Extended Value Stream Mapping: Creating a Supply Chain View of Phytosanitary Compliance for Export Timber

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This research examines expanding Value Stream Mapping (VSM) from a single organisation tool to a supply chain tool. VSM is a lean production tool that is used to identify areas of waste, traditionally in manufacturing processes internal to a single organisation. This research will adapt and apply a supply chain view of VSM in the context of New Zealand timber exports with a focus on phytosanitary compliance.

Phytosanitary regulations are an important part of international trade as it allows for countries to ensure that products entering their country are free from contaminants, such as pests and diseases. New Zealand must meet other countries phytosanitary requirements in order to enforce our biosecurity measures. Meeting these phytosanitary regulations for export adds cost and reduces efficiencies across the supply chain, reducing this impact while still maintaining a high standard would be beneficial to the export industries in New Zealand, this research will focus on the timber industry.

This research uses a multi case study approach to apply VSM to create six current state maps for the phytosanitary compliance processes in the supply chain for sawn timber being exported to Australia and a selection of countries in Asia. The research outlines the traditional methods used in VSM and suggests an adapted method of applying VSM to processes that cross multiple organisational boundaries for a supply chain view. A single future state map is then created, with suggested industry changes.

The research objectives are to apply VSM across multiple organisations in a supply chain, to identify the current state map of the processes involved with meeting phytosanitary compliance requirements for Australia and several countries in Asia for sawn timber, and to suggest a future state map for the phytosanitary compliance system in New Zealand.

Overall, it was found that the current phytosanitary processes are well managed in New Zealand and meets the requirements of our key export customers. However, the application of a supply chain VSM view has revealed some wastes that could improve the process. This research adds to the established Lean systems literature with an adapted supply chain VSM approach.

Keywords: Supply chain Value Stream Mapping, Phytosanitary compliance, Lean, Forestry, Supply Chain Management, Timber, Exports.

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Chapter 1

Introduction

The world is becoming increasingly more globally connected through trade. The New Zealand economy relies heavily on primary production. Primary products constitute about half of New Zealand's export trade, and exports make up a third of the GDP (Treasury, 2016). The third largest export earning industry in New Zealand is forestry (New Zealand Forest Owners Association (NZFOA), 2014).

New Zealand produces a range of wood products for export, including sawn timber which is processed by an array of saw mills across the country. New Zealand is the world's largest exporter of logs, but also exports a range of other wood products, such as timber. Timber products account for 17% of forestry exports (Ministry of Primary Industries (MPI), 2016a). New Zealand timber can be found in stores in many countries around the world, including the USA, China and Australia. These three countries account for 56% of the timber exported from New Zealand (MPI, 2016a).

Plantation forests cover around 7% of New Zealand's land area (NZFOA, 2014). Around 70% of the wood produced in these plantation forests will eventually be exported (Treasury, 2016). The New Zealand forestry industry employs around 20,000 people directly and contributes to 3% of the GDP and creates an annual gross income of $5 billion (MPI, 2016b). The forestry industries contribution to the New Zealand economy makes it an important area to maintain export integrity.

New Zealand is a remote country with a unique environment, which requires protection from introduced pests and diseases arriving from overseas. Internationally there is a reciprocal agreement through the World Trade Organisation, named the Sanitary and Phytosanitary Agreement (WTO-SPS). This agreement allows for countries to require animal and plant products entering their territory to be free of pests and diseases, while not creating unnecessary protectionist trade barriers (Stanton, 2010). For New Zealand to require imports to meet certain standards, exports must meet the standards imposed by other countries (World Trade Organisation, 2016). Primary products exported under this agreement often need to be accompanied by a phytosanitary certificate, that certifies the products meet the criteria of the country of destination. For export timber, this means that the supply chain needs to include processes to ensure that products meet the requirements.

All products and services have their own supply chains, and there is some benefit from looking at supply chains as whole systems, especially if they cross several company or country's borders (Fawcett, Ellram & Ogden, 2014). There is currently no centralized understanding of how

phytosanitary compliance fits within the overall supply chain for export timber from New Zealand. There may be opportunities for value to be added, or savings to be made by considering phytosanitary compliance from an integrated supply chain perspective, as this has not been widely researched. Key logistical factors of the supply chain impact on the supply chain's ability to meet the phytosanitary requirements for timber. These include the documentation, timing of processing, and product handling methods. Phytosanitary compliance is legislative (Government) requirement that requires industry level business processes that cross organisational boundaries of a number of actors within the forestry supply chain.

Creating and examining a process map can identify if there are opportunities for possible improvements to the processes which customize the products to their specific markets. In this case it might mean delaying country specific processing. Once a log or piece of timber has been tagged for a certain destination Importing Country's Phytosanitary Requirements (ICPR), then export is limited to that destination, or it must remain in the domestic market. Here, there is the potential for cost savings if this process can be delayed in the supply chain for as long as possible according to the doctrine of postponement (Pagh & Cooper, 1998). There may be potentially overlap in the processes being applied to meet phytosanitary requirements for any destination before specialization occurs. This would allow the product to potentially fill a variety of export orders rather than a country specific one. There is also potential for other areas of improvement, such as in the flow of information and delays through the system.

Lean production tools can be of benefit in situations that require meeting specific targets with a low degree of variation (Montgomery, Jennings & Pfund, 2011). Within this domain, value stream mapping (VSM) is one of the Lean tools that helps to create a picture of the entire production process for a single product within a company (Rother & Shook, 2003). A review of the literature could not locate research that examines the phytosanitary compliance of sawn timber supply chains utilizing VSM. Further, this research could not find any instances where VSM has been applied across multiple organisations to examine supply chain wide processes. The supply chain components for phytosanitary compliance require the interaction of multiple organisations that cannot be fully integrated due to the regulatory and governmental nature of some of these organisations. This makes creating an end-to-end map of the processes of particular interest. Creating a view of the supply chain including the regulation needs and the additional requirements that need to occur that are often not part of the product flow in value stream mapping, adds an extra dimension to this venture.

Hence, the aim of this research was to develop a value stream mapping approach that extends beyond the organisational boundaries of a single firm to create a broader picture of the supply chain.

In order to achieve this, this research will focus on applying the current knowledge of VSM to the phytosanitary compliance components of the supply chain for timber being exported from New Zealand.

1.1 New Zealand Forestry and Phytosanitary Requirements

New Zealand forestry exports are primarily made up of logs, accounting for approximately 42%, while sawn timber accounting for 17% of the value of forestry product exports in 2015 (Ministry of Primary Industries, 2016a). The top destinations for sawn timber differ from the top destinations for other wood products, however, China is one of the top three destinations by value for both logs and timber (NZFOA, 2014). The top 10 export destinations for sawn timber products by value are listed in Table 1.1.

Table 1.1 Value of sawn timber exports from New Zealand to different destination countries.

Country	*Value of Exports*
USA	$181,845,000
China	$148,901,000
Australia	$142,721,000
Vietnam	$47,904,000
Taiwan	$40,074,000
South Korea	$40,074,000
Thailand	$29,966,000
Japan	$29,778,000
Indonesia	$27,595,000
Philippines	$22,298,000

Source: Ministry of Primary Industries (2016a).

There are several actors in this industry that constitute the supply chain and are associated with phytosanitary compliance. These include sawmills, secondary wood processors (for some supply chains), transport companies, fumigation companies, the ports and port operators, along with regulatory bodies such as the Ministry for Primary Industries (MPI), and Independent Verification Authorities (IVAs).

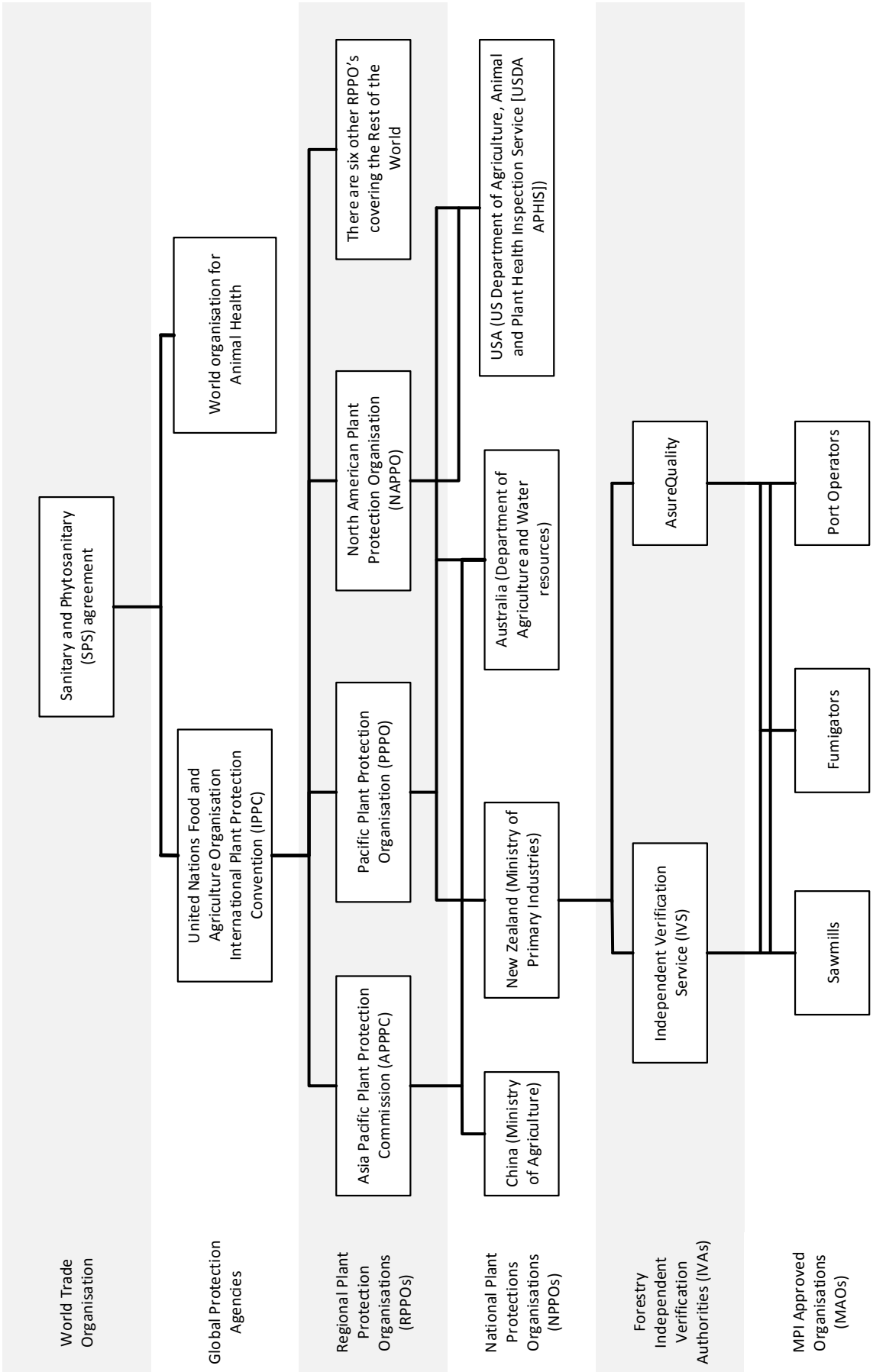
Phytosanitary compliance is required by all timber supply chains. It is argued that these processes are not a source of competitive advantage and competing firms are not able to differentiate themselves through levels of compliance (Porter, 1985). Firms will either meet the requirements or the product will be barred from reaching its intended export market. The concept of market 'order

qualifiers' and 'order winners' was developed to aid strategic decision making (Hill, 1994; Christopher & Towill, 2000). In order to 'win an order' or contract, certain expectations need to be exceeded, but in order to even be in the running, there are standard expectations that need to be satisfied. Knowing this, phytosanitary compliance can be considered as a market 'order qualifier' as opposed to a market winner. There is no added value from exceeding customer expectations, but failing to meet the standards will prevent the product from reaching the market. In cases where market winners are based on costs, a lean supply chain approach seems to be the most desirable (Hill, 1994; Christopher & Towill, 2000).

A recent survey identified that those within the industry consider cost to be the most important factor of meeting phytosanitary requirements for export timber (Scion, 2016). A lean approach to the supply chain could be beneficial in this instance. Identifying the drivers of costs would be beneficial to the industry as this could reduce the burden that compliance has on the actors in the supply chain. The literature shows little evidence of VSM being applied in a cross-organisational supply chain context, however there has been research into applying Lean thinking at a supply chain level (Naylor, Naim & Berry, 1999; Tompkins, 2014). It is this research's belief that the Lean production tool of VSM can be applied across the supply chain in relation to phytosanitary compliance. This application has the potential to help with identify wastes and therefore unnecessary costs in the system.

Phytosanitary regulations are managed at a global level through the World Trade Organisation, with other organisations, both Governmental and regulatory bodies, managing it at a regional, national and local levels. These organisations are in a hierarchical system (see Figure 1.1). For example, at the top is the World Trade Organisation (WTO) and the global Sanitary and Phytosanitary agreement. This covers everything about trade rules for protecting countries from unwanted pests entering on primary product imports (World Trade Organisation, 2016). At the bottom of the hierarchy for phytosanitary are the sawmills, whose role is specific to their environment. They need to ensure that their products are free of all pests and diseases, and meet all phytosanitary requirements, such as fumigation, before export. Each level is accountable to the next level above them, with everyone ultimately being accountable to the WTO.

Figure 1.1 World Trade Organisation Sanitary and Phytosanitary Agreement Hierarchy



Source: Author

For the export of New Zealand sawn timber, the top three countries by value (Australia, USA and China) each have their own set of phytosanitary requirements. These requirements are referred to in the industry as Importing Countries Phytosanitary Requirements (ICPRs). While these three countries require incoming products to be free of quarantine pests and diseases, as well as soil and bark, there are some individual specifications that require further consideration. Australia has some of the tightest phytosanitary regulations, while China and the USA have fewer concerns over pests on kiln dried timber. These are noted in the following sections. The other countries in the top ten list (See table 1.1) all have ICPRs. The majority of them can be directly compared to the requirements of China. There are a few exceptions to this, most notably Japan and South Korea who have far less stringent requirements and do not require sawn timber to be accompanied by a phytosanitary certificate.

1.1.1 Australia

Australia has the toughest phytosanitary requirements and there are a wide variety of conditions that are required to be met to export wood products to Australia (Department of Agriculture and Water Resources, 2016). Australia requires that all wood products are free of pests and diseases. All kiln dried timber meet the phytosanitary standard if it is exported within 90 days of being dried at the specified temperature for the specified time. During the Burnt Pine Longicorn beetle (*Arhopalus ferus*) flight season all timber is required to be fumigated with either Pestigas (for containerised products) or Barricade (for break bulk cargo), regardless of any other processes that have occurred. This is due to the fact that there is no other reliable way to control the spread of this insect, and it is considered a pest in Australia. This season in New Zealand stretches from November to late April depending on when a certain prevalence of *Arhopalus ferus* has been observed. This prevalence is measured through traps at certain sites across the country.

1.1.2 USA

The United States of America requires that all imported wood products have either import documentation or a phytosanitary certificate. The products must be free of bark, quarantine insects and fungi, and free from soil. It is required that there is a pre-shipment inspection if a phytosanitary certificate is being issued (Ministry of Primary Industries, 2016c)

1.1.3 China

China requires that all imported wood products have a phytosanitary certificate and are free of soil, quarantine fungi and insects. This is assured through visual inspection on arrival at the port in China. If any quarantine pests are found to be present at a pre-shipment inspection, fumigation is required

no more than 15 days prior to shipment by sea, or 15 days prior to arrival in China if by land or air (Ministry of Primary Industries, 2016d).

1.2 Method of Compliance

The primary way that the saw mills ensure their products are pest and disease free is through kiln drying, and fumigation in the case of the *Arhopalus ferus* season for Australian bound timber. There has recently been a move to an equivalence method for some processing sites, this advances from the visual checks that were previously required by everyone. This method uses a system approach; the process is audited by a third party to ensure that it meets the requirements. If it is adhered to then the products will be compliant and can be issued a phytosanitary certificate. If a shipment fails an inspection at the port it will be required to be fumigated at the cost of the exporter. This can occur at either port of departure or port of arrival.

Moving away from visual inspections for every piece of timber has enabled production speed to be increased in production. Using the services of Independent Verification Authorities, such as IVS and AsureQuality, allows for systems to be inspected and audited, which allows for phytosanitary certificates to be issued to their export products.

1.3 Research Objectives

This research aims to assess the strengths and weaknesses of applying value stream mapping to the supply chain processes involved with meeting phytosanitary requirements for export timber from New Zealand. This research discusses the methodology that has been applied, the results from applying it in selected supply chains, develops a single proposed future state map, and then provides some recommendations for both industry and future research.

Chapter 2

Literature Review

2.1 Supply Chain Integration

Supply chain managers in organisations are able to reduce the uncertainty they face as individual firms through supply chain integration, that is by way of collaboration between firms across the supply chain (Mason-Jones & Towill, 1998). Supply chain integration benefits include, among other things; cycle time reduction, inventory cost reduction and greater responsiveness to customer demand (Lin, 2013). Droge, Vickery and Jacobs (2012) discuss how supply chain integration, and product and process modularity or strategy interact in both the case of supplier integration and customer integration. Modularity in terms of both products and processes, incorporates standardised processes/parts that can been adapted for multiple different purposes (Droge, Vickery, & Jacobs, 2012). Cheng, Chaudhuri and Farooq (2016) look at inter-plant coordination and find that external coordination is significantly related to operational performance in a network. Manufacturing networks extend traditional manufacturing systems across multiple firms or factories. This allows for the sharing of knowledge, increased flexibility from collaboration and may result in cost savings.

