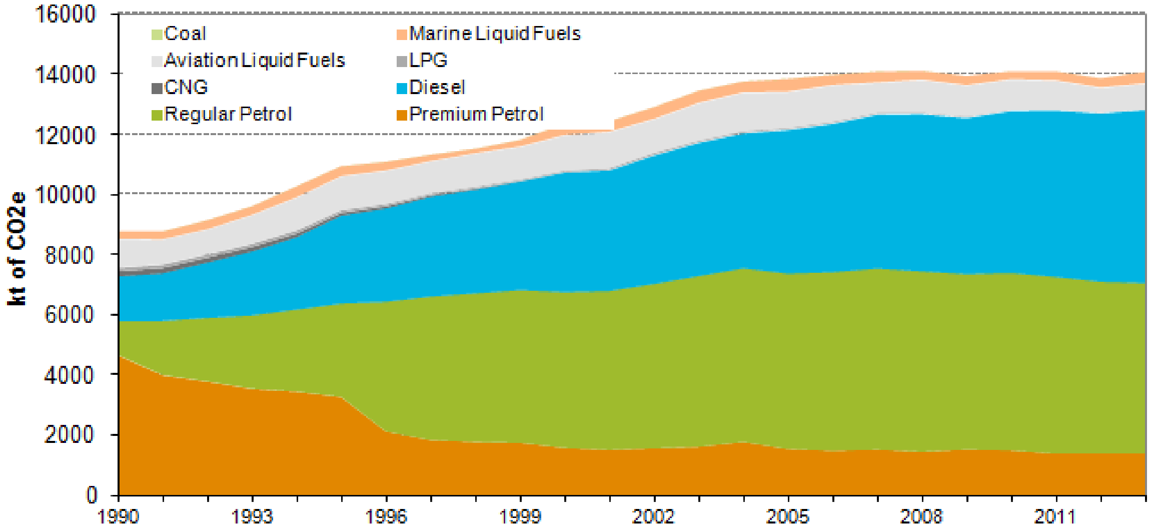


Determining the contribution of freight to the total 'road sector' emissions profile is challenging given that emissions are formally derived based on fuel consumption – not strictly by vehicle use (and type). There are further complications when considering ferries as they carry both trucks and passengers with clear difficulties in attributing GHG emissions to freight.

However, by using some proxies, it is possible to estimate that freight transport ranges from roughly 20% to 40% of energy used in the transport sector. The wide range is due to both the definitional issues of freight (whether freight consists of all goods moved or large scale) and the natural limitations of GHG emissions which are discussed further below. This logic is based on the assessment of two key assumptions:

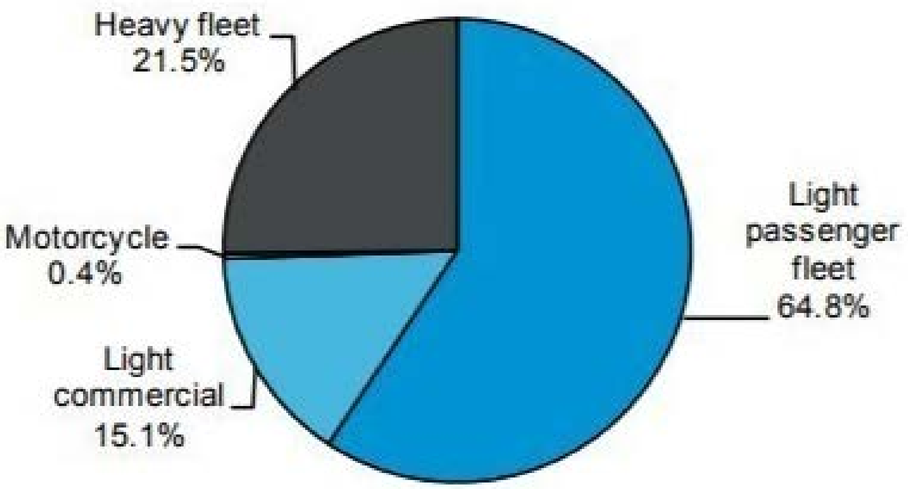
1 Diesel's contribution to total emissions is ~40% as demonstrated in figure 4.2. The fundamental assumption here is all diesel emissions are trucks (heavy and light) given that increasing numbers of vehicles that meet higher European vehicle emissions standards are entering the fleet. But freight vehicles are assumed to be the biggest demand vector.

Figure 4.2 CO2-e from domestic transport fuel (1990–2015) (Source MoT 2016d)



2 Light commercial and heavy commercial vehicles account for 37% of total emissions as demonstrated in figure 4.3. If light vehicles are removed, then the emissions numbers are 21.5%. Similar to the assumption above, there will be some light commercial and, to a lesser extent heavies, that run on petrol/biofuel, but again, diesel will be the largest demand vector.

Figure 4.3 2015 C02 emissions (Source: MoT 2016e)



The vehicle emission model from MoT represents the best current available data set to understand vehicle emissions by fleet type. Many of the informational inputs into this are based on existing data sets such as vehicle kilometres travelled (VKT) or are based on contemporary research such as investigating fuel consumption patterns by vehicle type.

Following discussions with MoT, it is believed that the use of heavy vehicles is a good proxy for road freight, particularly if the focus is on large scale or line haul movement of goods. The vehicle emissions model uses the number of km * fuel consumption profile * GHG factor as general variable inputs with the total VKT based on eRUC data.

There are however, some inherent limitations to the vehicle emissions model which include the following:

- Buses are included in the heavy vehicle data sets, although they are minor at around 10,000 compared with 130,000 heavy trucks.
- It is difficult to keep an up-to-date view of how laden trucks might be, how fuel efficient trucks are, and what routes they are travelling. Ongoing research into this area and/or better data collection methods over time will be beneficial.
- To a lesser extent, diesel is used as the default fuel, despite the fact there are a handful of heavy petrol vehicles.
- There are also limitations around understanding the composition of the light commercial fleet and the extent to which freight is carried.

It is likely the government will become more interested in meeting its GHG emissions target as it gets closer to 2030, and stricter policies may be imposed in response to this. Although there are clear plans and targets from government to reduce emissions, there is the possibility that more stringent policies will be implemented in future to ensure these targets are met. The importance of measuring and accounting for carbon emissions will therefore become more important for both public and private entities over time.

Understanding the level of GHG emissions over time, and how it differs by mode and potentially corridor, can inform interventions, regulatory and policy settings, and investments in infrastructure to support different modes for freight.

4.5.2 Definition

Understanding GHG emissions from the movement of freight at an aggregate level is possible from investigation of New Zealand's national inventory – which is required in accordance with the United Nations Framework Convention on Climate Change (and the associated obligations under the Paris Climate Accord).

Understanding GHG emissions at a more disaggregated level (by corridor and by mode) is more difficult given the diverse ownership interests across the various sectors, limitations in monitoring fuel use spatially, the capture of energy data at a wholesaler level, and the imposition of the New Zealand Emissions Trading Scheme upstream (ie on fuel retailers) rather than downstream (on fuel consumers).

Nevertheless, this research advocates for the continued collection of national-level measures, alongside the development of new measures to develop a better understanding of GHG emissions.

Table 4.7 Greenhouse gas emissions indicator definitions, advantages and limitations

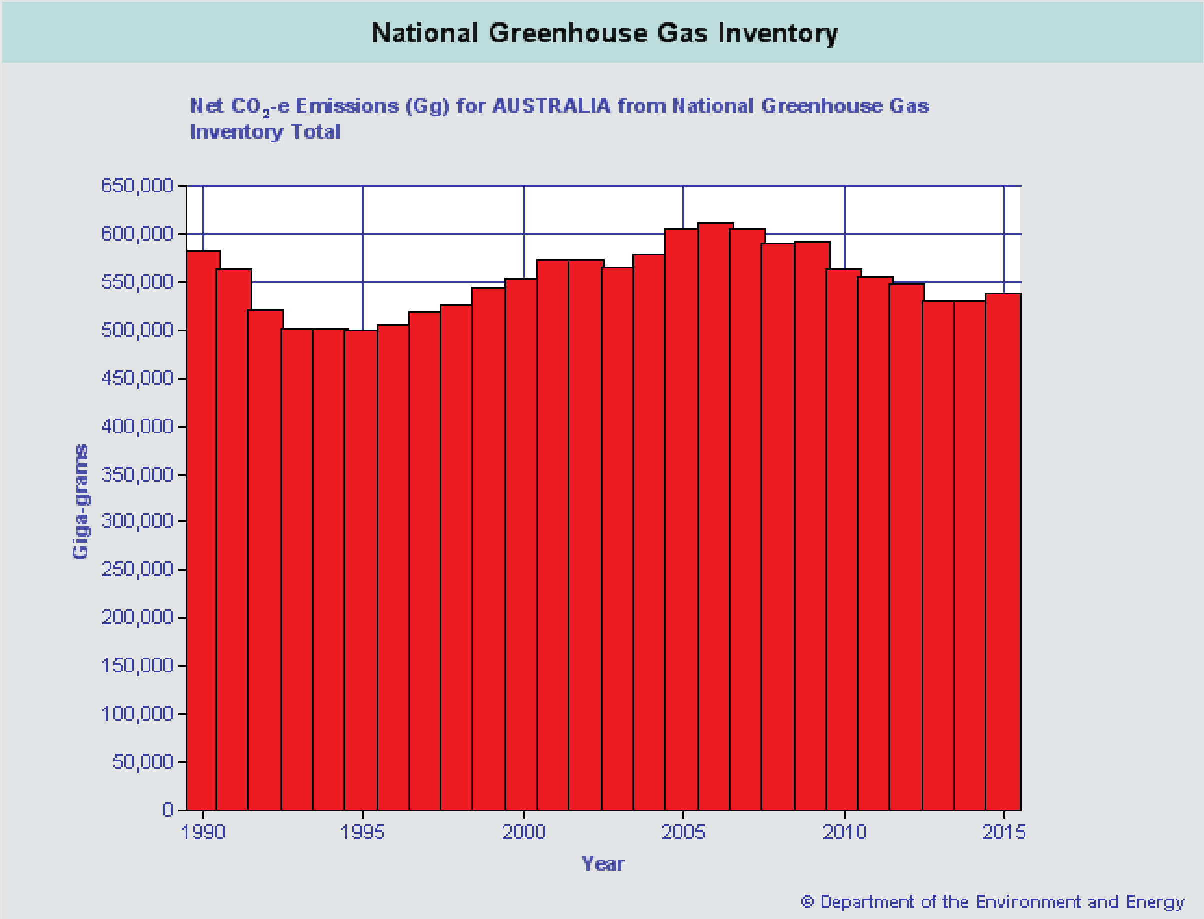
<table>
<tr><th rowspan="2">Indicator</th><th colspan="4">Mode</th><th rowspan="2">Description</th><th rowspan="2">Advantages</th><th rowspan="2">Disadvantages</th></tr>
<tr><th>Road</th><th>Rail</th><th>Maritime</th><th>Aviation</th></tr>
<tr><td>Emissions efficiency by mode</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>Definition: Total emissions by freight mode, indexed against an average GHG emission per tonne km metric.
This metric should be ‘net’ rather than ‘gross’.
There are obvious issues in attribution given the energy usage is the main input into modal emissions profiles and this does not always correlate perfectly. Specifically:
• Road will be based on petrol and diesel receipts.
• Rail will be based on diesel receipts.
• Aviation will be based on aviation gas and jet A1 receipts.
• Maritime will be based on heavy fuel oil (and potentially diesel) receipts.
MBIE and MfE already report these figures giving an established baseline to work from[a].</td><td>Understanding the relative composition of freight emissions by mode may result in future investment decisions on behalf of central and local government to better achieve their Paris Climate obligations.
By benchmarking against an average GHG emission per kilometre metric (possibly related to tonne kilometres), it is possible to understand the inter- and intra-modal efficiency gains being made.
This metric is effectively being captured and is easy to represent.</td><td>Understanding and attributing GHG emissions from the transport (and indeed freight) sector will rely on the utilisation of proxies – for instance, emissions factors - which are applied to fuel uptake metrics used across modes.
There will have to be some sizeable assumptions made about relative contribution by the maritime and aviation sectors given overlaps with ‘passenger’ emissions and also the impacts of domestic vs international freight movements.</td></tr>
<tr><td>Total emissions from the freight industry</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>Definition: Total GHG emissions, measured in CO_2e-, from across the domestic freight industry in New Zealand.
International emissions should be ignored on grounds of attribution.</td><td>Understanding the total emissions across the freight sector is necessary for New Zealand’s reporting obligations and can indicate whether New Zealand is tracking towards or beyond its climate change obligations.
This metric is effectively being captured and is easy to represent.</td><td>Understanding and attributing GHG emissions from the transport (and indeed freight) sector will rely on the utilisation of proxies – for instance, emissions factors.
There will have to be some assumptions made about the impacts of domestic vs international freight movements.</td></tr>
</table>

Note: [a] There may also be limited amounts of coal receipts used for rail and maritime.

4.5.3 Supporting evidence

Reporting of GHG emissions is vast and undertaken by numerous countries. Similar to the collection of emissions in New Zealand, Australia collects emissions on a national GHG inventory level through the Department of the Environment and Energy.

Figure 4.4 Australia's national greenhouse gas inventory



Australia also publishes reports on the national inventory by economic sectors. The information is disaggregated by the Australian and New Zealand Standard Industrial Classification (ANZSIC). The GHG emissions are estimated using Kyoto Protocol classifications which were developed under the United Nations Framework Convention on Climate Change. New Zealand is currently looking to adapt something similar to Australia. Reporting on emissions at a state and territory level is also undertaken.

Figure 4.5 Example of Australian industry emissions reporting

ANZSIC code	Industry Classification	Emissions (Mt CO_2-e)			Change in emissions (per cent)	
		1990	2014	2015	1990 to 2015	2014 to 2015
Div A	**Agriculture, forestry and fishing**	**247.5**	**87.8**	**85.1**	**-65.6%**	**-3.0%**
Div B	**Mining**	**41.4**	**71.4**	**74.5**	**79.8%**	**4.5%**
06	Coal mining	23.1	33.1	34.8	50.7%	5.1%
07	Oil and gas extraction	14.3	23.3	24.8	73.1%	6.4%
08-10	Metal ore and non-metallic mineral mining and quarrying	4.0	14.9	14.9	272.0%	0.0%
Div C	**Manufacturing**	**69.4**	**66.6**	**62.4**	**-10.0%**	**-6.3%**
11-12	Food, beverages, tobacco	5.2	4.8	4.6	-11.7%	-5.2%
13	Textile, clothing, footwear and leather	0.6	0.5	0.5	-16.6%	-3.3%
14-16	Wood, paper and printing	2.1	1.8	1.7	-18.6%	-5.4%
17-19	Petroleum, coal and chemical	15.7	19.3	17.5	11.8%	-9.0%
20	Non-metallic mineral products	10.1	9.7	9.6	-4.6%	-1.1%
21-22	Metal products	34.9	29.9	27.9	-20.0%	-6.5%
24	Machinery and equipment	0.8	0.5	0.5	-34.7%	-4.1%
25	Other manufacturing	0.1	0.1	0.1	32.8%	-0.3%
Div D	**Electricity, gas and water**	**136.5**	**185.8**	**194.4**	**42.3%**	**4.6%**
Div E-H, J-Q	**Commercial services and construction**	**34.6**	**33.8**	**33.8**	**-2.1%**	**0.0%**
Div I	**Transport and storage**	**12.7**	**26.8**	**28.0**	**120.2%**	**4.7%**
	Residential	**32.1**	**45.9**	**46.6**	**45.2%**	**1.7%**
	Residential (non transport)	12.9	12.9	12.9	0.0%	0.0%
	Residential (transport)	46.6	46.6	46.6	0.0%	0.0%

Source: Australian Greenhouse Emissions Information System:
http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/ageis

Along with countries reporting GHG emissions on a national sector level some countries such as the U.K. have made it mandatory for companies to report on annual GHG emissions. Under the Companies Act 2006 (Strategic and Directors' Reports) Regulations 2013, quoted companies are required to report their annual GHG emissions in their directors' report. The UK Department for Environment, Food and Rural Affairs has estimated that reporting will contribute to saving four million tonnes of C02e emissions by 2021 (Carbon Trust 2017).