Further, Childerhouse and Towill (2011) discuss the arcs of supply chain integration, and how integration is often considered to be the 'utopia' of supply chain management. The arcs of supply chain integration can be classified into inward facing, periphery facing, supplier facing, customer facing and outward facing; each classified by how widely integrated the supply chain is between manufacturing, suppliers and customers (Childerhouse & Towill, 2011; Frohlich & Westbrook, 2001). Özdemir, Simonetti and Jannelli (2015) examined the links between supply chain integration, competition capabilities and business performance. They found that there is a positive relationship between integration and competitive capabilities leading to increased business performance. Yet the most important factor that leads to increased performance is reliability. Moreover, Hou, Ye, Zhao and Shou (2016) examined how human capital can be an enabler of supply chain integration. They found that human capital, specifically organisational commitment, is a crucial part of supply chain integration. Jacobs, Yu and Chavez (2016) also deal with the effect of human capital on supply chain integration and conclude employee satisfaction significantly impacts on internal integration which in turn affects external integration. Trust and commitment are important parts of human capital, Lin (2013) assessed how mutual trust and commitment, referred to as partnership quality, between supply chain firms is conducive to establishing integration within a supply chain. The study finds that there are crucial factors that lead to successful supply chain integration.

This integration literature supports the argument that a supply chain perspective is beneficial when making strategic decisions. Processes can be improved by looking at the impact on the entire supply chain, and using a coordinated effort across organisations, or integrating processes can have a positive effect on the efficiency of the entire supply chain.

Examining a supply chain through a Lean production lens requires an understanding of integration as well as Lean. The next section begins to introduce Lean production and its development from the Toyota production system.

2.2 The Toyota Production System

The Toyota Production System (TPS) began by the introduction of "Just in Time" in the manufacturing plants of Toyota in Japan as a way to produce a large variety in small volumes in an economical manner (Holweg, 2007). This began after World War II and enabled Toyota to continue to grow during the recession that followed the oil crisis in 1973 (Ohno, 1988). The TPS evolved to become what is known today as Lean production systems which are focused around the initial work of Taiichi Ohno and the reduction of waste caused by elimination of non-value adding activities (Hines, Holweg & Rich, 2004). The Toyota Production System was the first to use the tool or technique of value stream mapping as part of the drive to reduce waste. It was, however, at Toyota referred to as "Material and Information Flow Maps" (Rother & Shook, 2003).

Toyota, as a fully integrated system is an ideal candidate for the application of value stream mapping. The TPS is a demonstration of the effectiveness of the consistent application of lean tools. This research will next address Lean production and then review VSM techniques and applications.

2.3 Lean Production

Lean production is a management concept which involves the identification and reduction of waste within a system, it is considered to be a problem solving approach (Omogbai & Salonitis, 2017). Using Lean to reduce wastes through identifying and removing non-value adding activities will also aid in reducing costs involved (Shah & Ward, 2007). It has been found that manufacturing firms that implement Lean have increased levels of operating performance and a higher quality standard (Krafcik, 1988).

Within Lean there are three core wastes, Muda, Muri and Mura (Hampson, 1999). Muda is focused around non-value adding activities (Robinson, Radnor, Burgess & Worthington, 2012). Muri is about overburdening, particularly workers or machines running over capacity (Hines & Lethbridge, 2008). While, Mura is in relation to wastes from unevenness and that variation waste is introduced through uneven schedules (Robinson, et al., 2012).

Extending this concept of wastes, Taiichi Ohno listed the seven waste categories of Lean that should be avoided, these incorporate the majority of non-value adding wastes, or muda, in production (Ohno, 1988). These wastes are displayed in Table 2.1. While initially focused on manufacturing environments these wastes have been identified in other environments such as healthcare (Bush, 2007). There are other waste categorization schemes, however, this is the most widely used and therefore the one adopted for this research.

Table 2.1 Seven Wastes of Lean

Waste	Definition
Over production	Producing more than demanded or a large quantity of a product before it is needed.
Waiting time	Machines or workers stop production and wait for materials or others.
Transportation	The non-value adding movements of parts, materials, labour, or others.
Over processing	Using highly skilled operator or machine to operate a job that others with less qualifications can perform.
Inventory	All sorts of product or material accumulation that increases lead-time. It is classified into four types, raw materials, work in progress, crib and finished good.
Defects	Bad quality level which results from reworking, repairing, re-inspection, and scrapping products or materials.
Motion	Excess operation movements that often result it tiring workers and lowering their performance.

Adapted from Al-Aomar (2011)

A Lean supply chain can be defined by the focus on the elimination of waste in a supply chain, and is especially suited for supply chains with predictable demand profiles and level scheduling (Mason-Jones, Naylor & Towill, 2010). Lean supply chains are often market winners in markets where the primary criteria for competition is cost, while the qualifying criteria usually includes competitive dimensions such as quality, lead time and service level (Christopher & Towill, 2000). Lean is not confined to production and must also be incorporated from product and process design in order for a supply chain to be truly Lean (Holweg, 2007). A Lean supply chain should operate on a demand-pull approach to production, which helps to eliminate waste due to obsolescence by holding lower levels of inventory (Bailey, 2015).

Moyano- Fuentes, Sacristán-Díaz, and Martínez-Jurado (2012) assess how supply chain cooperation impacts on lean production adoption. Their study finds that it is important to have a view of the

supply chain as a whole when it comes to Lean production adoption; the more holistic the view of the supply chain the wider the extent of adoption of lean production. Hence, the application of Lean production methods requires the use of a range of tools. As such, a wide variety of tools and techniques have been developed to implement Lean production. These include the five 'S's (5S), Value Stream Mapping, Poka-Yoke and Kaizen. Some of the most common tools are summarised and referenced in Table 2.2 below.

Table 2.2 Common Lean Tools

Name	Explanation	Example
5S	Sort, straighten, sweep, standardise, sustain	Al-Aomar (2011); Robinson, Radnor, Burgess and Worthington (2012); Omogbai & Salonitis (2017)
Kaizen	Small improvements that can be made in a short time frame. These improvements can be implemented at all levels of an organisation.	Baril, Gascon, Miller, and Côté (2016); García, Maldonado, Alvarado, and Rivera (2013); Radnor, Holweg and Waring (2012)
Poka-Yoke	Detecting and preventing errors in the production process, working towards zero errors i.e. Mistake proofing.	Daws and Robinson (2014); Wysk, Santos, and Torres (2015)
Value Stream Mapping (VSM)	VSM is a tool that is used to create a representation of the current state of the movement and activities performed to get a single product family from door to door in a production facility. This then enables waste to be identified and a future state map to be designed.	Chen, Li, and Shady (2010); Jimmerson, Weber, and Sobek (2005); Serrano, Ochoa, and Castro (2008); Singh, Garg, and Sharma (2011)

Source: Author

This literature explains the advantages of applying Lean concepts to a supply chain to increase performance. There are many tools in the Lean tool box, each has its own unique benefits. The one that is going to be focussed on in this research is Value Stream Mapping. The next section will provide an overview of this Lean tool.

2.4 Overview of Value Stream Mapping

One of the main tools for identifying areas with room for improvement in Lean production is VSM that seeks to represent discrete business processes. VSM is a way of visualising the *flow* of *materials* and *information* along the value chain. This broader view can be used to identify inefficiencies that may not be visible when only parts of the system are examined in isolation (Montgomery, Jennings & Pfund, 2011). The depiction of a value stream map is similar to that of a flow chart or operations

process chart. It illustrates visually the processes that occur to the product rather than the associated human activity (Montgomery et al., 2011). The use of VSM facilitates the identification of the sources of wastes at a system level (Weiss, 2013). Allowing organisations to avoid situations where improvement initiatives are focused on improving a single process without considering the flow-on effects, which may introduce inefficiencies elsewhere in the system (Sim & Rogers, 2008). VSM exercises are traditionally conducted within an organisation at the section, team or departmental level. However, it is argued that VSM should extend beyond the boundaries of the firm to the critical first tier customers and suppliers (Lambert, 2008), yet no published research could be found that has utilized VSM over wider sections of a supply chain.

While the process of VSM is not widely discussed within the academic literature, the work of Rother and Shook (2003) has often been cited as being the best reference for a conceptual framework of VSM. They argue that the first step is to create a '*current state map'* in order to understand the existing processes clearly and have a wider view of the system rather than focusing solely on one process and changing that without considering the flow on effects (Montgomery et al., 2011). Weiss (2013) lists the steps required to conduct a VSM. These are:

1. Define the boundaries of the process or system under investigation.
2. Define the value.
3. 'Walk' the process.
    - Identify tasks and flows of material and information between them.
4. Gather data.
    - Identify resources for task and flow.
5. Create 'current state' map.
6. Analyze the current conditions.
    - Identify value added and waste.
    - Reconfigure the process to eliminate waste and maximize value.
7. Visualize the 'ideal state'.
8. Create a 'future state' map.
9. Develop and track action plans.
    - Construct models, diagrams, and schematics that depict how a process is working or should work.

The data that should be collected for a VSM is outlined by Montgomery et al. (2011). Typically, this data is often time based and includes lead-time, processing, cycle, setup, available, uptime and queue time, it also includes pack size, batch size, work-in-progress and information flows.

There are seven mapping tools that align with each of the seven wastes seen in Table 2.1 (see Table 2.3 below). The mapping tools have been developed so that value streams can focus on eliminating the most applicable waste to the specific industry (Hines & Rich, 1997).

Table 2.3 VSM Tools for the Seven Lean Wastes

	Mapping tool						
Wastes/ structure	Process activity mapping	Supply chain response matrix	Production variety funnel	Quality filter mapping	Demand amplification mapping	Decision point analysis	Physical Structure volume and value
Overproduction	L	M		L	M	M	
Waiting	H	H	L		M	M	
Transport	H						L
Inappropriate processing	H		M	L		L	
Unnecessary inventory	M	H	M		H	M	L
Unnecessary motion	H	L					
Defects	L			H			
Overall Structure	L	L	M	L	H	M	H

Notes:
H = High correlation and usefulness
M = Medium correlation and usefulness
L = Low correlation and usefulness

Source: Hines and Rich (1997) pg. 50

VSM is a highly specified process, there are very detailed steps to follow to accurately apply it to a single organisation or system. Initially, VSM was designed for application inside a very narrow well defined set of processes. Over time it has been slightly expanded to fit other application areas. However, it is typically applied to a process within a single organisation. Here then, is an opportunity to attempt to deploy VSM as a strategic tool by applying it to a wider set of processes that crosses organisational boundaries of a supply chain. The following section examines the literature where VSM has been applied, with a focus on non-traditional applications outside of the manufacturing sector.

2.5 Applications of VSM

Value stream mapping has been used in a variety of circumstances, including as a part of health care where, for safety reasons, tight regulations need to be met throughout the processes. An example is a community medical centre who applied aspects of Lean, including value stream mapping (Jimmerson, Weber & Sobek, 2005). This work was focused on reducing time wastes that occurred from issues with information flow as well as physical items not always being where they need to be.

VSM allowed for the identification of the causes of the failures and they were able to reduce both patient wait times and system wastes. This application followed the traditional process of applying VSM and was successful in reducing waiting times. This application used the 'post-it-note' method, by displaying the current state map in a common staff area and asking for feedback from those involved. This lead to the creation of a future state map which was then implemented. A key change that was made to transition VSM from manufacturing to health care was an adjustment of the definition of *'ideal'* as the manufacturing definition of defect free was less easily applied. This adjustment allowed for the application to focus on what was important in this instance. This adjustment to the ideal could be reflected in the first step of VSM according to Weiss (2013) as the definition of '*value*'.

Another example of VSM in healthcare comes from Tortorella et al. (2016) and the Brazilian public healthcare organisation. In their research VSM was applied to the sterilised materials unit in a public healthcare organisation. A seven step research method was used as follows (Tortorella et al., 2016);

1. Literature review on Lean healthcare.
2. Selection of a healthcare organisation to carry out study, targeted area and improvement team.
3. Analysis of product/services offered by the organisation and their production processes.
4. Drawing of the current state map.
5. Analysis of current state map and deployment of improvement actions to attain future state map.
6. Drawing of a future state map.
7. Analysis of lessons learned and future developments.

This method is similar to that outlined in Weiss (2013), but contains less detail. Tortorella et al. (2016) found that there was some difficulty in obtaining data during the analysis, which made the analysis more challenging. However, it was found that the lack of variability incorporated within the VSM map presented a problem in a healthcare environment since there is often a large amount of variability and uncertainty that cannot be controlled in the same manner as in a manufacturing environment (Tortorella et al., 2016).

Braglia, Frosolini, and Zammori (2009) present an alternative to the standard method of VSM analysis by incorporating variability analysis. The limitation they identified was in the process variability, as this can lead to waste. The two alternative methods to manage this variability is through the use of statistics and fuzzy algebra. The first approach centres around the analysis of uncertainty in a value stream. The second approach is based on fuzzy theory and uses fuzzy triangular numbers to analyse

the time intervals at each stage of the production process. These methods can be applied to industrial applications and it was found that the use of statistics and fuzzy algebra made the analysis more manageable and quicker than the more traditional multivariate analysis.

Serrano, Ochoa, and Castro (2008) assessed how VSM can be integrated into manufacturing system redesign, specifically those with disconnected flow lines and an array of logistical problems. A case study methodology was used to highlight the use of VSM as a redesign tool. VSM was applied in six different organisations, using a combination of observations and interviews to gather the necessary data. It was found that VSM is a useful and efficient tool for redesigning production systems, however there is a disconnect between theory and practice in the usage of VSM concepts and tools. This is particularly the case in the time required to gather the necessary time based data required in the current state map creation stage. The use of technology can help mitigate this.

The applications of VSM in a non-manufacturing setting has been effective at creating order in an often chaotic or variable environment. VSM has been applied successfully to identify and codify wastes in these scenarios. These applications have all still been in the narrow context of a single organisations, department or team. The small adjustments that have been made in a few cases have not detracted from the benefits of the application of VSM.

An alternative to Lean and VSM is Business Process Reengineering (BPR), which is another method of changing or managing business processes. This method was a predecessor to Lean and VSM and shares many of the same steps.

2.6 Business Process Reengineering

Business process reengineering (BPR) was initially introduced by Davenport and Short (1990) as a way to incorporate information technology into business processes. They discuss the importance and the potential of using IT in redesigning business processes. BPR is closely linked to organisational change and change management, and there is a strong correlation between discussing BPR and organisational change through the literature (Grover, Jeong, Kettinger & Teng, 1995). The BPR construct consists of three components, (a) *process* based approach, (b) *change* and then involvement of (c) *human and technical* aspects of the change, this third component is argued to be often overlooked by organisations (Biazzo, 2002).

An example of BPR is seen in Greasley (2006) who assess implementing an information system for road traffic accident reporting in the UK. The study first defines the current reporting system, and then outlined the proposed new reporting system. Following this, Greasley (2006) followed a four step plan to implement the new system. These steps were; (a) build and communicate process map, (b) measure and analyse process performance, (c) develop future process design and (d) enable and

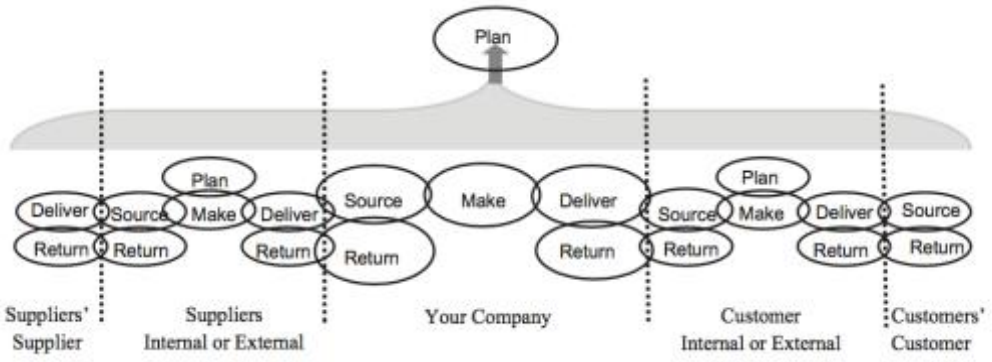
implement future process design. More recently, BPR has been incorporated into process reference models, an example is one that functions similarly to VSM, by helping organisations capture the current state of their processes, as well as creating a desired future state which the company can aim to achieve.

Another framework that seeks to measure processes and create a desired future state is the Supply Chain Operations Reference model (SCOR) (APIC, 2017). The next section discusses SCOR and the benefits of applying it. Along with the aspects that have been included in this research and why SCOR was not directly used.

2.7 SCOR

The Supply Chain Operations Reference (SCOR) model is a product of the Supply Chain Council (SCC) and is based on the framework of the five key functions of; plan, source, make, deliver, return framework (see Figure 2.1) (Stewart, 1997). This diagnostic model helps supply chain managers visualise and understand the processes in a business organisation and to highlight those that are most important for contributing to consumer satisfaction (Ntabe, LeBel, Munson, & Santa-Eulalia, 2015). SCOR contains three levels of analysis, these levels and an additional fourth level where traditional VSM fits, can be seen in Figure 2.2. In order to obtain the best from SCOR all three levels need to be applied, focussing solely on one level does not create the same benefit to the supply chain or organisation where SCOR is being applied.

Figure 2.1 Schematic representation of SCOR management processes



Source: Ntabe, LeBel, Munson, and Santa-Eulalia (2015) pp. 312

The SCOR model covers in considerable depth in the processes of an organisation, this tool is designed to establish the processes to remedy the issues it identifies. This makes it an excellent operational tool to for an in-depth analysis of a single firm. SCOR has not been applied in this research because to the depth of information required to complete all three levels. Instead of not completing SCOR to its full potential the decision was made to elevate VSM to a strategic tool to

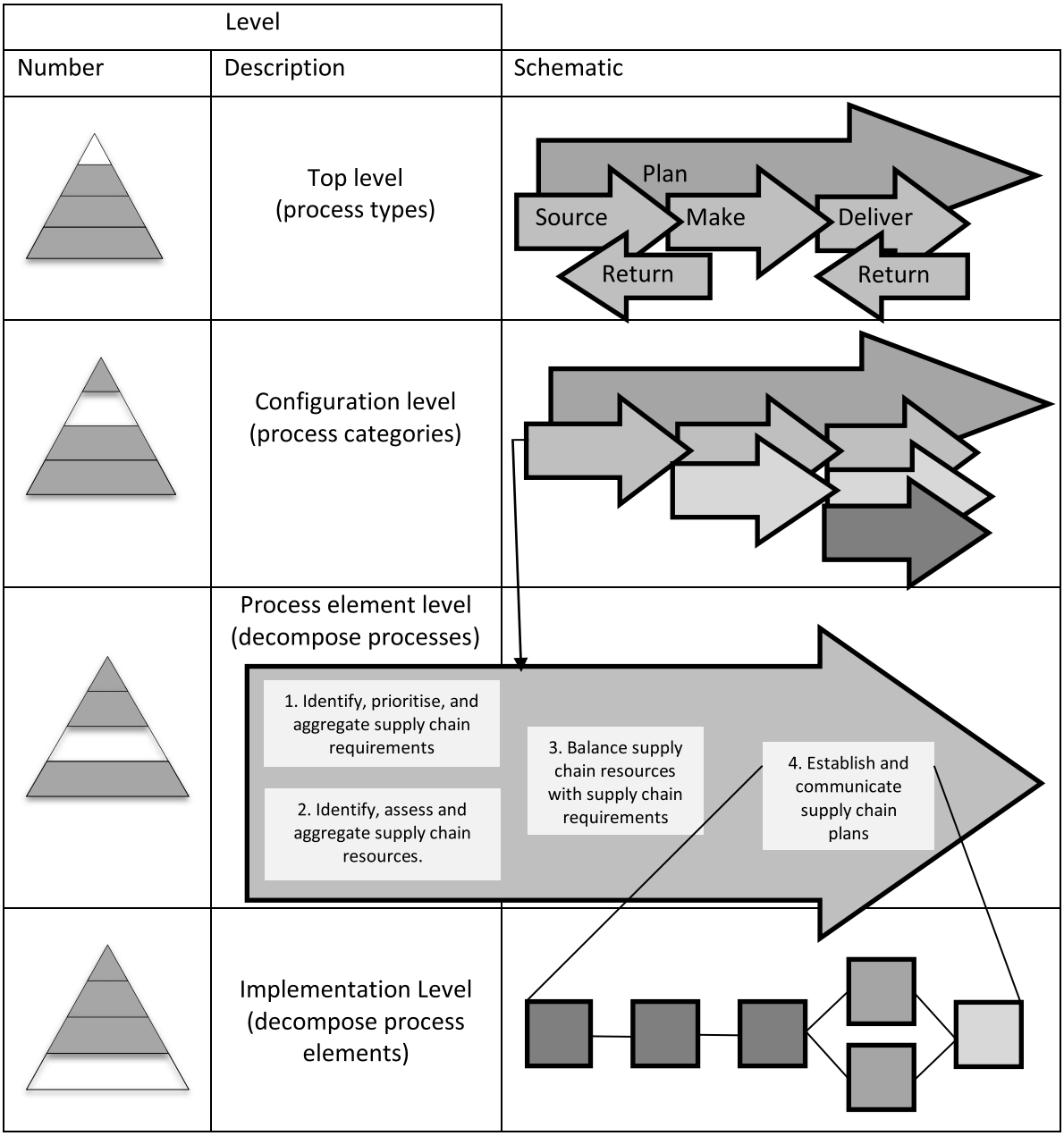
operate at the highest level of SCOR. The SCOR model has been criticised in that its process improvement benefits have been subsumed by its application as a benchmarking exercise in comparing one's supply chain to the competitors (Persson, 2011).

2.8 Current Research Opportunities

So far the literature has shown a number of examples of VSM being applied in a single department, section or firm. It seems as a consequence of this review that the gap that has been identified in the application of VSM *across multiple firms* in one supply chain. The end-to-end view enables a more comprehensive perspective of the supply chain processes and may identify more wastes than the more myopic single firm view. This is based on the same principle that wastes are identified by examining the end-to-end process map within one firm, as VSM was designed to do (Rother & Shook, 2003). To date, little work has been done in applying and modifying the VSM tools to a multiple firm view that cross organisational boundaries.

While there was some mentioning of an extended supply chain view in Lambert (2008), this was limited to one up-stream or down-stream firm, and did not provide any examples of this having actually been done. Applying VSM to a form of compliance is also limited to a single industry. There has been some application in health care, but this has been more in an operational sense as opposed to adhering to a set of standards, and confined to a single practice or team.

Figure 2.2 Levels of Process detail in SCOR



Source: Moberg and Vitasek (2008)

2.9 Research Aims and Objectives

Biosecurity is critical to New Zealand's future as a producer of primary products for a global market. Phytosanitary compliance is part of the reciprocal arrangement required to export sawn timber. Any failure in compliance is costly to individual business (a shipment may be rejected) and to New Zealand's global reputation and ability to ensure reciprocal compliance. This research applies value stream mapping as a tool to better understand how the New Zealand Forestry industry is meeting their phytosanitary requirements.

This research aims to adapt value stream mapping in order apply it to a section of the timber supply chain, consisting of multiple organisations, that focuses on the processes required to meet phytosanitary regulations. This is particularly applicable as phytosanitary compliance requires the involvement of multiple organisations and would not be possible to fully integrate due to the audits and regulations involved, as well as the involvement of the Government. Part of the aim is to evaluate the use of VSM in this multi organisation landscape which differs somewhat from previous applications, in order to assess the strengths and weaknesses of this approach.

This study will utilize a multi-case study approach as the research will be able to create a broader idea of how the required processes are applied across multiple countries of destination and different volumes of export.

The following are the stated research objectives for this project:

RO1 Adapt VSM to conduct analysis across multiple firms in a supply chain.

RO2 Identify the current state map of the processes involved with meeting phytosanitary requirements for Australia and Asian markets for sawn timber.

RO3 Identify wastes and opportunities to improve efficiency across the supply chain through the application of an adapted version of VSM.

RO4 Suggest a future state map for the phytosanitary compliance system in New Zealand.

2.10 Research Scope

The scope of this research excludes the final step of traditional VSM, implementation. It also excludes data requiring collection from any of the overseas sections of the supply chains examined. This research operates at a higher level depiction of the processes involved with meeting phytosanitary requirements so therefore excludes specific time data from the participating organisations, as well as any cost information as this is deemed commercially sensitive.

The next chapter will discuss the methodology. This will include the steps taken during the research.

Chapter 3

Methodology

3.1 Adapting VSM as a tool

VSM was used as a base approach for this project as it is a well established tool for creating an understanding of a system and identifying areas where there is potential for improvement. However, traditional VSM usually focuses on a single organisation and therefore needed some adaption to enable it to create a supply chain view of phytosanitary compliance processes.

This research has applied a broader approach to the Lean tool of VSM to create a big picture perspective of the processes across the organisations involved in meeting phytosanitary requirements for export timber. VSM was the primary source for the applied method, but it was adapted to enable the inclusion of other supply chain management concepts. The traditional approach to VSM is typically detailed utilising time based data in the map, for example, stopwatch measurements of the time it takes to execute discreet tasks in a manufacturing step. Expanding VSM to a wider section of the supply chain made collecting this level of detail very challenging, as there are a high number of variables for each organisation internally and externally. This could have been achieved if only one supply chain was being examined in greater detail. One goal of this study was to compare multiple supply chains across the country and so the approach taken was to create multiple supply chain VSM maps, but necessarily each with significantly less detail. This enabled a snapshot of how phytosanitary compliance fits into the supply chain overall and the steps that are taken to meet the requirements. It enabled different supply chain maps to be compared.

The adaption of VSM treated each organisation within the company as a single process rather than a sub-set of hundreds of detailed processes. This simplified the data collection and allowed the interactions between the firms to be highlighted, which creates a clearer picture of the overall processes. Had each detailed step along the process from 'tree to ship' been included, the detailed map would have been very large and unnecessarily detailed for the purposes of this study.

Aspects from the Supply Chain Operations Reference (SCOR) model were also incorporated into this research. As discussed in the literature review, the SCOR model is used to map, benchmark and improve supply chain performance (Persson, 2011). This research focuses on improving the performance of the supply chain, and comparing supply chains similarly to the SCOR model.

The key aspects from SCOR that were included in this research that are not a part of traditional VSM are the supply chain comparison (see section 4.3) and the examination of a supply chain rather than a single organisation.

Process maps have also been examined by way of a process reference model (PRM), which integrates concepts from business process reengineering. It is another kind of model that works towards creating a desired future state from a model of the current reality, similarly to VSM. The outcome and purpose should be stated in a PRM, with the outcome set to achieve the purpose (Tuffley, 2010). These models do not incorporate specific time data about the processes and lead time, nor do they differentiate between value adding and non-value adding processes (Carpinetti, Buosi, & Gerolamo, 2003). The ability to collect the time data for this project was limited, so incorporating elements from the process reference model helped to streamline the data collection process by not requiring what could be considered invasive data.

Supply chain network theory was drawn on in the design of this research. Hearnshaw and Wilson (2013) discuss how modern supply chains are inadequately represented by simple linear systems with dyadic relationships. This kind of map would not be sufficient to capture the complexity surrounding the relationships involved with obtaining a phytosanitary certificate to export timber from New Zealand. Using this knowledge, a degree of complexity needed to be incorporated into the data collection, it was not going to be sufficient to just discover who they talked with and who they sent and received product form.

3.2 Data Sources

This research will specifically assess the supply chains for countries that appear in the top ten list of destinations by value, in Table 1.1. The top three countries in this list, USA, China and Australia, account for 56% of the value of sawn timber exports from New Zealand (Ministry of Primary industries, 2016a). Focussing on these three destinations has the potential for the biggest return. This approach is aligned with the lean concept of the Glenday Sieve (Glenday, 2005), which highlights the benefits of focusing on a limited set of products that make up the bulk of the volume in a production process.

Much of the data for this study was collected in person as this allowed for the researcher to build rapport with the interviewees and encourage respondent commitment to the study (David & Sutton, 2011). In traditional VSM the processes to create the current state maps must be observed. This section of traditional VSM was retained, as much as possible, in this adaptation of supply chain VSM. Yet as typical in this type of research, it was not always possible to collect all the data personally, so in a few cases this was done via email or phone, which can still be considered to be ‘in person’. This

was mostly the case for organisations where participation in the phytosanitary component of the supply chain was peripheral. In person data collection allowed the researcher to collected data on the motivations for specific procedures, which due to the sensitive nature of this they may have been less willing to share in a detached manner (Ghauri and Gronhaug, 2005). The discussions with the participants were exploratory and as the research progressed new ideas and questions were able to be included.

Triangulation was used to corroborate the primary data that was collected in the case studies (Yin, 2003). This was done by talking to multiple organisations in the same supply chain and obtaining their perspectives on the processes. This was also achieved through reading of external reports, particularly those published by MPI. The MPI reports and documentation were used to help guide the decisions made regarding data collection methods. Additional sources of data included; phytosanitary certificates, fumigation certificates, internal audit sheets, phytosanitary handbooks/biosecurity manuals and request for fumigation forms. These sources were all either provided by the participating organisations in digital form, as photocopies or made available for the researcher to read while on the premises of the organisation and take notes from, but not take copies due to commercial sensitivities.

Combining these data sources from the discussed methodologies guided this research project. The earlier VSM research, such as Rother and Shook (2003); Tortorella et al. (2016); Weiss (2013), created the framework which was then implemented in order to create an understanding of the supply chain processes involved with meeting phytosanitary compliance for export timber in New Zealand. The completed current state maps are displayed and discussed in Chapter four.

An important section of each supply chain in this research is the system New Zealand has developed to manage phytosanitary certification, this is outlined in the next section. This is represented by the lowest three levels in the phytosanitary hierarchy in Figure 1.1.

3.3 New Zealand's Phytosanitary Certificate System

New Zealand has a unique approach to issuing phytosanitary certificates, this system is adhered to by all those wishing to obtain a phytosanitary certificate for any forestry product that requires it. The first step in the New Zealand system requires all organisations that directly handle forestry products or the fumigation of the products to be Ministry of Primary Industries Approved Organisations (MAOs). In order to become a MAO, organisations apply to the Ministry of Primary industries and need to meet their requirements by having appropriate systems in place to ensure products will comply with the standards of the importing country. They must also be aligned with an Independent Verification Authority (IVA), such as IVS or AsureQuality. During the first year MAOs are subjected to

an increased audit and inspection protocol in order to build trust with MPI. They have six inspections rather than the standard three.

Audits and inspections are completed by IVAs as part of the process to maintain an organisation's standing as an MAO and therefore their ability to export plant based products. These inspections and audits occur on an annual basis. For established exporters, they have three inspections and one audit each year, all typically completed within one day. The inspections involve a walk through and inspection of the site to ensure that practices are occurring as they should in accordance with the organisation's agreed system plans. This includes inspection of products, and check if staff know what to look for, and that all staff are registered as approved product handlers with MPI. The audit is a more thorough process that goes over the paperwork and the organisation's system is in place to ensure that it is continuing to meet the required standards and not allow products through that have the potential to pose a phytosanitary risk.

The data collection and map creation methodology was completed in four stages as explained in the following sections. First, the method was tested in a pilot study of a single sawmill and their supply chain partners, this is discussed in detail in Section 3.4. Secondly, the VSM process was applied to create current state maps for a further five supply chains with product destined for the Asian and Australian markets. Thirdly, a focus group was hosted involving the key players in the industry in order to analyse the five current state maps and create potential recommendations for improvement. Following on from this, a future state map was created to visualise the ideal for how these processes could be streamlined for greater efficiency.

3.4 Pilot Study

In order to test the modified methodology before applying it to multiple supply chains in parallel, a pilot study was carried out with a wood processor who showed particular interest in the project. This created the opportunity to test what would work and how much data could potentially be collected from the participating organisations. The pilot study informed the design of the study and helped to refine the process and streamline the process for creating the other five supply chains.

Initially, simplified internal VSM maps were planned, without times or specific details, this was eliminated from the plan as the time involved in collecting this data was too invasive for even the most interested organisation. A simplified VSM was created for the pilot firm, however it could not be replicated with the participating organisations in the supply chain as they were unwilling to share that level of information with the researcher. The process involved with creating the simplified VSM for the focal firm was useful for prompting questions and creating a deeper understanding of the processes involved with meeting phytosanitary requirements for their specific supply chain.

Once the pilot study was completed and a draft was reviewed by the focal firm, maps for the other five supply chains were developed after the data collection phase. The pilot study was very helpful in developing the researchers' background knowledge on the processes and provided a higher level of understanding, which helped to shape the questions that were asked during the creation of the other five supply chain maps. This was partly due to the very supportive nature of those who met with the researcher at the pilot study firm.

3.5 Creation of Current State Maps

The VSM method was planned and then adjusted as the research progressed, to find the most effective way of obtaining the information required. Each company had a different level of interest in the research, some were interested and happily provided significant amounts of information, others were less interested and concerned about their time investment, so collection approaches were adjusted to suit the circumstances. The main adjustment that was made after the pilot study was completed was to not collect the very detailed internal VSM data from each participating organisation to input into a full supply chain VSM. This decision was made when it became obvious that very little value would be added to the strategic tool of supply chain VSM by the capture of very detailed time data. Instead of adding value to the tool it detracted from the bigger picture, so was not collected. Yet, future applications of an extended VSM should include broad time categories where possible to measure the time delays between organisations to total time. Challenges relating to the data collection activities were carefully captured (see section 3.7)

3.5.1 The stages of current state map creation

The following details the adapted steps that were used in implementing the creation of current state maps using the extended VSM approach. This new approach involves examining the processing undertaken by more than one organisation. Table 3.1 indicates the differences between traditional VSM and Supply Chain VSM.

Step 1: Identify the potential focal firm

The population of potential focal firms for this research is defined as Radiata Pine wood processors that export sawn timber from New Zealand. In order to ensure that the firms are all subject to comparable Importing Countries Phytosanitary Requirements (ICPRs) the product type needs to be comparable and fit under comparable ICPRs. Sawn timber is the focus product of this research. Mills were not included that exclusively export MDF, veneer and packaging, as these are under different ICPR category. This is also a contributing reason for focusing on Australia and Asia. Australia has very strict ICPRs that differs from other countries, while most places in Asia that have been included had comparable and simpler ICPRs. The focus on Asia and Australia has also been because these two

areas make up most of the top ten countries of destination for sawn timber by value (see Table 1.1). With the top three countries accounting for 56% of total export value, as previously discussed.

The additional criteria that packaging materials are subject to, as mentioned above, include the International Standards for Phytosanitary Measures no. 15 (ISPM15), which covers wood product packaging used during export. This standard is particularly relevant to be aware of during this research as all timber is exported with some form of dunnage to support the timber, these must all be correctly stamped with the ISPM15 stamp. The participating focal firms are all approved to create products that can meet this standard, and therefore stamp them appropriately. Organisations that are not approved to use the ISPM15 stamp must purchase dunnage with the ISMP15 stamp from an approved organisation.