DEFRA (2013b) provided a guideline for companies to comply with the GHG reporting regulations and also voluntary reporting guidelines. A web-based tool containing emission conversion factors was also developed for GHG emissions reporting. These conversion factors help companies convert their activities, such as fuel consumption, car mileage or waste generated, into the equivalent carbon emissions. The conversion factors are updated annually at the end of May.

If industry chose to voluntarily report on carbon emissions in New Zealand, the guide could be adapted for the New Zealand context.

4.5.4 Data sources

The Domain Plan identifies a range of existing information that is collected, or has previously been collected, by various government departments. One of the 11 main categories is 'Environment' and this includes several indicators directly relevant for the freight sector. Table 4.8 outlines the proposed GHG metrics and data sources.

Table 4.8 Greenhouse gas metrics

GHG emissions metrics	Custodian	Data sources
Emissions efficiency by mode	MoT, MfE and MBIE	CO2equivalent emissions from domestic transport (MoT 2017b)
Road freight emissions	MoT	MoT vehicle fleet emissions model – use of heavy fleet as a proxy for road freight.
Rail freight emissions	KiwiRail	KiwiRail has freight line data which can be adopted.

These indicators have some inherent limitations that over time will need to be (re)considered including:

- Emissions factors for fuel usage will need to be corroborated. The obvious starting point is the Emissions Trading Scheme (MfE 2008). It is assumed these regulations will actively capture and account for improvements in fuel efficiency within the sector.
- Understanding passenger/freight split on volume ground for domestic maritime and aviation sectors. Various maritime and aviation operators could contribute to this understanding, but the outcomes are likely to be commercially sensitive.
- Understanding the proportion of the freight sector that diesel consumption represents. Because modal assessments are likely to rely on RUC data, and/or energy consumption data from MBIE, assumptions will have to be made about the proportion of the diesel market that is represented by the freight sector.
- Understanding the proportion of the freight sector that petrol consumption represents. Because modal assessments are likely to rely on local area fuel tax fuel consumption data, and/or energy consumption data from MBIE, assumptions will have to be made about the proportion of the diesel market that is represented by the freight sector.

Any methodology would need to remain consistent with the New Zealand GHG inventory.

4.5.5 Implementation plan

In most instances, this data is already available. Therefore, the implementation pathway is about updating a lot of what has already been undertaken. To assist with this, it is proposed that:

- MoT agrees to continue to be the custodian for this data through their role in the Domain Plan.
- A range of government departments (EECA, MBIE, MfE, MoT) hold discussions to understand the applicability of undertaking this analysis – particularly at a modal level.
- The above government departments discuss the level of analysis that can be provided from commercial operators, particularly for rail, maritime and aviation sectors (such as KiwiRail, Air New Zealand, Jetstar, Coastal Oil Logistics Limited, Maersk).
- Commission relevant technical research into outstanding methodological gaps as noted in section 4.5.4.

- Align this work stream with work being undertaken by Statistics New Zealand into air emissions attributable to various sectors of the economy.

4.6 Safety – national level

Table 4.9 National level safety – alignment to criteria

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementary
Government has a strong role in promoting workplace health and safety (including through imposition of regulations and payments through ACC).	Safety will always be considered paramount in any jurisdiction as governments and industry look to reduce externalities.	Safety data is widely available and currently measured in New Zealand. Increased regulatory requirements enhance the practicality of reporting.	Safety was considered an important measure to most stakeholders consulted.	All modes measure safety to a greater or lesser degree – albeit some proxies may be employed to arrive at 'actual' numbers.	Safety is not explicitly linked to other indicators, but overlaps with asset condition, travel time reliability and total freight moved by mode.

4.6.1 Why this is important

The importance of workplace health and safety is enshrined in the New Zealand operating environment from the requirements of the Health and Safety at Work Act 2015. At the heart of this regulation is a moral, legal and financial imperative for governments and industry to reduce harm to individuals.

Safety is an issue that was raised extensively throughout stakeholder consultations. Understanding safety performance is therefore important as it enables industry and government to move towards a zero harm work culture.

Deaths and serious injuries are a major social cost to New Zealand. The value of a death has been widely established by the MoT value of statistical life (VOSL). The VOSL is used in many cost-benefit appraisals along with evaluating proposed new projects and policies.

Tracking health and safety performance over time can highlight fundamental issues inherent in the sector but can also serve as a flag for discussions between government and private operators in the sector. Highlighting potential issues through the tracking of trends enables dynamic and targeted analysis, education, infrastructure improvements or process and procedure reviews.

Moving freight can be considered an overall system and therefore it is important to consider all elements of the supply chain from port safety transportation by all transport modes and lastly delivery, warehousing and unloading.

4.6.2 Definition

'Safety' as a concept has wide physical, psychological and cultural applications. However for the purposes of this research, the focus was on deaths and serious injuries directly related to the provision of freight.

In New Zealand there are a few differing definitions which should be considered when looking into 'safety'. For road transport the Transport Agency Crash Analysis System (CAS) is the predominant data point and uses the following definitions to define crash severity:

- Fatal: death occurring as the result of injuries sustained in a road crash within 30 days of the crash.[17]
- Serious: injury (fracture, concussion severe cuts or other injury) requiring medical treatment or removal to and retention in hospital.
- Minor: injury that is not 'serious' but requires first aid, or that causes discomfort or pain to the person injured.
- Non-injury: property damage only.

In recognition of the belief that the supply chain is wider than just the transport sector, and can incorporate incidents related to employees at the aggregation/disaggregation nodes of a network, a wider set of definitions can be explored by interrogating WorkSafe New Zealand (2017a) data. For the purposes of the report the definition used for serious injuries related to workplace injuries is the following:

- Severe injury: more than a week away from work (based on weekly compensation claims.) ACC pays employees, shareholders and self-employed workers 80% of pre-incapacity income but it excludes the first week of incapacity (for employees this is paid by the employer).
- Non-severe injuries: non-severe injury claims are accepted ACC claims where the worker's injury does not result in more than a week away from work. Non-severe injuries were not contemplated in the identification of relevant indicators.

New Zealand Government's Safer Journeys Strategy highlights the importance of road safety and the freight industry plays an important role in contributing to a safer road transport environment. Similarly, as all workplaces move towards reducing harm and including zero harm measures in the workplace, the availability of data is improving for incidents and incident reporting.

4.6.2.1 Reporting

The focus on the safety indicators is to highlight the trends around deaths and serious injuries related (directly or indirectly) to the movement of freight, and to raise issues and awareness of potential safety concerns. Further investigations can then occur into each event or into understanding the trend to determine if an intervention is required.

The MoT publishes the number of fatalities by transport mode with reporting originating from a range of contributing organisations and systems (MoT 2017f).

- Road deaths are sourced, and reported, from CAS.
- Rail deaths are reported to the Transport Agency by rail operators.
- Maritime deaths are reported from Maritime NZ.
- Aviation deaths are reported from the Civil Aviation Authority (CAA).

This is the primary source of information for all transport incidents.

The obvious limitation with all this information (for this research paper), is that there is not a specific metric with regards to freight. Current reporting of deaths and serious injuries is also at an aggregated

[17] The authors note that the time limit for any definition will always be contentious. But 30 days is intriguing.

level. It is envisioned that freight specific metrics at a corridor level could be developed in the next stage of consultation.

As freight can be moved in many vehicular forms it is suggested that the number of 'Truck occupant deaths' and 'Truck occupant injuries' be used as an important measure. Although this does not detail the cause of the crash or that a truck crash can result in multiple fatalities, for an overall freight indicator measure it would help track the overall performance.

To capture the externalities of the freight sector it is proposed that 'Deaths involving other road users' and 'Serious injuries to other road users' are also captured. These statistics are widely reported as seen in MoT (2016d) *Trucks 2016* report. There are known limitation when measuring trucks as not all trucks will necessarily be carrying freight (and not all freight is carried in trucks); however, measuring truck incidents as a proxy for freight safety on road is seen as an appropriate measure.

Current marine, rail and aviation related deaths and serious injuries are minimal and it is expected that those related to freight incidents are even fewer still. However, in the interests of achieving goals of mode neutrality, it is proposed to continue to report on these incidents.

To enable the capture of data from across the supply chain that is supported by the freight sector, it is proposed to complement MoT data with data from WorkSafe NZ.

WorkSafe NZ has data from their System for Work–related Injury Forecasting and Targeting (SWIFT) model which is published to show the amount of workforce injuries (WorkSafe NZ 2018a). Excel extracts are also available. Reporting at this level will miss many elements of the freight sector. For instance, WorkSafe NZ excludes 'deaths in the maritime or aviation sectors or fatalities due to work-related road crashes'. These deaths and serious injuries can be captured through the reporting from the MoT.

Inclusion of safety statistics related to ANZSIC category 'Transport, postal and warehousing' is acknowledged as being contentious. The value of this indicator is that areas such as warehousing, freight forwarders etc are an important part of the freight sector, and are often left out of the discussion. We therefore recommend capturing the performance of this sector, while acknowledging inherent anomalies (oil terminal etc), as this is a more holistic position than not capturing it.

The broad reporting categories are likely to be under these level 4 categories:

- road freight transport (I461000)
- rail freight transport (I471000)
- water freight transport (I481000)
- air and space transport (I490000)
- freight forwarding services (I529200)
- other transport support services n.e.c (I529900)
- other warehousing and storage services (I530900).

ACC claims its data is another useful source to consider although like all data sets, it comes with its own benefits and limitations. A clear limitation with ACC claims data is that not everyone will be incentivised to lodge a claim; for instance when a death occurs there may not be a desire to go through the administrative process of lodging a claim. This presents issues when trying to use this metric to report the total amount of deaths in the freight sector. A benefit of the ACC claims is that when injuries occur, especially in the workplace, individuals are incentivised to claim for work injuries. The ACC claims data is a useful data point to consider when reporting on serious injuries.

Table 4.10 Definitions, advantages and limitations for safety indicator[18]

Proposed metric	Definition/explanation	Advantages	Limitations
Truck occupant deaths	The number of truck occupant deaths resulting from a truck crash. A death occurring as the result of injuries sustained in a truck crash within 30 days of the crash.	Captures the fatalities not measured in the category 'Workplace fatalities by industry'. Can act as an efficient proxy into the safety of the road freight industry.	Does not capture all road deaths caused by the freight sector. The measure will not show in detail the causes of the deaths only highlight the number. May capture deaths not strictly freight related.
Truck occupant severe injuries	The number of truck occupant serious injuries resulting from a truck crash. A serious injury is defined as a fracture, concussion, severe cuts or other injury) requiring medical treatment or removal to and retention in hospital.	Data is available through the CAS system. Can act as an efficient proxy into the safety of the road freight industry.	Will require yearly updates and extracts. Does not detail the cause of injury. May capture deaths which are not strictly freight related.
Other road user deaths involved with truck crashes	The number of other road user deaths as a result of a crash involving a truck. A death occurring as the result of injuries sustained in a truck crash within 30 days of the crash.	Data is available through the CAS system. Externalities of road crashes are important for the government to publish.	Will require yearly updates and extracts. Does not detail the cause of injury. May capture deaths which are not strictly freight related.
Other road user severe injuries as a result of being involved in a truck crash	The number of other road users' serious injuries as a result of being involved in a truck crash. The severe injuries of other users highlight the externalities of the freight sector. Injuries often occur more to other road users as they will frequently have less protection than truck occupants.	Data is available through the CAS system. Externalities of road crashes are important for the government to publish.	Will require yearly updates and extracts. Does not detail the cause of injury. May capture deaths which are not strictly freight related.
Maritime commercial (number of	Maritime deaths are separated into commercial and recreational deaths. Commercial deaths are related to freight operations, whereas recreational	The data is already captured by Maritime NZ.	The metric will capture deaths not strictly related to the movement of freight – for instance, a death reported by the Interislander or Bluebridge could

[18] A limitation across all of these metrics is the need to determine a consistent definition of deaths and incidents to the extent possible. For example, the numbers of days that can pass before a death is attributable to an incident involving a truck, or an incident in the workplace.

Proposed metric	Definition/explanation	Advantages	Limitations
deaths)	deaths would anyone not involved in the ship's freight operations.		well be a recreational death. Also the ships could be carrying a majority of recreational passengers at any one time.
Rail freight deaths (total number of freight rail deaths)	The total number of deaths involving freight rail trains. The number of rail deaths is limited; however, regular reporting highlights the safety performance of the rail freight sector and also flags potential backsliding.	KiwiRail has the ability to identify freight specific trains and report on these regularly.	There is a limited number of deaths associated with rail freight currently compared with other modes of transport. Distinguishing between 'freight' and 'passenger' trains may present some minor challenges. Additional reporting requirements increase the burden placed on KiwiRail to capture data.
Rail freight serious injuries (total number of freight rail serious injuries)	The total number of serious injuries involving freight rail trains. The number of rail serious injuries is limited; however, regular reporting highlights the safety performance of the rail freight sector and also flags potential backsliding.	KiwiRail has the ability to identify freight specific trains and report on these regularly.	There is a limited number of deaths associated with rail freight currently compared with other modes of transport. Distinguishing between 'freight' and 'passenger' trains may present some minor challenges. Additional reporting requirements increase the burden placed on KiwiRail to capture data.
Workplace fatalities by industry	The number of deaths recorded under the ANZSIC category 'Transport, postal and warehousing'. The ANZSIC category broadly represents the freight sector and the amount of increases or decreases in fatalities. It can represent whether or not the safety of the industry is improving.	The metric is widely reported and currently collected by WorkSafe NZ. The measure is well understood by those who report to WorkSafe NZ. This metric goes beyond traditional reporting of just 'transportation modes' and into other parts of the supply chain, particularly where freight is often aggregated or disaggregated (such as warehouses, distribution centres and ports).	The measure does not include deaths in the maritime or aviation sectors or fatalities due to work-related road crashes. The measure will not show in detail the causes of the deaths but only highlight the number. There may be some definitional inconsistencies between land transport deaths and incidents and WorkSafe reported deaths and incidents.
Severe workplace injuries by industry	The number of severe injuries recorded under the ANZSIC category 'Transport, postal and warehousing'. The ANZSIC category broadly represents the freight sector and as the amount of injuries	Indicator is widely understood and is currently collected by WorkSafe NZ. The measure is well understood by industry.	The measure does not detail the causes of the severe injuries only highlighting the number and trends. The measure will not show in detail the causes of

Proposed metric	Definition/explanation	Advantages	Limitations
	increases or decreases it can represent whether or not the safety of the industry is improving. It is proposed the severe injury definition includes 'More than a week away from work (based on weekly compensation claims)'. ACC pays employees, shareholders and self-employed workers 80% of pre-incapacity income but it excludes the first week of incapacity (for employees this is paid by the employer).	This metric goes beyond traditional reporting of just 'transportation modes' and into freight nodes, or other parts of the supply chain. This data is considered to be very accurate as reporting is required for ACC claims.	the deaths only highlight the number.

The metrics being proposed for the safety indicator have been widely collected and are already available. The rationale for inclusion of these metrics is that they can help understand longitudinal trends and serve as flags for action.

Generally speaking, there are limitations to these metrics as they do not detail the causes of the deaths or serious injury; however, they are intended to highlight the direction of safety in the freight industry.

Reporting the high-level numbers for safety also allows other analyses to be undertaken. For example, by coupling these figures with tonne kilometres, we can understand the proportion or ratio of safety incidents per unit of freight moved. This will help normalise any natural biases that may be observed with an increasing total freight task.

Near misses were considered for inclusion in this indicator but were discarded primarily for practical reasons.

Near misses can be considered a leading indicator to deaths and serious injuries as the more near misses there are, the more likely they will result in something more serious. Despite this virtue, there are practical issues with reporting near misses, primarily around the definition and the practicality of understanding near misses across the entire freight system.

The ability to predict, record and measure near misses in the future will inevitably improve and this may enable a more structured response from government and freight operators alike. This should remain a watching brief for potential inclusion in this indicator list in the future.

4.6.3 Supporting evidence

Road casualties are collected in most jurisdictions. OECD (2017) statistics on road injury crashes is a comprehensive global repository for this information and report that ‘Road accidents are measured in terms of the number of persons injured and deaths due to road accidents, whether immediate or within 30 days of the accident, and excluding suicides involving the use of road motor vehicles’.

Crashes involving vehicles are widely collected and published allowing ease of comparisons between countries and also highlighting areas for improvement. In Australia, Safe Work Australia (2016) produces annual reports into work-related traumatic injury fatalities. It highlights various industries and shows trends across time. The fatalities are reported at a disaggregated level both at a vehicle crash level and at an industry level. The report focuses on fatalities and does not include workplace injuries.