The primary method used to identify wood processors was the SCION Wood Processing Database 2016 (Hall, 2016). Using this database, the research was able to identified 91 sawmills primarily producing sawn lumber and 23 organisations producing remanufactured firms using sawn lumber acquired from a NZ sawmill (Table 3.1). Of those 114 organisations, 5 were excluded from the population as the products they produce are not sawn timber products and are subject to different phytosanitary requirements.

Table 3.1 Population identification

	Sawmills Identified	Wood Processors Identified	Sawmills included in population	Wood Processors included in population
North Island	51	16	26	12
South Island	40	8	27	5
Total	91	23	53	17

The remaining 109 organisations were then checked against list of Ministry of Primary Industries Approved Organisations (MAOs). In order for an organisation to be an exporter of timber from New Zealand they would need to be registered on this list. After removing any organisations that did not appear on MPI's approved organisation register there remained 26 sawmills and 12 remanufacturing organisations in the North Island and 27 sawmills and 5 remanufacturing organisations in the South Island. These 70 organisations make up the population to be examined for this study (Table 3.2 below).

The websites of these 70 organisations were searched where possible to identify the markets to which they exported timber. A sample of 17 organisations were selected from the population that matched the export destination requirements and had valid contact details available. A cluster

sample selection method was used where the researcher identified a South Island and a North Island cluster. Given the diverse geography of the population a cluster sampling method allowed the research to account for differences in the scale of the resources available to the firms as well as and specific advantages or disadvantages of geography (David & Sutton, 2011).

Table 3.2 Population selection

	Population	Approached	Participated	Response rate
North Island	39	6	2	33%
South Island	31	11	3	27%
Total	70	17	5	30%

Of those organisations approached (*n* = 17) to participate, 30% responded positively. Those who elected not to participate, either did not respond to contact, indicated they were not able to commit the time required for data collection, or that they did not see phytosanitary compliance as a significant issue for them. This third reason was most notable for exporters to the USA, which is why supply chains destined to the USA have not specifically been assessed in this research.

Many of the wood processors did not maintain public information such as websites. This made identification of appropriate organisations inside the clusters difficult. This lead to the research using a snowballing or chain referral sample method applied within the clusters. Once an appropriate case was identified from the cluster population the researcher was able to use this contact to make connections with other suitable case's. This process of cross selection potentially results in a biased sample as those cases who chose not to participate also chose not to take part in the case selection aspect. Using participant referral will result in a sample of the population who are likely to have similar characteristics, the similarity of these characteristics may impact on business performance and the results of this study (David & Sutton, 2011). Watters and Biernacki (1989) however found that the use of chain referrals for targeted sampling allows for flexibility that is not inherent in probability sampling techniques. The use of chain referral sampling has been found to be more feasible than random sampling and more robust than convenience sampling in difficult to identify populations. The hidden nature of the population and the time and geography constraints leads to a clustered chain referral sample selection to be most appropriate for this research.

Step 2: Contact firm and agreement to participate

A first approach phone call was used once the firms had been identified. This was often followed up with an email to confirm visit dates and provide additional information in a written format. The written information explained the purpose and processes for the visit and described the level of confidentiality for all information provided (see Appendix A). As seen in Table 3.2, five firms agreed to participate, out of a total of 17 being approached. This enabled the researcher to create six supply

chain current state maps as one of the mills participates in two supply chains for the purpose of this study. It was expected that mapping six chains from various types and locations of focal firm would be sufficient to identify emerging patterns and to demonstrate the strengths and weaknesses of a VSM approach within this unfamiliar territory.

The organisations who agreed to participate come from a wide geographic cross section of New Zealand, with organisations in locations such as the Bay of Plenty, Tasman, Canterbury and Southland. There was also some overlap with several firms using the same Independent Verification Authority and fumigator. The five participating companies export through four ports; Port of Tauranga, Port Nelson, Port Otago, and Lyttelton Port of Christchurch. These Ports are not directly involved with the phytosanitary compliance processes of these supply chains; however, they give an idea of the geographical diversity of the supply chains.

Prior to the firms agreeing to participate, it was agreed that no company names or identifying features would be published, and that the information provided was only to be used for the purposes of this research. There were firms who saw their supply chains as a source of competitive advantage and declined to participate. The selection of supply chains in this study could therefore have a bias leaning towards a segment of the market that was having the most difficulty with phytosanitary. Alternatively, it could equally be those who are most secure in their processes and are therefore more inclined to allow an outsider to document them.

Step 3: Visit focal firm

Once the companies had indicated their willingness to participate in this research the researcher visited the firm in person. The roles of individuals with whom the researcher met at each organisation was different and are documented for each supply chain in Chapter Four. In some cases it was the CEO, in others it was a customer services representative, or the people who completed the paper work. It varied depending on the size of the company and the level of interest in the research. Some organisations were very interested in the research, some were happy to help out as part of their "social responsibility" while others were marginally interested and did not see any direct benefit for their organisation.

While on site, there was an in-depth discussion about the processes involved for that organisation to meet its phytosanitary obligations for their customer's countries. Following this conversation, a tour of the manufacturing facilities usually occurred. This lead to more open conversations surrounding the processes involved, and often provided prompts for questions and additional information. These meetings were documented by the researcher taking notes and a sketch of the supply chain structure was created, some additional paperwork was provided by the organisations, in some cases this was photographed (with permission) for later reference, or photocopies were provided by the

organisation. Immediately after the visits the researcher prepared a more detailed written record of the meeting.

Step 4: Development of current state map with organisation names

During the site visit a basic sketch of the supply chain was created. Following the visit, this map was refined and verified against the other actors in that supply chain in order to discuss their roles more effectively. In most cases, a fairly comprehensive first draft was able to be created from discussions with the focal firms. This was then corroborated with the additional supply chain actors, which gave them the opportunity to add their thoughts on how well the processes worked and to suggest any necessary adjustments.

The initial current state map was produced as a working document to aid conversations with the various organisations in each particular supply chain. Therefore, it contained the names of all the companies that the focal firm dealt with in order to ensure their product reaches the destination market in a phytosanitary compliant state. This list included suppliers, transport companies, fumigators, shipping companies, and IVAs. These firms were contacted and some were willing to participate. Permission from the focal firm was obtained for meetings to be held between the researcher and the service providers.

Step 5: Visit other supply chain actors, building on map created with focal firm

Visits to domestic organisations in the supply chain were conducted for four of the support organisations as well at the five focal firms. Further phone or email conversations were held with an additional three support organisations.

This research was focussed on meeting the phytosanitary requirements for export and therefore the customers, clearing agents or overseas ports, which were the destination of the timber were not included. The processes that are involved for meeting the phytosanitary requirements are all performed in New Zealand. Discussions with the focal firms and other organisations indicated that current phytosanitary processes meet the necessary threshold and while there is feedback from customers and overseas ports about the product this is unlikely to include any feedback on phytosanitary issues. Summary tables for which organisations were interviewed and the roles held of the spokesperson for each organisation are included with the summary of each map in Chapter 4.

Step 6: Complete current state map and follow up any missing data

A working draft of the current state map was continuously updated when additional information came to light, and as further discussions with supply chain organisations occurred. Any additional or missing data that was required was gathered via email or phone conversations with the various organisations in the specific map. These maps contained information, such as company names, that

cannot be made public and have therefore not been included in this document. The initial drafts of the maps contained company names to make it easier for those who were not familiar with the method of documentation to understand where they are positioned in the map. Using organisation names in this process saved time and reduced confusion for the organisations involved. This completed first draft of the current state map for each supply chain contains all the same information that is in the final maps in this document, but with the identifying information.

Step 7: Anonymise current state map

The final step included a final hand drawing of the current state maps which did not contain the organisations names, except for government organisations. This output was used in the second round of data collection, the focus group, to encourage in an open discussion around process improvement opportunities. The focus group is discussed in more detail in Section 5.1. Prior to the focus group the completed maps were shared with the organisations, who were also asked to share any last minute corrections or suggestions. Digital copies presented in this thesis were constructed only after all of the maps and analysis had been completed.

3.5.2 Summary of Maps

The six current state maps are divided into two categories based on destination markets, either Australia or Asia. These destinations differ in terms of the phytosanitary rules surrounding importation of kiln dried timber. There are three maps in each category, from five focal firms. Several of the focal firms export to multiple destinations, but the focus of the discussion was on these two major export destinations.

The Importing Countries Phytosanitary Requirements (ICPRs) for the countries were compared to the list and were grouped into three categories; Australia, Asia and Other. Asia in this context, consists of China, Vietnam, Taiwan, Thailand, Indonesia and the Philippines. Korea and Japan have been excluded because they do not require a phytosanitary certificate and therefore have significantly different ICPRs. The Other category includes USA, South Korea and Japan, because their ICPRs are different from others in the list. There was an attempt to examine the exports to the USA as this is the biggest market by value for kiln dried timber from New Zealand, however none of the organisations that export to the USA were willing to participate in this study. Australia's requirements are much higher and hence a different supply chain map category was created for this market.

3.6 Traditional VSM vs Supply Chain VSM

This research attempted to maintain as many aspects from traditional VSM as possible. In a few instances, some changes needed to be made to fit to the new application. The features of traditional

VSM and supply chain VSM, and which adaptation they are applied to, are listed in Table 3.3. The features that differ include; multiple organisations being included, focus group of multiple organisation assessment at a high level and a supply chain system focus being excluded from traditional VSM while being included in supply chain VSM. While, time data, post it note assessment and work group focus are included in traditional VSM but excluded from supply chain VSM.

The post-it-note assessment was replaced by a multi-organisation focus group to assess the high level current state maps. The time data was excluded as it was intricate detail that lost value in a high level application at the supply chain level. The work group focus was replaced by a supply chain system focus in supply chain VSM. These changes were all necessary to the adaptation of VSM.

Table 3.3 Traditional VSM vs Supply Chain VSM

Features	Traditional VSM	Supply Chain VSM
Time data collected	Yes	No
Processes observed	Yes	Yes
Hand drawn maps	Yes	Yes
Physical flows documented	Yes	Yes
Information flows documented	Yes	Yes
Multiple organisations included	No	Yes
Post it note assessment	Yes	No
Focus group of multiple organisations assessment at high level	No	Yes
Work group focus	Yes	No
Supply Chain system focus	No	Yes

Traditional VSM processes: Adapted from Rother and Shook (2003)

Supply Chain VSM processes: Author

3.7 Challenges of Finding Participants

Several challenges occurred during the data collection process and are important to report since this is the only VSM study to the author's knowledge that stretches across several organisations in the supply chain. These problems are not likely to be unique to this research. The reference list of firms was not up to date and did not identify destination of products, so it was difficult to identify firms that met the criteria for the sample. Once identified and approached many firms did not respond and some of those that did, declined to participate.

Three responded and said they were not willing to give the time to this research because they do not have any challenges in meeting phytosanitary requirements. These firms were exporters to either the USA or to Asia. Another responded that they were a rather infrequent exporter and did not feel there would be sufficient benefit in their participation.

Every effort was made to minimise the amount of time that was consumed during the data collection phase, but it still required several hours of commitment from employees at the focal firms. Concerns were raised by some firms concerning anonymity and publicity. This was mitigated through the anonymization of the current state maps that were developed. Most firms who raised these concerns elected to not participate in this research. Those who did participate were not overly concerned about the degree of anonymity that was maintained. Anonymity in this case was synergetic, while it helped to put the participants at ease, it also enforces a degree of rigor to the development of the maps. This made the maps more comparable across supply chains, which was beneficial.

Chapter 4

Results: Current State Maps

4.1 Introduction

Sawn pine timber that goes to Australia is required to have a phytosanitary certificate, be free of insects, fungi, soil, bark and other harmful organisms. It must also be heat treated within 90 days of export or it is required to be fumigated with Methyl Bromide. During the *arhopalus ferus* flight season it must also be fumigated with either Pestigas (for containerised products) or Barricade (for breakbulk shipments).

Sawn timber that is going to Asia is required to have a phytosanitary certificate, be free of insects, fungi, soil and other harmful organisms. Any wooden packaging, such as dunnage, that is used must meet the ISPM15 requirements and be correctly stamped. The difference between Asia and Australia's ICPRs is the allowance of bark and not requiring fumigation of any kind.

The current state maps reported in this chapter follow a similar template and are colour coded by information flows, product flows, product handling organisations and support organisations (see the key in Figure 4.1). These maps are best seen in colour. Each map has been assigned a colour in order to simplify reference while maintaining anonymity. The overall map colour (e.g. the orange map) has no relationship to the colours represented within the maps to depict different processes and organisation types. See Table 4.1 for a brief summary of the different current state maps.

All of the products exported by the processes represented in these current state maps require a phytosanitary certificate. These certificates are all authorised by MPI and follow a standard set of processes to obtain. In order to obtain a phytosanitary certificate, the focal firm must deal with an IVA in New Zealand, who has been given the power by MPI to monitor phytosanitary compliance. The IVA inspects the focal firm three time a year, and audits their processes annually. They also submit the application for the phytosanitary certificate to MPI, and will communicate any issues.

Figure 4.1 Key for Supply Chain VSMs

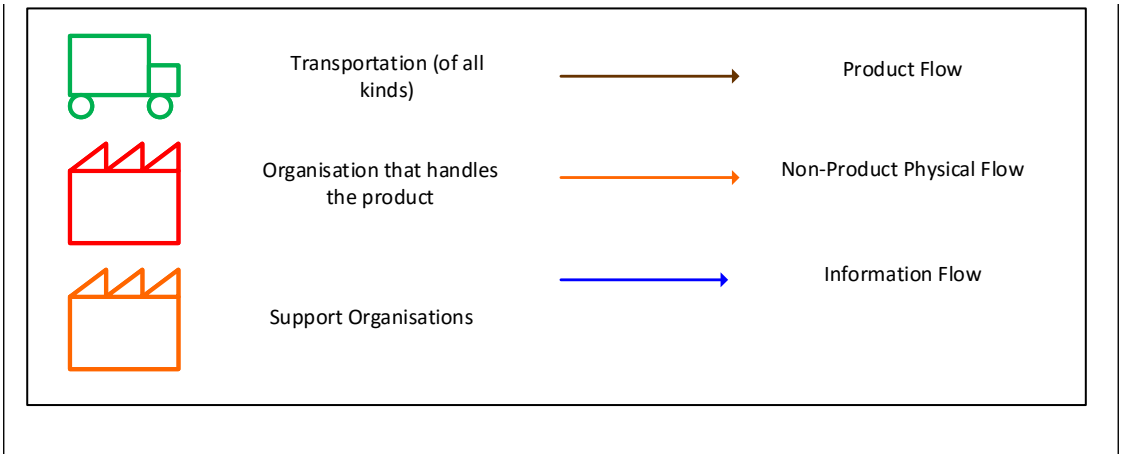


Table 4.1 Summary of Current State Maps

Supply Chain	Orange map	Purple map	Pink map	Red map	Yellow map	Green map
Destination	Australia	Australia	Australia	Asia	Asia	Asia
Port of Export	Tauranga	Tauranga	Otago	Otago	Lyttelton	Nelson
Number of organisations involved	11	10	9	6	6	7
Number or transport movements	4	2	2	2	2	2
Focal firm kiln drying status	No - outsourced	Yes	Yes	Yes	Yes	Yes- Occasionally outsourced
Containerised exports	Yes	No	Yes	Yes	Yes	Yes
Fumigation	Pestigas	Barricade and Methyl Bromide	Pestigas	None	None	None

4.2 Australian Bound Maps

The Australian bound maps were created to resemble the *arhopalus ferus* flight season (roughly October until April, depending on weather and flight patterns). All timber during this period is required to be fumigated. This is usually achieved through Pestigas added to the container prior to it being sealed. Alternatively, when products are not exported in containers, a product called Barricade is added to the holds in breakbulk ships.