There are efforts from both industry and government to improve safety by taking a system approach. The international standard Road Traffic Safety (RTS) Management Systems (IS0 390001) is widely adopted amongst operators in New Zealand and overseas. Adopting worldwide industry best practice international guidelines helps improve the safety of all road users and the freight industry.

4.6.4 Data sources

Table 4.11 provides an overview of the proposed information to capture and the proposed custodian.

Table 4.11 Safety indicator data sources

Metric	Data Source	Custodian
Truck occupant deaths	Truck occupant deaths can be extracted from Transport Agency's CAS. There are also reports published from MoT using the systems data regularly. It is expected that an extract from CAS would be done once a year to report on the performance of the measure.	MoT/NZ Transport Agency
Truck occupant severe injuries	Truck occupant severe injuries can be extracted from the Transport Agency's CAS. Similar to reporting on fatalities an extract from CAS would be expected to be undertaken once a year.	MoT/NZ Transport Agency
Other road user deaths involved with truck crashes	Other road user deaths can be extracted from the Transport Agency's CAS. Similar to reporting on fatalities an extract from CAS would be expected to be undertaken once a year.	MoT/NZ Transport Agency
Other road user severe injuries involved with truck crashes	Other road user severe injuries can be extracted from the Transport Agency's CAS. Similar to reporting on fatalities an extract from CAS would be expected to be undertaken once a year.	MoT/NZ Transport Agency
Maritime commercial (number of deaths)	The number of commercial deaths is currently reported by Maritime NZ.	Maritime NZ
Rail freight deaths (total number of freight rail deaths)	The number of freight-specific deaths can be reported by KiwiRail.	KiwiRail/NZ Transport Agency
Rail freight serious injuries (total number of freight rail serious injuries)	The number of freight-specific serious injuries can be reported by KiwiRail.	KiwiRail/NZ Transport Agency
Workplace fatalities by industry	The number of fatalities in the 'Transport, postal and warehousing' category can be seen and obtained on WorkSafe NZ website. The website also enables secondary industries to be filtered and the excel spreadsheet is provided. WorkSafe NZ (2017b)	WorkSafe NZ
Severe workplace injuries by industry	The use of ACC claims data 'more than a week away from work' for severe injuries is considered most appropriate. (WorkSafe NZ 2017c)	ACC/WorkSafe NZ

4.6.5 Implementation plan

In most instances, this data is already available. Therefore, the implementation pathway is about updating a lot of what has already been undertaken. To assist with this, it is proposed that:

- A formal custodian for this work stream be agreed, with MoT/WorkSafe NZ appearing to be the most appropriate parties.
- Questions around the following be included in the consultation programme:
  - the need for including and developing specific safety metrics for rail, maritime and aviation in addition to what is already currently reported
  - the ability to distinguish freight incidents when there are passengers and freight involved in the same mode (for instance on ferries and trains)

- the importance of attribution of incidents and whether this can be meaningfully included
- agreeing which ANZSIC level 4 categories are included for the final freight safety indicators.

- agreeing to develop safety indicators at a key freight corridor level, including how this can be achieved.

4.7 Human capital – national level

Table 4.12 National level human capital – alignment to criteria

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementary
Government has a role in controlling immigration levers and preparing the skills system for skills shortages.	Human capital issues are likely to occur on an ongoing basis. Despite automation threatening the way we work, the need for government and industry to respond to human capital issues is likely to be ever-present.	Human capital aspects are currently measured by MBIE along with short and mid-term forecasts.	Stakeholders were interested in human capital measures as there was concern amongst stakeholders about perceived (or real) skills shortages in the industry.	Human capital metrics are generally across all modes of transport. The individual measure may, however, be different across modes.	Human capital metrics are not explicitly related to other indicators, although the performance of human capital may influence indicators around total freight moved and even measures of reliability and safety.

4.7.1 Why this is important

In an increasingly digitised world, where the future of employment is increasingly uncertain, understanding human capital issues and implications has never been more important. This issue has been strongly raised through most stakeholder interviews. In particular, two interrelated issues emerged as being of prime importance:

- It is important to note the state of the labour force to ensure there is enough human capital to maintain operations in the industry. Understanding the human capital requirements in the freight industry will be particularly important as the industry moves towards an automated future and the changing nature of jobs within the industry. It will also be important to understand any critical shortages in the industry which can enable supply side responses from government and/or industry – ideally in collaboration.
- It will also be important for governments to understand from a transitional perspective if jobs in the freight sector are becoming increasingly scarce, then what role does government have (if any) in securing new pathways for these workers? What impacts might an increasingly underutilised labour force have on the welfare system? Increased levels of unemployment can lead to an increase in welfare payments, although this is not strictly a transport sector response it is a 'problem' that is generated by the transport sector and hence should be captured.

Having a clear understanding of labour force trends enables policy makers to prepare for major changes in the workforce and can support constructive dialogue between government and industry in solving human capital issues over the short, medium and long term.

Specifically, a mutually agreed marker of key employment categories in the industry can also enable evidence-based policy discussions on key interventions, such as amendments to immigration settings. Anecdotally there is a view that the sector is under pressure from an ageing workforce and increasing difficulty in finding suitable local replacements. The importance of getting the ‘right’ immigration settings, alongside appropriate local recruitment and retention policies, will be informed by a solid evidence base.

4.7.2 Definitions

The measure of human capital in a freight indicators context is as concerned with total numbers of employees (to monitor trends) as it is with the specific job categories that make up the freight sector to understand what is needed to maintain a functioning freight sector.

The ability to fully understand skill shortages is a difficult and complex issue with a number of interrelated components including attractiveness of the sector, wage expectations, working conditions, skills requirements and immigration settings. The ability to accurately forecast the required demand for skills is also made increasingly more difficult by the need to accommodate the current and future supply of skills and the inherent shortages.

In lieu of the perfect information being available it is proposed a compilation of indicators and measures are tracked over time to help understand the ‘human capital elements’. A balanced indicator would consider current demand for roles, current availability of resources and the forecasted demand for resources.

It is proposed the measure of human capital be captured and split in two distinct areas:

1. A continual measure: It is important to understand the current levels of employment therefore a continual measure should be applied across the freight industry. The continual measure is proposed to follow the ANZSIC level 4 categories.
2. A detailed measure: This could be undertaken when there is wide-ranging concern across government and industry of issues in a particular employment category. The detailed measure(s) are likely to change from time to time.

It is also proposed that both skills issues as well as the total number of employees within a particular sector be captured in line with the rationale for the collection of this indicator as noted in 4.7.1.

4.7.2.1 Continual measures

Currently the freight industry is reported under the classification of ‘Transport postal and warehousing’ under the ANZSIC06: Australian and New Zealand Standard Industrial Classification 2006. This classification is not granular enough to understand individual skill shortages. It is therefore proposed that the following sub-categories be reported on a periodic basis.

Table 4.13 Proposed ANZSIC level categories for human capital indicator

ANZSIC Level 4	Description and inclusion
Road freight transport (I461000)	This class consists of units mainly engaged in the transportation of freight by road. It also includes units mainly engaged in renting trucks with drivers for road freight transport and road vehicle towing service. Primary activities: • furniture removal service • log haulage service (road) • road freight transport service (including truck drivers) • road vehicle towing • taxi truck service (with driver) • truck hire service (with driver).
Rail freight transport (I471000)	This class consists of units mainly engaged in operating railways for the transportation of freight by rail. Primary activities: • rail freight transport service • suburban rail freight service.
Water freight transport (I481000)	This class consists of units mainly engaged in the operation of vessels for the transportation of freight or cargo by water. Primary activities: • coastal sea freight transport service between domestic ports • freight ferry service • harbour freight transport service • international sea freight transport service between domestic and international ports • river freight transport service • ship freight management service (ie operation of ships on behalf of owners) • water (river, sea and lake) freight transport service.
Air and space transport (I490000)	This class consists of units mainly engaged in operating aircraft for the transportation of freight and passengers. Primary activities: • air freight transport service • air passenger transport service • aircraft charter, lease or rental, with crew, for freight and/or passengers.
Freight forwarding services (I529200)	This class consists of units mainly engaged in contracting the transportation of goods for other enterprises, using one or more different enterprises to perform the contracted services by road, rail, air, sea freight transport or any combination of the modes of transport. (In these cases the 'forwarding' unit takes prime responsibility for the entire transport operation.) Primary activities: • air freight forwarding service • rail freight forwarding service • road freight forwarding service • water freight forwarding service
Other transport support services (I529900)	This class consists of units mainly engaged in providing transport support services not elsewhere classified. Primary activities: • container terminal operation (road and rail) • freight brokerage service

ANZSIC Level 4	Description and inclusion
	• road freight terminal operation • road passenger terminal operation • road vehicle driving service (except owner/operator) • railway station or terminal operation • taxi radio base operation • toll bridge operation • toll road operation • weighbridge operation.
Other warehousing and storage services (I530900)	This class consists of units mainly engaged in operating warehousing and storage facilities (except cereal grain storage). Primary activities: • bond store operation • bulk petroleum storage service • cool room storage service • controlled atmosphere store operation • free store operation (storage of goods not under bond) • furniture storage service • refrigerated storage service • storage • warehousing • wool storage service.

Reporting of the whole sector enables the generation of other measures such as how labour intensive the freight industry is. Potentially this will highlight the changes in labour mix of the freight industry and can support identification of future trends such as the uptake of automation.

4.7.2.2 Detailed measure

Complementing continual measures in the human capital elements of the sector is the potential to undertake detailed measure(s) on topical issues. A detailed measure would be required when considering a specific employment category which is considered in need of further investigation from both industry and government.

An example for a detailed measure is proposed below for truck drivers. It has been mentioned from multiple stakeholders that this is a current concern in the sector. By reporting on these measures, it is hoped that industry and government can collectively 'see' issues and have a common basis for discussion. If and once concerns around the number of truck drivers subside, then other potential employment measures can be considered.[19]

This concept of a topical 'detailed measure' goes somewhat against the criterion of a durable metric, but is considered appropriate in this instance given the perceived need for a quick policy response.

[19] These concerns might subside through government interventions or policy changes, or may result from market forces. For example, in the long-run, standard economic theory would suggest that wages should respond to address any labour shortages (unless there are underlying structural impediments). However, the nature of the road transport industry and the relative low barriers to entry mean there may naturally be downwards pressure on wages.

Table 4.14 Example of a detailed indicator: 'Truck drivers'

Measure	Definition/explanation	Advantages	Limitations
Annual percentage change in advertised job vacancies. ANZSCO 7331 'Truck drivers'	Changes in online job advertisements from four internet job boards – SEEK, Trade Me Jobs, Education Gazette and KiwiHealth jobs. Tracking the changes in the percentage of advertised jobs overtime will reflect the changing demand for roles and the length of time taken to fill the roles.	This measure is currently available and will help indicate the amount of trucking roles being advertised as a proxy for demand.	The measure does not consider jobs posted outside the listed job boards.
Number of class 5 – heavy combination driver licences issued per year.	The number of new class 5 heavy combination driver licences issued. Tracking the overall number of new class 5 heavy combination driver licence holders gives an understanding of the gap between current holders and future requirements. There is a potential to report on the average age of class 5 truck drivers.	Measuring the new number of class 5 licences per year will indicate whether future supply of labour is increasing or decreasing. Reporting on the average age of all drivers enables a high level trend to be tracked and keeps a level of anonymity.	There is no ability to determine how 'active' the drivers are or how long the drivers will remain in the industry. This does not capture those freight movements that do not require class 5 licences. The number of new class 5 drivers does not capture the net numbers of stock, which is the aim; however, it will look into the trend to see if the gap in new drivers is closing in on the short-term employment forecasts. The average age of truck drivers does not enable tracking of the overall number of truck drivers actively driving trucks.
Short-term employment forecasts Code 733 'Truck drivers'	The short-term employment forecasts of truck drivers. The short-term employment forecasts the projected number of employees in the respective categories.	This measure is currently available and will show the projected number of employees in the respective categories.	With all forecasts there is always a difficulty in predicting future events.

4.7.3 Supporting evidence

Overseas jurisdictions similar to New Zealand currently produce labour market statistics in two main formats:

- Labour force surveys: Current labour force surveys in Australia (Parliament of Australia 2018), USA (US Department of Labor 2015) and UK (Office for National Statistics 2017) report current labour force at an aggregated industry level. Similar to New Zealand they report the current number of workers in industry and the percentage change between periods of reporting.
- Labour market forecasting: Similar to MBIE producing labour market forecasts for the New Zealand labour force:

- The UK Commission for Employment and Skills produced a Working Futures 2010–2020 report (UKCES 2012). The report forecast long-term expected labour force rates and predicted levels of employment at the industry level.
- In the US, the United States Bureau of Labor Statistics produces similar employment projections. The Employment Projections program develops information about the labour market for the nation as a whole for 10 years in the future.

4.7.4 Data sources

Table 4.15 provides an overview of the proposed information to capture and the proposed custodians.

Table 4.15 Human capital indicator data sources

Metric	Data Source	Custodian
Continual reporting of current employment levels at ANZSIC level 4.	The current household labour force survey conducted by Statistics New Zealand reports employment numbers at an aggregated level, a more disaggregated level could be reported if amendments were made. There is also the potential to adapt the business operations survey to be reported at a more disaggregated level, this will enable a more granular level of data collection. This would necessitate a change in the provision of a tier 1 statistic which is not a small undertaking. Census data could be used to report the employment levels, however, these only occur every five years.	Statistics New Zealand/MBIE Household Labour Force Survey (Statistics NZ 2017b) Business Operations Survey (MBIE 2016)
Annual percentage change in advertised job vacancies. ANZSCO 7331 'Truck drivers'	Changes in online job advertisements from four internet job boards – SEEK, Trade Me Jobs, Education Gazette and KiwiHealth jobs. Tracking the changes in the percentage of advertised jobs over time will reflect the changing demand for roles and the length of time taken to fill the roles.	MBIE (2018)
Number of class 5 – heavy combination driver licences issued per year.	The number of class 5 heavy combination driver licences issued each year will show if the amount of new truck drivers is keeping up with demand. Tracking the overall number of class 5 heavy combination driver licence holders gives an understanding over time of the gap between current holders and future requirements.	Transport Agency/MBIE Transport Agency driver licensing database.
Short-term employment forecasts Code 733 'Truck drivers'	The short-term employment forecasts show the projected demand for employees in the respective categories. It is proposed that truck drivers are included in the forecasts to highlight the freight demands of human capital.	MBIE (2017e)

Along with general surveys a census is conducted periodically which also provides in-depth information for the whole population. It is expected the classifications and employment numbers would come from the quarterly employment survey or the business operations survey with some calibration when the census is conducted.

Labour market reporting, including projections and predictions would be mainly undertaken by Statistics New Zealand and MBIE. Statistics New Zealand would hold the data around employment and MBIE makes labour force predictions. According to MBIE (2017a) anticipating supply and demand in the labour market is a core service of the Evidence, Monitoring and Governance Branch. Analysis and commentary from their forecasting programme informs New Zealand employers and government policy.

MBIE uses short-term and medium to long-term employment forecasts to inform the Ministry's immigration policies and support priority setting for tertiary education and industry training.

4.7.5 Implementation plan

In most instances, this data is already available. Therefore, the implementation pathway is about continuing to update what has already been undertaken. To assist with this, it is proposed that:

- A formal custodian for this work stream be agreed, with MBIE appearing to be the prime candidate given their prominent role in providing advice on labour markets in New Zealand.
- Agree the level of ANZSIC level classifications required for the freight sector and discuss with Statistics New Zealand the ability to report numbers.
- Investigate with Statistics New Zealand the possibility of either amending the Business Operations Survey or amending the Quarterly Employment Survey to enable reporting of ANZSIC level 4 data at the desired level.
- Monitor the average age of employees in the above ANZSIC level classifications to prepare for the potential of large workforce retirements.
- Undertake consultation with industry periodically to establish the need for other detailed measures for employment categories to be reported.
- Inclusion of a question into the proposed stakeholder consultation to determine whether it would be beneficial to include the average age of truck drivers in the detailed measure.

4.8 Core freight metrics – key freight corridor level

4.8.1 Why this is important

Having a set of base metrics for each key freight corridor serves as a measure of the 'vitals' of that corridor. By tracking important markers of the size, scale and magnitude of the freight task across a key freight corridor, it is believed this will set the general context for government (both central, regional and local) policy making about whether additional interventions are required, or whether greater focus and support for the freight sector is required.

4.8.2 Definitions and data sources

The following metrics and their respective definitions are believed to be good markers of the size and scale of the total freight task across key freight corridors in New Zealand. Elements of all these indicators are already being captured and provided by government and so representation in this dashboard is more about validation of their importance to the sector.

In some instances, these indicators are also building blocks for the construction of other, more conceptual, indicators posed throughout the remainder of this research report.

Table 4.16 Proposed core freight corridor indicators

Proposed metrics	Rationale and definition	Source and custodian
Total vehicle fleet (heavies) along a specific corridor	The amount of heavy vehicles travelling along a specified corridor as measured through representative average annual daily traffic (AADT) data at telemetry and other count sites. Five day average daily traffic and seven day average daily traffic could be reported to show variability. As could the production of maximum and minimum daily flows.	Transport Agency – AADT data Individual corridors will be held in RAMM data bases which will need to be obtained from the Transport Agency and individual local authorities.
Total number of freight train trips along key freight corridor	Similar to understanding the number of heavy vehicles for road, the number of train trips can help highlight the importance of the freight corridor. This metric will not tell the 'full story' as the importance of the freight, and the topographical conditions may skew results in certain instances.	KiwiRail has extensive trip information on its fleet and would be the natural custodian.
Tonnes moved along key freight corridor	It would be beneficial to understand the total tonnes moved along freight corridors. This will include road, rail and ships where relevant. Average tonnes over the length of the corridor will need to be derived (which presents challenges in accommodating assumptions around aggregation/disaggregation points. There may also be challenges in using this information to determine the importance of a corridor to a wider network.	Road tonne information can be estimated through current average weights of trucks at current WIM sites and then estimated across with telemetry site data. This can be improved with additional WIM sites which can be considered. Rail data is held by KiwiRail and currently reported on a net tonne km level. It can be reported by corridor these are defined. There is limited information available on domestic shipping along key freight routes and it would be beneficial to investigate inclusion in the future for development.
Length	A measure of the length of the key freight corridor.	MoT – this can be gathered from Google Maps, or from asset management plans from the Transport Agency, local authorities and KiwiRail.
Freight corridor safety	Safety at a corridor level would be an important metric to capture.	MoT – with input from the Transport Agency, KiwiRail and Maritime NZ on relevant routes.

4.8.3 Implementation plan

In some instances, this data is already available. Therefore, the implementation pathway is about aggregating the right information into the right format. The following proposals will assist with this:

- Defining the key freight corridors is an important first step. The actual markers of where one corridor stops and another starts and gaining agreement across modes and industry will require consultation with multiple agencies and industry to gain broad agreement.
- The *National freight demand study* (MoT 2014) and the Transport Agency's long-term view use freight flows, which represents a good start to defining corridors.

- Collaboratively, industry and government agree and confirm the freight corridors to be measured and the final list of base indicators.
- MoT continues to be the custodian for this data element and be responsible for coordinating with other data owners as required.
- Include this information in the development of future dashboards.

4.9 Asset condition trends– key freight corridors

Table 4.17 Key freight corridors– alignment to criteria for asset condition trends

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementary
Government should understand the condition of assets under its management (or oversight) as it is likely to bear the future maintenance costs.	Asset condition trends are likely to be an important consideration regardless of trends such as e-commerce and vehicle automation.	Asset condition reports should be a normal part of the asset maintenance function of all infrastructure owners. Information is already available and public.	Stakeholders endorsed the view that government must report on the quality of its assets, to show where future investment is needed.	Asset condition metrics are likely to be present for all modes – although road and rail measures were considered the most important for this research.	Asset condition trends are complementary to resilience measures and can also be important determinants for travel time reliability and safety.

4.9.1 Why this is important

Asset condition is fundamentally important as it provides an indication of the long-term health of the transport network supporting the freight system. Having the right infrastructure provided at a reliable standard enables certainty for both freight operators and users and supports the New Zealand economy.

Providing a sense of underlying asset condition is considered by stakeholders to be useful for a number of reasons:

- Accountability for network operators: Highlighting asset condition trends will demonstrate the performance of the assets at a high level and will highlight the long-term trend and performance of the assets over time. It will indicate whether sufficient maintenance is being undertaken to maintain the assets to an acceptable standard.
- Understanding deferred maintenance patterns: As the search for efficiencies and value for money continues it is important to understand whether the savings are being achieved through deferred maintenance or through appropriate design, and ultimately whether this will lead to future liabilities for the industry and asset owners.
- Enables freight operators to better undertake route planning: By understanding the state of key freight corridors across New Zealand, freight operators will be better able to undertake route planning functions under normal circumstances and to plan for situations where there are disruptions to the network.

All of these outcomes are beneficial for central government, local government and the freight sector.

4.9.2 Definition

'Asset condition' is a key parameter in determining remaining useful life, and can be used to predict how long it will be before an asset needs to be repaired, renewed or replaced. Asset condition is also an indicator of how well the asset is able to perform its function. While definitions of asset condition will inevitably be subjective, the general concept of asset condition measurement is widely understood.

There is an interesting relationship between asset condition and levels of service. While there may be some deterioration in asset condition, there may be no functional effect on levels of service. Despite this potential relationship, reporting asset condition should continue as it will indicate the potential trend. Levels of service are inherently captured through some other indicators reported (for example travel time reliability).

It was proposed for this research not to apply a uniform 'score' for asset condition, but to apply individual measures to each mode. The important issue to monitor in this instance would be the trend over time and so a heterogeneous approach to defining asset condition by mode was considered to be appropriate.

4.9.2.1 Road transport

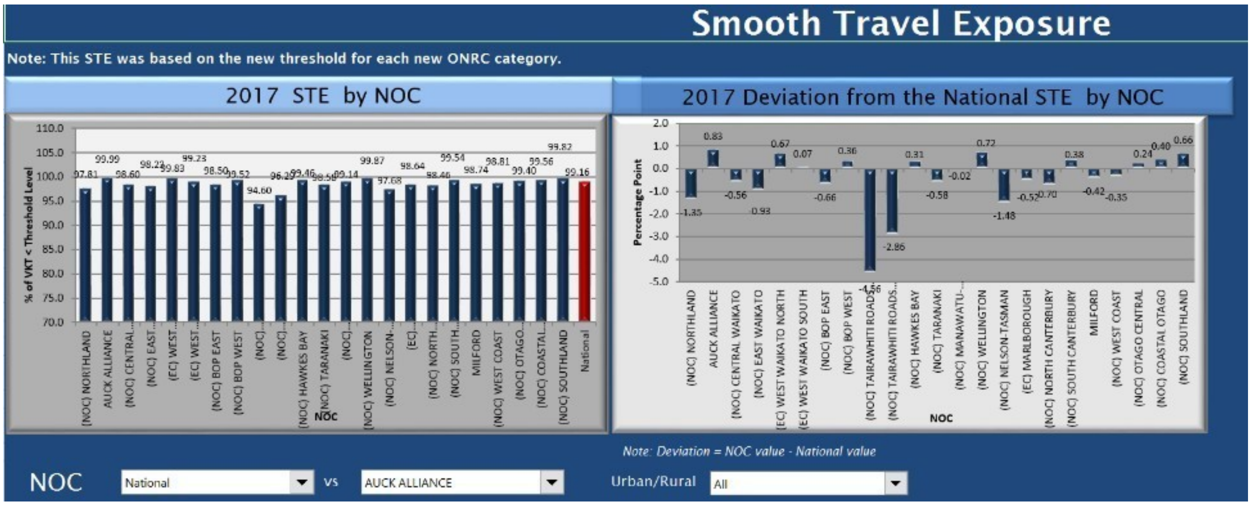
For road freight transport, the Transport Agency and local authorities collect asset condition data regularly and it is widely available and reported at an aggregated level (NZ Transport Agency 2017a). The potential measures include the following:

- The condition index (CI) is a single index summarising surface condition based on visually measured condition defects.
- The pavement integrity index (PII) is a combined index of the pavement faults in sealed road surfaces. It is a 'weighted sum' of the pavement defects divided by total lane length. PII combines surface faults (CI) with rutting and shoving. 100 - PII ensures that the higher the number the greater the pavement integrity.
- Smooth travel exposure (STE) measures the proportion (%) of VKT in a year that occurs on 'smooth' sealed roads and indicates the ride quality experienced by motorists.

Road asset managers will naturally have numerous measures of conditions and will understand the operating environments in more detail. While they will have more sophisticated measures and will run various intervention strategies for day-to-day operations, it is suggested that STE would be an appropriate measure for the freight sector as the quality of ride is more important for the road freight industry.

Reporting STE regularly also enables the prevention of backsliding in ride quality and in the condition of the road. If the STE measure gets below a point, truck drivers and the freight industry in general may start looking for alternative routes and take other roads which may not be specifically designed to cater for heavy traffic or heavy flows. It may also provide a public data point for stakeholder interest groups to begin discussions about investment priorities.

Figure 4.6 Example of STE measure



Source: NZ Transport Agency (2017d)

4.9.2.2 Rail

KiwiRail has a variety of measures for asset quality and depending on the development of the final rail asset condition measure there is the potential to use both or either temporary speed restrictions or track quality index.

- Temporary speed restrictions are monitored and reported weekly and are a good indicator for the state of the network. They are generally used to represent areas where asset condition could be improved. Other uses are minor such as level crossings and during upgrades and maintenance.
- A track quality index (TQI) measure is also available to consider. A track recording car goes around the network every six months to check characteristics of the track including level and alignment and this is converted into a TQI. This is relatively dynamic and there is an ability to report on a line-by-line basis. The TQI improves as the maintenance improves.

Both measures of asset condition are currently collected by KiwiRail which enables an ease of implementation and durability in the metric. A TQI has been suggested in the first instance as temporary speed restrictions will be applied when maintenance activities are occurring. If these restrictions are used as a proxy they will show the asset condition declining although maintenance is actually improving the quality of the asset.

4.9.2.3 Maritime/aviation

The usefulness of tracking port condition and aviation condition is more questionable. There are clear health and safety implications from wharfs and runways not being in good condition; however, in many instances these are governed by regulations protecting minimum standards. It is therefore not immediately apparent how the condition of assets at these particular nodes will affect the freight industry.

A summary of the advantages and disadvantages of this approach is provided in table 4.18.

Table 4.18 Advantages and limitations of asset condition measures

Measure	Definition/explanation	Advantages	Limitations
Smooth travel exposure.	The proportion (%) of VKT in a year that occurs on 'smooth' sealed roads and indicates the ride quality experienced by motorists. This will help flag any freight corridors that are experiencing sub-optimal levels of investment in the underlying asset.	Reporting only STE for roading assets will enable ease of collection and the smooth travel exposure will directly affect the freight operators such as 'Truck Drivers' as they would be able to feel the difference and impacts of STE.	Currently reported at an aggregate level, if specific corridors are required then manual calculation or collection may be required. The measure does not give a detailed assessment of the condition of the asset only how the operator 'feels' about the travel.
Track quality index.	The TQI used by KiwiRail to measure asset condition.	The measure is currently collected and can be disaggregated line by line.	The TQI will not change frequently – although this is not strictly a problem. Understanding the gradual improvement/degradation of lines is still important for users.

4.9.3 Supporting evidence

Overseas jurisdictions have a considerable amount of information on the state of assets across all modes. A small sample of this information is provided throughout the remainder of this chapter.

Australia collects information on STE and track condition. STE can be seen as a readily collected and widely understood measure across jurisdictions. The calculation of the indicator, however, may have slight differences although STE will still enable a high-level comparison across boundaries. According to Henning et al (2013) STE can be used as an indicator for improvements in the provision of infrastructure and services that enhance transport efficiency and lower the cost of transportation. A smooth network reduces vehicle operating costs, thereby lowering the cost of transportation. This is relevant in the freight industry as the impact will be greatly felt by truck drivers.

The Australian Rail Track Corporation measures track condition using the 'track condition' performance indicator (ARTC 2008), which is ostensibly the same as the TQI Kiwirail uses.

Additionally, there is a multitude of measures of asset performance in the United States and a selection of these measures is provided across various states in table 4.19.

Table 4.19 Selection of condition indicators used in America

Mode	Measure	State
Road	International roughness index (IRI)	Arizona (AZ), Massachusetts (MA), Montana (MT), Nebraska (NE), Nevada (NV), Pennsylvania (PA)
Road	Rut index	MT
Road	Miscellany crack index	MT
Road	Overall performance index (calculated as a weighted average of others)	MT
Road	Ride quality index	Minnesota (MN), New Mexico (NM)
Road	Maintenance rating index	Tennessee (TN)
Road	Percent state road in acceptable condition	Illinois (ILL), Maryland (MD)

Mode	Measure	State
Road	Percent of major highways in good condition	Missouri (MO)
Road	Percent of pavement in ‘fair or better’ condition by road class	Utah (UT), Washington (WA)
Road	Number of distressed lane miles	California (CA)
Air	Number of airports with pavement ratio >70	Los Angeles (LA)
Air	Percent of airport runway rated satisfactory or better	Iowa (IA), NM
Air	Airport pavements at or above acceptable	Wyoming (WY)
Water/ports	Dredge material replacement capacity remaining for harbour and bay maintenance dragging	MD
Rail	Percentage of short line track miles with capacity over 286,000 pounds	TN

4.9.4 Data sources

Table 4.20 provides an overview of the proposed information to capture and the proposed custodian. It is proposed that reporting occurs half-yearly and annually depending on the mode. STE is generally reported once a year on a particular date and TQI is collected once every six months. Reporting the levels of performance of both of these measures as they are published will suffice.

Table 4.20 Asset condition indicator data sources

Measure	Source	Custodian
STE	Data sources are likely to be held by the Transport Agency or individual local authorities. As data is provided to the Transport Agency they should hold a database of information. At a practical level, the reporting vehicle will drive along the road network and report any deviations in the ride quality. This means that individual STE reporting can be interrogated to determine corridor level information. www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/performance-management/state-highway-reports/	MoT/ Transport Agency
Track quality index	KiwiRail has a TQI measure and data availability. This needs to be presented in a way that is suitable for a wider audience.	KiwiRail

4.9.5 Implementation plan

Much of this information is already collected. However, a formal consultation phase should still occur to ensure the information is collected and presented at a level that can be easily understood by the wider public and use of the metric is clear.

- It is proposed the Transport Agency take the lead in preparing road information. The Transport Agency should work with local authorities and other relevant parties (such as major contractors) to agree on what data will be presented.
- KiwiRail will naturally lead the rail information and have a TQI measure. The research owner should undertake formal consultations with KiwiRail to determine both a willingness to publish the metric and determine how to present it in a format that is accessible and easily understood by the wider public.
  - If there are difficulties or resistance in presenting this information, then temporary speed restrictions should be investigated and adopted.

4.10 Freight resiliency score – key freight corridors

Table 4.21 Freight resilience score for key freight corridors – alignment to criteria

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementary
A 'freight resilience score' may help government further understand areas where freight infrastructure is critical and/or vulnerable and where alternatives may need to be prepared.	Understanding route resilience for freight corridors is likely to be relevant regardless of any trends affecting the sector – particularly as natural hazard events continue to be unpredictable.	Several components of the resilience score are already measured – although there may be some contention in agreeing the final methodology.	Stakeholders were particularly interested in resilience and believed information that could be provided to highlight potential issues and prepare for resilience would be beneficial.	Resilience score is generally applicable across modes – although there is a stronger focus on road and rail corridors.	Freight resilience is complementary with other measures such as travel time reliability. When a route is more resilient it is likely to be more reliable. Other measures, such as asset condition, are an explicit component of the score.

4.10.1 Why this is important

The importance of resilient transport freight corridors is often under-appreciated, until a disaster occurs rendering the corridor unavailable. This is well illustrated by the 2016 Kaikoura earthquakes in New Zealand where the Main North Line and State Highway 1 were significantly damaged and closed. The impacts of these closures are still being felt as most goods in and out of the region were transported through those key corridors. Significant changes to supply chains have since occurred with costs to operators and consumers. The disruptions to the industry were anecdotally highlighted throughout the stakeholder consultations. Moreover, a report prepared for the MoT *Economic impact of the 2016 Kaikoura earthquake* showed the estimated loss to the New Zealand economy over two years under certain scenarios was $NZ465 million of GDP (Market Economics 2017).