4.2.1 Orange current state map (Pilot Study)

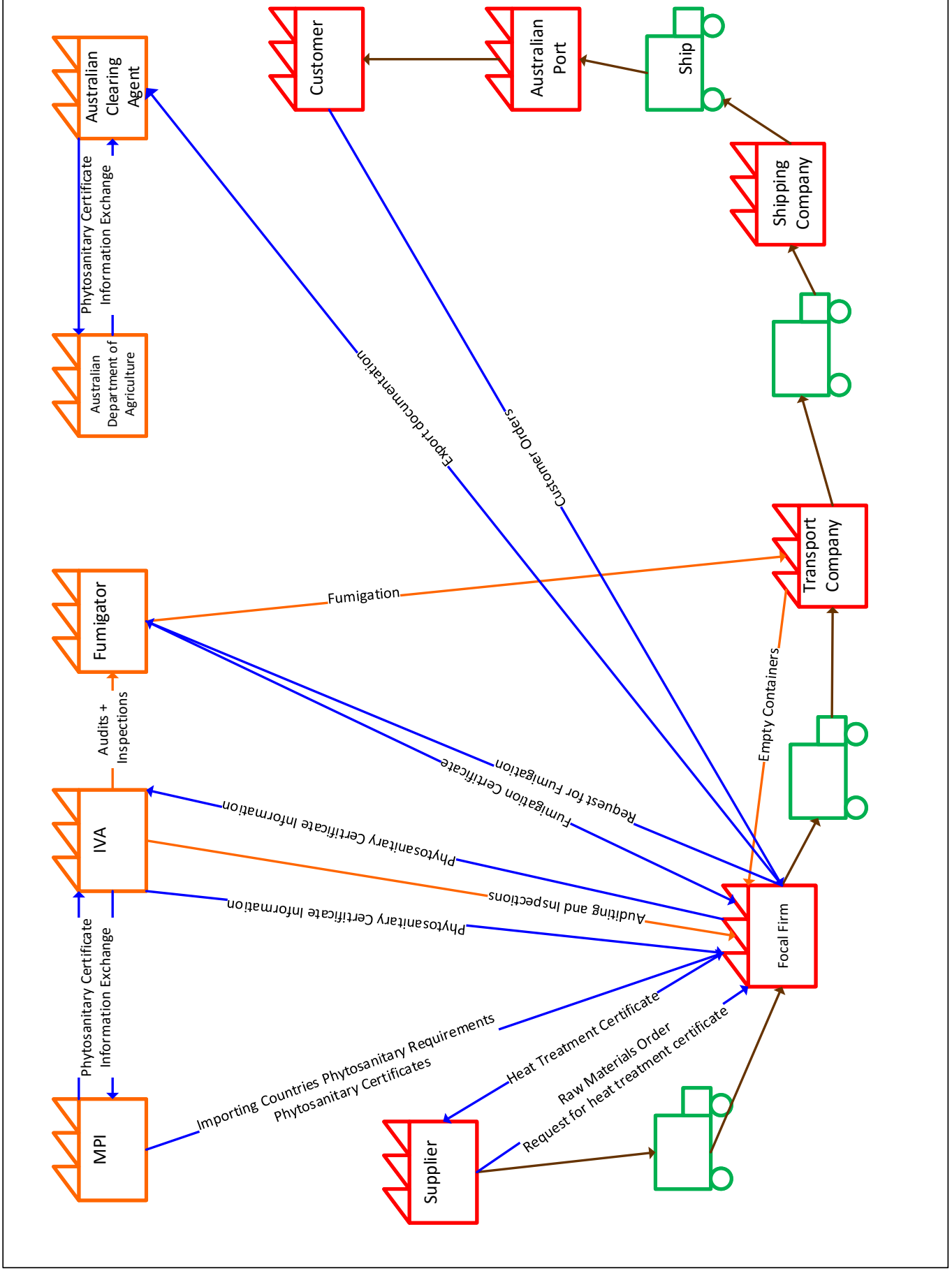
The Orange supply chain is for a focal firm based in the Bay of Plenty and exports through Port of Tauranga. This supply chain map, as seen in Figure 4.2, was created as the pilot study discussed in the methodology. This appears to be the most complex of all of the supply chain maps. The high

level of initial interest in the project may have been related to the current levels of complexity in this supply chain as opposed to some of the other supply chains in this study.

This supply chain consists of six firms that directly handle the product while phytosanitary compliance is relevant, as well as five other organisations that handle the information that surrounds the phytosanitary compliance. This is a higher number of organisations involved than in any of the other supply chains mapped.

The supplier in this map is a sawmill which produces kiln dried sawn timber as well as other kinds of wood products. The kiln dried timber is sold both internationally and domestically. The sale in this supply chain is a domestic sale, this means that they do not treat it in the same way as they would an export sale. On request they will provide a heat treatment certificate. It is necessary for the heat treatment certificate to be included in export documentation to Australia, this is because the product must have been heat treated within 90 days of it being exported in order to avoid methyl bromide fumigation.

Figure 4.2 Orange current state map



The focal firm is a secondary processor that produces mouldings and other detailed timber products from lumber that has already been sawn and kiln dried by a different organisation. This means that the internal processes at the focal firm are streamlined and can be focused on producing a high quality product rather than trying to do everything internally themselves. This firm has a high number of visual inspections of the product during its production process making it easy to identify and remove any potential quality defects or any timber that might pose a phytosanitary risk. For example, inspecting for any residual bark or bugs, the operations manager informed the researcher that in his ten years with the company he had not found any products that might create a phytosanitary risk.

The transport company in this supply chain provides empty containers to the focal firm which have been inspected for defects or dirt prior to their arrival at the focal firm's site. The transport company also uplifts the full containers and takes them to their site near the port where they are held until they are ready to be delivered for loading onto the ship. While the container is staged at the transport company, the fumigator is notified and they will then treat the container with Pestigas and seal it ready for shipment.

The fumigator in this supply chain is only involved in the summer months during the *arhopalus ferus* flight season, the rest of the year this step does not occur. The request for fumigation is received by the fumigation company and the company is informed of when the container will be on site at the transport company. Once the Pestigas has been sealed in the container the fumigation certificate is provided to the focal firm.

The fumigation company and the focal firm are audited and inspected by an Independent Verification Authority to ensure it is compliant and operating in accordance with the rules to ensure the products are fit to receive their phytosanitary certificates. These inspections occur three times a year, in addition to a full systems and paperwork audit annually.

The shipping company was not spoken with as once the container has been sealed at the transport company site by the fumigator there is no special handling required to maintain a phytosanitary certificate. This applies to the Australian Port and the Customer as well, neither were spoken with, but are included in the map to create a fuller picture of the whole supply chain. The customer order is the information flow that begins the processes in the supply chain. The focal firm in this VSM makes their products to order with a two month lead time.

Prior to the product being released to the customer in Australia the clearing agent needs to have been provided with the suitable documentation relating to its phytosanitary state. This means the phytosanitary certificate number, and this is then checked with the Australian Department of

Agriculture to ensure everything is in order. If there are no issues the container can be released. Potential issues that could occur include identification of a phytosanitary contaminant in the container. If there are issues, then there is a hold up and the product may have to be fumigated in Australia creating a high extra expense for the focal firm. The focal firm for this supply chain has not found this to be an issue so far and they have an excellent record for having their documentation in order. The summary of who was spoken to in the data collection process for this supply chain can be seen in Table 4.2.

The key wastes identified in this supply chain are transport and waiting. The transportation waste is in relation to the offsite fumigation, the movement of the product from the initial site of production to the site of fumigation prior to moving it to the port for loading onto the ship. The waiting waste is due to the slow response time for the fumigation paper work to be provided to the focal firm.

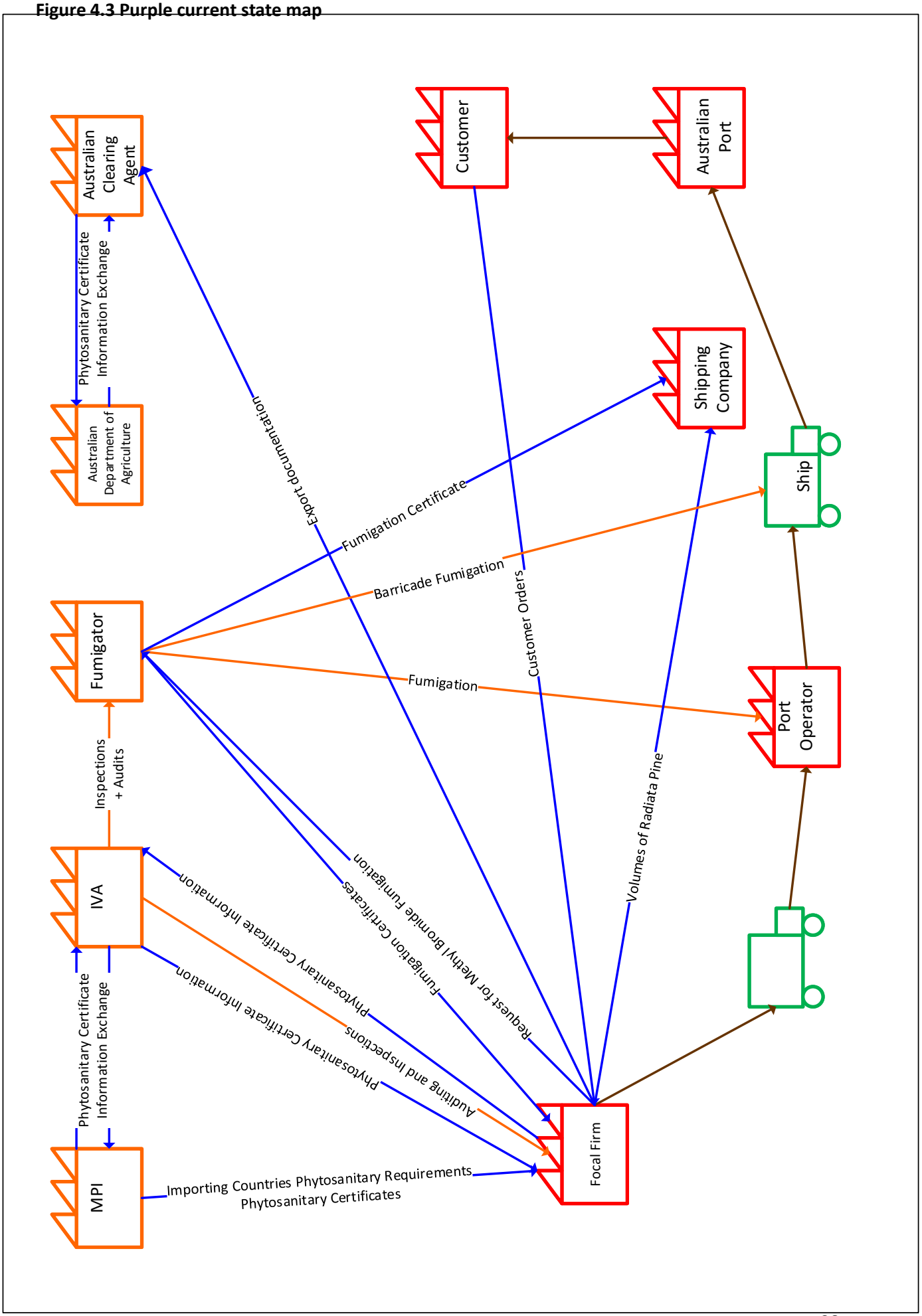
Table 4.2 Orange Supply Chain Data Collection Summary

Organisation	Interviewed	Key Respondent
Focal Firm	Yes	Export Manager
Supplier	Yes	Customer Service Manager
IVA	Yes	Senior Assessor
Fumigator	Yes	Service Manager
MPI	Yes	Plant and Forestry Manager
Port Operator	Yes	Operations Manager
Shipping Company	Yes	Cargo Management Officer
Destination port	Out of Scope	
Customer	Out of Scope	
Australian Clearing Agent	Out of Scope	
Australian Department of Agriculture	Out of Scope	

4.2.2 Purple current state map

The Purple supply chain is for a focal firm based in the Bay of Plenty that exports through Port of Tauranga (see Figure 4.3). This is the only supply chain examined in this study that exports its product in breakbulk rather than in shipping containers. The preference for shipping the product in breakbulk is based on the scale of production, as well as the nature of the product as outdoor structural timber is more weather resistant than timber that has been crafted into mouldings for indoor use. The use of breakbulk adds some complexity to the supply chain and results in the product being fumigated twice. This is one of the more complex supply chains, with five other organisations that directly handle the product and five companies that handle the information flows.

Figure 4.3 Purple current state map



The focal firm in this supply chain buys logs and processes them into sawn kiln dried timber for domestic and international sale, as well as a range of other treated timber products. Once the products are ready for sale they are stored on site until they are required by a customer. Once sold they are then trucked to the port and passed on to a port operator. This on site storage creates the need for the additional fumigation, as products that are exported to Australia are required to have been fumigated within 90 days of export to Australia.

The port operator ensures that the products are appropriately stored while on the port and are in the right place for timely fumigation. The port operator is not always notified as to which shipments will require fumigation, therefore all untreated kiln dried timber is stored where it will be fumigated by the fumigator. All shipments of untreated kiln dried timber are fumigated with Methyl Bromide, to ensure compliance. The product is fumigated for 24 hours under tarpaulins on the port. The timber is then ready for loading into the hold of the ship.

For the second fumigation the shipping company organises for the hold of the ship to be Barricaded, this is another kind of fumigation, similar to the Pestigas used in containers to target the *arhopalus ferus*. The Barricade is applied to the relevant holds of the ship upon its departure from its last New Zealand stop usually Tauranga or Marsden Point.

The fumigation company does both the Methyl Bromide fumigation and the Barricade fumigation. These are completed once the request for fumigation has been received from the port operator or from the shipping company. Once the fumigation has occurred a fumigation certificate is provided to the focal firm. The Barricade in the holds of the ship can occasionally have delay on the fumigation certificate as the system used to generate it take longer than the focal firm would like.

The destination port and the customer are included in the map to give an indication of the path of the product, they were not included in the study as once the product has reached Australia and been cleared by customs there is no longer a phytosanitary component. The customer order is sent to the focal firm, this begins the process of preparing the product for export.

Once the ship has arrived in Australia the product needs to be cleared by customs before going to the customer. This means that all the paperwork needs to be in order and meet the Australian regulatory requirements. The focal firm reported that occasionally the product has been initially rejected. When this has occurred, it has been because the Australian clearing agents, or the Department of Agriculture (Australia) has classified the product incorrectly and therefore assessed it under a different set of phytosanitary requirements. This is not a frequent error and has been addressed by direct communication with the Australian party about the nature of the product and how to correctly apply the rules by the focal firm, via MPI or the IVA.

The focal firm obtains information regarding the importing countries phytosanitary requirements from MPI. The phytosanitary certificate is authorised by MPI and sent digitally to the focal firm for printing. The process of obtaining the phytosanitary certificate goes through the IVA. The IVA checks and processes the paperwork surrounding the phytosanitary certificate and passes it on to MPI. The IVA also audits and inspects the focal firm three to four times per year. These ensure that the processes used in the mill are up to standard to meet the necessary phytosanitary requirements.

Wastes in this supply chain include Inventory, Motion, Waiting and Over processing. The inventory waste and the over processing waste in this supply chain are compounding, the high levels of inventory result in the products not being exported within the 90 day time period to avoid methyl bromide fumigation. This otherwise unnecessary fumigation also contributes to the waste motion, as timber is moved around the port for its fumigation that would otherwise be unnecessary. The waiting waste surrounds the delay in the fumigation certificate being loaded into the fumigation company's system after the barricade has been applied in the last port of call, this is similar to the waiting waste faced in the Orange supply chain. The data collection participation is summarised in Table 4.3.

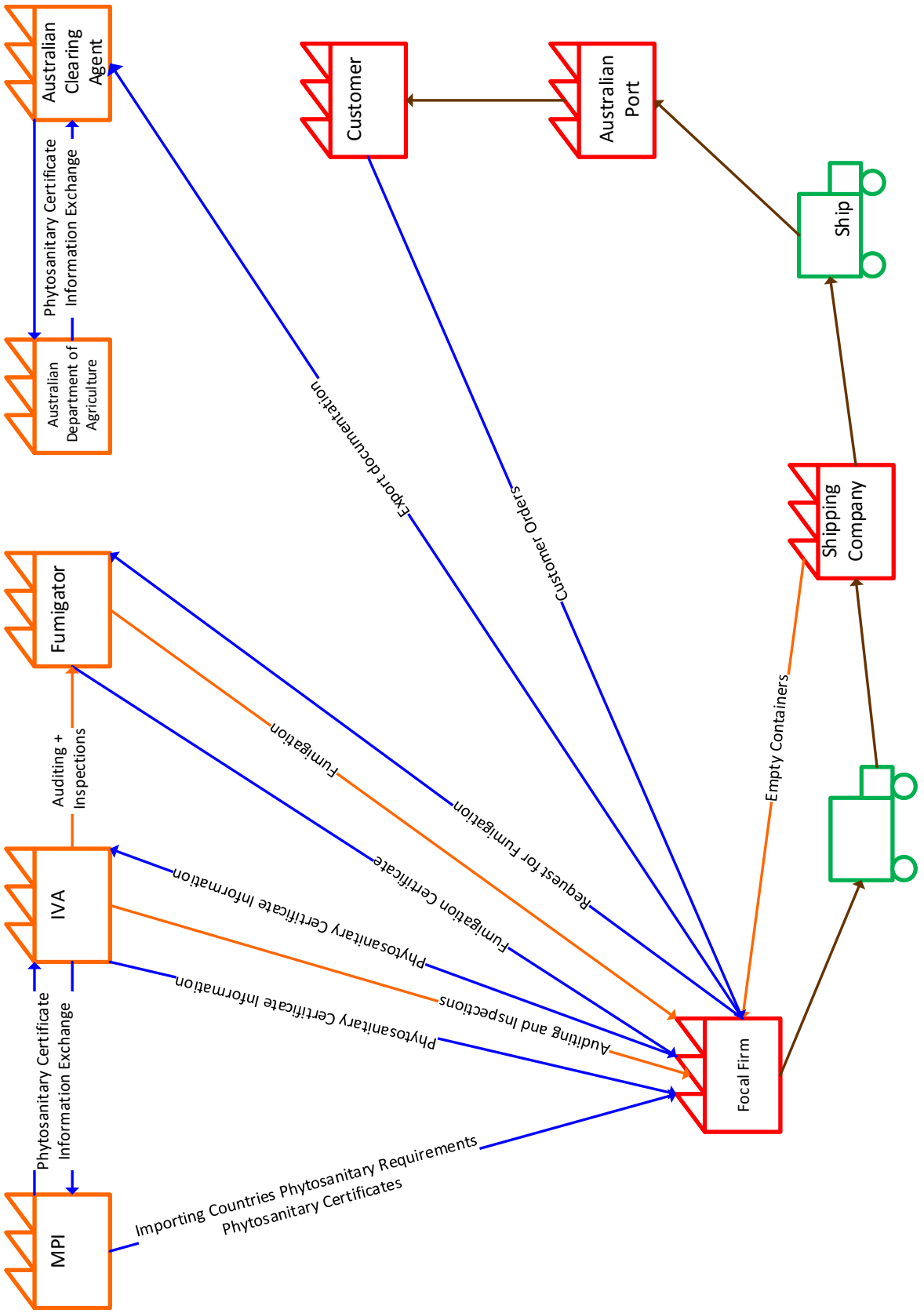
Table 4.3 Purple Supply Chain Data Collection Summary

Organisation	Interviewed	Key Respondent
Focal Firm	Yes	Customer Service Manager
IVA	No –unavailable during research period	
Fumigator	Yes –email	Service Manager
MPI	Yes	Plant and Forestry Manager
Port Operator	Yes	Operations Manager
Shipping Company	Yes	Cargo Management Officer
Destination port	Out of Scope	
Customer	Out of Scope	
Australian Clearing Agent	Out of Scope	
Australian Department of Agriculture	Out of Scope	

4.2.3 Pink current state map

This supply chain (see Figure 4.4) is for a company that is almost entirely vertically integrated. It is based in Southland and exports through Port Otago. The focal firm takes in logs and produces kiln dried timber, along with a wide range of other timber products. This company has a focus on reducing waste and uses 99% of each log in a variety of products. The company's vertical integration facilitates this goal. This is the simplest of the three Australian bound supply chains, this is because it exports in containers and the focal firm packs and arranges fumigation of the containers on site. There are four companies that handle the product and a further five that manage the information surrounding it.