The ability to capture freight resilience is important from a transport planning function. Governments should be interested in the levels of resiliency inherent in their transport corridors as this may indicate the need to invest for robustness or redundancy reasons, or improve governance practices and recovery plans.

Understanding route resilience is also useful for the private sector as it can provide an indication of the need to plan and coordinate freight functions better (ie through the need for on-call drivers, or to inform negotiation of delivery on time fees or have readymade contingency plans if key routes are unavailable).

Mapping out key freight corridors (from a resilience perspective) allows for easier planning for future events alongside enablement of a measured response when costs to increase resilience are too great. A viable contingency enables freight operations to continue despite the presence of disruption.

It is also important to note that investments made (or disruptions felt) in one region can have flow-on effects for others. The flow-on effects of securing resilience and redundancy in one local region therefore have potentially widespread impacts on the whole system. This was apparent during the Kaikoura earthquakes as changing freight patterns emerged across the whole country. This pan-regional context is critical to keep in mind when deciding on investments in the freight sector – particularly on resilience grounds.

4.10.2 Definition

'Resilience' is a term that means different things to different stakeholders. Accordingly, there are many definitions used throughout the literature. Previous research reports such as 'Establishing the value of resilience' (Money et al 2017) reviewed over 120 definitions and arrived at the following definition:

> *Resilience is the ability of systems (including infrastructure, government, business and communities) to proactively resist, absorb recover from, or adapt to, disruption within a timeframe which is tolerable from a social, economic, cultural and environmental perspective.*

While this definition helps underpin the concept of resilience; it does not provide a steer on exactly what should be measured in a freight context. Given that the resilience of freight corridors is paramount for investment and planning purposes, it is proposed that a unique metric be developed that accommodates these two objectives.

Specifically, the proposed definition for 'resiliency freight score' is:

> *To develop a bespoke index that measures the importance of freight corridors and the levels of resilience between two key destinations.*

This score would be supported by a transparent methodology that outlines the constituent parts that contribute towards 'freight resilience'. Being able to track this performance over time would help decision makers understand whether particular corridors are descending into 'hotspots'.

The proposed methodological components are documented in table 4.22. It is proposed that the 'freight resilience score' is a dynamic score which can be used to inform policy decisions about investment, route planning and emergency response. As more data becomes available, the freight resiliency score will be updated to reflect these changes.

Table 4.22 Proposed potential methodological inputs to resilience score

Methodology	Definition/explanation	Advantages	Limitations
Freight volume per annum	Volume of freight moved along key freight corridor. The higher the volume of freight moved on a particular corridor, the higher the potential impact on the network if an external shock occurs.	Freight volumes can be used as a proxy for importance of freight in a particular corridor. It enables investment to be focused and targeted on those routes that may experience the highest disruption.	There may be difficulties in measuring the freight moved along the corridor especially if the freight does not stay on the full route from start to finish. Freight volume may not correlate directly to freight value/importance – for example, aggregates. There is also the potential for the measure to be tied to heavy commercial vehicle volumes directly affected, as measured by traffic counts or similar.
Asset condition	The current condition of the assets under investigation in the chosen key freight corridors some consolidation across modes may be required). The condition of the asset is likely to determine its resilience to external shocks. If the asset is already in poor condition, it is unlikely to be able to withstand an	Asset condition is widely evaluated and reported by asset owners. Asset operators are likely to know and understand the vulnerabilities in the current networks.	The ability to measure across modes is more difficult as it will not be a like-for-like comparison. Not explicitly tying this metric to vulnerability to disruption may be an over simplification of reality.

Methodology	Definition/explanation	Advantages	Limitations
	external event.		
Disruption vulnerability	The extent to which a particular corridor is subject to modest but significant outages (as a result of events such as natural hazard events or vehicle roll-overs). The higher the vulnerability of an asset to disruption, the higher the potential impact on the freight sector. Overlaying vulnerability with frequency data can demonstrate potential propensity for disruption (consequence). Asset vulnerability can be measured by overlaying various known potential hazards similar to the exercise undertaken by the Transport Agency. The state highway resilience report Opus International Consultants (2017) details the hazards and vulnerabilities of the state highway and areas which are susceptible to hazards. It would be expected a similar exercise would be undertaken for rail, thus enabling freight corridors to be compared for their vulnerabilities. KiwiRail has currently assessed slope hazards which can be used as an input into the vulnerability assessment for rail.	This may use historic data which is generally well captured and understood by asset owners to predict potential future events. This also supports taking a wide view of disruption.	There are inherent difficulties in predicting future events and data may not be available for all types of incidents. Moreover, comparisons between modes may raise consistency issues. There is also a natural limitation in linking up the vulnerability with the consequence. There are issues in considering the extent to which corridors may need to be disaggregated to reflect different resiliency considerations, both in terms of vulnerability to events and the volumes of freight traffic likely to be affected.
Travel time added	The additional travel time taken on the alternative routes – should disruption occur. The whole supply chain is affected as delays increase the costs to importers and exporters as well as domestic transportation. These costs can be significant as was experienced post-Kaikoura.	Inherently captures alternative modal choice and considerations of alternative routes and redundancy (hence supporting recovery efforts) and its impacts.	There are difficulties in accurately predicting how an event will impact on a route (spatially) and its impact on demand. This assumes that all parties have access to, or are willing to use, alternative modes/routes in an event. Potentially as this indicator is being developed there is an ability to consider a binary option of whether or not road or rail (or sea freight) is an alternative. There are limitations in regards to rail as there is usually no natural alternative line in rail apart from where there is double tracking but during major disruptions both lines would potentially be out of service.

4.10.3 Supporting evidence

A lot of research has been conducted on resilience in New Zealand, particularly with respect to infrastructure.

Previous Transport Agency research from Hughes and Healy (2014) has previously come up with a qualitative tool the ‘resilience measurement framework’ which has some benefit in considerations of individual assets and the system as a whole. The research was focused on evaluating key resilience assets and a framework for measuring these assets was developed. Adopting the framework approach of evaluating freight resilience, although using different measuring points, helped progress the development of the ‘freight resilience score’. The report also highlighted the importance of resilience and the ability of societies to recover to acceptable levels of service after an event is fundamental to the wellbeing of society.

Furthermore, Money et al (2017) built on this research and developed a taxonomy and a supporting decision support tool to help value resilience, so investments could be prioritised. The taxonomy helped define resilience and a common interpretation to help with the explanation of resilience. The decision support tool also provided a way forward in valuing resilience which could be used to help develop the rationale of progressing the resilience score.

Brabhaharan et al (2006) also developed a method to establish ‘performance criteria’ and example metrics by which elements of the transport system could be measured after an event. These were based on specific levels of service requirements following hazard events, and performance criteria developed for specific critical sections of the network by relevant stakeholders. Applying the methodology of understanding service requirements was an important consideration which helped in the formation of the resilience score. The availability of alternative routes was identified as one of many key factors affecting performance measures.

Clarke et al (2015) conducted a resilience evaluation and state-of-the-art summary report as part of the European Union’s Horizon 2020 Research and Innovation Programme. The report sought to frame the operationalisation of resilience approaches as applied to critical infrastructure. The report found there was no uniform implementation standard for critical infrastructure resilience. The approaches available generally related to the identification and assessment of hazards. ISO 31000 is the standard risk assessment methodology utilised across a range of sectors and by critical infrastructure providers. Although there may be some reluctance to adopt resilience-based approaches there is consensus that resilience offers a necessary frame for considering unknown or unforeseen events.

Furthermore, a think piece from LGNZ (2014) highlights the need to move towards more resilience measures compared with risk management. It highlights the inherit limitations in risk management such as the need for prior knowledge the hazard or threat exists, information on the source and likelihood of the event and nature and scale. Risk management requires understanding of vulnerabilities, exposure and chain of causality. These along with many other considerations lead to the value of resilience being more important.

All of these research pieces have common threads about understanding vulnerability as well as the value at stake, and then understanding alternatives to the status quo. The combination of these elements forms the basis of the proposed resilience score.

The ways to measure and report on resilience are endless with this in consideration and so a ‘resiliency score’ is proposed to quickly identify the resilience on ‘key freight corridors’. This is acknowledged as not being perfect but it would provide a quick way of focusing in on the parts of the network that could be of most interest to asset owners and users alike.

4.10.4 Data sources

The freight resiliency score identifies a potential method for scoring the resilience of freight corridors. The final resilience inputs will require specific input from the key agencies involved in moving freight along corridors which naturally leads to the Transport Agency and KiwiRail.

Most data inputs for the score will inevitably be held by these organisations and they are likely to have other methods of calculating resilience which should supplement the following sources of data.

Table 4.23 Potential inputs into the resilience score

Measure	Sources	Custodian
Disruption vulnerability	The Transport Agency has developed a state highway resilience map: https://nzta.maps.arcgis.com/apps/MapSeries/index.html?appid=5a6163ead34e4fdab638e4a0d6282bd2 The Transport Agency resilience hazard maps can be found at: www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Resilience/Resources-and-information/2016-40-National-state-highway-resilience-9pbc-corridors-issue1-full.pdf It is expected that KiwiRail will undertake a similar exercise or will use their slope hazards map as an input. Other potential sources to use include ONRC performance measures: 'proportion of network not available to Class 1 heavy vehicles and 50MAX vehicles' (Road Efficiency Group 2016)	NZ Transport Agency/KiwiRail
Travel time added	Potential sources of added travel time include the interactive detour tool developed by the Transport Agency which can work out the added travel distances and times: https://detours.myworksites.co.nz/ The input source can also be an average measure of previous outages on certain routes.	NZ Transport Agency/KiwiRail
Asset condition	Asset owners will have measures on condition which may be more suitable for resilience measures; however, TQI and STE can be used as a starting point.	NZ Transport Agency/KiwiRail
Freight volume per annum	The freight volumes of the key corridors can be identified once the key corridors have been defined. This data is likely to be held by both the Transport Agency and KiwiRail, or a proxy can be used to obtain an average.	NZ Transport Agency/KiwiRail

There are some limitations and nuances in the data sources which will need to be worked through in the final development of the freight resilience score including issues such as the identified alternative route may not be suitable for freight trucks, and the lack of alternatives for rail due to the nature of the rail network. These limitations and others will need to be worked through in the formal consultation stages.

4.10.5 Implementation plan

Because this is a new indicator, it is proposed the eventual research owner will need to undertake some detailed consultations with affected stakeholders before agreeing to this indicator set:

- It is proposed MoT take the lead on this work programme, but consult strongly with the Transport Agency and KiwiRail given their extensive work on resilience undertaken to date and importance of these organisations in land freight transport.
- To successfully implement the resilience score measure it is important to define its purpose and parameters. It is proposed to:

  - confirm the key freight corridors that require measuring
  - undertake workshops with key stakeholders to develop the methodology across all freight modes
  - undertake separate workshops with affected stakeholders to agree the initial scores for each measure (ie how long would additional routes take)
  - after the initial evaluation of the corridors the resilience score should highlight areas where investment may be required to bring the corridor to an acceptable standard in regards to corridor resilience.
- Regular monitoring of the corridor should be undertaken to determine if the key freight corridor is improving in its resilience (or otherwise).

4.11 Travel time reliability – key freight corridors

Table 4.24 Travel time reliability for key freight corridors – alignment to criteria

Useful for government	Durable	Practicality	Stakeholder interest	Modal applicability	Complementary
Travel time reliability can be used as a determinant in many project appraisals. It can also indicate the need for future investment by government.	Travel time reliability was cited as one of the most important issues facing freight operators. It is likely this issue will endure any market changes.	Travel time reliability is currently measured across various routes, and new suggested methods have been previously used internationally.	Understanding reliable travel was considered to be vitally important especially for the movement of freight.	The reliability of travel is applicable across modes although the measure used will be different across modes.	Travel time reliability is complementary with a number of other measures including asset condition and core freight metrics.

4.11.1 Why this is important

Travel time reliability is important for the freight industry in many ways, from workforce planning to supply chain management. Trip reliability enables individuals and operators to make clearer plans and allocate resources more effectively.

Specifically, there is the potential to plan the whole workforce with more certainty, and in certain circumstances it can enable the potential reallocating of resources increasing productivity. This enables more trips with the same resources, or the same level of trips with fewer resources.

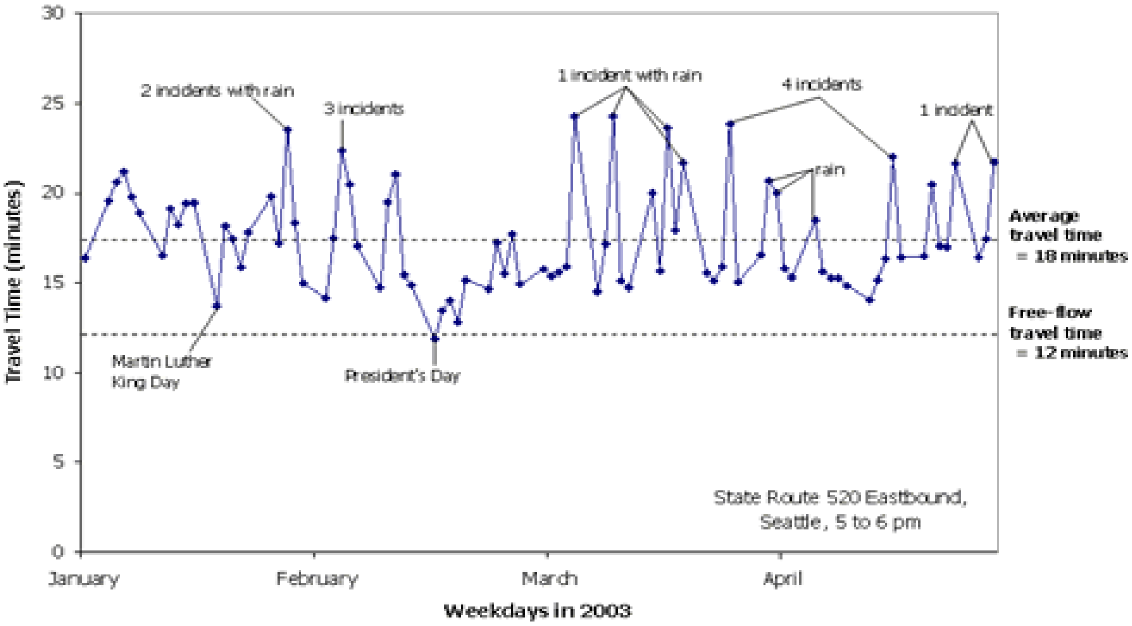
Travel time becoming more reliable increases the ability to run a just-in-time system. Having leaner supply chains can enable the benefit of reduced storage and warehousing costs for businesses and can also mean the response times for delivery are clear and well understood by industry.

Brennand (2011) highlighted that travel time variability could have significant impacts on people and the economy. Travel time variability could add significant stress to drivers particularly if their trip purpose had high value or there was some absolute deadline to meet. Travel time variability means additional time has to be allowed if goods need to be delivered by a specified time. This leads to additional cost for goods and inefficient use of resources. The additional cost was significant especially for perishable goods.

According to the US Department of Transportation (2017b), because reliability is so important for transportation system users, transportation planners and decision makers should consider travel time reliability the key performance measure. This position has been confirmed through stakeholder conversations where the importance of travel time reliability has appeared more important than average travel times or even travel time savings.

The importance of travel time reliability is further highlighted by the US Department of Transportation Federal Highway Administration. Figure 4.7 highlights commuters who travel this particular route must ‘build in’ peak variability to their departure decisions if they want to arrive on time. If they plan their commute based on the average travel time, they will be late half the time and early the other half of the time. The concept of building in peak variability is a similar issue for freight operators.

Figure 4.7 Commuter travel patterns, Seattle (2003) Source: US Department of Transportation (2017a)



Measuring travel time reliability would be beneficial for key freight corridors as freight operators would have to build in extra buffer time to ensure on time delivery. This results in added costs in terms of people hours and loss productivity. As the amount of the buffer increases, the opportunity costs of time increase for truck drivers, rail operators, freight shippers and for businesses.

4.11.2 Definition

Travel time reliability can be defined as a ‘measure of dispersion of the travel time distribution’. Travellers want travel time reliability – a consistency or dependability in travel times, as measured from day to day or across different times of day.

Some different definitions include:

- US Department of Transportation (2017a) ‘the consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day’.
- The Transport Agency’s monitoring approach is: Coefficient of variation; standard deviation of travel time divided by average minutes of travel time.