Figure 4.4 Pink current state map



The focal firm receives empty containers from the shipping company. These are inspected prior to arrival, but are reinspected before they are loaded to ensure they meet the focal firm's standards. The method the focal firm uses to inspect the containers is by shutting someone inside a container who then checks for light. This method has proven to be effective as they pick up about 6% of the containers arriving from the shipping company, as slightly damaged. Damaged containers are sent back to the shipping company to be repaired, this occurs at the cost of the shipping company. The focal firm noted that containers that would be destined for Vietnam are slightly more likely to be damaged as the repair costs are much lower there. Once the containers are loaded a request for fumigation is sent to the fumigator.

The fumigator in this supply chain goes to the site of the focal firm to apply Pestigas to the containers before they are sealed and sent to the port by rail. This fumigation visit is carefully timed to ensure the Australian timeframes for recent fumigation are be met. These containers are transported to the shipping company, via rail, where they are loaded onto the ships. In some situations, if timing is tight to meet a ship schedule, alternative arrangements are made; containers may be trucked to the port, or packed at the port.

The key waste identified in this supply chain is the defects in the containers, the damaged containers that are sent by the shipping company can be categorised under the seven wastes of lean as defects. This waste could be reduced through more stringent inspections of the shipping company on the containers. Table 4.4 summarises the data collection participation for this supply chain.

Table 4.4 Pink Supply Chain Data Collection Summary

Organisation	Interviewed	Key Respondent
Focal Firm	Yes	Sales and Marketing Manager
IVA	Yes	Senior Assessor
Fumigator	No	
MPI	Yes	Plant and Forestry Manager
Shipping Company	No	
Destination port	Out of Scope	
Customer	Out of Scope	
Australian Clearing Agent	Out of Scope	
Australian Department of Agriculture	Out of Scope	

4.3 Asia Bound Maps

The following three current state maps (Figures 4.5, 4.6 and 4.7) are for supply chains that export kiln dried timber from New Zealand to countries in Asia, specifically China and the Philippines. These three focal firms all export to multiple destinations, both in Asia and elsewhere in the world.

Timber imported from New Zealand by most countries in Asia, including all the examined supply chains, requires phytosanitary certificates. This is obtained in a similar manner to the Australian examples. The ICPRs are obtained by the focal firm from MPI via their website. This information is then used to ensure that the product meets the specific standards required by the importing country. The information required to obtain a phytosanitary certificate is sent by the focal firm to the IVA for checking. Once everything is in order the IVA makes the application to MPI for the phytosanitary certificate. If everything is compliant MPI approves the certificate, issues a certificate number and the focal firm is then able to print it on the approved paper to accompany its product.

The IVA audits and inspects the focal firm so three to four times a year. This ensures that the processes are consistent and reliable under the ICPRs for the destination countries.

4.3.1 Red current state map

This supply chain (see Figure 4.5) is for the same focal firm as the pink supply chain (Figure 4.4). The notable difference in the Australia bound map and the Asia bound map is the Fumigator. Fumigation is not required for exports to Asia. The red current state map is how the Pink supply chain would look outside the *arhopalus ferus* flight season.

An order from a customer is received by the focal firm and initiates the export process. Once the order has been received and the product prepared, the product is containerised on site at the focal firm and begins its journey to the customer. The products produced by this supply chain includes finishing products made from solid or finger jointed timber. The containers follow the same inspection process discussed in section 4.1.3. The containers are taken by train to a shipping company at Port Otago and then shipped to the destination port in Asia. The containers are sealed on the focal firms site and there are no further physical flows that are specifically related to the phytosanitary requirements. The path on the map in Figure 4.5 is therefore simple.

Following all of the processes in this supply chain map will ensure that the products are approved to cross the border once they reach their country of destination. The customer in this supply chain manages that side of the process, so it was not included in this study.

The waste identified in this supply chain is the same defects waste identified in the Pink supply chain. Damaged containers arriving from the port results in their return and waste being created. Table 4.5 summarises the data collection participation for this supply chain.

Figure 4.5 Red current state map

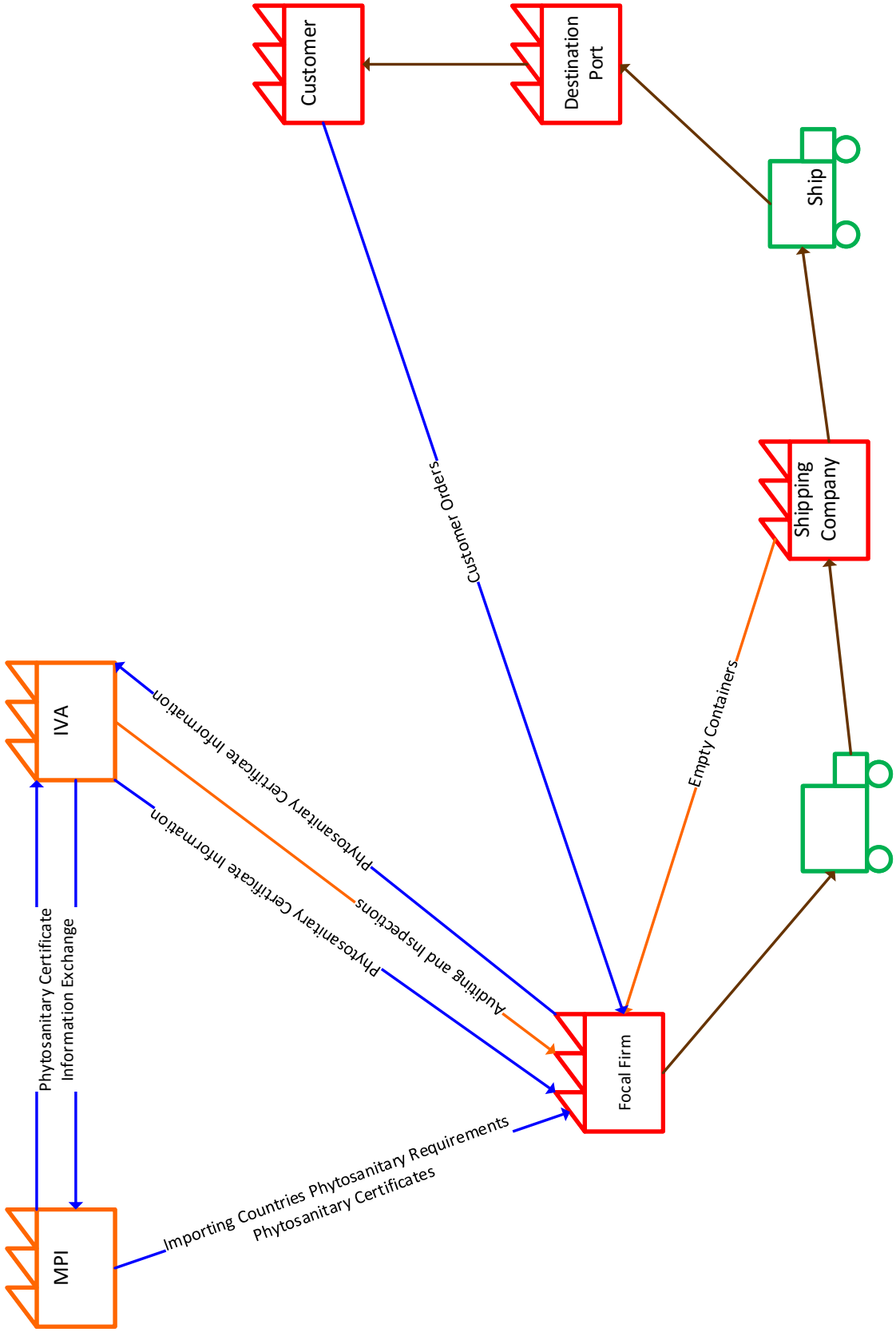


Table 4.5 Red Supply Chain Data Collection Summary

Organisation	Interviewed	Key Respondent
Focal Firm	Yes	Sales and Marketing Manager
IVA	Yes	Senior Assessor
MPI	Yes	Plant and Forestry Manager
Shipping Company	Not relevant for Phytosanitary	
Destination port	Out of Scope	
Customer	Out of Scope	

4.3.2 Yellow current state map

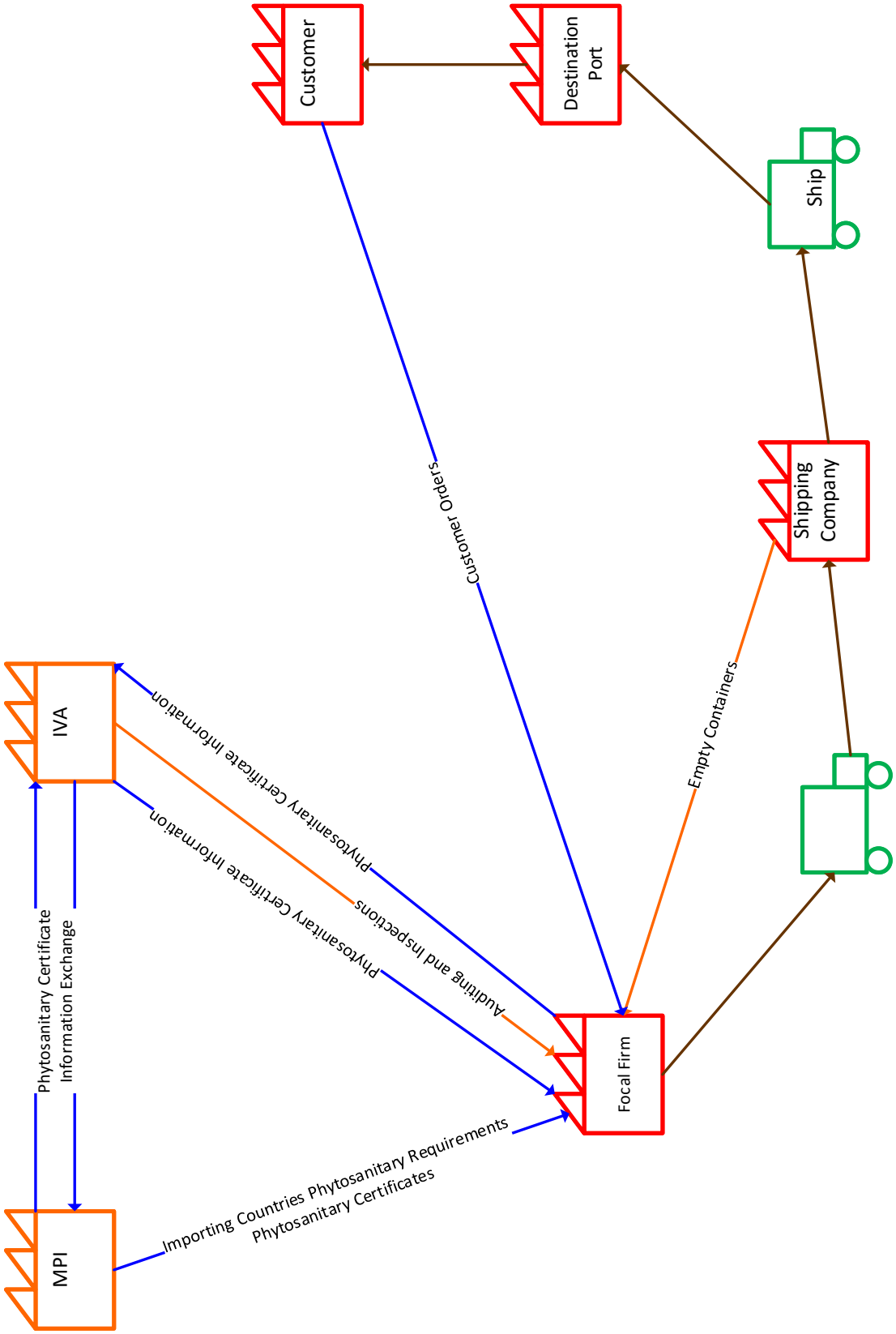
This supply chain is for a focal firm based in Canterbury. The Yellow current state map (Figure 4.6) appears to be identical to the Red current state map (Figure 4.5). This is because, although it involves different organisations there is the same basic structure for the involved processes. Neither of these focal firms had any issues or concerns with ensuring that their products were compliant to the Importing Countries Phytosanitary Requirements (ICPRs).

The focal firm in this supply chain buys logs and produces kiln dried timber and a range of other products, including packaging products such as pallets, wooden boxes and cable drums. These products fall under the ISPM15 classification as they are used to transport other products (as discussed in Section 3.2.1). The export process begins once an order from overseas has been placed by the Asia based customer.

Once the timber has been through the internal processes at the focal firm, including containerisation, it is despatched to Lyttelton Port to be loaded onto the ship. This is a much simpler process than for Australian bound timber as there is no fumigation required.

The process of obtaining the phytosanitary certificate is the same as that required for the Australian market, with the absence of fumigation. The focal firm partners with an IVA. In this instance the IVA inspects the firm and its processes three times a year and does one larger audit of all of the processes annually. The focal firm in this supply chain finds these inspections to be too frequent. However, the firm understands the serious consequences if there was to be a phytosanitary failure as they will have their approval to export either suspended or terminated. This is a strong incentive for the focal firms to get their processes right.

Figure 4.6 Yellow current state map



In order to obtain the phytosanitary certificate, the focal firm sends the necessary information to their IVA, this is checked and passed on to MPI. The certificate is then approved and the focal firm is able to print it and include it in their export documentation. These processes appear to be streamlined and no issues of concern were raised. The participation in data collection is summarised in Table 4.6.

The key waste identified in this current state map is the frequency of inspections to ensure compliance. This was identified by the CEO of the focal firm. This waste can be categorised as over processing under the seven wastes of lean. This current state map appears to be very efficient, other wastes could not be easily identified.

Table 4.6 Yellow Supply Chain Data Collection Summary

Organisation	Interviewed	Key Respondent
Focal Firm	Yes	CEO
IVA	Yes	Senior Assessor
MPI	Yes	Plant and Forestry Manager
Shipping Company	Not relevant for Phytosanitary	
Destination port	Out of Scope	
Customer	Out of Scope	

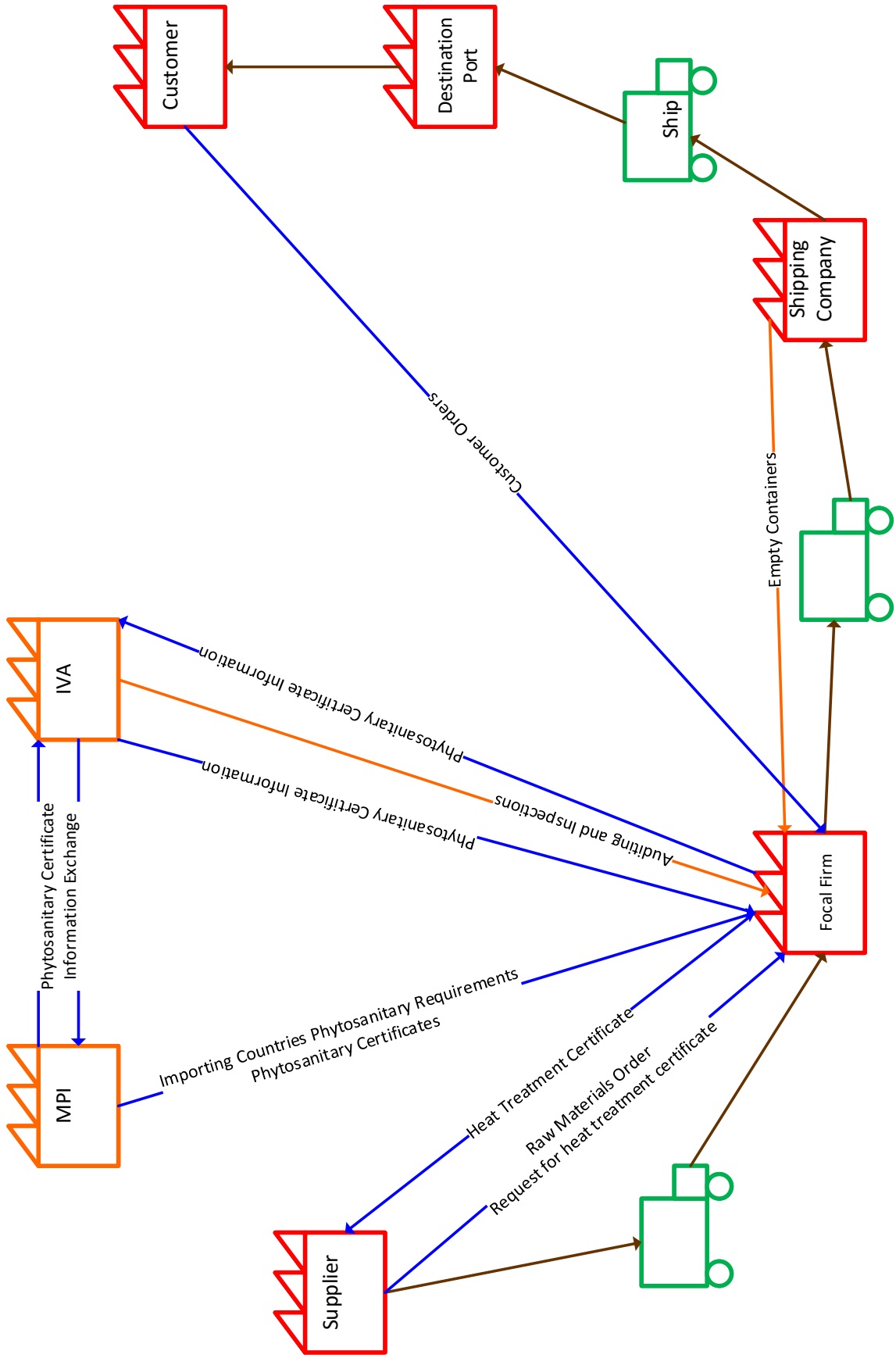
4.3.3 Green current state map

This supply chain is for a small saw mill based in the Tasman region that exports to Asia, including the Philippines and others, through Port Nelson. See Figure 4.7 for the current state map.