It is worth noting the unit of measurement of travel time reliability can be seen as similar across all modes (time); however, the way to measure reliability across modes will be inherently different.

A number of different travel time reliability measures currently exist for road transport.

- According to the US Department of Transportation (2017a), travel time reliability is usually measured through the 90th or 95th percentile travel time, buffer index, planning time index and frequency that congestion exceeds some expected threshold.
  - 90th or 95th percentile travel times – for specific travel routes or trips, which indicate how bad the delay will be on the heaviest travel days.
  - Planning time index – how much larger the total travel time is than the ideal or free-flow travel time (ie calculated as the ratio of the 95th percentile to the ideal)
  - Buffer index – the size of the buffer as a percentage of the average (ie calculated as the 95th percentile minus the average, divided by the average).
  - Frequency that congestion exceeds some expected threshold – this is typically expressed as the percentage of days or time that travel exceeds X minutes or travel speeds fall below Y km/h.

It is also important to measure the throughput of the corridor for freight. (Denne et al 2013) recommend including the following:

- Travel time reliability (peak): the coefficient of variation of average travel time on a representative sample of key routes during peak hour. This is likely to be most important for routes in major urban areas.
- Travel time reliability (average): The coefficient of variation of average travel time on a representative sample of key routes throughout the day.
- Average travel time will need to be collected to undertake the necessary calculations of travel time reliability.

In general, it is recommended that travel time reliability be measured in regards to the buffer index. The ability of the freight industry to plan around a reduced buffer of reliability ensures an overall higher performing freight system. Furthermore, the buffer enables the ability to track and establish a trend of performance. As the buffer reduces over time the reliability of the freight system has improved and vice versa.

Measuring the buffer time index along with more traditional measures of travel time reliability (peak and average) will enable the wider freight industry to understand the reliability of freight corridors and help them plan accordingly.

4.11.2.1 Difficulties in measurement

There are inherent difficulties in measuring travel time reliability and the ability to undertake or obtain a perfect measure is not likely to be possible. Some of these difficulties are discussed below:

- Defining the corridor: There will be some difficulties in defining the two points of measure and the exact start and stop points. Having specific points also leads to the inevitable notion that trucks will not always drive along the points without turning off in between the points. Using clearly defined ‘key freight corridors’ can mitigate the risks of measuring the reliability.
- The use of measure: Different measures of travel time reliability can be used, which all have some inherent benefit as a corridor indicator; however, we suggest the focus be on the reduction of the buffer index. Capturing the buffer index enables a clear focus on reliable trips along key corridors and enables a good indicator over time of reliability. The buffer index of the selected key corridor measures can act as an effective proxy for the freight system. As the buffer reduces over time and the corridor becomes more reliable we can expect the overall freight system to become more reliable.

- Methodology of collection: Using GPS data on trucks or use of other information may give a skewed result as there may be inherent biases associated with those trucks that utilise sophisticated GPS equipment. The use of a singular truck or even a fleet of trucks will have limitations as there are different sizes, make and performance of varying degrees for trucks. Some trucks may struggle up steep hills more than others for example. Purchasing Google API data may also have issues in regards to the travel time experienced by the majority of traffic may be experienced differently for trucks as they are generally heavier vehicles and travel at varying speeds compared with general traffic. There are also issues around commercial sensitivities and actual number of participants recorded in the data sets.

It should be made clear, to avoid any doubt, that the importance is not the absolute value of travel time reliability but the changes over time and the trend of increasing or decreasing reliability.

These are only some of the issues inherent in the measure, collection and assimilation of travel time reliability. As more data becomes available and more digital solutions and automation occurs these can enable better data collection and outcomes or change the industry completely. Focusing on the buffer enables an overall indicator as when the buffer reduces the overall system is more reliable.

Table 4.25 Proposed travel time reliability measures

Mode	Method	Advantages	Disadvantages
Road freight transport	Placing GPS trackers on trucks whom volunteer to collect data. The use of Snitch, Google, eRUC and others are current examples of such applications. The final proposed vendor will be determined in conjunction with the likely 'owner' of the measures as they may have current commercial ties they wish to leverage. Collection of data across all times of day enables a large data set for comparisons across congestion periods and peak periods along with comparisons of key days. Purchasing eRuc data once a year across key freight corridors would be seen as the easiest way forward until other recording measures and technological advancements are available.	Having industry participation enables more live or 'real data' as it would simulate the real road freight task. eRuc data can be easily purchased as previous data is available.	Tracking reliability along the whole freight corridor may prove difficult if the trucks participating do not go the whole corridor and turn off at a node or intersection. The trucks used may not be representative of the entire fleet as they may be older or underperforming. The willingness of all industry may be limited if only a few organisations decide to sign up and others do not which may give a skewed result. The mere presence of a GPS/eRUC system can result in different driver behaviours.
Rail freight transport	KiwiRail has arrival time information which can be used to determine reliability measures. The travel time reliability would be measuring how often the consignment arrives on time or the times it arrives and to calculate the 'buffer' of times. If this data is not available then a proxy for freight can be estimated by the amount of times the train leaves on time or similar.	The advantages of this measure are that it is simple and likely to be already collected and collated. Tracking the travel time reliability will enable other freight users to plan around the expected departures and arrival times and the buffer time that is available.	There may be commercial sensitivities which will require considerable consultation and effort to anonymise data. There may not be any meaningful changes to the index over time or the ability to influence change is limited.

Mode	Method	Advantages	Disadvantages
Sea freight	Ship arrival times can be used to determine the travel time variability as the rest of the freight system would be determined by the arrival of the ships. This enables the collection of travel time reliability and other operators to plan around the arrival of ships.	This measure is held by individual ports, although it is unclear how widespread the willingness to release this information would be.	There may be commercial sensitivities which will require considerable consultation and effort to anonymise data. There may not be any meaningful changes to the index over time or the ability to influence change is limited.
Air freight	Aircraft arrival times can be collected and the travel time reliability can be calculated from the airports as they will have arrival times in which travel reliability measures can be calculated. The measure will be centred on flight arrival times as the more flights arrive on time the more reliable the travel and vice versa.	This measure is easily collectable and is likely to be held by individual airports.	There may not be any meaningful changes to the index over time or the ability to influence change is limited. The reliability of air freight also depends on whether goods are carried on the desired flight or are shifted on to an alternative later flight. There is also a limitation to air freight travel time reliability in terms of the ability to separate freight from normal passenger flights.

Travel time reliability is likely to be measured on a ‘point-to-point’ basis along key freight corridors as this will enable greater clarity and analysis of the corridors and tracking. As data increases the ability to focus on reducing the ‘buffer’ will be improved and more targeted measures can be put in place. Publishing the buffer index along key freight corridors will enable freight operators to be able to plan accordingly and optimise their scarce resources.

4.11.3 Supporting evidence

Travel time reliability and its importance have been heavily researched both here and abroad.

Brennand (2011) showed early that it appeared road users value travel time reliability and the limited available evidence suggests the value of reducing passenger travel time variability is greater than that of reducing mean travel time.

Although there may be differences in preference between passenger carriers and freight carriers there is an assumption that travel time reliability is important for freight operators. The importance of freight reliability was also confirmed in various stakeholder discussions held over the time of the research.

Furthermore, research from Bone et al (2013) investigated reliability and freight literature and practice. Discussions ranged from stated preference surveys, elasticities to sources of delay. There are many more studies of travel time reliability from the use of predictive modelling to its use in project evaluation such as the *Economics evaluation manual* (EEM).

An overseas study by Jin and Shams (2016) prepared for the Transport Statistics Office Florida Department showed a variety of measures and calculations from the use of utility based modelling to proposed market segmentation.

The research showed that travel time reliability is an important measure to consider with it widely being used in economic and project evaluations. The importance of the indicator to the overall freight system is evident as more and more businesses move towards a just in time system.

As information and communications technology and data improves there is a potential to move towards greater predictabilities around travel time reliabilities. The use of GPS tracking systems is becoming more widely used with Google API data and other data points enabling greater accuracy. As the trend towards big data occurs, the ability to improve data quality and technological solutions becomes more possible.

Racca and Brown (2012) highlighted the ability to track GPS data in their study and calculation of travel time reliability measures. As part of the study 2,000 vehicles owned by the State of Delaware had their GPS data analysed to generate travel time and reliability measures across two corridors in New Castle County. The study commented that with more data points a more accurate measure would be obtained.

McCormack and Hallenbeck (2006) documented the development of data collection methodologies that can be used to measure truck movements along specific roadway corridors. The research was fortunate in having truck drivers volunteer to use GPS tracking systems to obtain performance measures.

In summary, overseas studies have routinely highlighted the ability to use intelligent transport systems to collect data and relevant analytics are becoming more and more available. The ability to undertake a similar task (potentially using GPS) in New Zealand would help greatly in understanding travel time reliability. This data is currently available through eRUC in New Zealand although the accessibility to the data is limited.

4.11.4 Data sources

Tracking movements along key freight corridors will show the travel times and variance from the mean. Tracking GPS movements of trucks along key truck corridors will enable tracking of the long-term travel time and also the travel time reliability of the corridor. Starting with trucks for road freight this will give a long-term trend and also the ability to easily see if interventions are required. Using Snitch, Google, eRUC or others will enable the collection of the key data sets and collection and analysis of the travel time buffer.

Table 4.27 Proposed travel time reliability sources

Mode	Source	Custodian
Road freight	eRUC, Snitch, Google or other vendor. Equipping industry volunteer ‘truck drivers’.	MoT/Transport Agency
Rail freight	The collection of KiwiRail arrival times for freight, across days.	KiwiRail
Sea freight	Ship arrival times measuring the time they arrive and collection of data over time.	MoT/individual ports
Air freight	Individual airports late flight arrivals. As the amount of late arrivals across airports decreases the more reliable the air freight system is.	MoT/CAA

4.11.5 Implementation plan

The development of a metric for a buffer time index is a new proposition for New Zealand. The MoT is proposed to be the owner of this development given the overlap across all four transport modes. In practice, this will require:

- Confirmation of the key freight corridors this index can be applied to.

- Identification of key data collection points/methodologies to support the development of the index.
- For road freight, it is proposed that once a year eRuc data is analysed across key corridors to determine if the travel time reliability measures are improving.
- For all other freight we suggest discussions with individual operators, as they would know the start and end times of key freight corridors.

5 Conclusions and recommendations

5.1 Conclusions

Information is a precursor for effective decision making. In a sector with the size and complexity of the freight sector in New Zealand, the importance of high-quality information cannot be understated.

The technological age is here, where relevant transportation data and information is more sophisticated and more freely available. The technologies shaping the future will change transport and the freight sector in many vast ways. The potential advancements in technologies such as block chain and automation mean that every item moved in the future has the potential to be tracked and 'perfect information' in the market for freight can be considered a possibility.

In lieu of access to this information, freight performance and contextual indicators serve a valuable purpose. These indicators will help guide both the public and private sector in making decisions from investment to changes to policy settings and help guide the response of the rapidly changing environment.

The indicators set out in this research report have been identified in consultation with stakeholders and should be both robust in nature and practical in implementation. The primary usefulness of these indicators is their ability to serve as touchstones or flags for discussions between government, regional authorities, local authorities and industry participants about initiatives, polices and investments to improve the operation of the sector.

Accordingly, the areas identified in this research report fundamentally represent a suite of issues that are deemed important to the freight sector both now and into the future.

It is ultimately proposed that an interactive dashboard be developed, leveraging the content of this research report, to serve as a one-stop-shop for information on the performance of the freight sector.

5.2 Recommendations

There are four fundamental recommendations (set out in sections 5.2.1 to 5.2.4) that stem from this research. These have been presented in order of importance, and would ideally be implemented sequentially – even if actions to support each recommendation are developed concurrently.

5.2.1 Determine effective governance structures

It is important to consider potential governance arrangements associated with the progression of this work, particularly given the fragmented nature of data ownership as well as the breadth of indicators proposed.

Owner of work programme

It is envisioned the final indicator suite will be progressed in harmony with, or through, the Domain Plan. The Domain Plan aims to help the transport sector to better coordinate how agencies collect and manage data and knowledge, and to ensure the information is visible and easy to use. The principles of the Domain Plan are underpinned by more effective data sharing and integration, and these appear well suited to the function of the proposed freight indicators.

It is therefore proposed that MoT would lead the progression of this work programme in the first instance, given their leadership role over the Domain Plan.

Coordination

The proposed freight indicators rely on coordination from a range of agencies, as well as industry participants. This supports the view that MoT should take a leadership role in the progression of this work given extensive networks across modes and sectors.

Some indicators require an annual update whereas others require migration or translation to a standardised format. It is important to have clear lines of communication and to consider the coordination approach to be used. It is therefore proposed that the principles of the Domain Plan around communication and collaboration are followed, along with the experience of Statistics New Zealand in setting up domain plans for various agencies and leveraging the lessons learned. These communications and coordination lines should be well documented to help clarify roles and responsibilities.

Ownership

Individual agencies (and where appropriate industry participants) are best placed to produce the required data/information that underpins the indicators, and therefore it is recommended each individual agency still owns their own data and MoT is responsible for the collation and presentation.

Each individual agency will be expected to provide the data to the MoT and explain areas where there are nuances and limitations of the data. This can lead to debate about the final way in which data is presented. The importance of this step should not be underestimated.

5.2.2 Undertake consultation with industry to gain consensus behind these metrics

While these indicators and the supporting evidence have been based on stakeholder conversations, they have not been developed under the banner of stakeholder consultation, ie concepts have been explored but stakeholders have not been asked to 'endorse' findings.

It is therefore recommended that the eventual guardian of this work considers it in more detail and becomes comfortable with the contents, before undertaking formal stakeholder consultation. This consultation could also explore the best approach to capturing, visualising and presenting the indicators as well as plugging knowledge gaps where they exist.

This task should also not be underestimated as it would be expected there are a lot of entrenched views about the merits of certain indicators as well as some reluctance to provide more information. It is also expected there will be a latent level of consultation fatigue across many potential respondents, given the number of interactions that they will have invariably had with government agencies, researchers and consultants over the past 10 years in particular.

The extent of consultation that may also be needed to arrive at a durable solution should also not be underestimated. It is expected there would be a material burden placed on the agency that is tasked with taking this work forward.

To help limit some of the challenges associated with consultation, it is recommended that a clear and consistent structure be applied through any consultation on each indicator:

- What is the indicator?
- What is the rationale (including pros and cons and supporting comparative evidence)?
- What supporting data is needed and who is best placed to supply/own the data?
- What readily available alternative indicators can provide similar results?

- What issues will exist in data collection, including definitions?
- What is an appropriate threshold/exception to report (if any)?

Additional consultation around aspects such as presentational approach, development of guidance materials and periodicity of reporting should also be canvassed.

5.2.3 Utilise consultation to develop a lasting freight forum (or regional forums)

An important observation throughout this research was the importance of communication between the private and public sectors, and agreement to underlying information to make better policy and investment decisions. The development of a structured consultation process to progress this work raises an additional opportunity to create a supporting industry forum to enable free and frank exchanges of ideas and information as well as discussion of issues affecting the sector. These discussion forums may also enable the regular review and development of the indicators and proposed changes or inclusion of future indicator sets so they remain fit for purpose.

It is critical that a wide selection of industry participants (freight operators, port operators, freight users, data providers etc) as well as public sector participants (MoT, the Transport Agency, KiwiRail, Statistics NZ etc) are all represented in this forum so ideas and information can be debated robustly – and an echo chamber avoided.

Governance structures, reporting requirements and forum protocols will all need to be developed, and could be aligned with some of the consultation questions proposed in section 5.1.2.2.