The focal firm in this supply chain buys sawn timber from a supplier, similarly to the orange supply chain. It then processes the timber further into a variety of products, such as finger jointed timber and mouldings. This focal firm-supplier relationship is important to ensure constant supply, quality and value. This firm obtains its timber from a variety of sources and kiln dries most of the timber themselves, giving them greater control of this part of the process. Occasionally they use a supplier that provides wood that is already kiln dried, which is usually because of limited availability of undried timber.

Once the timber is ready for export, it is containerised on site at the focal firm. It is then collected by a transport company and taken to the shipping company on the port, in this case at Port Nelson. The containers are loaded onto the ships and taken to the country of destination and then to the customer. The containers are sealed on the site of the focal firm so this path was not followed as part of the research as it is not pertinent to the phytosanitary compliance.

Figure 4.7 Green current state map



Similarly, to the other supply chains, products in this supply chain require a phytosanitary certificate. This is obtained through the IVA and MPI, in the same manner as the other two supply chains going to Asia. Data collection participation for this supply chain is summarised in Table 4.7.

Wastes in this supply chain include the inconsistent availability of undried sawn timber, which results in the underutilisation of the focal firm's kilns, as if raw timber is unavailable the alternative is timber that had already been dried. This part of how the industry is set up and results in waste. This waste can be categorised as over processing, as the focal firm has the capacity and skill set to complete this task internally.

Table 4.7 Green Supply Chain Data Collection Summary

Organisation	Spoken with	Key Respondent
Focal Firm	Yes	Purchasing and Outsourcing manager
Supplier	No	
IVA	Yes	Senior Assessor
MPI	Yes	Plant and Forestry Manager
Shipping Company	Not relevant for Phytosanitary	
Destination port	Out of Scope	
Customer	Out of Scope	

4.4 Cross Map Analysis - Similarities and Differences

The key difference observed from these maps is the variety in the levels of complexity in the supply chains. This is often because of the differing levels of outsourcing of activities by focal firms. The less done internally in the focal firm, the more other organisations that are required to be involved. This is most notable in the Orange supply chain. The off-site fumigation adds to the complexity, but also potentially decreases the costs in this situation, as the focal firm is able to take advantage of the economies of scale the supply chain partner organisation is able to produce. The geographic distance of the Orange focal firm to the port is potentially a contributor to the reason why the fumigation occurs offsite. There is a trade-off in transaction costs between different organisations and the advantages of economies of scale by consolidating specialist services. Clearly the different maps show different degrees of consolidation, this is seen in the number of organisations involved in each supply chain, the more processes completed by the focal firm, the fewer additional organisations are required.

Another difference that can be seen in the complexity is whether the focal firm has a supplier. This difference indicates if the focal firm sources logs for production or lumber from a different sawmill, the Orange and Green supply chains both outsource the cutting of logs. Those who do use a supplier, such as the Green and Orange supply chains, create a more specialised, detailed product

such as mouldings or finger jointed timber. These sawmills also tend to be smaller and have more specialised operations than the log processors. In the case of the Green focal firm, they still have the ability to kiln dry their own timber, while the Orange focal firm does not. Outsourcing these operations allows for the focal firms to operate on smaller sites and in more urban locations.

All exporters to Asia and Australia need phytosanitary approval for every load of exported kiln dried timber. The storage, visual inspection and documentation required is accepted as mandatory and causes little concern among supply chain partners. All six supply chains expressed a high level of confidence in the phytosanitary compliance processes. No respondents expressed concerns or indicated that they were thinking of changing or improving their approaches. This contributed to why this research decided to focus on phytosanitary compliance for timber, it is a very stable system which allows for the new method of supply chain VSM to be tested.

The rules that apply to products exported to Australia and Asia have some similarities and some differences. Most notably, fumigation during the summer months for Australia. All countries included in this study require a phytosanitary certificate, and that the product and shipment packaging is free from soil, insects, fungi and other harmful organisms.

MPI has a nationwide system for issuing phytosanitary certificates, using IVAs as inspection agents. All six supply chains used this system, as not using this national system would result in a failure to obtain a phytosanitary certificate. Respondents reported that the system works well and indicated the approach to be unique to New Zealand and that international competitors do not seem to have the same system efficiencies in obtaining certificates. Across all of the participating organisations, and some who did not participate, there was a general consensus that the existing system is functional and only poses a minor inconvenience, but as it cannot be eliminated completely, this inconvenience was regarded as manageable. Still it contained a number of wastes.

Table 4.8 Similarities and Differences between current state maps

Similarities	Differences
All supply chains follow the same process to obtain a phytosanitary certificate.	Outsourcing of kiln drying and log milling
High level of understanding about the phytosanitary requirements for product destinations	Additional transport stops on route to ship loading (Off site fumigation)
Most of these supply chains export containerised product	Fumigation depending on destination of the product and season
Focal firms were satisfied with their phytosanitary compliance processes	Varying number of external organisations involved in each supply chain
Positive history of phytosanitary compliance	

4.5 Wastes and Inefficiencies Identified in Current State Maps

Each of these current state maps identified at least one form of waste in each system. Some of these were self reported by those directly involved in the processes, others were observed during the data collection. These wastes are identified in terms of the seven wastes of Lean (only six of the wastes were identified) in Table 4.9. The seventh waste, over production, was not identified in this research, as data surrounding this as it is very specific to the focal firm and the internal processes were deemed out of scope.

Table 4.9 Identified lean wastes in each supply chain

	Orange	Purple	Pink	Red	Yellow	Green
Over processing	×	✓	×	×	✓	✓
Waiting	✓	✓	×	×	×	×
Transport	✓	×	×	×	×	×
Inventory	×	✓	×	×	×	×
Motion	×	✓	×	×	×	×
Defects	×	×	✓	✓	×	×

There are a more wastes identified in the Purple and Orange supply chains than in any of the others. This is potentially due to the increased levels of complexity in these two supply chains.

Ten instances of wastes have been identified, seven of these in the Australian bound supply chains and three in the Asian bound supply chains (see Table 4.10). The added complexity in the processes required to meet Australia's ICPRs is likely the cause of this.

Table 4.10 Waste Identification Count

	Australian bound	Asian bound	Total
Number of instances of waste identified	7	3	10

The most common waste found is over processing with three instances, in the Purple, Yellow and Green, followed by waiting with two instances, in the Purple and Orange, defects occurs in both the Pink and Red supply chains, transport and inventory appear once each in the orange and Purple supply chains respectively.

Over processing may be occurring most frequently due to the compliance nature of the focus topic, in the case of phytosanitary and exports it may be better to over process something than to risk the product failing to reach the market without extensive additional costs imposed by additional fumigation on arrival. There is also a risk that failing to meet the ICPRs could cause damage to New Zealand's reputation surrounding the ability the meet ICPRs. A failure to meet the ICPRs will also

result in consequences to the focal firm with regards to its status as an MAO. This status may be suspended for a period of time or revoked entirely depending on the severity of the failure.

The waiting waste has been reoccurring with regards to the fumigation paperwork system. This may be occurring because of a distance between the fumigation company and the export paperwork. The fumigation company is a service provider so may not see the importance of the timely delivery of the fumigation certificates as clearly as the focal firms. This waste was identified to the researcher by one of the focal firms.

Chapter 5

Development of Future State Map

5.1 Introduction

Creating a future state map is an important part of any VSM process, be it traditional or this new supply chain version. Without a future state map, there is very little point in creating a current state map. The purpose of the future state map is to take the information that was created in the current state map, or in this case maps, and turn it into a visual representation of the ideal state for the collection of processes. This includes any changes that should be made to create the perfect collection of processes to meet the desired outcome of the initial system. The future state map can be referred back to as processes are updated, and used as a guide for future improvements.

All participants in the project had the opportunity to provide feedback on the map that was prepared for their particular supply chain. This occurred as a follow up to the hand drawn anonymous maps created in Step 7 of the methodology (see section 3.2).

The future state map was developed after consultation with multiple organisation in the industry by way of a focus group. The single future state map also took input from the comparison of the six current state maps and consideration of the data that was collected in order to create them. This allowed for the 'best practices' from each of the participating supply chains to be included in this future state map. This chapter discusses the format and outcomes of the focus group and then proposes the single future state map.

5.2 The Focus Group

A Focus Group was held to obtain feedback and facilitate discussion amongst those participating organisations surrounding the current state maps. Ideas were sought to aid in the creation of a future state map. The future state map incorporates the ideas from the focus group to identify any approaches to potentially improve the processes that were mapped to meet phytosanitary requirements. The aim was to find a way to increase efficiency and reduce waste in the transactions between organisations and to encourage industry to assess the maps and discuss emerging issues. It was also an opportunity for those who had participated in the project to understand the wider perspective and see how their businesses might vary.

This focus group was held in an online format since the geographic locations of the various participants was widespread. Representatives from all five of the visited companies, as well as the Ministry for Primary Industries (MPI), the two Independent Verification Authorities (IVAs), a

fumigation company and a port operating company were invited. A total of ten organisations were invited, along with the thesis supervisors. Responses were received from all invitees except the port operating company. Two of the focal firms were unable to attend due to prior commitments. A total of twelve participants joined the discussion, including eight different industry organisations.

The online format was a Zoom video conference, this allowed everyone who had video links to be seen by all participants and for the sharing of slides during the two short presentations in the focus group. There were slides available with the current state maps which helped to facilitate discussion. There were a few participants who were able to join the meeting through audio only.

Every organisation received a digital copy of the map of their particular supply chain. Those organisations who participated in the focus group were also given access to the anonymised maps of all the other supply chains.

The focus group was semiformal. Each participant was sent an information pack prior to attending. This contained an outline schedule, details on connecting to the online format, a table consisting of the seven wastes of lean, notes on how to read the current state maps and all six of the current state maps.

The meeting began with introductions for all attendees, and a brief introduction to the project for those who were not already familiar with it. There were two brief presentations, the first from Dr Jeff Heyl on Normalising Deviation (Vaughan, 1996) and the second a brief overview of the seven wastes of Lean (Ohno, 1988) from the researcher. These brief presentations were intended to assist the participants in understanding the topic at hand, and to focus on the bigger picture rather than just being tied up in their own small parts.

5.2.1 Focus Group questions

Three questions were posed to the focus group participants. There were varying levels of participation from those who attended.

Question One: Do any of the Seven wastes of lean seem obvious to you from these maps?

This question was used to break the ice in the room, after going over the wastes of Lean and explaining how they could be applied, input from the participants was requested. There was minimal input. None of the participants could easily identify any of the wastes without further prompting. This is potentially due to a lack of familiarity with the seven wastes of Lean, as well as a lack of familiarity with the collection of processes across all involved organisations. It may have been challenging to connect the abstract wastes with the familiar or unfamiliar processes in the short time frame available.

After a brief discussion, the two key wastes that were identified were waiting and over processing. The waiting applied to communication following fumigation where documentation needed to flow through several parties before completion. Over processing was raised with regards to the double fumigation in the purple supply chain map, which was the only firm using breakbulk rather than container shipping. Participants noted that this was likely due to the costs of the alternative.

Question two: Is there anywhere that you can think of where we have collectively accepted deviations?

This question encouraged the participants to think back to the short presentation made by Dr Heyl and it proved more engaging than the first question. There was some discussion around the levels of communication about the fumigation process, specifically at the port. While standards were consistently being met, they are not necessarily being met in a way that would allow for the process to run as smoothly as possible. This has not been causing a failure in the phytosanitary compliance in any way, but does cause a small amount of difficulty in the process that could otherwise be avoided with better communication between the fumigator and focal firm.

This question reiterated the previously mentioned slow response time for the certificate of fumigation being provided to the necessary focal firms when exporting to Australia. This could be reduced if the process is digitised and streamlined or the existing system is updated. There were not obvious difficulties when it came to dealing with exports to Asia, or when fumigation was not required.

Question Three: Is there anything else you think we could identify as being an area with room to improve? How do we address these issues, even if we have to break the "rules"?

This question was used to allow the participants to think outside the box. The idea was to come up with ideas that would improve the efficiency while still enabling New Zealand to be world class in meeting phytosanitary requirements. This might be achieved by changing something more drastic than the obvious changes. For example, a member of the industry, prior to the focus group, suggested that perhaps eradicating the *arhopalus* beetle from New Zealand would make life easier as it would remove the need for products going to Australia to be fumigated with Pestigas or Barricade during the flight season, as there would be no flight season. This would not be detrimental to the New Zealand ecosystem, as the beetle has been introduced to New Zealand.

However, during the focus group few ideas came from the industry participants. The ideas tended to focus more around smaller opportunities, such as increasing the communication between organisations, particularly surrounding the fumigation, and speeding up the existing communication processes that occasionally causes delays for completing paperwork. Smaller opportunities are potentially easier to identify for those working closely in the industry. Drastic changes are hard to

imagine when the status quo is working well. This focus on small changes is important because it reflects the current success in the established system, this makes it a good system to examine through VSM.

There was some discussion during the focus group surrounding new exporters. They were viewed as more challenging than the established existing exporters. This was an issue for the support organisations in the supply chain, such as the fumigator, IVAs and MPI. This was specifically noted by an IVA as they are the ones who have to manage the new exporters and guide them through the process of obtaining phytosanitary certificates for their exports. This difficultly with new exporters is potentially due to an initial steep learning curve surrounding the rules of the processes. It will initially create more work for the IVAs as they coach new exporters through the processes, this coaching is not needed for established exporters, but would have been required when they were new.

5.2.2 Focus Group discussion

There were a number of challenges associated with running a mixed focus group, overall the attendance was very good but there were a few challenges with encouraging full participation in the discussion. A number of factors may have contributed to this.

I. There were some challenges in getting everyone to connect to the video conference link with a video and audio connection, everyone was able to connect via audio, however there were a few participants who were not able to connect via video and had voice only. This made incorporating them into the discussion more difficult than it otherwise would have been. It was challenging to know who was in the room and who wanted to talk. The three participants who had no video link included MPI and two focal firms. Their full participation would have been valuable to this discussion.

II. Participants may not have actively engaged with the material provided before attending the focus group. One participant suggested that providing the actual questions in advance would have been useful.

III. There were a range of positions held by people within each organisation represented in the focus group. This may have added to the hesitance to participate on behalf of some of the attendees, as well as some reticence from competing companies. The regulator, MPI, was also part of the focus group, their presence may have hindered open conversation about certain issues and organisations would not wish to criticise parts of the processes, as there was no anonymity in the focus group.

IV. As discussed elsewhere (see Section 3.6), industry does not view phytosanitary compliance as a problem and they are confident about their current processes and costs, so the subject matter is not something of burning interest or potential.

The general discussion among the active participants was valuable in highlighting what was important to those organisations. It was this feedback that helped to shape the future state map discussed in the next section. The discussion enabled different organisations to discuss the processes examined in this research. These are organisations that do not necessarily have direct communication with one another at other times.