5.2.4 Begin implementation

Once the above three steps are undertaken, formal attention should then be given to implementation. This might take the form of three key elements:

- Consider the domain/website/delivery platform: a single website or domain should be available for all freight information. Early consideration of this platform will enable proper testing and development. The importance of user interface and presentation helps the wider public understand the issues in the sector and can help contribute to improved performance of the sector.
- It is also acknowledged that work is currently being undertaken to develop a Transport Outlook Dashboard. Looking to align the outputs of this research project with the Transport Outlook Dashboard appears sensible.
- Further research areas as needed: This report has highlighted several indicators for inclusion in an online dashboard. Many of these indicators, and supporting measures, are based on an understanding that they are practically able to be presented. In some instances, there are indicators or measures that would also be ideal to capture, but the evidence base to support their presentation is not sufficiently developed.
- It is recommended that future research, recommended in chapter 6, be undertaken on a case-by-case basis. Decisions to pursue research in these areas will ultimately be based on the costs and utility of investigating the information.
- Monitoring and evaluation: The need to monitor and continuously evaluate the indicators is important. As time progresses, regular reviews should be undertaken to understand the trends and proposed targets to ensure progress is being made towards the set goals and thresholds. If there are clear gaps between the desired and actual, this will highlight the need for more interventions in certain areas or

increased funding to obtain a desired result. This monitoring and evaluation can, in many respects, be tied in with the proposed freight sector forum. Empowering 'the sector' to review and consider the relevance of the indicators will provide a good test of their being fit for purpose. Internal periodic reviews of data capture and presentation processes would also be a good initiative should budgets allow. This may also enable indicators to be developed that explicitly capture emerging trends, such as the level of automation in the freight sector.

Additionally, we acknowledge that the development of 'thresholds' for each indicator may be met with some challenge from certain stakeholders in the sector. Explicitly including a question on the importance of thresholds in the stakeholder consultation phase helps cover off any views of the sector, and also forms the basis for testing the level of input and oversight various levels of government would expect to have in this process.

It is also recommended that serious consideration be given to the notion of two stages of consultation, whereby less contentious indicators where information is already largely available are presented first. This can be presented more as a view from the relevant agency for challenge from industry and wider stakeholders.

A second tranche of consultation could then discuss some of the concepts that are less well-known and may be more contentious, for example some of the port performance measures, the resiliency score, the safety data and the human capital indicator.

Undertaking a two-stage process can enable 'quick wins' to be gained and the production of tangible outputs. This process can serve to build momentum for the more difficult indicators and can enable the relevant agency more time to fully consider its position.

6 Future research areas

In the development of the indicators, there was difficulty in obtaining the required information to fully form a position on several indicators including operational efficiency and transportation costs. Along with these indicators the potential impacts of technology on the freight sector are not well understood. These and other supporting areas of future research are set out in table 6.1.

Table 6.1 Limitations of research and future research areas

Limitations of research	Future research areas
Understanding transportation costs	
Transportation costs were one area that stakeholders thought would be an interesting indicator to report on over time. By understanding whether freight costs change over time, by commodity and by freight corridor, it was hoped this would lead to better decision making. While the rationale for collecting this information appears sound, the practicalities (both commercial and technical) in preparing this information to a level of accuracy that would provide a sufficient amount of rigor, presented hurdles that appeared to be too large to overcome.	It is recommended that bespoke research be undertaken if this indicator is to be included within the proposed dashboard. Future research could potentially track transportation costs over time: • costs of freight to individuals • costs of freight to businesses • opportunity costs of freight • cost competitiveness of various modes • transportation corridor costs The development of a rigorous methodology that normalised the complexity noted above would need to be the fundamental component of the research. Moreover, a significant amount of stakeholder engagement would be required to ensure the right information and methodology is developed to properly reflect the dynamic commercial realities of the sector.
Freight efficiencies for New Zealand	
Similarly, a better understanding of freight efficiency was another area that stakeholders thought would be an interesting indicator to report on over time. While the rationale for collecting this information appears sound, the practicalities (both commercial and technically) in preparing this information to a level of accuracy and usefulness would prove challenging.	It is recommended that bespoke research be undertaken if this indicator is to be included within the proposed dashboard. Understanding the efficiency of freight movements in New Zealand is an important consideration for a range of reasons including the impact on GHG emissions and travel time reliability. Due to New Zealand's sparse cities and long lengths of travel it is important to understand if there are further efficiencies to be gained. Potential areas to research include: • improved reporting on empty running of containers • development of incentives to further support the optimisation of freight movements.
The effects of technological improvements in freight	
This report has focused on current technological trends and how they are shaping the freight sector, but it is not possible to understand what the next wave of innovation will bring and how this may disrupt the sector.	Continuing investigation into the effects of technological improvements in the ability to capture information in the freight sector would be a beneficial exercise. Alternatively, an in-depth study on the future of data collection in the transport sector, and the specific role of government in managing this information, would also be a useful research exercise. For example, telematics data is becoming increasingly prevalent and important. This information will rightfully be held by individual vehicle operators – yet this may have some applicability for the government in its function as an investor in the transportation network, and potentially as a network operator. Should government's role be to legislate to access this information under the guise of a public good investment? Or,

<table>
<tr><th>Limitations of research</th><th>Future research areas</th></tr>
<tr><td></td><td>should the role be to facilitate an exchange of this information in a market context? Or should the government have no role?
Given that the government's role in transport will increasingly be focused on the management of data and information, this research topic appears highly relevant.</td></tr>
<tr><td colspan="2">The value of amenity</td></tr>
<tr><td>While a range of indicators have been prepared that look for ways of measuring the direct performance of the freight sector, there is limited acknowledgement of the impacts freight has on amenity values.</td><td>Increasing freight and productivity is an important consideration which is generally tied to the increases in consumption benefits and increase in the wealth of the nation; however, this increase in wealth could have a detrimental effect on the value of amenity as the increasing number of trucks and other freight movements decreases the localised value of place, as perceived by individuals.
Further research on amenity value can lead to a more balanced view understanding that people may value amenity more than a small increase in wealth.</td></tr>
<tr><td colspan="2">Understanding emissions in the freight sector at a more granular level</td></tr>
<tr><td>Emissions data is currently captured at a more aggregated level as this supports reporting of the national inventory. As the ability to collect data improves there is an ability to disaggregate information so that individual modes and geographies have a better understanding of their contribution to GHG emissions.
This information may assist governments (local, regional and central) to put in place measures to improve GHG emissions outcomes.</td><td>Understanding GHG at a granular level can help improve both the reporting of emissions and the information flow of emissions. A granular level of reporting can improve and help target suggested research areas including:
• GHG by commodity
• GHG by mode
• GHG by corridor
• GHG by region.</td></tr>
<tr><td colspan="2">Understanding freight tonnage by key freight route</td></tr>
<tr><td>Currently the flow of freight cannot be tracked along freight corridors in terms of exact volume and value. Understanding this information would be highly beneficial for route planning and regional investment committees.
The National Freight Demand Study has good flow information; however, this was and is an ad hoc publication. The provision of continuous or at least high-frequency data on tonnes moved would be a useful exercise to explore.</td><td>Improving technology and increased investment in data capture increases the ability to understand the origin and destination of freight. Furthermore, improvements in data increase the ability to determine and understand freight tonnage along a route in more detail including potentially every item moved.
For example, a combination of telematics with RFID tags/blockchain could enable the freight task to be better understood. A precise understanding of this technology transition as well as the costs and barriers to implement the technology chain would have value.</td></tr>
<tr><td colspan="2">Generators of freight and destination data</td></tr>
<tr><td>Reporting on current indicators of freight performance is an important tool to help predict future policy and investment decisions. However, understanding the future requirements – or in this case the generators of freight activity would be an even better proposition.</td><td>Developing a forecasting mode for future freight tasks would be an invaluable tool for transport agencies. Such a model would be a substantial undertaking and might give rise to considerations of:
• commodity price impacts
• demographic changes
• transport investments
• freight infrastructure (warehousing, port infrastructure etc)</td></tr>
</table>

Limitations of research	Future research areas
	• resource concentrations • labour force constraints. We note that MoT now has such a model, called 'Transport Outlook Future State'. See www.transport.govt.nz/news/land/transport-outlook-future-state/ This model helps answer several of the questions noted above.
Airport and inland port efficiency	
In general terms, there is a lot of good information about sea port measures as well as road and rail measures of freight movements. Comparatively speaking, there is a much weaker understanding of the important role inland ports and airports play in the freight sector.	It is proposed that a standalone research project be undertaken to further develop measures and metrics that can support a better understanding of the role airports and inland ports play in the freight supply chain. At present, it is often difficult to 'demarcate' airport activity given the interface with freight forwarders, as well as disentangling the interface with passenger movements. In a different vein, inland ports are a relatively recent phenomenon in New Zealand, but are increasingly playing an important role in the sector. Moreover, there are some difficulties in defining the function of an inland port from, say, a major warehousing facility or a freight forwarding facility. A better description of the role these two parts of the supply chain play, as well as measures to support this understanding, would be valuable.

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Appendix A: Literature review

A1 Introduction

This literature review summarises a range of indicators for freight that are presented publically in Australia, Canada and the European Union. The purpose of the literature review was to provide support and suggestions for indicators to be applied to the New Zealand freight industry.

A2 Australia

The Bureau of Infrastructure, Transport and Regional Economics (BITRE) has prepared a range of mode specific indicators for container ports, rail, road and air freight (BITRE 2017).

	Container ports	Rail	Road	Air freight
Cost	$/container (including land-side) ABS producer price indexes*	Freight rate estimates ARTC revenue/tkm ABS producer price index	Freight rate estimates ABS producer price index	Freight rate estimates
Travel/transport time	Container turnaround times Truck turnaround times Vessel turnaround times Duration of import/export procedures (Dept of Immigration & Border Protection)	Scheduled terminal to terminal time	Some road speeds, as available from states In development: Average travel time/Truck speeds on key freight routes	
Reliability	95th percentile of ship turnaround time Ships waiting at anchorage > 2hr	Trains within 30 minutes of schedule	In development: GPS truck movement data	Flight delays
Productivity	Wharfside, landside and whole of port indicators	Tonnes/truck per kilometre		
	ABS productivity estimates (whole of transport & storage industry)			
Capacity	Ship turnaround times	Scheduled dwell time (due to other trains using line)	Congestion measures (e.g. TomTom, HERE) In development: truck speeds at congested locations (from GPS data)	
Safety	Maritime fatalities and injuries	Rail-related fatalities and injuries	Fatalities and injuries from heavy vehicle crashes	Aviation fatalities and injuries

*The producer price index (PPI) measures changes over time in prices received by producers

	Transport modes	Potential indicators
Access	Road	% of network accessible to each vehicle class
		% of producers within a set distance of network for each class
Land use / encroachment	Ports, intermodal terminals	Population and jobs density within set distance of port precinct or intermodal terminal sites
		Congestion on roads approaching ports

BITRE has also proposed investigating two additional indicators: access and land use/encroachment.

A3 Canada

Canada uses a range of performance indicators across container port (Board of Transportation Statistics (2017), rail (Canadian National Railway Company nd) and road transport (Transport Association of Canada 2006).

	Container ports	Rail	Road
Cost			Maximising the current and future benefits from public and private investments, is generally considered and important outcome for transportation departments
Travel/transport time	Average truck turnaround time (minutes) Average vessel turnaround time (seconds/TEU) Average vessel turnaround time (hours) Vessel on-time performance	Train speed: Measures the line-haul movement between terminals. The average speed is calculated by dividing train-miles by total hours operated, excluding yard and local trains, passenger trains, maintenance of way trains, and terminal time. System-wide average train speeds are given for the following train types: intermodal, manifest, coal unit, grain unit, all trains	
Reliability	Dwell target – % under 72 hours (%) Average container dwell time (days)	Terminal dwell (hours). The average time a car resides at the specified terminal location expressed in hours. The measurement begins with a customer release, received interchange, or train arrival event and ends with a customer placement (actual or constructive), delivered or offered in interchange, or train departure event. Cars that move through a terminal on a run-through train are excluded, as are stored, badly ordered and maintenance of way cars.	Standard deviation of trip time; standard deviation of link speed Sustainability and environmental quality – atmospheric levels of carbon monoxide, ozone, nitrous oxides and particulates Physical condition of infrastructure, for example – typical measures of pavement performance include the following indices: riding comfort

	Container ports	Rail	Road
			(RCO), surface distress (SDI), structural adequacy (SAI), pavement condition (PCI), roughness (IRI) and pavement quality (PQI).
Productivity	Port productivity (TEU/gross ha) Crane productivity (lifts per hour		
Capacity	Number of vessel calls (number/month) Average TEU per vessel call (number/month) Container throughput (number/month)	Cars on line – the average of the daily on-line inventory of freight cars. Articulated cars are counted as a single unit. Cars on private tracks (eg at a customer's facility) are counted on the last railroad on which they were located. Maintenance of way cars are excluded.	
Safety			Injuries and/or fatalities per unit of transportation
Mobility/ accessibility			Delays; congestion; average travel speed; closures and detours

A4 European Union

The European Union uses a range of performance indicators across container ports (Portopia 2014), rail (Platform of Rail Infrastructure Managers 2016) and road transport (European Freight Transport Statistics 2010)

	Container ports	Rail	Road
Cost		Maintenance expenditure relative to traffic volume – euro per train km Sum of total operational expenditure – euro per main track km	Labour costs (driver wages including social costs and reimbursed expenses Capital costs (costs of depreciation and interest cost of vehicle) Fuel costs (including excise duties) Other costs (insurance, vehicle tax, repair and maintenance, tyres, overhead)
Travel/transport time	Truck turn-around time Ship turn-around time Berth occupancy (%) – total time of ships at berths (in day)/total number of berth expressed as a	Number of freight trains which arrive at strategic measuring points with less than 15 minutes delay compared with all freight trains – % of number of trains	Level of empty running: the proportion of truck-kms run empty Tonne-km loading factor: the ratio of the actual tonne-kms moved to the maximum tonne-kms that could have

	Container ports	Rail	Road
	percentage		been moved if the vehicle had been travelling at its maximum legal weight. Unlike the first measure which assumes that the loading factor is constant on a particular trip, this measure allows for weight-based loading to vary during the journey, as consignments are delivered or collected
Productivity	Labour productivity – annual throughput (TEUs) per FTE/annual labour per employee Crane productivity (net crane rate) – containers moved over the quay per crane/hours between first and last life minus idle time Ship productivity (net moves per hour) – containers moved to or from a shop/hours between first and list lift minus idle time	Degree of utilisation – average daily number of freight trains	Utilisation of fleet – number of trips per vehicle-kilometre Road freight transported is related to the level of economic development – tonne-km/GDP
Capacity		Time loss due to temporary speed restrictions of the infrastructure not included in the yearly timetable. – minutes per thousand main track km Length of main tracks of congested infrastructure – main track km	Deck-area coverage (or 'load area length'): the proportion of the vehicle floor (or deck) area covered by a load, representing a two-dimensional view of vehicle loading. Where the height to which products can be stacked is tightly constrained, loading is usually limited more by the available deck-area than by the cubic capacity.
Safety		Significant crashes – number per million train km	
Mobility/accessibility		Delays caused by security incidents – minutes per train km Average delay minutes per track failures – minutes per number of failures	Weight-based loading factor: the ratio of the actual weight of goods carried to the maximum weight that could have been carried on a laden trip.

A5 Conclusion

The literature review identified a range of international measures which have helped guide the identification of freight indicators for New Zealand. These indicators have been narrowed and supplemented through consultations with stakeholders and evaluated through criteria.

Appendix B: Stakeholder engagement

Table B.1 List of organisations consulted

Organisation
Air New Zealand
Christchurch Airport
Environment Canterbury
Environment Southland
Halls
HW Richardson
HWR
Interislander
KiwiRail
Maersk
MBIE (Labour Markets Group, Energy Data Group)
Ministry of Transport
National Infrastructure Unit
New Zealand Shipping Federation
NZ Post
Other independent parties on the Steering Group and as part of official Peer Review
Ports of Auckland Limited
Road Transport Forum NZ
SB Global Logistics
Smart Freight Centre
Spark Qrious
The Transport Agency
The Warehouse Group
WorkSafe New Zealand

Appendix C: Stakeholder insights

All stakeholder interviews were conducted in a similar manner where the general intention of the research project was first discussed by Ernst and Young (EY). Stakeholders were then given a chance to discuss their particular role in the freight sector. Finally, interviewees were given a chance to raises issues, trends and challenges in the sector, as well as comment on the appropriateness of the indicators (currently captured, proposed for capture, or not yet captured).

Some of the insights from the various stakeholders have been summarised below. These insights reflect points of predominant commonality across the stakeholder group – although they do not strictly reflect consensus. All comments have been de-identified.

- 'All freight modes have a role in the freight sector'. Each operator and stakeholder within the sector has a very specific role and set of commercial drivers. Amongst other things, this leads to different requirements for data provision in regards to public availability, completeness, spatial extent and granularity of freight type.

While it was acknowledged there is already a lot of information captured in the freight sector, and there was naturally a level of asymmetry about data requirements, there was a general view that the intermodal interface is an increasingly critical part of the supply chain that would be better to understand.

- 'Benchmarking to overseas jurisdictions has merits in some instances but requires caution'. Benchmarking New Zealand's freight sector performance was seen as desirable in principle. However, the ability to truly compare jurisdictions is limited by the natural economic differences between countries (ie resource concentrations as well as economies of scale) but also in terms of indicator definition(s). It is important to understand and acknowledge different operating environments before looking to compare jurisdictions too literally.
- The reliability of freight movements is considered more important than time savings. The reliability of freight movements was repeatedly seen as a more important indicator than travel time savings. This was not to say that travel time savings were not important, but rather that travel time reliability has wider implications for the performance of the freight sector.

The focus on this issue may have taken on extra impetus given the experiences associated with the Kaikoura Earthquakes in 2016 and the implications these had on freight route planning.

- Human capital elements of freight were generally underappreciated. There was a strong perception amongst many in the industry that there is a real shortage of skills looming (particularly with an ageing workforce). The requirements and new obligations of Health and Safety at Work Legislation as well as decisions that have been, or may be made, in New Zealand's immigration settings have also put a stronger focus on 'people'.

Having a strong evidence base around human capital issues conveniently housed in one place can aid discussions between policy makers and those in the industry.

- The growth in the freight task is outstripping the levels of investment. Significant increases in population in major cities in particular are causing issues for the movement of freight. Not least of which because investment decisions for asset owners become more urgent, but also because of the externality effects of moving more freight on congested roads, rail lines, shipping lines and through airports.

The freight interface with the general population also presents a challenge in attribution, this is particularly relevant for safety and reliability measures.

- The rise of e-commerce is complicating the already complicated freight picture. Market developments with horizontal and vertical integration across the supply chain are complicating the definition of freight. Where consumers used to pick up their groceries from supermarkets (with the practical effect of being a private vehicle on the road for the last mile) they are now getting their groceries delivered, or their meals collectively delivered through businesses like Uber Eats and My Food Bag (with the practical effect of being a van on the road for the last mile).

The type of vehicle being monitored (private vehicle vs van vs light truck) can often be used as a proxy for freight; however, the examples above highlight that this 'rule of thumb' may be less relevant as business models change.

- The value of detailed data is increasing and this is challenging the role of government. There was a strong belief that technological developments are placing a premium on the value of data. This makes the ability to access private sector data more difficult as it is increasingly seen as a competitive advantage.

General information provided by government is often seen as being 'too late' or 'too general' to enable any freight operators to make meaningful decisions. However, data that was directly related to the role of government was seen as important to publish as this enabled accountability for decisions (investment, regulation, policy or funding).

- 'The natural evolution of data would be towards a commodity'. The general view was that the data wave is coming – telematics, process automation, block chain amongst other technologies will all eventually contribute to a much richer picture about origin and destination of all freight in New Zealand. The clear question for government is therefore what does it want to monitor/measure and why? What are the reasons and principles that underpin data collection – this was seen as key.
- 'New Zealand freight infrastructure is deceptively complex'. A common refrain was the recognition that the freight sector is complex – and that any indicator set will never be 'enough'.

Appendix D: Indicators considered but discarded

D1 Transportation cost – key freight corridors

D1.1 Why this is important

In theory, being able to track the cost of moving freight from selected origins to destinations over time would serve as an indication of the levels of productivity, competition and profitability of the sector. Government should be interested in all these three elements (productivity, competition and profitability) as they can indicate/lead to higher employment rates, higher tax takes and a more productive economy.

Governments also frequently make investments in new transport infrastructure on the grounds of improving outcomes for users (travel time reliability, reduced travel times, lower operating costs). Being able to track whether these investments truly lead to lower input costs for operators, and ultimately prices for customers, will help support the justification of these investments.

To the extent that information about pricing is reliable and accurate, this indicator could also be used by some parts of the market to undertake price comparisons between different modes of freight or to benchmark operators within the same mode (for instance different trucking operators).

Undertaking this assessment across key commodity types could also serve to highlight particular pinch-points, or sectors that could warrant greater government/market responses. For example, if the cost of transportation of one commodity has been escalating consistently over a long period of time, but the cost of transportation for all others has remained flat, that could indicate an overly complex regulatory environment, or concerns around competition.

D1.2 Definition

The creation of a standardised 'cost of transportation' within the freight sector is a complex undertaking. There are a number of important considerations that will inevitably bring into question the accuracy and relevance of this indicator:

- The nature of the freight being moved: Different goods have very different freight requirements which will lead to different approaches to pricing/cost of transportation. These factors include, but are not limited to, weight, distance, volume, economies of scale, frequency, competitive position of the operator, strategy of the operator, expected rates of return and specific handling requirements. The presence of this wide array of pricing factors means it will always be difficult to determine an accurate and reliable 'cost of transportation' proxy.
- Bespoke cost structures: Each freight operator has a unique cost structure, which poses difficulties in developing a uniform 'cost of transportation' indicator. The presence of cost-saving strategies such as hedging on fuel and the level of capital investment vis a vis operating costs further complicate this picture.
- Commercial sensitivities: Much of the information/data required to build this indicator would benefit from being sourced directly from industry participants – as they will have the most up-to-date views on the drivers of price. There will, however, be a natural level of caution on behalf of operators in providing any information that may jeopardise commercial positions in the market. It is therefore likely that most if not all the information will come from public sources, which may reduce the credibility of the indicator.

Regardless, the creation of a cost proxy for moving a standard measure of freight from origin to destination, across modes was something that stakeholders believed would be a useful contribution to the public discourse, if it could be developed robustly.

In order to create this indicator, it would be likely that a hedonic pricing-type assessment across modes and freight type (logs, milk, vehicles) would be used whereby key inputs to the end price of the movement of a standard measure of freight would be determined. These could then be tracked and where relevant updated over time using official measures to keep the cost of transportation indicator relevant.

Due to the complexities involved in determining these proxies, and the importance of collaboratively developing this measure with relevant stakeholders, it is proposed that a separate research project be commissioned to determine the most appropriate methodology (ie the freight type included, the inputs into the cost of transportation indicator).

D1.3 Supporting evidence

In a New Zealand context, there have been several attempts to develop this proxy over time. For example, Flack (2008) contemplated the development of a cost of transportation measure for the road and rail sector using the following factors.

Road:

- vehicle operating costs (including labour, fuel inputs and vehicle capital costs)
- traveller time costs
- additional road crash costs experienced by road users but not internalised within vehicle operating costs
- parking costs.

Rail:

- operating costs
- capital charge on rolling stock
- capital charge on infrastructure assets
- environmental externalities.

This was then summarised into tables that showed high-level cost estimates for the movement of key freight across traditionally important corridors. The information underpinning a lot of these assumptions was gathered through case studies with industry.

Figure D.1 Example of pricing comparison across modes, freight corridors

Via Sea freight (NZ Coastal vessel ex Auckland)		Via Rail		Via Road (1,054 km)	
Items	**NZ$**	**Items**	**NZ$**	**Items**	**NZ$**
Cartage ex AKL CY to Auckland	$110.00	Auckland CY to Christchurch rail head (including Fuel Adjustment Factor (FAF) of +19%)	$1,655.30	Auckland CY to door Christchurch warehouse (including MT return to depot)	$2,800.00
Transhipment fee	$56.00				
Vehicle booking system fee	$5.00				
NZ Coastal vessel Ocean Freight – Auckland to Christchurch CY	$770.00				
Christchurch wharfage	$75.00				
Christchurch demurrage	N/A				
Container cartage ex Christchurch port to Christchurch warehouse (including MT return* to depot)	$180.00	Container cartage ex CHCH rail head to a Christchurch warehouse (including MT return to depot)	$150.00		
Total (Excluding GST) (Rounded)	**$1,200.00**	**Total (Excluding GST) (Rounded)**	**$1,800.00**	**Total (Excluding GST)**	**$2,800.00**
Delivery time					
Auckland CY to Christchurch depot	4 days	Auckland CY to Christchurch depot	2-3 days	Auckland CY to Christchurch depot	1-2 days
Singapore to Christchurch depot (providing timely connection)	17-18 days	Singapore to Christchurch depot	15-16 days	Singapore to Christchurch depot	14 days

Source: (Flack 2008).

In Australia, BITRE (2017) has recently consulted, as part of the freight and supply chain enquiry, into mode specific performance indicators.

A range of mode specific performance indicators was prepared as part of this consultation. Most notably, 'cost' is considered within this publication, and is expected to be applied to a range of freight types (grain, beef imported goods etc).

BITRE consulted on the merits of capturing information across all modes, with a view to determining an average cost per unit/km measure for all modes. An example of the eventual performance indicator set is provided.

Figure D.2 Example of proposed cost performance measures for grain exports from Riverina

Supply chain: Grain exports from Riverina						
	Component					
	Road	**Road to rail transfer**	**Rail**	**Port**	**Sea**	**Total**
Cost	\$x/tkm	\$x/tonne	\$x/tkm	\$x/tonne	\$x/tkm	\$x/tkm
Time	x hours	x hours	x hours	x hours	x hours	x hours
Reliability	x hours (95th percentile)	x hours (95th percentile)	x hours (95th percentile)	x hours (95th percentile)	x hours (95th percentile)	x hours (95th percentile)

BITRE also published a periodic report that looks at interstate freight rates across a range of modes. This information and some of the modelling underpinnings are then used to predict what future freight rates might be insufficient. Information is included in these reports to understand all determinants of cost in the modelling (BITRE 2017a).

Across these examples it is clear there is a range of different ways of determining cost proxies, and the best way to create a durable indicator is to work with industry to help devise it.

D1.4 Conclusion

While the rationale for collecting this information appears sound, the practicalities (both commercial and technically) in preparing this information to a level of accuracy that would provide a sufficient amount of rigor, present hurdles that are too large to overcome.

It is recommended that bespoke research be undertaken if this indicator is to be included in the proposed dashboard. Moreover, a significant amount of stakeholder engagement would be required to ensure the right information and methodology is developed to properly reflect the dynamic commercial realities of the sector.

D2 Operational efficiency – key freight corridors

D2.1 Why this is important

In theory, being able to track the efficiency of moving freight around key corridors and selected destinations and origins would serve as an indicator of how well both industry and government are receiving a return on their infrastructure investment.

Understanding operational efficiencies of freight is also important as it will help understand if there are more efficient ways of operations or if the industry is finding ways to 'improve' over time. This can translate into the potential for reduced costs and can increase returns to the overall economy and GDP as a whole.

D2.2 Definition

According to McKinnon (2015), operational efficiency can be measured in various ways with utilisation and productivity commonly applied in the freight sector.

- Utilisation: the ratio of the capacity actually used to the total capacity available (such as the amount of space in a container actually occupied by a load).
- Productivity: defined as the ratio of outputs (such as tonne-km or vehicle-km) to inputs (such as fuel, vehicles or labour).

There are other ways to measure efficiency of the freight system with 'empty running' being the most widely discussed among stakeholders interviewed. Empty running is a measure of vehicle utilisation. Being able to measure 'empty running' may be important as it can indicate latent efficiencies in the freight transport system.

Measuring empty running also enables the establishment of long-term trends for freight. By tracking whether empty running volumes are increasing or decreasing over time, it may be possible to draw conclusions about the efficiency of the system as a whole.

It is our opinion that the determination of the 'best' measure of freight efficiency is a complex undertaking requiring detailed stakeholder engagement and bespoke research. Regardless, a discussion of some of the limitations and challenges expected to be faced through this research is discussed in the following sections.

D2.3 Limitations

There are clear limitations to the ‘empty running’ measure. Empty running is often a necessary by-product of freight flows, and so distinguishing this ‘necessary’ activity from general empty running due to operational inefficiencies is difficult. Natural competition in the market will lead to efficiencies in the current freight system, and so the development of a measure of operational efficiency from this perspective may be unnecessary.

There are natural limitations on the ability to carry more freight due to size and capacity constraints of vehicles and the infrastructure in which they operate. There are limits to the loads bridges can handle and roads, also, can suffer greater damage depending on the weight of vehicles. This may put a cap on the extent to which ‘empty running’ can manifest in reality.

In addition, there is likely to be resistance from private industry to the provision of information that details ‘empty running’ across the country. This information is commercially sensitive and is likely to be treated as such.

D2.3.1 Limitations on collecting freight utilisation

There is potential to use weigh stations and calculate the loading of trucks to act as a proxy for the overall freight system. Limitations to this could be some trucks would be fully loaded to capacity or loaded to the weight restrictions and as the truck moved goods it might unload freight, therefore weigh stations would not capture the full description of the load.

There are also issues in trucks being over loaded as shown in previous annual WIM studies. As mentioned there are weight restrictions on the carrying capacity in terms of weight and load as the roads and bridges are not designed to handle certain loadings and it is widely known that as the weight increases the loading increases on the axles and the damage/useful remaining life of the asset deteriorates faster.

Freight patterns may change based on seasonal trends and or developing trends over time. Freight patterns may vary from time to time as the economy changes over time and moves up the value chain.

Utilisation measures for trains would have issues in terms of understanding whether consignments are intentionally ‘empty’ (to enable time constraints to be met) or whether they are unintentionally empty due to the lack of demand and coordination.

Shipping containers will have the same issues regarding utilisation of loads. The ability to gain or require the information from ship operators may prove difficult.

Air freight has the issue of passengers to contend with as flights can only carry a certain amount of weight deemed safe for flying. Separating passenger weight capacity with freight is difficult as there are not many specific freight planes available.

D2.4 Supporting evidence

Very few countries routinely collect utilisation statistics. A study conducted by McKinnon (2015) highlighted Eurostat data showing the proportion of truck-km that run empty in EU member states. This study confirmed the view expressed by stakeholders that it is often found that underutilisation is often justified and not necessary evidence of inefficiency.

Furthermore, Piecyk and McKinnon (2013) conducted a technical report into road freight transport in the UK. It highlighted the factors influencing the long-term decrease in the percentage of empty running, often justified by standard commercial incentives:

- increase in the average length of haul

- change in trip structure
- greater use of load-matching services
- reverse logistics
- management initiatives to improve back-loading
- increasing cost of road transport.

The study was useful in showing how operational efficiency can change over time, with empty running in the UK decreasing from over 31% of the total distance travelled in the mid-1980s to 26% in 2001; however, this position increased again rising to nearly 29% in 2010.

Empty running is a complex topic and its usefulness in a New Zealand context will need to be examined carefully before implementation.

Eurostat (2016) gives a robust guidance in sample surveys and manuals. The survey guidance can be adapted to a New Zealand context if collection of empty running statistics through surveys was deemed necessary.

D2.4 Conclusion

While the rationale for collecting this information appears sound, the practicalities (both commercial and technically) in preparing this information to a level of accuracy that would provide a sufficient amount of rigor, present hurdles that are too large to overcome.

It is recommended that bespoke research be undertaken if this indicator is to be included within the proposed dashboard. Moreover, a significant amount of stakeholder engagement would be required to ensure the right information and methodology are developed to properly reflect the dynamic commercial realities of the sector.

Appendix E: Glossary

AADT	average annual daily traffic
ACC	Accident Compensation Corporation
ANPR	automatic number plate recognition
ANZSIC	The Australian and New Zealand Standard Industrial Classification
API	application programming interface
BITRE	Bureau of Infrastructure, Transport and Regional Economics
CAA	Civil Aviation Authority
CAS	Crash Analysis System
CCTV	closed circuit television
CI	condition index
EEM	*Economic evaluation manual* (NZ Transport Agency)
EY	Ernst and Young
FIGS	Freight Information Gathering System
FTE	fulltime equivalent (employee)
GDP	gross domestic product
GHG	greenhouse gas
GNSS	Global Navigation Satellite System
GPS	global positioning system
IMEX	International Monetary Exchange
ITF	International Transport Forum
LGNZ	Local Government New Zealand
LTSV	long-term strategic view
MBIE	Ministry of Business, Innovation and Employment
MCDEM	Ministry of Civil Defence and Emergency Management
MfE	Ministry for the Environment
MoT	Ministry of Transport
nd	no date
ONRC	One Network Road Classification
PII	pavement integrity index
RFID	radio frequency identification
RUC	road user charges

STE	smooth travel exposure
TEU	twenty foot equivalent unit
TMIF	transport monitoring indicator framework
TQI	track quality index
Transport Agency	New Zealand Transport Agency
VKT	vehicle kilometres travelled
VOSL	value of statistical life
WIM	weigh-in-motion
WorkSafe NZ	Work Safe New Zealand