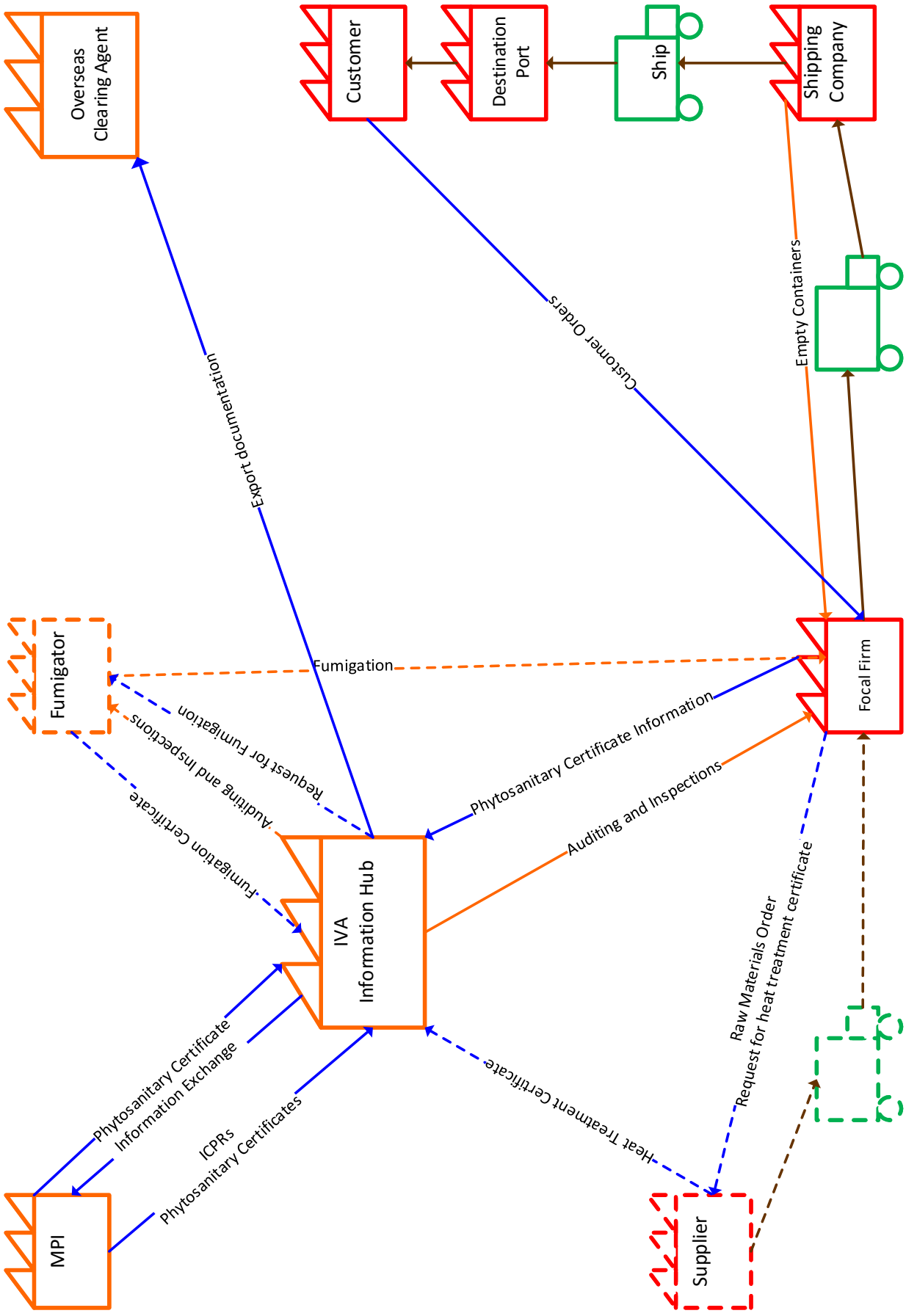
5.3 The Future State Map

The collective future state map (see Figure 5.1) was created based on the feedback received from the focus group, as well as from the information collected from the site visits. As noted previously, most organisations were confident about their phytosanitary processes and this inevitably limits the possible scope of suggestions for change. The satisfaction levels with the current system leaves little room for small improvements, instead the result is an outsiders perspective on overhauling the supply chain structure.

A single future state map was created, as opposed to individual future state maps for each supply chain, because it allowed for the opportunity to combine the best practices from each of the six current state maps to be incorporated to create a single ideal state. Creating six individual future state maps would have been an option, however it was decided that a single future state would be in keeping with the use of a national system, similar to the IVA – MPI system for obtaining phytosanitary certificates. Using a national set of 'best practice' will also help with the issues discussed in the focus group of the difficulties that new exporters find with meeting ICPRs.

The area with the biggest opportunity for improvement was the level of communications between organisations within the supply chain, represented by the blue information flows. There seemed to be both double handling of information and insufficient communication in some areas of the chain, such as the fumigation certificates being passed from the fumigator to the focal firm then onto the IVA (in the Purple, Orange and Pink supply chains). This delay, relates to waiting as one of the seven lean wastes. There also seemed to be a lack of communication in the Purple supply chain surrounding the use of Barricade in the ship's hold. During the data collection, no one at the shipping company could say who sent the request for fumigation to the fumigator, it seemed to just happen. This lack of communication can result in one of the seven wastes, over processing, as it means that some timber may get fumigated that may not have needed to. The same waste applies to the methyl bromide fumigation.

Figure 5.1 Future State Map



The double handling of information about fumigation and other phytosanitary compliance measures could be improved by creating an "information hub" that could be managed by the IVAs. This would be best achieved by having an online portal, which each organisation can access for information about each relevant shipment. This would reduce the need for active management of information flows and may even ease the audit events. In the VSM it may appear that this creates a higher level of complexity but it simplifies the MPI-IVA-focal firm communication channels, as well as incorporating the fumigation company into this loop. This improvement is easily achievable and future research is warranted to work out its feasibility.

Another improvement might be outsourcing certain aspects of the supply chain (for example the cutting of logs and kiln drying of timber as seen in the Green and Orange supply chains). While this adds complexity on the future state map, it could reduce the complexity of the operations of a single organisation by allowing them to focus their resources on what they are best at. Levels of outsourcing were influenced by history, location, skills and values. The Red and Pink focal firm, for example wanted to avoid waste and kept processes in-house to maintain total control. In the future state map the option for a supplier, as seen in the Orange and Green maps, can be included for those who prefer to outsource the sawmilling and kiln drying of timber. This however does not need to be included for the more vertically integrated supply chains. As seen in Figure 5.1, the supplier is an optional addition indicated by the dashed lines.

The fumigator is a necessary part of being able to export to Australia for roughly six months of the year. However, it is not a requirement for the other six months of the year, or for exports to Asia. This map is designed for supply chains that are exporting to Asia and/or Australia, so the fumigator is included in an optional format, depicted by the dashed lines, the same as the supplier. The fumigation is a source of waste, the resources need to be available to apply Pestigas or Barricade for six months of the year, but are unused in these supply chains, for the other six months. It was not discovered what the fumigation company does during the winter season, but there is a chance the resources are used in a different industry during that time.

This future state map represents some options for improvement. The approach used to prepare a map that shows the whole supply chain raised some issues about the level of detail that could be captured. There may be minor adjustments in processes, these could improve efficiency, which could not be captured on this broad mapping process. The mapping process used, coupled with the industry confidence in the status quo, limits the potential usefulness of a future state map for phytosanitary compliance. While the current state maps were valuable research tools, both the methodology and the outcome of the future state map appears to be more limited in this novice application.

5.4 Future State Implementation

Implementing the future state map created in this research is out of scope for this research. Implementation may require legislative changes as well as overhauling a national system and the practices of multiple large businesses and their practices. This future state map is provided as an idea of what the ideal could be, further research and considerable industry discussion would be required to understand the feasibility and finer details of the proposal.

5.5 Discussion on this Application of Supply Chain Value Stream Mapping

The approach that this research used was unique and involved an adaptation of the existing methodology of VSM to include the whole supply chain rather than a single organisation. This resulted in a higher level depiction of aggregated processes. Participants in the study appreciated the opportunity provided by the completed maps to see the bigger picture of their supply chain and to provide feedback if the map differed from their experience. The maps proved useful discussion tools and have enabled a cross industry examination of similarities and differences in phytosanitary processes.

However, the broadening of the value stream mapping to the whole supply chain also had challenges. Every process on the supply chain maps could be unpacked into much greater levels of detail, this could be achieved through the application of SCOR. This complexity was not examined in the context of mapping the whole chain. An example of greater detail is in the Purple map where fumigation occurred twice, a more detailed approach would have enabled discussion of the reasons, solutions and options for streamlining this.

The SCOR model that could be applied has multiple levels (see Figure 2.2). This was not applied in this research, as the intention was to take VSM from an operational tool to a strategic tool, which could not have been achieved by using an alternate model. For the purposes of this study the research has focused on the comparable processes to the top level of the SCOR model.

A more detailed examination of issues might have identified further improvements but this would depend on the purpose of the mapping. There will be other industry processes that might be suitable for this approach. However, phytosanitary compliance is a supply chain wide process, this makes phytosanitary compliance less suitable for single firm research and a key component of its selection as an area to test VSM as a supply chain wide tool.

The phytosanitary compliance systems that were assessed in this system are all inherently Lean to begin with, regardless of whether or not Lean systems have actively been implemented by the organisations involved. This is because of the nature of the phytosanitary compliance: it is

mandatory and it adds costs. This means that all those involved like to complete it in the quickest and easiest way possible. There is little scope for variation or quality, its binary it either complies or it doesn't.

All, bar one, of seven wastes of lean were able to be identified in one or more of the current state maps in this application of VSM. These wastes were all in small aspects of the supply chain rather than being very obvious, but this is not untypical. This may not be the case across all aspects of the supply chain, but for the phytosanitary aspects, it was fairly uniformly lean. The two main identified areas of waste, such as over processing during fumigation, and the waiting times for the fumigation certificate.

The application of this adapted version of VSM to these six supply chains did not highlight any minor changes that could be implemented in a future state map to increase the efficiencies in the system, instead the creation of the future state map opted for a coordinated system overhaul. This new system would require the coordinated efforts of those organisations involved to establish and maintain the new system. This new system included the centralised information hub, which would be the primary need for a coordinated effort to establish.

This research was successful in creating an understanding of how this particular supply chain works, and presenting it in a manner that is understandable to an outsider to the industry, this will allow further research to be done. The research was also successful and points out the strengths and weaknesses of VSM in this extended context. These strengths and weaknesses are summarised in Table 5.1.

Table 5.1 Strengths and Weaknesses of Extended VSM

Strengths of Extended VSM	Weaknesses of Extended VSM
Creates a clear depiction of supply chain wide processes	Not implemented
Input from multiple organisations	Low level of detail captured
Anonymity of maps	Inability to include costs
Triangulation of data from wider sources	Difficulty to coordinate a nationwide focus group
Supply chain wide view of processes	Lacked detailed time based analysis
Strategic tool	

The processes followed in this research created a current state map of the general processes and interactions between organisations that are required to export products that meet the ICPRs of either Asia or Australia. The method was suitable to create a general level of understanding for how

the system fits together. However, if a different outcome was required then a different method would need to be applied.

Chapter 6

Conclusions

6.1 Recommendations for Industry

All of the organisations that participated in this study appear to meet the necessary requirements for phytosanitary compliance well and with minimal difficulty. The confidence of participants with the status quo in their phytosanitary processes has been reflected in the difficulty to find participants for this study, their restrained contributions to the focus group and the limited number of relatively minor improvements that were identified in both the mapping process and the discussion.

The future state map has assisted in identifying areas that could be future proofed to ensure that New Zealand remains at the forefront of phytosanitary compliance processes. This is especially important to support the reciprocity arrangement that contributes to protecting New Zealand's biosecurity.

Actively incorporating some Lean production principles into the phytosanitary compliance processes can help to keep costs down and effectiveness high. For example, increased levels of communication between supply chain partners might lead to a more cohesive supply chain strategy and this could be beneficial for all those involved. This is why the future state map turns the IVA into a central hub of information flows. This hub could be held by other organisations within the supply chain but given that the IVAs are the MPI and phytosanitary certificate 'gatekeeper' it works well to have them be the information hub. Some further industry discussion would be necessary to implement this idea. The hub would be supported by increasing use of digital communications with real time information flows.

6.2 Recommendations for Future Research

It is hoped that this research will stimulate further investigations in this area of applying VSM to supply chains. There are several recommendations for future research in relation to this research, some regarding phytosanitary compliance research and some involving further research into extended VSM.

Future research comparing how New Zealand fares relative to similar supply chains in other countries in terms of phytosanitary compliance processes would be a very interesting study, this idea was suggested by a participant in this study. A different method would likely need to be used, but overall those involved in the industry in New Zealand believe that they operate within a world class system that is highly efficient.

Under current conditions there does not seem to be a strong case for further research into phytosanitary compliance processes for kiln dried timber exports. This study shows that across a range of enterprises, sizes, types and locations, the focal organisations had confidence in their current phytosanitary processes. Feedback from regulatory bodies and overseas customers support that current practice meets the standard required. Minor efficiency adjustments were identified. If the global environment or regulations changed there may be a case for further research.

Future research into extended VSM could include developing the methodology used in this research further as there is potential for VSM to be applied to a supply chain in detail in a more traditional approach. This would be particularly beneficial if completed in a supply chain with multiple organisations on board with the concept of mapping it. A potential catalyst for this could be starting at the customer and having them send the researcher "up stream" one organisation at a time. Organisations may be more inclined to participate if it was coming from the customer and addressed an area of current concern. The extended VSM approach could be applied in other industries.

If this research was to be repeated it would be beneficial to establish early on the level of detail that was required in the maps in order to meet the necessary objective. The greater the level of detail incorporated the easier it will be to create solid conclusions of areas with room for improvement, particularly achievable targets. When only general information is included in the research, then only general changes can be recommended. These are often significantly more drastic than may be otherwise required to achieve improvement.

The time constraints and the exploratory nature of this research prevent the researcher from knowing exactly what needed to be asked before going to each of the organisations involved. This presented a particular challenge in the consistency of the information that was collected. A clearer goal for the output of the project, and a clearer process for how things would be collected would have resulted in a smoother research process, but potentially fewer learning opportunities.

A key limitation to this research was not incorporating the costs involved, this data would not have been possible to gather in this instance, but it would be highly beneficial to future research. During the focus group, there was some broad discussions about how the costs impact on how things are done. Delving further into this with detail might result in further efficiencies that could be obtained. It would potentially also explain a lot of the apparent inefficiencies, for example the Orange current state map appears to be the most complex but a lot of this complexity is due to cost saving measures created by outsourcing. However, it is unlikely that supply chain partners are ever going to willingly discuss the costs involved, particularly with those not directly involved in the transaction.

6.3 Research Limitations

This research has had both strengths and weaknesses in the approach and outcome. Some of these limitations include; the exclusion of costs from the data collection, taking a high level view of processes and using a digital format for the focus group.

The costs being excluded from the data collection was inevitable, the organisations included in the study have transaction costs between them and being completely open with what is charged to the other organisations could have resulted in a difficult situation, particularly for the service providers. Removing the costs may have limited this research slightly in the justification for why in some cases the complexity from outsourcing may have been the best option. However, not including this data potentially encouraged participation in the study and enabled a greater number of organisation's input to be included than could have been if they had been protecting themselves from an invasive cost based survey.

Taking a high level view of the supply chain is a limitation as it removes some of the intricate detail from the processes involved at every organisation. Treating each organisation as a single step in a higher level supply chain VSM however provides a bigger picture view of the overall system. The absence of the intricate detail may result in some non-value adding processes to going unnoticed.

The digital nature of the focus group could have been avoided at high cost and time input from those involved, however asking for this seemed to be excessive and unnecessary for the purposes of this research. The limitations created by the inability to physically bring everyone in the focus group into one location were noted, however they were deemed to be manageable. Results from the focus group were still able to be used and there was still an open discussion between some of the participants.

There were a number of strengths of this research. These include adapting VSM from a purely operational tool to a strategic tool, creating a high level view of supply chain wide processes, analysis of the inter-organisational links and relationships, the anonymity of the maps, and the ability to triangulate the data by collection it from multiple sources.

6.4 Research Summary

This project provided an opportunity to use a VSM approach adapted to a supply chain environment. The resulting process maps proved useful to participants in reflecting on a bigger picture of their processes and were a useful tool for industry discussions identifying waste and scope for efficiency. The approach created a set of maps that demonstrate that phytosanitary compliance of export of kiln

dried timber across large and small, Northern and Southern New Zealand follows remarkably similar processes and that these could be strengthened with improved communications. The tool could be further developed to apply to supply chain issues in other industries.

This research created a novel contribution by extending a well established Lean tool, VSM, from a single organisation operational tool to a strategic tool. This extended version of VSM, supply chain VSM, creates a high level depiction of the processes and organisations involved in a supply chain and presents them in a manner that can be used as a strategic tool. In the case of phytosanitary compliance, the outputs of this research can be used as a guide to help future proof the New Zealand phytosanitary compliance system and allow for the country to remain world class in this area.

This research aimed to adapt and apply VSM to a supply chain view, in the case of phytosanitary compliance for timber. This was achieved through the development of six current state maps and a single future state map to represent the ideal for the industry. This research contributed to the existing knowledge on Lean and VSM, taking VSM one step further into the realm of supply chain management.

Appendix A

Letter of Introduction

Dear [Contacts Name]

As discussed on the phone here is a summary of my research and what is involved in participating.

This research is applying the lean production tool of value stream mapping to the supply chain for sawn timber exports. The focus is on the physical and communication processes required for NZ's top three export destinations for sawn timber (USA, China and Australia). Value stream mapping involves creating a map of the information and physical flows, in this case relating to phytosanitary compliance between companies in a supply chain as well as internally in the focal company.

Collecting this data requires conversations with those who are familiar with the information flows and working with them to draw a map of them. It also requires observations of the physical flows of the product, this is best achieved through a tour of the site, walking "up stream" from finished product back to raw materials. Seeing the paper work involved is very helpful and knowing the path it takes along the supply chain is essential. This research will not ask about prices or costs. This data can usually be collected in a single site visit of around an hour depending on the complexity of the system.

Once the data has been collected from all parties in the supply chains and the value stream maps have been created, they will be analysed in a focus group to see if any areas of waste can be identified at a supply chain level. This will involve an examination of the number of actors and flows within each map, and any patterns that appear across the multiple supply chains that are being mapped as part of this research. In return for your participation a copy of the map for the supply chain/chains that your organisation is involved with will be provided. This may enable organisations to identify areas of opportunity for improvement in your own supply chains.

We would like to extend an invitation to participating organisations to attend the focus group on the 11th of April 2017 at Scion in Rotorua, or via video conference.

[Company name]'s participation would be greatly appreciated. Participation is voluntary, and your involvement will not be identified beyond the focus group and your own supply chain, in the thesis pseudonyms will be used to ensure participation is anonymous. The supply chain maps provided to organisations will identify the firms within that chain.

Kind regards,
Elizabeth Anderson
[Researcher's contact number]

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